PICTURE PROJECTION

Perfected by Norelco

HERE'S THE OPPORTUNITY THAT MANUFACTURERS OF TELEVISION RECEIVERS HAVE BEEN AWAITING!

10 SIGNIFICANT FEATURES

1. Flat 16" x 12" non-reflecting picture provides fatigueless viewing from less than 5 feet and upward!
2. Wide-angle visibility—square corners.
3. True photographic black and white picture quality—no discoloration.
4. Compact unit—suitable for table model cabinets.
5. Long-life, low-cost picture tube.
6. Manufacturers can most economically extend their product range into projection television by adapting their 10" EM chassis for use with PROTELGRAM.
7. Easy to service.
8. High contrast ratio and broad gray tone range.
9. Simple optical adjustment system.
10. Quality built after more than 10 years of development.

NORELCO PROTELGRAM consists of a projection tube, an optical box with focus and deflection coils, and a 25 kv regulated high-voltage supply unit, making possible large-size home projection. More than ten years of exhaustive research resulted in this ideal system for reproducing a projected picture. The optical components are designed to produce perfected projection for a 16" x 12" image, the optimum picture size for steady, distant observation and also for proper viewing at less than 5 feet.

NORTH AMERICAN PHILIPS COMPANY, INC.
DEPT TE-10, 100 EAST 42ND STREET, NEW YORK 17, N. Y.

IN CANADA: PHILIPS INDUSTRIES LTD., 1200 PHILIPS SQUARE, MONTREAL. EXPORT REPRESENTATIVE: PHILIPS EXPORT CORPORATION, 100 EAST 42ND STREET, NEW YORK 17, N. Y.

Other Norelco products include standard 10" direct-viewing tubes and special-purpose cathode-ray tubes for many applications.

www.americanradiohistory.com
RADIO-CONTROLLED JET FIGHTER

Electronic equipment mounted in nose of F80 permits pilotless flights directed from truck in background and mother plane (see p 126)

TELEVISION TRANSCRIPTIONS, by Thomas T. Goldsmith, Jr. and Harry Milholland

Recording images on film, directly from a cathode-ray monitor

SERRASOID F-M MODULATOR, by J. R. Day

New phase-shift device with low distortion and noise for use in broadcasting

THE EDITORS REPORT ON ELECTRONICS PARK

The full story, with emphasis on the engineers, supervisors and workers on whom the future depends

PEAK-TO-PEAK VOLTOMETER, by F. H. Shepard, Jr. and Edmund Osterland

Narrow voltage pulses are measured by the pulsed pulses

SATURABLE REACTORS AND MAGNETIC AMPLIFIERS, by Frank G. Logan

Practical effect of materials on characteristics are discussed; illustrative applications show utility of these components

TELEVISION SYNCHRONIZING SIGNAL GENERATOR, by A. Baracket

Driving, blanking and sync signals to fit FCC and RMA specifications

SINGLE-SIDEBAND CRYSTAL FILTERS, by Paul K. Taylor

Multiple-section filters are used for the carrier frequency and the two sidebands

TELE SERVICE AREAS, by John H. Battison

Charts show approximate distances to 5,000 μv per m and 500 μv per m contours

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When Hastings Laboratories engineered a new, more precise type of anemometer some very real problems were encountered. One was to find an inside instrument that would accurately indicate the direction and velocity of the wind passing the anemometer located outside. Because of Marion's recognized reputation for manufacturing fool-proof, trouble-free meters and instruments, it was natural for Hastings to turn to Marion for this vital component.

Marion then designed, engineered and manufactured two matched meters for this purpose. Now, matched Marion meters and these matchless new Hastings anemometers are helping weather forecasters, air pilots and navigators measure the wind more accurately all over the world.

When you have a problem involving electrical measuring or indicating we will be glad to have you turn to us. We have helped others. And, because we know "Marion" means the "most" in meters, we believe we can help you.

**THE NAME MARION MEANS THE MOST IN METERS**

Write for complete information

---

**MARION ELECTRICAL INSTRUMENT COMPANY**

MANCHESTER, NEW HAMPSHIRE

Export Division, 458 Broadway, New York 13, U. S. A., Cables MORHANEX

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

October, 1948 — ELECTRONICS
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Drafting, Reproduction, Surveying

Equipment and Materials

Slide Rules • Measuring Tapes

ELECTRONICS — October, 1948
How a quartz ring drove the first crystal clock in 1928

Heart of the crystal clock built 20 years ago at Bell Laboratories was this quartz ring, adjusted to a frequency of 100 kc. With the crystal cut to correct proportions in this annular shape, positive and negative temperature coefficients of frequency effectively neutralized each other. Resultant temperature coefficient was less than 1 part in 10^6 per degree C.

In the complete oscillator, the crystal was mounted inside a chamber in which the temperature was kept constant within 0.01° C, and placed in a hermetically sealed bell jar to maintain uniform pressure. The frequency of the oscillator output was reduced to 1,000 cycles by means of sub-multiple generators.

In the clock mechanism, a 1,000-cycle synchronous motor, driven by the output of the sub-multiple generators, was geared to the clock hands. Accuracy of this clock in 1928 was within 1 part in 10^4. Accuracy of its present-day successor is of the order of 1 part in 10^8—an advance made possible by continuing research.

Where a second is

...in the clock that varies less than 1/1000th of a second a day

There's a clock at Bell Telephone Laboratories—evolved by the scientists there—that keeps accurate time within 0.001 second a day. It is the latest step in a series of developments that began 20 years ago when Bell Laboratories built the first crystal clock.

Why are the men of Bell Laboratories, whose basic interest is communications, so concerned with time? Because the study of communications is largely the study of frequency—and frequency is the inverse of time. To deal with frequencies in megacycles requires accurate measurement of fractions of micro-seconds.

In their early studies of piezoelectric crystals for frequency control, Bell scientists saw the desirability of using them also as a source of accurate time.

Two obstacles stood in the way of devising a crystal clock: the relatively high temperature coefficient of crystals, and the fact that their frequencies were too high to drive a synchronous motor. Annular crystals, with extremely low temperature coefficients, solved the first problem. Sub-multiple generators solved the second, accurately dividing the crystal frequency. Thus the barrier between frequency standards and time standards was finally broken down.

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

October, 1948 — ELECTRONICS
...in a frequency standard that's accurate to 1 part in $10^8$ a day

Continuing research on piezoelectric crystals at Bell Laboratories resulted in a development of far-reaching importance—the GT cut.

This opened the way to revolutionary advances in instruments for time-frequency measurements. The GT-cut crystals make possible entirely new standards of accuracy, because of their extremely low temperature coefficient—less than 19 parts in $10^8$ per degree C, far lower than produced by any other method of cutting.

Moreover, GT-cut crystals are admirably adapted to wire-suspension mounting, which virtually nullifies the effect of shock on frequency. This greatly enlarges the range of conditions under which accurate measurements can be made.

The Western Electric Primary Frequency Standard is the embodiment of these new concepts in design. It is a 100-kc source that combines accuracy and ruggedness to a remarkable degree. Frequency variation is less than 1 part in $10^8$ over a 24-hour period; yet the Standard, far from being confined to the laboratory, performs with equal accuracy on ships, planes and vehicles—even in earthquake areas! Wherever there is a need for time-frequency measurements, or the synchronous operation of two or more systems, the Frequency Standard is ready and able to take on the job.

QUALITY COUNTS

How the Frequency Standard maintains its accuracy

Key to the accuracy of the Western Electric Primary Frequency Standard is a GT-cut crystal, surpassing even the annular cut in the degree to which it nullifies the effect of temperature on frequency. The crystal is suspended by wires inside an evacuated glass envelope. The wire mounting results in an exceptionally rugged crystal unit, practically immune to shock.

The complete Standard, compactly designed, ruggedly built, weighing only 90 pounds, brings the accuracy usually associated only with delicate laboratory apparatus into field service.
"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.

SPECIALISTS IN RADIO RECEIVING TUBES SINCE 1921

HYTRON

RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS

October, 1948 — ELECTRONICS

www.americanradiohistory.com
How Allen-Howe — first to use "Printed Electronic Circuit" in hearing aids — depends on this Centralab development for smaller, finer units.

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

Size and weight are vital to Allen-Howe, hearing aid manufacturers. That's why this firm's engineers chose Centralab's Printed Electronic Circuit to help them design and build smaller, lighter, more efficient units. Just as important to Allen-Howe is product dependability. Months of actual experience using Printed Electronic Circuits have proved to them how very rugged these miniature audio-amplifiers are... just how well they resist humidity and moisture. That's why they continue to use Centralab's revolutionary P.E.C.

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.

This outstanding hearing aid development, illustrated above, was the result of close cooperation between Centralab and Allen-Howe engineers. Working with your engineers, Centralab may be able to fit its Printed Electronic Circuit to your specific needs. Write for full information, or call your nearest Centralab Representative.

LOOK TO Centralab
Division of GLOBE-UNION INC., Milwaukee

ELECTRONICS — October, 1948
ANNOUNCING THE GENERAL ELECTRIC S-T BROADCAST SYSTEM!

* With it — your signal from studio to transmitter now rides on air! With it — your problems of outages due to weather or rugged terrain are solved! Sleet storms, fires or floods can damage studio to transmitter transmission lines or cables — but not micro-wave transmission from General Electric S-T broadcast system. There are no transmission lines or cables. With it — you can select the best sites for your station and transmitter with increased assurance of reliable program service!

The new General Electric S-T Link equipment is easily installed and occupies remarkably little studio space. A product of the research and engineering skills assembled at Electronics Park, this system is another General Electric contribution to better broadcasting.

Broadcasters, station managers and engineers will want all the facts. Your nearest G-E office can give them to you. Call there, or write: General Electric Company, Transmitter Division, Electronics Park, Syracuse, New York.

S-T TRANSMITTER

- Conservatively rated 10 watts output. Continuously adjustable 1 to 10 watts, for maximum tube life.
- Remarkably easy installation.
- Single unit. Entire transmitter is complete within its cabinet. All maintenance done under comfortable indoor conditions.
- Low power consumption: 675 watts total input.
- Can be tuned and adjusted without special test equipment.
- Instant accessibility. All meter and tuning controls immediately at hand when front doors are open.
- Rear doors interlocked for maximum safety to personnel.
- Simple and easy to change tubes.

WHAT THE SYSTEM DOES FOR YOU...

- Operates in band 920 to 960 MC. This includes the band permanently assigned by FCC for S-T broadcast service.
- Permits you to meet all FCC FM broadcast system requirements.
- Remote controlled over single-pair telephone line.
- Uses standard type “N” RF fittings throughout.
- Provides high fidelity performance:
  - Less than 1½% distortion from 50 to 15,000 cycles.
  - Noise level better than 65 db.
  - Frequency response well within ± 1 db from 50 to 15,000 cycles.
- Designed for unattended remote operation.
for dependable broadcasting

S-T RECEIVER

- Double-conversion superheterodyne circuit, fully crystal controlled for maximum long-term frequency stability.
- Standard receiver tubes throughout.
- Sensitivity—95 db below 1 watt (for specified system performance).
- Total power input only 135 watts.
- Compactly assembled for mounting in standard 19-inch cabinet rack.
- All tuning adjustments are made from the front.

S-T ANTENNAS

- 40-inch reinforced aluminum paraboloid, with dipole feed.
- Power gain each antenna 15.3 db over standard dipole. Total gain 30.6 db.
- Low standing-wave ratio over full frequency range (970-1060 MC) without adjustment.
- Two-clamp mounting construction permits firm attachment to single structural member or pole.
- Easy to install and aim.
- Fully protected from adverse effects of icing.
- Designed for 100 m.p.h. wind loading.

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Walnut 9767

BOSTON 1, MASS.
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Hubbard 1800

CHICAGO 54, ILL.
1722 Merchandise Mart
Whitewall 3915

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215 W. 3rd Street
Parkway 3431

DALLAS 2, TEXAS
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Lo 224

DENVER 2, COLO.
655 17th Street
Keystone 7171

KANSAS CITY 6, MO.
100 W. 46th Street
Victor 9745

CLEVELAND 4, OHIO
710 Williamson Bldg.
Euclid & Public Square
Superior 6822

LOS ANGELES 14, CALIF.
Suite 1200-1201
Security Title Insurance Bldg.
530 West Sixth Street
Trinity 3417

MINNEAPOLIS 2, MINN.
12 Sixth Street
Main 2541

NEW YORK 22, N.Y.
570 Lexington Avenue
Wickersham 2-312

PHILADELPHIA 2, PA.
1923 Locust Street
Pennypacker 5-9000

SAN FRANCISCO 4, CALIF.
231 Montgomery Street
Douglas 3740

SCHENECTADY, N.Y.
Bldg. 267, Rm. 209
Schenectady 4-2211

SEATTLE 4, WASH.
710 Second Avenue
Main 7100

WASHINGTON 5, D.C.
806 15th Street N. W.
Executive 3600

LEADER IN RADIO, TELEVISION AND ELECTRONICS

GENERAL ELECTRIC

ELECTRONICS — October, 1948
Designed for a wide variety of laboratory measurements, especially those where high sensitivity and a long scale arc are required. Electrostatically and magnetically shielded, Model 622 is ideally suited for precise measurements of potential and current at the very low energy levels frequently encountered in nuclear physics, electronics and electro-chemical research. Microammeters, milliammeters, millivoltmeters and voltmeters are available in single and multi-range D-C types; milliammeters and voltmeters in thermo and rectifier types for RF and A-C.

Complete information on Model 622 is available from your nearest WESTON representative, or by writing ... WESTON Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark 5, N. J.

WESTON Instruments
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.

SOLA
Constant Voltage
Transformers

Transformers for: Constant Voltage • Cold Cathode Lighting • Airport Lighting • Series Lighting • Fluorescent Lighting • Luminous Tube Signs Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • SOLA ELECTRIC COMPANY, 4633 W. 18th Street, Chicago 50, Illinois

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ELECTRONICS — October, 1948
REVERE makes Free-Cutting Copper Rod, and if you are making electronic devices requiring machined copper parts of high conductivity, it will pay you to investigate the savings made possible by this metal. We would suggest that you make trial runs to prove what it will do under your own shop conditions. That was the procedure followed by The Trumbull Electric Mfg. Co., Plainville, Conn., with these results:

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

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

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

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

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

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

REVERE COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
230 Park Avenue, New York 17, New York

TOROIDAL COIL FILTERS
AND TOROIDAL COILS DESIGNED
FOR CRITICAL APPLICATIONS

Frequency in Kilocycles

Extremely sharp side band suppression filter. Available in either low or high pass.
Size: 2 1/2 x 4 x 2 1/2.

Frequency in Cycles

The big three out of 30 types of toroidal coils we are supplying.

TC-1 any ind. up to 10 hys.
TC-2 any ind. up to 30 hys.
TC-3 any ind. up to .750 hys.

A wide band sharp cutoff band pass.
Size: 2 x 3 1/2 x 6 5/8.

Wide band sharp cutoff band pass.
Size: 2 x 3 1/2 x 6 5/8.

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

Tone channel filter for extremely high crossover attenuation requirement.
Size: 2 1/2 x 2 1/2 x 5.

ALL INQUIRIES WILL BE PROMPTLY HANDLED...WRITE FOR TECHNICAL INFORMATION
For top-flight quality and rock-bottom economy in telecast programming . . . DU MONT Type 5130-B

16mm SOUND

Telecasting Projector

Superlative movie programming utilizing economical 16 mm sound films—that's the meaning of this latest Du Mont achievement.

Designed and built "from scratch" to meet the exacting needs of movie telecasting. Not to be confused with usual improvisations. Definitely, with this unique projector, movie telecasting comes of age.

Ready for the heavy-duty service normal to telecast operations. All parts readily inspected, checked, replaced, when needed. Self-contained. Fully enclosed. Streamlined. Smartly designed.

Better movie presentations over the air are bound to follow the installation of such equipment by telecasters seeking the largest audiences.

Details on request. Meanwhile, submit your telecasting problems and requirements.

FEATURING . . .

Complete with sound preamplifier and necessary power supplies.

Sound system response of 50 to 5000 cycles—quality of reproduction limited solely by film sound track.

Ample reel reservoir capacity permitting use of 4000 ft. feature movies.

Synchronous locking type driving motor ensuring perfect tie-in with television sync generator.

Lamp assembly and pull-down mechanism available for instant replacement.

Adjustment for both positive and negative film.

Light output far exceeds previous equipment, permitting use of low-sensitivity pickup tubes even with narrow vertical blanking interval.

For direct throw on television mosaic or with intermediate translucent screen and prism for utilization of image Orthicon Camera for film pickup.

Built for continuous use on an average of 20 hours weekly. At least 3000 hours' life expectancy for major components.

In sum, the stability and performance which television film pickup has needed for many years.

© ALLEN B. DU MONT LABORATORIES, INC.
**TECHNICAL ADVANTAGES**

**Multicore Solder**
- Three separate cores of flux eliminate possibility of no flux in a portion of the wire, which may occur in single cored solder. Guaranteed continuity of the flux stream prevents "dry" joints, i.e., those having high electrical resistance.
- Although there are three cores of flux in Multicore, the total percentage of flux to solder is no greater than in single cored solder.
- Very rapid melting results from the multiple core construction which provides thinner walls of solder than are found in some gauge single cored solder.
- Multicore's unique properties make perfect joints possible on difficult metals and alloys, even if oxidized.
- Ability to tin rapidly produces perfect joints with less solder. Greater coverage per pound.

**Ersin Flux**
- Ersin Flux is an exclusive product of Multicore solder's limited, and is only supplied as part of Multicore solder. It is a high grade, water white rosin, homogeneously activated.
- Covers on resin a vigorous fluxing action without affecting the non-corrosive and protected features of the original rosin.
- Soldered joints made with Ersin Flux do not corrode even after prolonged exposure to a degree of humidity.
- Reduces the surface tension of molten solder, causing it to wet metals rapidly, increasing speed of operation with resultant production economies.
- Free from objectionable odor. Non-toxic in use.
- Leaves nothing but pure rosin on the work after soldering, and may be used wherever plain rosin is specified.

---

**ERSIN MULTICORE SOLDER**

The only 3 core solder made with ERSIN FLUX...the original non-corrosive, extra-active flux

**ALLOY AND MELTING POINTS OF ERSIN MULTICORE SOLDER**

<table>
<thead>
<tr>
<th>Alloy Tin/Lead</th>
<th>Multicore Color Code</th>
<th>Solidus °C.</th>
<th>Liquidus °C.</th>
<th>Recommended bit temperature °C.</th>
<th>USES</th>
</tr>
</thead>
<tbody>
<tr>
<td>60/40</td>
<td>Red</td>
<td>183</td>
<td>190</td>
<td>230</td>
<td>High quality work requiring low melting point alloy.</td>
</tr>
<tr>
<td>50/50</td>
<td>Yellow</td>
<td>183</td>
<td>212</td>
<td>252</td>
<td>Hand soldering, radio, telephone and electrical equipment, batteries.</td>
</tr>
<tr>
<td>45/55</td>
<td>Crimson/ Buff</td>
<td>183</td>
<td>227</td>
<td>260</td>
<td>Fuses, motors, dynamos.</td>
</tr>
<tr>
<td>40/60</td>
<td>Green</td>
<td>183</td>
<td>238</td>
<td>278</td>
<td>Lamps, motors, dynamos.</td>
</tr>
<tr>
<td>30/70</td>
<td>White</td>
<td>183</td>
<td>237</td>
<td>269</td>
<td></td>
</tr>
<tr>
<td>20/80</td>
<td>Purple</td>
<td>183</td>
<td>276</td>
<td>316</td>
<td></td>
</tr>
</tbody>
</table>

**STANDARD GAUGES**

<table>
<thead>
<tr>
<th>Standard Wire Gauge Diameter in Tenths</th>
<th>Approximate Number of Feet per lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>1.120 x 2.251</td>
</tr>
<tr>
<td>21</td>
<td>0.104 x 2.642</td>
</tr>
<tr>
<td>25</td>
<td>0.099 x 2.337</td>
</tr>
<tr>
<td>24</td>
<td>0.090 x 2.037</td>
</tr>
<tr>
<td>26</td>
<td>0.080 x 1.676</td>
</tr>
<tr>
<td>28</td>
<td>0.064 x 1.120</td>
</tr>
<tr>
<td>30</td>
<td>0.048 x 1.016</td>
</tr>
<tr>
<td>32</td>
<td>0.036 x 0.914</td>
</tr>
<tr>
<td>34</td>
<td>0.028 x 0.711</td>
</tr>
</tbody>
</table>

**ERSIN MULTICORE SOLDER** is made in a wide range of gauges, as shown. It can also be supplied in any intermediate size. For general radio and electronic production 14, 16 and 18 S.W.G. are the most widely used gauges.

**FEDERAL SPECIFICATIONS**


**ALL GAUGES AND ALLOYS READILY AVAILABLE FROM NEW YORK STOCK.**

Address U.S.A. and Canadian inquiries to:

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315 Broadway, New York 7, N.Y.

Inquiries regarding other territories to:

**MULTICORE SOLDERS LTD.**
Mellier House, Albemarle Street, London, W. 1, England

www.americanradiohistory.com
PROBLEM: How to produce better,

ANSWER: ....Westinghouse

FOR EXAMPLE: Resistance Welding Controls

YOU CAN BE SURE...
IF IT'S Westinghouse
Want to speed fabrication? Reduce handling and welding time? Get top-quality welds? Then investigate Westinghouse electronic resistance welding controls. You can select the basic patterns of controls you need—synchronous or non-synchronous. Each is a complete, unified, factory-assembled package that eliminates awkward, cumbersome equipment of the past. Every part has been especially designed for heavy-duty industrial use. Controls are within easy reach of the operator. Circuits have been simplified; troublesome gadgets eliminated; designs on-the-job tested and performance proved. Everything has been designed and built with one purpose in mind—to make resistance welding more practical ... more efficient than ever before.

Check Westinghouse Electronic Welding Controls today. See their simplicity ... their compactness. For complete detailed information, call your nearest Westinghouse representative or write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.
Wherever There's a CORE and COIL

Choose FERRANTI

Power and Audio Transformers
Chokes • Filters

3 EXAMPLES OF OUR WIDE RANGE:

OPEN FRAME TYPE for mass production, minimum cost and weight for enclosed equipment.

ENCLOSED CASE, compound filled, for high moisture resistance. Standard cases up to 500 VA. Wide range of standard audio transformer units.

HERMETICALLY SEALED and compound filled cases. Glass or ceramic sealed terminals. Designed to meet JAN salt water immersion tests.

We offer ample modern facilities and intensive experience in up-to-date practice, including the latest core material developments, and components for 400 cycle power supplies. Our large accumulation of patterns, tools and dies often makes it possible to supply your specific requirements from standard parts, thus cutting your costs without sacrifice of quality. Whatever the type of unit, our bid will meet your needs. Submit your inquiries.

POWER SUPPLY UNITS AND ELECTRONIC ASSEMBLIES TO SPECIFICATIONS

Ferranti Electric, Inc.

30-A Rockefeller Plaza • New York 20, N. Y.
NOW! 10 cps to 10 mc

...with the New -hp- 650A RESISTANCE-TUNED OSCILLATOR

SPECIFICATIONS

FREQUENCY RANGE: 10 cps to 10 mc
FREQUENCY CALIBRATION: 0.5 to 10.
Multiplying factors are:

<table>
<thead>
<tr>
<th>MF</th>
<th>Freq. Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>X10 cps</td>
<td>9 to 100 cps</td>
</tr>
<tr>
<td>X100 cps</td>
<td>90 to 1000 cps</td>
</tr>
<tr>
<td>X1 kc</td>
<td>900 to 10,000 cps</td>
</tr>
<tr>
<td>X10 kc</td>
<td>900 to 100 kc</td>
</tr>
<tr>
<td>X100 kc</td>
<td>90 to 1000 mc</td>
</tr>
<tr>
<td>X1 mc</td>
<td>90 to 10 mc</td>
</tr>
</tbody>
</table>

STABILITY: ±2% at 10 cps to 100 kc; ±3% at 1000 to 10 mc, including warmup, line voltage, and tube changes.

OUTPUT: 10 milliwatts at 3 volts into 600 ohm resistive load. Open circuit voltage is at least 6 volts. 600 ohm reflected impedance. Output impedance of 6 ohms also available.

FREQUENCY RESPONSE: Flat within ±1 db, 10 cps to 10 mc.

DISTORTION: Less than 1%, from 100 cps to 100 kc. Approx. 5% from 100 kc to 10 mc.

OUTPUT MONITOR: Vacuum tube voltmeter monitors output level in volts or db at 600 ohm level. Output response beyond monitor is accurate within ±5% at all levels and frequencies.

OUTPUT ATTENUATOR: Output level attenuated 50 db in 10 db steps, providing continuously variable output voltage from +10 dbm to -50 dbm, 3 volts to 3 millivolts, or down to 30 microvolts with voltage divider.

HUM VOLTAGE: Less than 0.5%, below maximum attenuated signal level.

POWER SUPPLY: 115 volts 60/60 cps. Consumption 135 watts. Plate supply electronically regulated.

MOUNTING: Cabinet or relay rack. Panel size 19" x 10 1/2". Depth 13 1/2".

Here it is... another -hp- "first"... a new resistance-tuned oscillator that not only covers a frequency range of 10 cps to 10 mc, but brings to the r-f and video field all the speed, accuracy and ease of measurement traditional to famous -hp- audio oscillators. And, this important addition to the -hp- line incorporates all the family characteristics of other -hp- oscillators... no zero setting, minimum adjustment during operation, virtual independence of line and tube characteristics, accurate calibration, and streamlined circuits for long, trouble-free performance.

The result is a highly stable, wide-band precision instrument which provides output flat within 1 db from 10 cps to 10 mc, and a voltage range of .00003 to 3 volts. Output impedance is 600 ohms or 6 ohms with output voltage divider.

Like other -hp- resistance-tuned oscillators, the new 650A gives you the advantage of decade frequency ranges, a 94" scale length, and a 6 to 1 micro-controlled vernier drive. A complete vacuum tube voltmeter, included in the 650A circuit, monitors output in volts or db at the 600 ohm level. A continuously variable output voltage is obtained by means of an output attenuator of 50 db, variable in 10 db steps and an amplitude control which adjusts the level to the monitor vacuum tube voltmeter.

Where it is desirable that the measurements be made with a low source impedance, an output voltage divider unit is supplied. This attachment consists of a cable, which may be extended to the point of measurement and provides an internal impedance of 6 ohms. It also reduces the output voltage 100 to 1.

The Compact, efficient -hp- 650A is available now for making a wide number of measurements... testing television amplifiers, wide-band systems, filter transmission characteristics, tuned circuits, receiver alignments. And... it serves admirably as a power source for bridge measurements or as a signal generator modulator.

For full information... write today

Hewlett-Packard Company • 1495A Page Mill Road • Palo Alto, Calif.
It's sweet music to us...and to our customers, we think, to know that Karp Metal Products Co., Inc., next month will move into a brand new streamlined building of 70,000 square feet of space, with a 600 foot frontage.

Our new plant will be the last word in modern manufacturing quarters, equipped with the newest and most efficient machinery and facilities, including the most complete and up-to-date paint and finishing department, scientifically air conditioned and dustproof. These advancements will enable us to extend the scope of the precision service we render the leaders of the radio and electronics industry.

Your loyal patronage has helped make possible this expansion, and you may be sure the favor will be returned in the form of greater production and better-than-ever Karp service...from the simplest chassis to the most elaborate console.

Ask For Our Informative New Catalog

KARP METAL PRODUCTS CO., INC.
215-63rd Street, Brooklyn 20, New York

Custom Craftsmen in Sheet Metal
The answer to your HOME ENTERTAINMENT CENTER. Designed by leading furniture stylists and electronics engineers, CUSTOMODE custom cabinets give you hundreds of refined functional arrangements, enhancing all interior styles and requirements.

Four Basic Units: Reproducer Cabinet—Bass Reflex design utilizes any 15” speaker including Jensen coaxial speakers; Medium Utility Cabinet—for large equipment, communications receivers, television sets, amplifiers, etc.; Small Utility Cabinet—for tuner, amplifier, recorder, record changer, etc.; Record Cabinet—holding more than 200 records. Mahogany in Blond or Cordovan finish.

Customode’s “building block” versatility enables you to create your own layouts as you wish, when you wish. Please accept our invitation to write today for free literature and scale cut-up illustration. Jensen Manufacturing Company, 6601 S. Laramie Ave., Chicago 38, Illinois.
If You Need punched parts of laminated plastics by the MILLION

Look to RICHARDSON
Insist on INSUROK

The Richardson Company offers you the services of an established, experienced, manufacturing organization with ample facilities for quantity production of Laminated INSUROK, proven by years of experience to be one of the world's truly fine punching stocks.

The RICHARDSON COMPANY
GENERAL OFFICES: LOCKLAND, OHIO • FOUNDED IN 1858
Sales Headquarters: MELROSE PARK, ILLINOIS

www.americanradiohistory.com
Glass bushings

Now Available

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

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

The resulting joint between bushing and equipment is permanent, vacuum-tight, and of high mechanical strength. It is especially desirable for equipment subject to vibration, shock, fungus growth or severe changes in temperature. These glass bushings are currently available to meet dry, 60-cycle, flashover values of from 10 to 50 kv, and in current ratings of 25 and 50 amperes (large sizes up to 800 amperes). They may be single or multi-conductor and can be provided with a top flange to permit mounting tube sockets directly on the bushings. Diameters range from $1\frac{5}{8}$ to $3\frac{3}{8}$ inches and weights from $2\frac{3}{4}$ oz. to 4 lb.


ELECTRONICS — October, 1948

www.americanradiohistory.com
Recommended for use under stringent conditions such as encountered in television, auto radio applications, and sets for export use.

Samples on request to quantity users. Write for Sprague Data Bulletin 201A.

Wherever small, paper capacitors are required to operate under exacting conditions of heat, moisture or vibration, Sprague Phenolic Molded Tubulars are setting new, higher standards of efficiency.


Sprague Electric and Electronic Progress

Capacitors • Koolohm° Resistors
The Collins 3000A-1 provides radiophone facilities for transmission and reception in the frequency range of 118 to 136 mc. It is expressly designed for airlines and airport tower vhf communications.

The installation consists of a Collins 242B-1 vhf transmitter (r-f, modulator, relay control, and high and low voltage power supply units), and a Collins 51M-2 vhf receiver, all compactly integrated in a Collins cabinet.

The r-f section permits transmission on either of a pair of frequencies not more than 1% separated, anywhere within the band, and has a power output of 50 watts. The number of channels can be increased by the addition of r-f units, each unit having two channels. By selection of vhf units and a Collins remote control unit the installation can provide transmission on as many as eight frequencies.

The transmitter units are designed for 19" rack panel mounting. Convenience for maintenance has been an important design consideration. All tubes and adjustments are available from the front of the cabinet. Thorough engineering throughout insures dependable, uninterrupted performance at either a local or remote position.

The 51M-2 is a fixed channel crystal controlled dual-superheterodyne receiver, and is highly sensitive and selective. It includes all modern circuit features, such as flat avc, noise limiter, and squelch. Write us for further information.
If you want to get the electrical insulating material best suited to improve product performance, here's an engineering service worth investigating. Experienced Continental-Diamond engineers will welcome the opportunity of working with you from the start of a job to its completion. Backing them up is a complete line of insulating plastics with unusual combinations of electrical, chemical and mechanical properties. There's Diamond Fibre for toughness, wear resistance, and light weight, Vulcoid for superb arc resistance, toughness, good dielectric strength and fair moisture stability, Dilecto for structural strength and dimensional stability. All in all, there are five different C-D Plastics subdivided into grades to fit your specific application.

Take advantage of this complete plastics service designed to help you improve product performance, lower unit costs. For personal engineering help or prompt delivery of insulating plastics, call your nearest C-D office today.

C-D HIGH-STRENGTH PLASTICS
Diamond Fibre—Vulcanized Fibre
Vulcoid—Resin Impregnated Fibre
Dilecto—Laminated Thermosetting Plastic
Celoron—Molded High-Strength Plastic
Micabond—Bonded Mica Splittings
You get all these features ONLY in the
Western Electric 5A Monitor
for FM Broadcasting

CENTER FREQUENCY MONITOR:
Accuracy—better than ±500 cycles. (±200 cycles if occasionally adjusted to agree with a primary standard)
Meter Range—±3,000 cycles
Terminals for connecting remote meter

MODULATION PERCENTAGE MONITOR:
Accuracy—better than 5% for all readings
Modulation Range Capability—up to 133% (±100 kc)
Terminals for connecting remote meter

QUALITY DESIGN AND MANUFACTURE:
Designed by Bell Telephone Laboratories. Built by Western Electric to Western Electric standards of quality.

PROGRAM MONITORING CIRCUIT:
Output suitable for either aural program monitoring or FM noise and distortion measurements
Frequency Response—±0.25 db, 30 to 30,000 cycles, without de-emphasis; with de-emphasis, response is within ±0.5 db of the standard 75 microsecond de-emphasis curve
Audio Output Power—output level adjustable up to ±12 dbm—permits direct switching of program monitor from transmitter input to 5A Monitor output
Harmonic Distortion—less than 1/4 of 1% from 30 to 15,000 cps
Output Noise—at least 75 db below signal at 100% modulation

MODULATION PEAK INDICATOR:
Indication Lamp—flashes when a selected level of modulation is exceeded
Peak Limit Range—continuously adjustable between 40% and 140% modulation

AM NOISE DETECTOR:
An exclusive feature in the 5A Monitor. The output of this detector—which may be read directly on an electronic voltmeter or noise meter—is automatically referred to 100% amplitude modulation, thus simplifying measurement of transmitter AM noise.

The 5A Monitor includes numerous other valuable features such as: dual thermostats and dual heaters for each crystal—means for checking the inherent noise level of the monitor from its input to output terminals—requires only a low RF input level (1 watt) which can vary from 0.3 to 3.0 watts, i.e., a 10 to 1 variation without affecting the performance of the monitor. To get the complete story on this outstanding monitor value, call your Graybar Broadcast Representative or mail the coupon below.

Western Electric

Distributors: In the U. S. A.—Graybar Electric Company.
In Canada and Newfoundland—Northern Electric Company, Ltd.

—QUALITY COUNTS—

Graybar Electric Company
420 Lexington Avenue, New York 17, N. Y.

Please send me Bulletin T-2437, including curves, schematics and block diagram of the 5A Monitor.

NAME___________________________

STATION__________________________

ADDRESS_________________________

CITY_____________________________ STATE_____________________

E-10

www.americanradiohistory.com
Only Sorensen electronic voltage regulators offer as much as 0.1% regulation accuracy under simultaneous line and load changes.

Shown above is the ARL Projection Comparator Densitometer. Applied Research Laboratories, internationally known manufacturers of precision spectographic and densitometric equipment, have standardized on Sorensen AC line voltage regulators because only Sorensen units provide the 0.1% regulation accuracy necessary for the scanning lamp. SIX IMPORTANT SORENSEN FEATURES: • Precise regulation accuracy; • Excellent wave form; • Output regulation over wide input voltage range; • Fast recovery time; • Adjustable output voltage, that once set, remain constant; • Insensitivity to line frequency fluctuations between 50 and 60 cycles.

If you calibrate meters, need quality control on test lines, work with X-ray equipment, or are a research physicist or chemist, there is a standard Sorensen AC or DC unit to solve your voltage problem. The Sorensen Catalog contains complete specifications on standard Voltage Regulators and Nobatrons. It will be sent to you upon request.

THE FIRST LINE OF STANDARD ELECTRONIC VOLTAGE REGULATORS.

SORENSEN & Company, Inc.
Stamford, Connecticut
Represented in all principal cities.
Designers and Manufacturers of
Communications, Microwave and Electro-Mechanical Equipment

PRESS WIRELESS
MANUFACTURING COMPANY, INC.
(Combining Press Wireless Manufacturing Corporation and Milliken Machine Company)

A STATEMENT BY THE PRESIDENT

To the many friends of Press Wireless Manufacturing Corporation and Milliken Machine Company, we take pleasure in announc-ing that these two long-established concerns are now united under the name Press Wireless Manufacturing Company, Inc.

The new company has continued intact the exceptional engineering staffs and production facilities of its predecessors and now offers to government and industry a complete service for the design and manufacture of a wide variety of communication, microwave and electro-mechanical equipment.

Press Wireless Manufacturing Company, Inc., places at your disposal a coordinated and experienced team, which has consistently delivered successful military and commercial equipment and which knows how to interpret intangibles and create efficient designs where no precedent exists.

WE WELCOME YOUR INQUIRIES

President

PRESS WIRELESS MANUFACTURING COMPANY, INC.
First in "Packaged" Communications Equipment—From Antenna Tower to Operating Console
Manufacturing Plants Located at Hicksville, L. I., and West Newton, Mass.

ELECTRONICS — October, 1948
Centralab reports to

Centralab reports to

Check the features of Centralab's revolutionary new Rotary Coil and Cam Index Switch. You'll agree it's one of the most important switch developments of the year! (1) New tested step-strength of 48 inch pounds. (Standard RMA step-strength—only 24 inch pounds.) (2) Guaranteed minimum life — 150,000 cycles (RMA Standard — 10,000 cycles.) (3) Removable spring can be replaced without removing switch from chassis. Get all the facts. Write for Bulletin 995.

Four Positions Give You Wide Choice of Switching Combinations

Pl — Positive Index
SR — Spring Return

1. Two position positive index.
2. Two position spring return, from counterclockwise.
3. Two position spring return from clockwise.
4. Three position positive index.
5. Three position spring return from both sides to center.
6. Three position index — two positive spring return from counterclockwise.
7. Three position index — two positive spring return from clockwise.
8. Four position, three positive, spring return from counterclockwise.
9. Four position, three positive, spring return from clockwise.
10. Four position, two positive, spring return from clockwise, counter-clockwise.
For utmost reliability in small physical size, low mass weight, use CRL Hi-Kap — miniature ceramic disc capacitors. Write for Bulletin 933.

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

Centralab's Filpec is designed for use as a balanced diode lead filter, combines up to three major components into one tiny filter unit, lighter and smaller than one ordinary capacitor. Capacitor values available from 50 to 200 mmf. Resistor values from 5 ohms to 5 megohms. For complete information write for Bulletin 976.

CRL's Coup/ate consists of a plate lead resistor, grid resistor, plate by pass capacitor and coupling capacitor. Write for Bulletin 933.

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!
IN THE BATTLE FOR THE LISTENER'S EAR...

Here's increased coverage for your station!

with the new

LIMITING AMPLIFIER

FITS neatly into your audio cabinet—attractive, sturdy, quiet. But what a wallop it packs when you want attention from Mr. Big—the listener!

Based on engineering developments by CBS engineers, the Limiting Amplifier has been designed by General Electric to give you greater coverage and more potential listeners without changing your present transmitter or antenna.

For more information, call your nearest G-E broadcast equipment representative, or write us. General Electric Company, Transmitter Division, Electronics Park, Syracuse, New York.

MEMO TO STATION MANAGERS:

- Increases modulation and thus makes signal reach farther, sound clearer.
- Raises effective signal strength—this means increased coverage.
- Low installation cost—quickly, easily mounted in G-E Audio Cabinet Rack.
- In FM, too—protect your listeners against receiver distortion caused by transmitter over-swing. Dynamic range, so important in FM, is maintained.

MEMO TO ENGINEERS:

- Increases average level of modulation as much as 8 to 10 db.
- Anticipatory circuit prevents overmodulation—even on the first half cycle of the overmodulation peak. Automatic recovery time improves program fidelity!
- Prevents distortion and adjacent channel splatter.
- G-E popular hinged panel construction—easy to get at.
- Vertical mounted for better ventilation.

G-E Limiting Amplifier at the 50,000 watt transmitter of WTOP, Washington, D. C.

You can put your confidence in...

GENERAL ELECTRIC

October, 1948 — ELECTRONICS
HERE'S A VALUABLE SOURCE OF DESIGN INFORMATION

IF YOU have a design problem involving rheostats or resistors, call on Ohmite for assistance. The accumulated experience of the entire Ohmite engineering staff . . . the combined thinking of its many resistance specialists . . . are all available to you for the asking. Ohmite engineers are well qualified to help analyze your requirements and select the correct units to fit your specific application. Years of experience in building dependable rheostats and resistors, 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.

Be Right with OHMITE
Compact—Dependable

Here's a line of non-shorting, rotary tap switches that combine high current-capacity and a large number of taps, with unusual compactness. Their sturdy one-piece ceramic bodies provide permanent insulation, as the ceramic is not affected by arcing. The heavy silver-to-silver contacts have a self-cleaning action, and (except for Model 111) are totally enclosed and protected. Switch shafts are electrically dead—insulated by strong ceramic hubs. A positive cam-and-roller mechanism provides “slow-break quick-make” action—particularly designed for alternating current use. Two or three of these Ohmite tap switches can be mounted in tandem to form multiple-pole assemblies.

Send for Catalog and Engineering Manual No. 40

Write now, on company letterhead, for your copy of this helpful 96-page Ohmite catalog.

Be Right with...
If Recorders came with Mileage Meters...

Presto 6N would be **MILES AHEAD**

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

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

So when you're looking for a new recorder, remember: By actual test the best recorder for the most people is Old Faithful, the Presto 6N.
MOLDED INSULATED TUBULAR
GP CERAMICONS
Have extremely rugged, molded insulation, axial leads. Capacity range 10-5,000 MMF. Smallest size .250" x .362" max.

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

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

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

NON-INSULATED
STAND-OFF CERAMICONS
Style 318 (left) mounts 1/2" high above chassis, has .032" diameter wire top terminal. Capacity range 1-560 MMF. Style 319 (right) mounts 1/4" high, has .067" diameter top terminal. Capacity range 2-1,000 MMF. Both styles have 3-48 thread.

SIDE-LEAD STAND-OFF
CERAMICONS
Wire leads are correct height from chassis for shortest possible connection to tube sockets. Style 2322 (left) 45/64" high. Capacity range 5-2,500 MMF. Style 2336 (right) 13/16" high. Capacity range 6-5,000 MMF.

FEED-THRU
CERAMICONS
By-pass R. F. to ground when feeding through chassis or metal can. Body length 1/4"; mounted with 12-28 nut. Type 362 (above) has 20 gauge feed-thru wire. Capacity range 5-1,500 MMF. Type 357 (below) has 0.53" diameter hooked ends feed-thru wire; capacity range 5-1,000 MMF.

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

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

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

ERIE RESISTOR CORP., ERIE, PA.
LONDON, ENGLAND • TORONTO, CANADA

October, 1948 — ELECTRONICS
WIRING is the Life-Line of every electrical product

Whatever your product, you can more surely predict dependable performance-in-use when it is Rockbestos-wired.

For Rockbestos wires, cables and cords are permanently insulated with impregnated felted asbestos — the ageless, heat and flame resistant insulation that insures top wiring dependability under even the most gruelling conditions.

Protect your product’s life line with the wire that does so much more for so little more . . . Rockbestos.

WRITE TODAY — for your copy of the new No. 10-F Catalog, sectioned for easy reference to Appliance, Aircraft, Electronic, Fixture, Switchboard, Lighting and Magnet Wires; Apparatus Wires and Cables; Power and Control Cables.

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

NEW YORK CLEVELAND DETROIT CHICAGO PITTSBURGH
ST. LOUIS LOS ANGELES OAKLAND, CALIF.

ROCKBESTOS
THE WIRE WITH PERMANENT INSULATION
Take a close look at the insulation on this Warner "ICB" Electric Clutch-Brake. The wire that conveys the current from the collector ring to the magnet requires an insulation that is heat resistant to $300^\circ F$ at $110 \text{ v}$.

When the Warner Electric Brake Manufacturing Company put this problem up to Bentley, Harris, they got complete performance data on BH Extra Flexible Fiberglas Sleeving and samples for laboratory test. Here is what they found:

"BH Fiberglas Sleeving fully meets our requirements for insulation of electric brakes used on industrial machinery."

**BH Fiberglas Sleevings** are made to meet specific requirements — double-braided, triple-braided, heat resistant to $1200^\circ F$, if necessary. Remarkably flexible — can be spread to cover knobs or terminals, cannot dry out. Non-fraying — without use of hardening varnish or lacquer.

If you have a problem of insulation breakdown caused by high heat, extreme cold, harmful gases, grease or moisture, try BH Fiberglas Sleeving in your plant, in your product.

FM LEADER!

110-mc ring-seal power tetrode streamlined for new transmitters. Forced-air-cooled. A pair will put out more than 3 kw, with only 120 w drive required!

Also best for your final stage because...

1. Tube installation or replacement takes only a few seconds (see sketch).
2. Wide terminal-contact areas greatly increase h-f efficiency.
3. Internal shielding is complete... tube inductance low... little if any neutralizing is needed.

To tailored to your needs as builder or designer of new broadcasting equipment, Type GL-7D21 is the right tube for medium-power FM. Check the lower drive requirement of 120 w—real economy!—against an output (push-pull in open-line circuits with proper external shielding) of well over 3 kw. Note the convenience of forced-air cooling!

Study the tube's other advantages given above, then add plus-features like silver-plated contacts to reduce i-f losses; strong, lasting Fernico metal-to-glass seals; trim contour and compact construction to match the other advanced components of your ultra-modern transmitter.

One of a distinguished family of ring-seal power tubes for FM and television, the GL-7D21's brilliant all-around performance also marks these larger types:

GL-5513. A 220-mc forced-air-cooled triode, with typical Class C output (per tube) of 2.45 kw.
GL-5518. A 110-mc forced-air-cooled triode with typical Class C output (per tube) of 6.4 kw.
GL-9C24. A 220-mc triode, cooled by water and forced air, with typical Class C output (per tube) of 9 kw.

In this group is a tube directly suited to your requirements, no matter what type or size transmitter now is on your drawing-boards. For prices and detailed information phone your nearby G-E electronics office, or write to: Electronics Department, General Electric Company, Schenectady 5, New York.

CHARACTERISTICS

Filament voltage current
6.3 v 3C amp
Interelectrode capacitances:
grid-plate
9.4 mmfd
grid-screen
9.4 mmfd
plate-screen
4.4 mmfd
Plate plate output
110 mc
Type of cooling
forced-air
Max plate ratings, Class C telegraphy:
voltage
4,000 v
current
3,000 amp
dissipation
1,200 w

Sketch shows how easily the GL-7D21 can be plugged into a coaxial socket. Ring-seal design also provides ample contact surface for all terminals.

ONE OF A DISTINGUISHED FAMILY OF RING-SEAL POWER TUBES FOR FM AND TELEVISION, THE GL-7D21'S BRILLIANT ALL-AROUND PERFORMANCE ALSO MARKS THESE LARGER TYPES:

GL-5513. A 220-MC FORCED-AIR-COOLED TRIODE, WITH TYPICAL CLASS C OUTPUT (PER TUBE) OF 2.45 KW.
GL-5518. A 110-MC FORCED-AIR-COOLED TRIODE WITH TYPICAL CLASS C OUTPUT (PER TUBE) OF 6.4 KW.
GL-9C24. A 220-MC TRIODE, COOLED BY WATER AND FORCED AIR, WITH TYPICAL CLASS C OUTPUT (PER TUBE) OF 9 KW.

TWO OF A DISTINGUISHED FAMILY OF RING-SEAL POWER TUBES FOR FM AND TELEVISION, THE GL-7D21'S BRILLIANT ALL-AROUND PERFORMANCE ALSO MARKS THESE LARGER TYPES:

GL-5513. A 220-MC FORCED-AIR-COOLED TRIODE, WITH TYPICAL CLASS C OUTPUT (PER TUBE) OF 2.45 KW.
GL-5518. A 110-MC FORCED-AIR-COOLED TRIODE WITH TYPICAL CLASS C OUTPUT (PER TUBE) OF 6.4 KW.
GL-9C24. A 220-MC TRIODE, COOLED BY WATER AND FORCED AIR, WITH TYPICAL CLASS C OUTPUT (PER TUBE) OF 9 KW.

In this group is a tube directly suited to your requirements, no matter what type or size transmitter now is on your drawing-boards. For prices and detailed information phone your nearby G-E electronics office, or write to: Electronics Department, General Electric Company, Schenectady 5, New York.

GL-7D21
RING-SEAL CONTACTS
FILAMENT
GRID
SCREEN GRID
K-F GROUND PLANE

Sketch shows how easily the GL-7D21 can be plugged into a coaxial socket. Ring-seal design also provides ample contact surface for all terminals.

CHARACTERISTICS

Filament voltage current
6.3 v 3C amp
Interelectrode capacitances:
grid-plate
9.4 mmfd
grid-screen
9.4 mmfd
plate-screen
4.4 mmfd
Plate plate output
110 mc
Type of cooling
forced-air
Max plate ratings, Class C telegraphy:
voltage
4,000 v
current
3,000 amp
dissipation
1,200 w

ONE OF A DISTINGUISHED FAMILY OF RING-SEAL POWER TUBES FOR FM AND TELEVISION, THE GL-7D21'S BRILLIANT ALL-AROUND PERFORMANCE ALSO MARKS THESE LARGER TYPES:

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In this group is a tube directly suited to your requirements, no matter what type or size transmitter now is on your drawing-boards. For prices and detailed information phone your nearby G-E electronics office, or write to: Electronics Department, General Electric Company, Schenectady 5, New York.
POTTER & BRUMFIELD, foremost supplier of relays to industry, now makes available for the first time their Series MTA telephone type relays for AC operation up to 220 volts 60 cycles. "Smaller than your thumb", this midget relay, weighing only 1-1/4 oz., measures 1-1/2" x 1-7/32" x 11/16".

With the MTA series, rectification is no longer needed to obtain chatter-free operation. This relay is the same size as the long famous MT series which is supplied for DC operation.

The MTA is fitted with twin palladium contacts which will carry approximately 2 amperes non-inductive load and is available in single or double spring stack with any contact combination up to 12 springs. The baked varnish impregnated coil will stand constant duty with dissipation of only .50 to .75 watts and will operate on varying line source within 18% of rated voltage without hum.

Either the MTA for AC or MT for DC meet UL and JAN specifications and are essentially shock or vibration proof. They are practically suited to aircraft application.

Developed to meet the requirements of today's exacting miniaturization program, the MTA relay is only one of POTTER & BRUMFIELD'S answers to the demand for reliable miniature component parts for control equipment.

150 standard basic models for power, telephone, plate circuit, motor starting and all general applications, or we will design and produce practical relays for special requirements. Tear-out this ad and ph it to your letterhead for New Relay Catalog.

Potter & Brumfield
SALES COMPANY
549 WEST WASHINGTON ST., CHICAGO 6, ILLINOIS • FACTORY PRINCETON, INDIANA
EXPORT 2020 ENGINEERING BLDG., CHICAGO 6, ILL. • CABLE ADDRESS ENOTS
Your Electronics Parts Distributor stocks many models of P & B relays

www.americanradiohistory.com
ELECTRONICS — October, 1948

Look about you . . . check the equipment shows . . . thumb through the trade magazines . . . talk to design engineers . . . yes, the Eimac 4-125A power tetrode is the standout vacuum tube, accepted in all fields of electronic endeavor for its stability, long-life and dependability.

Each tube is backed by the combined engineering resources of Eitel-McCullough plus over a million hours of proven field-service. It’s Pyrovac® plate is highly resistant to momentary overloads and contributes to the tube’s long life. Processed grids control primary and secondary emission, providing a high degree of operational stability. The tube is ruggedly designed to withstand abnormal physical as well as electrical abuse.

Detailed data and application notes are immediately available and statistics for unusual applications will be supplied on request.

EITEL-McCULLOUGH, INC.
204 San Mateo Ave., San Bruno, California
Export Agents: Fraser & Hansen, 310 Clay Street, San Francisco 11, California

*Reg. Trade Mark

| Filament: Thoriated tungsten | Voltage: 6.5 volts | Eimac Technology and Oscillator
|-----------------------------|-------------------|-----------------------------
| Grid Current                | -35 MA.           | Audio Frequency Power Amplifier and Modulator
| D.C. Plate Voltage          | 300 MAX. VOLTS    | Class AB (Sinusoidal wave, two tubes unless otherwise specified)
| D.C. Screen Voltage         | 355 MAX. VOLTS    | Class AB (Sinusoidal wave, two tubes unless otherwise specified)
| D.C. Grid Voltage           | 155 MAX. VOLTS    | TYPICAL RATINGS
| D.C. Grid Current           | 167 ma.           | D.C. Plate Voltage
| D.C. Screen Current         | 42 ma.            | 1300 MAX. VOLTS
| D.C. Screen Dissipation     | 14 ma.            | 460 MAX. VOLTS
| Direct Dissipation          | 2.2 watts         | 13,400 MAX. VOLTS
| Typical Operation (Currents below 150 Ma.) | | 30,000 MAX. VOLTS
| D.C. Plate Voltage          | 2500 3300 volts   | 105 MAX. VOLTS
| D.C. Screen Voltage         | 350 350 volts     | 100 MA. MA.
| D.C. Grid Voltage           | 150 150 volts     | 500 500 volts
| D.C. Grid Current           | 150 ma.           | 600 600 watts
| D.C. Screen Current         | 45 ma.            | 400 400 watts
| D.C. Screen Dissipation     | 10 ma.            | 250 250 watts
| Direct Dissipation          | 1.8 1.8 watts     | 250 250 watts
| Typical Operation (Currents below 150 Ma.) | | 150 150 watts
| D.C. Plate Voltage          | 3000 3500 volts   | 150 150 watts
| D.C. Screen Voltage         | 400 400 volts     | 150 150 watts
| D.C. Grid Voltage           | 250 250 volts     | 150 150 watts
| D.C. Grid Current           | 250 ma.           | 150 150 watts
| D.C. Screen Current         | 45 ma.            | 150 150 watts
| D.C. Screen Dissipation     | 10 ma.            | 150 150 watts
| Direct Dissipation          | 1.8 1.8 watts     | 150 150 watts
| Typical Operation (Currents below 150 Ma.) | | 150 150 watts
| D.C. Plate Voltage          | 2500 2500 volts   | 150 150 watts
| D.C. Screen Voltage         | 300 300 volts     | 150 150 watts
| D.C. Grid Voltage           | 150 150 volts     | 150 150 watts
| D.C. Grid Current           | 150 ma.           | 150 150 watts
| D.C. Screen Current         | 45 ma.            | 150 150 watts
| D.C. Screen Dissipation     | 10 ma.            | 150 150 watts
| Direct Dissipation          | 1.8 1.8 watts     | 150 150 watts
| Typical Operation (Currents below 150 Ma.) | | 150 150 watts
| D.C. Plate Voltage          | 2500 2500 volts   | 150 150 watts
| D.C. Screen Voltage         | 300 300 volts     | 150 150 watts
| D.C. Grid Voltage           | 150 150 volts     | 150 150 watts
| D.C. Grid Current           | 150 ma.           | 150 150 watts
| D.C. Screen Current         | 45 ma.            | 150 150 watts
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| D.C. Grid Current           | 150 ma.           | 150 150 watts
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| D.C. Screen Dissipation     | 10 ma.            | 150 150 watts
| Direct Dissipation          | 1.8 1.8 watts     | 150 150 watts

Eimac Pyrovac Plates • Processed Grids

NATIONAL INDUSTRY FOR ELECTRONICS AND PHONOGRAPHIC EQUIPMENT

EIMAC® TUBES
THE POWER FOR B-F
for the **BEST** in reception and performance use

"**NOFLAME-COR**"

the **TELEVISION** hookup wire

by **CORNISH**

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Chosen after exhaustive tests by leading manufacturers of 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**.

**COMPLETE ENGINEERING DATA AND SAMPLES ON REQUEST**

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**RUBBER** 75°

**PLASTIC** 80°

"**NOFLAME-COR**" 90°

"**made by engineers for engineers**"

**CORNISH WIRE COMPANY, Inc.**

605 North Michigan Avenue, 15 Park Row, New York 7, N. Y.

1237 Public Ledger Bldg., Philadelphia 6

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

October, 1948 — **ELECTRONICS**
Alliance Model B is another new, 4-pole shaded type induction motor. It is especially adapted to fan blades and other mechanical loads. This motor is made in three standard stack thicknesses with variable horsepower ratings for particular operating conditions such as fan loads—other mechanical loads—continuous or intermittent duty. And to further meet varied load requirements, Alliance Model B can be supplied semi-enclosed as illustrated or completely enclosed with oil tubes and oilers.

With a range of power ratings from 1/100 h.p. up to 1/25 h.p. and a speed of 1550 rpm, Model B, like all Alliance motors lends itself to mass production at low cost.

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

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

### Engineering Features of the Allied Type "RA" Relay

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

**Coil Rating:** Up to 110 volts D.C. and 115 volts A.C. 60 cycles.

<table>
<thead>
<tr>
<th>No.</th>
<th>Volts</th>
<th>D.C.</th>
<th>Current</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>6</td>
<td>.46</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>12</td>
<td>.32</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>26.5</td>
<td>.083</td>
<td>320</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>48</td>
<td>.060</td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>110</td>
<td>.026</td>
<td>4100</td>
<td></td>
</tr>
</tbody>
</table>

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

**Dimensions:** 2" x 2 7/8" x 1 1/2". **Weight:** 4 oz.

NON-CORROSIVE  NON-CONDUCTIVE

"Resin-Five" is virtually without odor at relatively high temperatures!

"Resin-Five is Available In 5 Core Sizes with Varying Percentages of Flux Content. Diameters ranging from .010" to .250"—All Practical Alloys!

"Resin-Five" is so mobile it is highly effective in sweating seams. The activity and stability of "Resin-Five" Flux make this an accomplished fact!

"Resin-Five" is STABLE under the most extreme soldering temperatures and the flux still does the job!

Contact Kester's Technical Department and get the facts on this unusual product.

KESTER SOLDER COMPANY
4201 W. Wrightwood Avenue, Chicago 39, Illinois
Factories also at Newark, N. J. • Brantford, Canada
HOW American Phillips Screws

"Make Better Sport"

both for Makers and Users of Sporting Goods

THEY MAKE WORK EASIER... in fact, American Phillips Screws make assembly a pleasure because, as one user says: "They're 3 times faster to find and drive!" And they're far easier to handle, to drive at angles, and into cranky inside corners. Any worker who "goes crooked" with slotted screws will "go straight" with American Phillips... the only screw with the tapered, engineered recess. Fatigue is banished. Production stays up all day long. And time-savings, too, stay up around 50%.

THEY MAKE SELLING EASIER... American Phillips Screws look new, modern, craftsman-like... plainly say: "Here's a top-quality product!" And when your dealers sell the whole story of American Phillips extra holding strength, vibration-resistance, and greater dependability in strenuous use... then watch sales-resistance melt away. Get these double-barreled production and sales advantages for your product. Write.

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

AMERICAN PHILLIPS Screws

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

October, 1948 — ELECTRONICS
At Last—

a truly portable Field-Intensity Meter

Weighing only 12 1/2 pounds—including batteries, here's a small, compact field-intensity meter of high accuracy that carries around like a portable radio...and operates almost as simply. You tune in a signal, adjust a built-in calibrating oscillator and receiver gain...and read signal intensity directly in microvolts-per-meter. No charts, curves, or correction factors to worry about. No computations to make.

Designed with a wide sensitivity range of 10 microvolts/meter to 10 volts/meter, Type WX-2A enables you to make field-strength readings anywhere—from the very shadow of your transmitter, to the toughest location "down-in-the-noise." Plenty of front-end selectivity, too. Loop antenna Q is approximately 100 at one megacycle; An r-f amplifier stage provides a very high order of image rejection.

Power supply; Ordinary flashlight dry cells for the quick-heating tube filaments—and a 67-volt battery of the size used in camera-type radios for the B supply.

A lot easier now to get the facts on your coverage, service area, and antenna efficiency...with RCA's new portable WX-2A. Ask your RCA Broadcast Sales Engineer for the facts. Or write Department 36-J, RCA Engineering Products, Camden, New Jersey.

BROADCAST EQUIPMENT
RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal
KENYON one of the oldest names in transformers, offers high quality specification transformers custom-built to your requirements. For over 20 years the KENYON "K" has been a sign of skillful engineering, progressive design and sound construction.

KENYON now serves many leading companies including: Times Facsimile Corporation, Western Electric Co., General Electric Co., Schulmerich Electronics, Sperry Gyroscope Co., Inc.

Yes, electronification of modern industrial machinery and methods has been achieved by KENYON'S engineered, efficient and conservatively rated transformers.

For all high quality sound applications, for small transmitters, broadcast units, radar equipment, amplifiers and power supplies — Specify KENYON! Inquire today for information about our JAN approved transformers.

Check Your Requirements

"T" LINE TRANSFORMERS
HERMETICALLY SEALED TRANSFORMERS
"A" LINE TRANSFORMERS

- PLATE TRANSFORMERS
- FILAMENT TRANSFORMERS
- REACTORS
- CHOSES
- MODULATION TRANSFORMERS
- INTERSTAGE TRANSFORMERS
- INPUT & OUTPUT TRANSFORMERS
- SPECIAL FREQUENCY TRANSFORMERS
- ISOLATION TRANSFORMERS
- AUDIO TRANSFORMERS
- HUMBUCKING TRANSFORMERS
- AUTO TRANSFORMERS

Now — for the first time in any transformer catalog, KENYON'S new modified edition tells the full complete story about specific ratings on all transformers. Our standard line saves you time and expense. Send for the latest edition of our catalog now!

SEND FOR OUR CATALOG NOW!

KENYON Transformer Co., Inc.
840 Barry Street, New York 59, N. Y.
Send me the latest edition of your new catalog without obligation

Name: ___________________________ Address: ___________________________

Position: ________________________ City: _________________________________

Company: ________________________ State: ________________________________
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

Flexural and Compressive Strength

No. 9
in a series of advertisements on
dielectric theory and testing —
designed to help in the selection
of electrical insulating materials.

Mechanical and electrical stresses encountered in electrical equipment confront the designer with many factors to weigh in selecting the insulating material which will provide optimum performance characteristics.

In some applications, what might seem conservative design from the standpoint of electrical stress is explained by other performance essentials. Why, for example, for insulating commutator bars in small dc motors, should a material of such high dielectric strength as mica segment plate be used, when electrical stress between bars is only a few volts? The reasons are found in other requirements that only mica satisfies: temperature resistance, moisture resistance, non-carbonization under poor commutating conditions, a uniform rate of compression and ability to stay in place under repeated temperature fluctuations.

In large rotating machines, peripheral speeds are high; extreme compressive, flexural, tensile and abrasive forces are encountered. Voltage may also be quite high. Because efficiency depends upon the amount of conducting (and not insulating) material in the slots, electrical insulation must be quite thin yet possess high dielectric strength.

WEIGH ALL FACTORS

Insulation performance requirements are as varied as the types of electrical equipment manufactured. Standard methods of testing established by the ASTM supply important values for comparison, specification and design.

FLEXURAL STRENGTH TEST

This test determines the load in pounds required to break a test specimen of sheet or plate material loaded at the center as a simple beam. Supports and loading nose of the testing apparatus have contact edges rounded to a radius of 1/4" for material 1/8" thick or over, and to a radius of 1/16" for thinner materials. Distance between the supports is 4" for edgewise tests and eight times material thickness for flatwise tests.

Test specimens are 1/2" in width, except for specimens over 1/4" thick being tested flatwise, where the width is made equal to the specimen thickness.

Test reports include: (1) directions of cutting and loading the specimen; (2) thickness and width of each specimen to the nearest 0.001"; (3) the room temperature; (4) breaking load in pounds; (5) maximum fiber stress in pounds per square inch calculated from the formula:

\[
S = \frac{9Pl}{2bd^2}
\]

where \(S\) = maximum fiber stress, \(P\) = breaking load in pounds, \(l\) = distance between supports, \(b\) = width of specimen, and \(d\) = depth of specimen.

COMPRESSION STRENGTH TEST

Apparatus for the compressive strength test is illustrated in Figure 1. Test specimen for sheets 1" thick or over is a 1" cube with faces flat and perpendicular to the axis. Where sheets are less than 1" thick, the specimen consists of a pile of sheets 1" square at least 1" high.

Where material under compression fails by a shattering fracture, the compressive strength has a definite value. Where the material does not fracture, the value obtained for compressive strength is an arbitrary value, depending upon the degree of distortion allowed as indicating failure.

Test reports include: (1) significant dimensions of each specimen; (2) load on each specimen in pounds at time of failure; (3) ultimate compressive load strength in pounds per square inch calculated from measured area before load is applied; (4) description of material and how it acts under test; and (5) room temperature.

ASTM Designation D229-46.

LAMICOID SHEETS — AVERAGE VALUES

<table>
<thead>
<tr>
<th>NEMA GRADE</th>
<th>Flexural Strength, psi</th>
<th>Compressive Strength Flattwise, psi</th>
<th>Dielectric Strength v/m. 1/16&quot; to 1/8&quot; Short Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>23000</td>
<td>35000</td>
<td>500</td>
</tr>
<tr>
<td>P</td>
<td>15000</td>
<td>22000</td>
<td>500</td>
</tr>
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<td>16000</td>
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<td>500</td>
</tr>
<tr>
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<td>35000</td>
<td>150</td>
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<td>LE</td>
<td>19000</td>
<td>37000</td>
<td>360</td>
</tr>
<tr>
<td>A</td>
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<td>36000</td>
<td>160</td>
</tr>
<tr>
<td>AA</td>
<td>20000</td>
<td>38000</td>
<td>50</td>
</tr>
</tbody>
</table>

Figure 1 — Typical design of tool for making compressive strength tests.

October, 1948 — ELECTRONICS
A limiting factor in performance efficiency and service life of electrical equipment is the dependability of the insulating materials used. Electrical, chemical and physical environments each demand performance standards that make the selection of the right material a difficult design problem. To meet varied needs, Mica Insulator Company has developed a complete line of products, each offering specific advantages depending upon requirements. Typical applications are illustrated.

**LAMICOID** brackets provide the high mechanical strength necessary for bracing end-woundings against short circuit stresses. This thermosetting laminated material may be used for spacers placed at frequent intervals between coils, as well as for braces to which the coils are lashed with strong cords. Clamps or cleats of the same material may be attached to provide rigidity to prevent movement of the coils.

**MICANITE** segment plate composed of amber mica splittings, finds primary application in flush-type commutators, as in this dc motor, where mica and copper wear down uniformly. For under-cut commutators, Micanite composed of India mica splittings is more economical. Segment Micanite contains approximately 94% mica and 6% binder, and is manufactured for minimum compressibility under heat and pressure. Films do not slip or exude cement when properly assembled.

**EMPIRE** varnished Fiberglass provides high tensile strength, small stretch and flexibility needed when insulating leads to this 15,000 KVA, 3-phase, 60-cycle outdoor type transformer. Varnished Fiberglass is a Class B insulation which will withstand a "hottest-spot" temperature of 190° C (374°F). The impregnating varnish, from which electrical characteristics are derived, shows unusual resistance to erosion and ozone, especially important for high-voltage applications. Varnished Fiberglass also resists moisture and most acids.

Fifty-five years of specialized experience in the development, manufacture and improvement of electrical insulating materials has enabled Mica Insulator Company to keep pace with the increasingly exacting requirements of electrical equipment builders. We welcome the opportunity to work with you in the selection and application of our complete line of materials. Consult our Technical Service Department on your insulating problems.

**Insulator Company**

SCHENECTADY 1, NEW YORK

Atlanta • Birmingham • Boston • Chicago • Cincinnati • Cleveland • Detroit • Houston
Los Angeles • Milwaukee • New York • Philadelphia • Rochester • St. Louis • San Francisco

ELECTRONICS — October, 1948
WE CAN HELP YOU WITH

Energy-Storage Capacitors!

Our experience—in engineering, designing, and building performance into energy-storage and discharge capacitors—may provide just the help you are looking for.

Do you make discharge welding or photographic flash-tube equipment? Radar equipment? Flash beacons, aircraft signalling, or similar devices? Or research tools, from spectrosopes to cyclotrons? We have furnished a large proportion of the capacitors used for all of these applications.

Unusual applications, too—like those listed below—are a specialty with us. Whatever your problem, let our engineers give you a hand. Apparatus Dept., General Electric Company, Schenectady 5, N. Y.

NEED SQUARE WAVES? Pulse-forming networks can provide them. Networks are used where the normal capacitor discharge wave shape is not suitable and where an impulse must have definite energy content and duration. The Type B network, produced by General Electric, consists of capacitor and coil sections, adjusted to close tolerances, and hermetically sealed in single metal containers. Built by the thousands for radar, they are now available for commercial use.

NEED ARTIFICIAL LIGHTNING? Potent artificial lightning bolts—at voltages up to 10,000,000—are not a usual need. But when required—for universities, laboratory testing, or exhibition—General Electric can build the capacitors. A typical example is the 100-kv d-c unit, about 3 feet in diameter and 2 feet high. Units can be stacked, as shown, for ease of installation and minimum space. In some instances as many as 100 separate units have been placed in series to produce 10,000,000 volt discharges.

OR DO YOU WANT TO TAKE A PICTURE? A maker of flash-tube photographic equipment wanted a lighter capacitor for his portable sets. Our designers went to work and came up with just what he desired—and one which he could use, also, for his studio equipment at a considerable saving in price. (In case you're interested, this capacitor is rated 14 muf, weighs 2½ lb, and delivers 3.8 watt-seconds with 1000 hour service life or 53 watt-seconds at 400 hours. Used in pairs, they replace a 28 muf-studio capacitor, save in cost too.)

GENERAL ELECTRIC

ELECTRIC

Specialty Capacitors
FOR

Motors
Luminous-tube transformers
Fluorescent lamp ballasts

Industrial control
Radio filters
Radar
Electronic equipment
Communication systems
Capacitor discharge welding

Flash photography
Stroboscopic equipment
Television
Dust precipitators
Radio interference suppression
Impulse generators

AND MANY OTHER APPLICATIONS

October, 1948 — ELECTRONICS

www.americanradiohistory.com
Some call it:  
SLIP RING ASSEMBLY

Some call it:  
COLLECTOR RING ASSEMBLY

Some call it:  
ROTOR ASSEMBLY

When you break wires to permit free rotation—that is where this PMI specialty comes in. We are currently handling all phases of this type of work, including design, manufacture of prototypes and production assemblies. PMI experience includes monitoring, video and power circuit requirements. We are manufacturing on a volume basis production assemblies ranging from 3-circuits to more than 200. Let us consult with you on your requirements.

PLASTIC MANUFACTURERS
STAMFORD INCORPORATED CONNECTICUT

INJECTION • TRANSFER & COMPRESSION MOLDING • COMPLETE ASSEMBLY

ELECTRONICS—October, 1948
Engineers, Designers, Production and Maintenance men... in fact everyone in the electrical and electronic industries can use the MITCHELL-RAND WALL CHART OF TABLES AND DATA to excellent advantage. Easy to read... it contains data and tables used most often... write for your copy today... on your company letterhead.

There are no restrictions to the Mitchell-Rand offer to distribute Wall Charts to members of the Electrical and Electronic Industries except that requests must be on company letterheads—write for your copy today, free for the asking.

MITCHELL-RAND INSULATION CO. Inc.
51 MURRAY STREET • Cortlandt 7-9264 • NEW YORK 7, N.Y.
The dependability of Hi-Q components contained in your finished product will enhance your reputation as a manufacturer of quality equipment. The dependability of Hi-Q components is the result of meeting exacting specifications which insure their conformance to your requirements...temperature coefficients within recommended tolerances, insulation resistances to minimum standards, capacities as specified. Hi-Q dependability results from the use of highest quality materials and from constant surveillance throughout processing...your assurance of efficient, dependable service. Write for detailed information and engineering specifications.

**Hi-Q COMPONENTS**

**CERAMIC CAPACITORS**

Hi-Q Ceramic Capacitors of unquestionable stability assure you the ultimate in performance for all electronic appliances. Let us assist you with your Ceramic Capacitor problems.

**CHOKE COILS**

**STAND-OFF CONDENSERS**

**WIRE WOUND RESISTORS**

**Hi-Q COMPONENTS**

**BETTER 4 WAYS**

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

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

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

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

**Electrical Reactance Corp.**

Franklinville, N. Y.


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

Electronics — October, 1948

www.americanradiohistory.com
Memo to... DESIGN ENGINEERS

about... MYCALEX 410 - MOLDED

NOW PRICED TO MEET RIGID ECONOMY REQUIREMENTS

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

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

www.americanradiohistory.com
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&quot;</td>
</tr>
<tr>
<td>2 Insulator</td>
<td>Electrical Instrument</td>
<td>None</td>
<td>3.18</td>
</tr>
<tr>
<td>3 End Seal</td>
<td>Thermostat Shell</td>
<td>Stainless Steel</td>
<td>3.75</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 Water</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>
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<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>4.69</td>
</tr>
<tr>
<td>16 Insulator</td>
<td>Telephone Transmitter</td>
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<td>0.88</td>
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<tr>
<td>17 Dual Bushing</td>
<td>Oil Burner Transformer</td>
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<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>
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<td>1.44</td>
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<tr>
<td>20 Actuating Bar</td>
<td>Telephone relay</td>
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<tr>
<td>21 Spacer</td>
<td>Radio Vibrator</td>
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</tr>
<tr>
<td>22 Panel</td>
<td>Television Selector Switch</td>
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<td>1.75</td>
</tr>
<tr>
<td>23 Spacer</td>
<td>Telephone relay</td>
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</tr>
<tr>
<td>24 Spacer</td>
<td>Relay</td>
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</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>
Television waveforms selected even to the scanning line and fraction of that line, for critical study or recording, with the new

DU MONT
Type 280
Cathode-ray
OSCILLOGRAPH

Du Mont proudly announces the new Type 280 Cathode-Ray Oscillograph especially designed for television studio and transmitter installations. Here at last is a means for accurately determining the duration and shape of the waveform contained in the composite television signal, as well as the character of the picture-signal video in conjunction with transmitter operation, according to FCC standards and practices.

Excellent for research on all television equipment. Also for study of wide-band amplifiers. Well suited for industrial use wherever high-speed single transients are studied. Consists of four units mounted on standard relay-rack type panels and chasses, and installed on mobile rack. Removable side and rear panels. Grouped controls for easy operation.

By virtue of its great range of applications, Type 280 becomes a "must" for television studio and research laboratory.

Further Details on Request!

© Allen B. Du Mont Laboratories, Inc.
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.
These general-purpose panel instruments are particularly suitable for use in radio equipment and industrial applications where accuracy and quality are required and space is at a premium. Many of the instruments have been newly styled for better readability and for the smooth, modern appearance that will help give your panels a well-engineered look.

Thermocouple-type instruments, for measurements of high-frequency alternating current in radio or other electronic circuits, are available. There is also a complete line of rectifier types (a-f), for measuring alternating current or voltage at high frequencies or where the source is not sufficient to operate conventional a-c instruments. Typical applications include television transmitters, radar wave meters, testing equipment for electronic circuits. For a full story of G-E instruments, send for Bulletin GEC-227.
Digest

CAGED FOR PROTECTION

Suitable for wall or panel mounting, these cage-type, enameled resistor units employ a strong, high-best-resisting silicate-compound body which withstands sudden and extreme temperature charges without weakening or in any way being injured. The resistance wire has a low temperature coefficient so that the resistance remains nearly constant as the temperature increases. Ample protection to the units is provided by the perforated metal case. Each unit is rated at 85 watts and is available in resistance values from 0.5 to 100,000 ohms; one to four units in a cage. For more complete information please contact your G-E representative.

NEED A "LOW VA" VOLTAGE STABILIZER?

General Electric's latest additions to its line of automatic voltage stabilizers are three 115-volt, 60-cycle designs in 15-, 25-, and 50-va ratings. Check the low prices—you may now be able to utilize the advantages of an automatic voltage control for your application. The price consideration plus the low case height and small size will make these units especially applicable to radio chassis and other shallow-depth installations. Other features include totally insulated design, which is necessary where isolation is required between primary and secondary circuits, and universal lead construction which makes these units adaptable to various wiring and mounting arrangements. If you have an application problem, contact your G-E representative, or check bulletin GEA-3634B.

SOMETHING NEW IN CIRCUIT CONTROL DEVICES

Simplify your circuit designs by replacing complicated and costly components with simple, economical G-E Thermostors. These electronic semiconductors are unique in that the resistance changes rapidly with slight variations in temperature—electrical resistance decreases as temperature rises, and increases as temperature falls. G-E Thermostors give you these five advantages: flexible in application, small in size, available in various shapes, indefinitely stable, and they are economical. These new circuit devices are especially adaptable as sensitive elements in flow meters, liquid-level gages, time-delay relays, vacuum gages, switching devices, and modulating thermostatic circuits. Check coupon for technical report CDM-9.

HERMETIC SEAL ELIMINATES MOISTURE PROBLEMS

The new cast-glass bushings with their sealed-in metal hardware can be readily welded, soldered, or brazed directly to the apparatus, thus eliminating gaskets and providing a better seal than ever before. The small, compact structure of the bushings often makes it possible to reduce the overall size and weight of the electric apparatus. Bushings are practically unaffected by weathering, microorganisms, and thermal shock. Their great mechanical strength makes them well suited for use in airplanes, etc., where they are subject to continual vibration. Available in ratings up to 8.6 kv and for currents to 1200 amperes. Check bulletin GEA-5093.

MORE SOLDERING WITH LESS POWER

G.E.'s midget soldering iron can do a big job for you with only one-fourth the wattage usually used. This handy 6-volt, 25-watt iron is only 8 inches long (with 3/8 or 1/4 tips) and weighs but 13/4 ounces. It was especially designed for close-quarter, pin-point precision soldering. The "midget" offers you all these advantages: low-cost soldering; "fingertip" operation; quick, continuous heat; easy renewal; long life; low maintenance. The iron is a real aid in manufacturing radios, instruments, meters, electric appliances, and many other products requiring precision soldering. Irons and specially designed 115/6-volt transformers are available from stock. Check bulletin GES-3488.

TIMELY HIGHLIGHTS
ON G-E COMPONENTS

GENERAL ELECTRIC COMPANY, Section E642-18
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:

☐ GEC-227 Instruments  ☐ GEA-5093 Cast-Glass Bushings
☐ GES-3488 Midget Soldering Iron  ☐ CDM-9 Thermistors
☐ GEA-3634B Voltage Stabilizer

Name

Company

Address

City State

ELECTRONICS — October, 1948

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For KDKA — "America's Pioneer Station"—Blaw-Knox—America's pioneer builder of radio towers recently furnished this 500 ft. H-40 heavy duty tower.

The location of the tower on a rise overlooking Pitt Stadium and adjacent to buildings of the University of Pittsburgh made it imperative that station engineers select a structure of sufficient built-in strength to provide a high factor of safety in this congested area.

The Blaw-Knox heavy duty H-40 tower, supporting an FM and television antenna is not only adequate to meet these provisions but is also rugged enough to take care of any reasonable changes in equipment which might arise in the future.
Here's Real News!

AC-DC TELEVISION MADE POSSIBLE FOR THE FIRST TIME

Trend Is to New Low Prices for Lighter, Smaller 7" and 10" TV Sets

SMALL, COMPACT POWER SUPPLY HANDLES AM-FM-TV COMBINATION

All Resulting from Federal's New Miniature 500 MA Selenium Rectifier

Yes, this mighty miniature makes big television headlines! Its hitherto unapproached power-handling capacity promises a virtual revolution in television design. Think of the possibilities—a single Selenium Rectifier power supply able to handle an AM-FM-TV combination...AC-DC television...drastic reductions in size, weight and price of 7" and 10" sets.

These important savings result not only from the small size of this new Federal Miniature Selenium Rectifier, but its elimination of large, heavy, expensive transformers and expendable rectifier tubes in the power supply. What's more, it can be used with smaller condensers with lower voltage ratings.

Here's the diagram of a suggested circuit for an AC-DC power supply for 7" and 10" electrostatic deflection tubes.

Capitalise on these design advantages and the instant starting, cool and efficient operation of Federal Miniature Selenium Rectifiers. For technical data, write to Department F213.

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.

www.americanradiohistory.com
In the 1948 electronics Issue of the BUYERS’ GUIDE the following list of 270 manufacturers’ advertising appears.

This list is indicative of the all-inclusive scope of specifying, buying and reference advertising of products which appears in the Buyer’s Guide — and is convincing evidence of the industry-wide acceptance of the issue for its advertising value.

Artem Electric Corp.
Adams & Westlake Co.
Advanced Electric and Relay Co.
Aircraft-Marine Products Inc.
Atronic
Allen Co., Inc., L. B.
Allied Manufacturing Co.
Allied Control Co., Inc.
Aluminum Screw Products Co.
American Gas Accumulator Co.
American Lamp Corp.
American Phenolic Corporation
American Platinum Works
American Television and Radio Co.
American Transformer Products, Inc.
American Transformer Company
Amperite Co.
Arens Corporation
Art-Lloyd Metal Products Corp.
Art Wire and Stamping Co.
Astatic
Atomic Instrument Co.
Audio Development Corp.
Audio Devices, Inc.
Avionics Sales, Rosewell Corp.
Ballantine Laboratories, Inc.
Barber Labs., Alfred W.
Baron & Wilm, Inc.
Barry Corporation
Beckman Industries
Bead Chain Manufacturing Co.
Beckhav Electronics Laboratory
Bendix-Philco Corporation
Bendix Wire and Cable Div.
Bendix-Wilson Co.
Bent Manufacturing Co., Inc.
Beta Electronics Co.
B-G Electronics, Inc.
Bixwax Corporation
Biley Electric Mfg. Co.
Billard and Reese Inc., Publishers
Bromo-Seltzer Mfg. Co., Inc.
Brookfield Manufacturing Co.
Brooklyn Insulated Wire Co.
Boston Insulated Wire and Cable Co.
Bradley Laboratories
Bradshaw Instruments Co.
Braine Co.
Brand and Co., William
British Electric Corporation
Brocell Electronics Laboratory
Brown-Blodgett Mills, Inc.
Brownning Laboratories, Inc.
Buck Electric Manufacturing Co.
Burgess Battery Company
Burrus and Company
Busmann Mfg. Co.
Cambridge Harmonic Corp.
Cannon Electric Development Co.
Center of America
C-B Manufacturing Co.
Dellanos Products, Inc.
Delnastrah, Div. of Globe-Union, Inc.
Chalmers Electronics, Inc.
Chicago Transformer, Div. of Essex Wire Company
Clansyard Speakers, Div. of Alenon Mfg. Co.
Clab Mfg. Corp.
Clark Wire & Cable Company
Cleveland Container Co.
Collier Audio Products Co., Inc.
Communication Products, Inc.
Commercial Corporation
Continental-Diamond Fibre Co.
Cromwell Corp., Inc.
Cromwell Mfg. Co.
Cramer Co., Inc.
Crest Co. Inc.
DeCourage Engineering Laboratory
DeMornay Budl., Inc.
Dial Lighting Company of America
Drake Manufacturing Co.
Driver Corporation
Drum, Will Jr.
Drwards-Harris Company
Duke, Robert, Inc.
Eastern Air Devices Inc.
Ebert Engineering and Mfg Co.
Eiler Engineering Co., Inc.
Elet-McCullough, Inc.
Emerson-Thompson Co.
Electric Indicator Co.
Electric Instruments, Inc.
Electrical Resistance Corp.
Electronic Attenuation Co.
Electro-Scel Corporation
Electro-Tech Equipment Co., Inc.
Electronic Controls Co., of New York
Electrical Transformer Co., Inc.
Elliott Manufacturing Co.
Engineering Company, Inc.
Erie Resistor Corporation
Essel Electronics
Federal Telecommunications and Radio Corp.
Ferranti Electric, Inc.
Field electronic Instrument Co.
Fisher Radio Corporation
Ford Instrument Co., Inc.
Franklin Airloop Corp.
Franklin Products Inc.
Franklin Mfg. Corp., A. W.
Gamewell Co.
Gang Specialties
General Aniline and Film Corp.
General Cement Mfg. Co.
General Ceramic and Steatite Corp.
General Electric Company
General Electronics Corp.
General Plate Diode of Metals and Controls Co.
General Radio Co.
Globe Industries, Inc.
Handy and Harmon
Harrington Electric Co.
Haskell, Inc., John
Heyden Manufacturing Co., Inc.
Heydu Brothers
Heneman Electric Co.
Herbach and Redamex, Inc.
Hewlett-Packard Company
Hillburn Electronic Products Co.
Hunzinger Corporation
Illinois Transformer Co.
Indiana Steel Products Company
Industrial Tube Corp.
Int'-X Co., Inc.
Instrument Parts Corporation
Instrument Resistors Co.
Insulation Manufacturers Corporation
Insuline Corporation of America
International Machine Works
Izard, Varnish and Insulator Co.
J-T-J Circuit Breaker Co.
J-B-T Instruments, Inc.
Kahle Engineering Co.
Karp Metal Products, Inc.
Kay Electric Company
Keithley Instruments
Kenyon Transformer Co., Inc.
Kepco Laboratories
Kester Solder Co.
Knight's Co., James
Kobly Tool Company
Kolman's Transformer Div. of Square "D" Co.
Kurman Electric Co.
K-V Transformer Corp.
Lampkin Laboratory, Inc.
Lapp Insulator Co., Inc.
Lapey Laboratories
Lear, Inc.
Leaves & Co.
Lord Manufacturing Co.
Macbeth Laboratories, Inc.
Magnetic Insulator Co.
Makepeace Co., D. E.
Mallory and Co., P. R.
Marion Electrical Instrument Co.
MB Manufacturing Co.
Measurement Engineering Ltd.
Measurements Corporation
Milton Mfg. Co., Inc., James
Mitchell-Rush Insulation Co., Inc.
Moffet, C. P.
Muller Electronic Ltd.
Mycalex Corporation of America
National Co., Inc.
National Carbon Company, Inc.
National Electronics, Inc.
National Mobilete Co.
National Varnished Fibre Co.
New York Transformer Co.
Northern Communication Mfg. Co.
Northern Radio Co., Inc.
Ohmite Mfg. Co.
Panasonic Radio Corp.
Parker Machinery and Research, Inc.
Par-Aklo Products Corp.
Phide Plastics Corp.
Phillips Central Corporation
Pickering and Co., Inc.
Polaroid Electronic Company
Polytechnic Research and Development Co., Inc.
Potter Instrument Co.
Precision Products, Div. of Chisholm-Rhee
Rogers Corporation
Presto Recorders Corp.
Productions and Engineering
Pyroelectric Co.
Radio Corp. of America
Radio-Music Corporation
Radio Replacement, Inc.
Raytheon Mfg. Co.
Reeves-Hoffman Corporation
Reeves Instrument Corporation
Reeves Soundcraft Co.
Rex Rhesotrol Corp.
Rohm and Haas, Co., Inc.
Rogers Brothers
Rome Cable Corporation
Sac Harbor Industries, Inc.
Schaefer Inc., Peter J.
Scientific Electric Div. of "S" Corrugated Quack Corporation
Scott, Inc., Herman Houser
Seeburg Corporation, J. P.
Selecta Industries, Inc.
Serto-Teks Products Co., Inc.
Sherron Electric Manufacturing Company
Shure Brothers, Inc.
Shurtite Manufacturing
Sidward Mfg. Co., Inc.
Sigma Instruments, Inc.
Signal Engineering and Mfg. Co.
Snooker and Son, C. A. F.
Sorensen & Co., Inc.
Sound Acoustics, Inc.
Speciality Battery Co.
Spheral Industries, Inc.
Sprague Electric Co., Inc.
Standard Arcturus Corp.
Standard Electrical Products Corp.
Standard Pressed Steel Co.
Standard Triumph Div. of British Aircraft Corp.
Star Expansion Products Co., Inc.
Stevens Manufacturing Co., Inc.
Super Electric Products Corp.
Superior Electric Corp.
Superior Tube Company
Teck Laboratories, Inc.
Teleax, Inc.
Terminal Radio Corp.
Tetrad Corporation
Thermionic Engineering Corp.
Thorndarson Div., Maguire Industries
Tidiplants, Inc.
Trans-ionics, Inc.
Transvision Inc.
Tung-Sol Lamp Works, Inc.
Union Carbide and Carbon Corp.
United Condenser Corporation
United States Insulation Mfg. Corp.
United Transformer Co., Inc.
Universal Winding Co.
Vacuum-Electric Engineering Co.
Varflex Corporation
Vickers, Inc.
Vulcan Electric Co.
Walker Co., George
Walker Co., Inc.
Ward Laboratories, Inc.
Ward Leonard Electric Co.
Ward Products Corporation
Waterman Products Co., Inc.
Western Electrical Products
Westinghouse Electric Corp.
Weston Electrical Instrument Corp.
White Dental Mfg. Co., S. S.
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THE BUYERS’ GUIDE is the 13TH ISSUE of electronics...
RELIT TO SUBSCRIBERS ON THE 1948 electronics BUYERS' GUIDE

The ELECTRONICS Buyers' Guide, published annually for 5 years as a part of the regular June issue of ELECTRONICS, enters its 3rd year as an individual issue—a 13th issue included with every subscription. Like Topsy, it grew too big and too important to be included in the regular issue of ELECTRONICS. Therefore, every subscriber has for the past three years received this "extra" as a bonus issue.

And this bonus has proved a boon to subscribers—if we can believe only half of what they tell us. Letters from all over the country, and abroad too, have literally poured in. The main themes have been the technical value of the Guide, its usability and the fact that it's so much of a time saver. Design engineers tell us they use it daily—keep it at their elbows—no longer have to thumb through countless individual company catalogues—purchasing agents use it for product sources, etc. And many large manufacturers* have requested copies in lots of 25 to 100 to be used by their entire engineering staffs or in their reference libraries. Flattering? Yes, but more important to us is the fact that it indicates that it dovetails in with industries' needs.

That doesn't mean that our editors or researchers are going to rest on their laurels. Hardly. They look forward to and are now planning improvements and additions. You, the subscriber, can help by making suggestions, letting us know how you use the Guide, what we've omitted that you find necessary in your work. Remember it's YOUR BOOK—and your comments and suggestions are valuable yardsticks if we are to tailor the Guide more closely to your needs.

*Names on request

TO ADVERTISERS

In making your 1949 advertising and promotion plans, we urge you to include adequate use of the 1949 Mid-June Buyers' Guide issue of ELECTRONICS. Remember—it is a 13th issue and should be included in your 1949 budget. You can get the complete facts regarding the Guide from your ELECTRONICS representative or write direct.
BUSINESS BRIEFS
By W. W. MacDONALD

Seems that a taxi equipped with radio came upon a car wedged between railroad tracks at a grade crossing. The cabbie called his dispatcher who called the telephone company, who called the railroad, who called the tower-man, who flagged the oncoming fast freight in the nick of time.

TV set production continues to hold up while seasonal slump hits other lines. Six months production of TV among RMA member companies totalled 278,896, as against 659,313 fm-am sets, and 6,771,210 straight-am receivers. June video production was 64,353 for five weeks, a record high. The industry is now hoping to produce 850,000 units this year, and RCA predicts 1.6 million will be produced in 1949. Dollar volume in television will by then have outstripped income from sound-only sets, by a large margin.

A Correspondent wants to know who is making a predetermined electronic counter that will figure out a race horse's chances of winning from his past record. This is just one step from a predetermined horse race, which, we understand, is illegal. Anyone having such a gadget, please send us the plans in a plain envelope.

Now that High-Band television stations (channels 7 through 13) are getting on the air, there is a flurry of surveying to determine coverage compared with the low-band outlets. The N. Y. Daily News station, WPIX, on channel 11, reports 88.6 percent of set owners interviewed get station OK, other 11 percent cannot receive it.

Video in Hotels is having a big effect on the bell-boy business. A recent survey of New York Hotels shows that room service sales in video-equipped rooms increased from $35 to $175 per month following installation of teletsets.

Question: Has room service added crackerjack, popcorn or peanuts to the menu? Answer: At those prices, it's not peanuts.

Current slump in the phonograph business has convened many a pow-pow in record circles. Columbia-Philco development of long-playing records (p 86, September) is one attempt to blow life into the business, would have more effect if whole industry adopted the system for future releases. As it is, record boys predict a big fight between LP and standard disks.

It was only a matter of time, etc. The roadside circuit now has the tele-juke, a box with records and video. A record for a nickle, or three minutes of visual entertainment. You takes your pick. For those who want the whole ball game, the machine will take up to 25 nickels at a crack. A side panel gives the customer access to the tuning control with a choice of four stations, but experience teaches that this little door should be kept locked tight, with the key in the hands of the branniest bartender.

Latest version of the electronic rat trap (selling for $198) is set over a rodent runway. An electric eye picks up the intruder, causes a pair of charged tongs to close, then lift sideways, depositing the lifeless body to one side. Whole cycle takes about 24 minutes.

Technical writers with an engineering background, primarily communications, are needed by the Signal Corps. Salaries range from $3,727 to $5,232. Write Chief, Signal Corps Publications Agency, Fort Monmouth, N. J., or call Eatontown 3, 1060, ext. 767, S. S. Oliver.

Pulling power of "giveaway" radio programs was dramatically proved when Fred Allen's rating

Solar's new Type DY-TV series of dry electrolytic capacitors assures dependable operation under the severest conditions found in television receivers.

An especially developed processing technique makes possible small yet sturdy capacitors designed for high temperature operation with no sacrifice in long life or electrical characteristics.

Because of the remarkable film stability of Solar's DY-TV series of electrolytics, there is but an extremely small change in power factor and leakage current from room temperature to 85°C.

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Solar Solar Capacitors "Quality Above All"

64 October, 1948 — ELECTRONICS
fell to an all-time low in competition with "Stop The Music." Many broadcasters, usually alarmed at FCC meddling with program content, have applauded the Commission's recently proposed action against "lotteries." Seems we are all in agreement on this one.

How Many People, in which industries, could use a complete industrial television package consisting of transmitter and receiver, for what specific purposes, if the cost was under $5,000? One of our readers thinks he can build a good rig for that price but wants to feel the water before jumping in. Any comment?

New Business tied in with the 70-group airforce is beginning to show in electronic circles. One concern reports new orders totaling $900,000 in recent weeks, all from aircraft manufacturers, calling for electronic, electrical and mechanical gadgets.

NAB group worrying out playing-time versus fidelity of magnetic tapes has tentatively decided on two standards, with tops of 7,500 and 15,000 cycles. They hope to limit high-fidelity speed to between 15 and 22.5 inches per second with minimum playing time of about half hour per reel.

Ten Years Ago, we were amazed at fact that there were then more radio tubes in use than there were people in the country. Today, more than that many tubes are sold in a year. Six months total reported by RMA was just over 100 million bottles. About three quarters of these were for new sets, 20 million for replacement, nearly 7 million for export. Government agencies took half a million. These are big figures. But radio tube sales are dwarfed by electric bulbs. Total sales of latter in 1947: 1.6 billion.

Hangover Cure for 12-inch surplus cathode-ray tubes (type 12GFT) replacing conventional 7-inch types in television receivers (p 66, August) is to stick a piece of blue cellophane over the screen. The big bottle uses two phosphors, blue for transients and yellow for persistency. An optical filter largely masks the latter.

Rates for television transcriptions (movies taken off picture tube screen suitable for rebroadcast, see p 68, this issue) have been issued by Paramount Pictures, Inc. They will record a ten minute show for $200, and sell release prints on 35-mm film, with sound track at $36.00 for 10 minutes in lots of 10 or more. Rates for an hour are $550 and $216 on the same basis. Also available at lower cost are 16-mm prints.

Designers Planning next year's radio cabinets may be interested in west coast reports from furniture buyers, indicating a strong swing to traditional styles, including French and American provincial. Darker finishes are in vogue in modern styles.

Nick Lefor (W2HILQ) says that 75 percent of the engineers employed by Airadio are amateurs, and that 75, 20 and 10-meter 'phone operators predominate.

Television in Great Britain is now dwarfed by Stateside industry. Licenses for television receivers, required of every set owner in England, totalled 54,850 at end of June, and are increasing at rate of 2,350 a month. Total sets in U.S.A. are now just over 500,000 and rate of increase is about 50,000 a month. All forms of broadcast set licenses in England now exceed 11,000,000. The British are bearing down on the license deal: 839 successful prosecutions for non-licensed reception in the month of June.

Among recent college graduates taken on by GE are 1046 electrical, mechanical and industrial engineers, 50 chemistry graduates, 15 physicists and 250 graduates of liberal arts and business courses. Looks like physics is still something of a specialty, despite big reputation physics majors got during the war at Radiation Laboratory and elsewhere.
Better Sealing Means Longer Life for MALLORY Cardboard Tubulars

Careful pouring of end seals protects Mallory cardboard tubulars against impurities that cause deterioration.

MALLORY cardboard tubular capacitors come in the standard types shown above—but their service potential is far above standard—thanks to the extra care used in their manufacture.

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MALLORY CAPACITORS (ELECTROLYTIC, OIL and WAX)

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

October, 1948 — ELECTRONICS
BITS . . . Claude Shannon’s articles in the Bell System Technical Journal, explaining at length the important new concepts on the bandwidth required to transmit intelligence in the presence of noise, are destined to become classics in the literature of communications. While not claiming to have mastered the subtleties of the argument at the present writing, we do want to pass on the new word “bit”, a contraction of “binary digit” suggested by J. W. Tukey. Binary digits, or bits, are important because pulse circuits, whether used in pulse code modulation or in electronic computers, are most reliable when they operate, flip-flop fashion, with only two states, on and off. So the discipline of such circuits is most easily analyzed in binary notation. It turns out that a decimal digit is 3.32 bits. Accordingly the value of a twenty-five cent piece, being expressible in two decimal digits, is expressible in 6.64 bits. We thought it was two bits, but we failed to reckon with Shannon and Tukey.

DECIMAL . . . An old-time contributor to this journal, Walther Richter, in a recent speech coined a neat phrase when he said that electrical engineers could be divided into two groups, those working on the right side of the decimal point, and those working on the left. The communications engineer is, very largely, a microwatt-microvolt-microampere man. The power engineer is, in contrast, a kilowatt-kilovolt-kiloampere character. To Mr. Richter’s apt division, we would add the group of decimal-point straddlers, the industrial electronic engineers who progress from the right to the left side, taking a microwatt impulse and bringing it to bear on a kilowatt system. These electronic universalists are familiar with the left and the right, and their number grows. More power (megawatts) to them.

MKS . . . The growing acceptance of MKS units in electronic practice is not without important exceptions. The IRE technical committee on electroacoustics has recently discovered that this system of units has, apparently, never been used in the acoustical field and has urged that this omission be rectified forthwith. Fortunately, the conversion from the metric units commonly used to MKS units is accomplished simply in powers of ten. But, unfortunately, there are no simple names for acoustic quantities expressed in these units. The acoustical ohm, for example, is translated literally into emkayess-ese as “joule per stere per stere per second”, than which we cannot imagine a less handy term. The committee is now searching for suitable short-form names for MKS acoustic units, and will recommend the same for the forthcoming revised ASA standard terminology on this subject. This is good work. Other committees might well examine their fields for similar omissions.

GEO-RESCUE . . . Some months ago we related the story of the Bell Labs engineer who, lost on the way to a dinner party, was “talked in” to his friend’s house through mobile radio installed in his car. Now comes the story of the geophysical exploration party which, roaming over the flatlands searching for suitable test sites, become completely lost. Having explained their predicament to the field office by radio, the members of the party were instructed to explode a charge of dynamite, which they carried for seismic exploration, at a pre-arranged time. The blast, traveling through the earth, was intercepted by a pattern of geophones connected with the field office, while an oscillograph recorded the times of arrival of the shock wave at several locations. A short computation, essentially the loran problem worked backwards, revealed the location of the lost geophysicists. Informed by radio, the party took a bearing for home and got there. Readers will recognize this technique as a solid-land version of thesofar system, which locates ships at sea by precisely the same technique (June, 1948 issue, p 98).
FIG. 1—General view of transcription equipment. Two units are used to provide uninterrupted recording of lengthy programs.

TELEVISION

By THOMAS T. GOLDSMITH, JR. and HARRY MILHOLLAND

Director of Research Senior Engineer
Allen B. DuMont Laboratories, Inc.
Passaic, New Jersey

For many years photographic recording has been employed by television engineers to preserve a record of station operation and outstanding programs. The staff of A. B. DuMont Research Dept. has been engaged in studying photographic recording for over ten years. The early efforts used still cameras or nonsynchronous movie cameras which produced results suitable for record purposes. But the quality of such recorded programs was not sufficient for re-broadcast because of insufficient detail and contrast range, as well as stroboscopic-flicker effects caused by lack of synchronization.

With the coming of network television, the need for broadcast-quality photographic transcriptions of television programs has emerged. To meet this need, DuMont Laboratories has developed a transcription system, with the results described in this paper. Teletranscriptions have already proved useful in providing delayed-broadcast network service beyond the limits of coaxial-cable and radio-relay circuits. For this purpose they will undoubtedly serve for many years, until network connections are more widely available and less expensive than at present. Transcriptions also serve many other purposes, such as promotional advertising, as aids to criticism of program techniques and content, and as legal records including documentation of station operation for the records of the FCC. Similar techniques, employing rapid development of film, serve for theater television.

Frame Synchronization

In setting up a teletranscription system, the choice between 35-mm and 16-mm film must be made. Ideally, 35-mm film is to be preferred since it imposes no limitation on the detail of the transcribed image. In practice, however, 16-mm film is preferable on the score of economy, not only in the cost of film stock, but also in the cost and main-
TRANSCRIPTIONS

Recording television images on film, directly from a cathode-ray monitor, preserves programs for rebroadcast, legal records, and network syndication. Broadcast quality is achieved in equipment which transfers from the 30-frame rate of television to the 24-frame movie standard.

Using fine-grain stock, the film can be exposed and processed so as to retain the full detail of the image. Accordingly, 16-mm equipment was adopted in the equipment described.

An early attempt to solve the frame-synchronization problem resulted in a camera which operated at 15 frames per second, that is, one-half the television frame rate. The exposure time and the pull-down time of this camera were approximately equal, so it photographed one complete television frame and skipped the succeeding one while the film was being pulled down. This system produced a non-standard film which could not be used in standard 24-frame movie projectors. Moreover, the film could not be used for rebroadcast at 30 frames, because of the flicker and discontinuity of motion caused by the missing frames.

This project was abandoned in favor of building a camera which would record directly at 24 frames per second from 30-frame television images. The process is essentially the inverse of the projection system used in televising standard 24-frame film. The 24-frame film may be used in standard 16-mm sound projectors for nontelevision uses, or in television projectors. The prototype camera was constructed. When the principle was proved, the prototype was taken to the Eastman Kodak Company, which produced a commercial version of the camera.

The sound-recording aspect of teletranscriptions was also a matter requiring attention. Separate sound-on-film recording facilities are employed to assure high quality of reproduction. The two film records, one for picture and the other for sound, are processed separately, using process techniques best suited to each type of recording. The sight and sound portions are combined in a composite 24-frame film. For documentary purposes it may be satisfactory to employ a single camera with sound-recording facilities incorporated in it, the so-called single system, but the processing must then be a compromise between that for best picture and that for best...
sound reproduction quality.

Figure 1 shows a general view of the transcription equipment. Two identical cameras and monitors are used to permit uninterrupted recording if the program lasts more than one-half hour. Each camera has reels which hold 1,200 feet of stock, which allows about 33 minutes of recording. When switching from one monitor-camera to the other, care is taken to assure that the average brightness of the two monitors is closely the same. This measurement is performed with a photographic exposure meter held successively in the same position before the two screens when both carry identical test patterns. Records are kept of power-supply voltages and beam currents in the monitor picture tubes to assure reproducible results from day to day.

**Uniform Focus**

The monitor circuits and picture tubes have been designed with particular care to remove imperfections that might be tolerated in a home receiver. For example, the high-voltage power supply has excellent regulation to avoid changes in picture size with changes in average brightness. The high-voltage supply is a 25,000-volt unit conservatively operated at 17,000 volts. The monitor picture tube is a 12-inch magnetically-focused and deflected unit. The area scanned is 6 by 8 inches. This small area assures uniform focus and a flat field. The tubes are conventional, but are carefully selected to have uniform phosphors and good focus over the area scanned.

It is possible to operate the system with negative or positive images on the monitor, but experience has proved the positive image preferable. The film image is then a negative and the composite print (made from the negative picture film and sound film) is a positive. If time is very short, the negative film image may be transmitted without making the composite positive print, merely by reversing the polarity of the television camera output. But the best quality has been found to result consistently from a composite positive print made from a negative.

To assure that the film shall not limit the resolution of the system, very-fine-grain film is used, that is, positive stock ordinarily used for making projection prints. DuPont type 602A has been found highly satisfactory. This film, speed approximately Weston 8, is slow compared with negative stock and reversal film, but it has extremely fine grain and wide latitude. Also, it costs about one third as much as faster films, and this may be a very important factor in an extensive recording project. The same type of film is used for picture negative, sound negative and composite positive. A special processing technique, is used to develop the picture negative. Otherwise the processing is conventional.

To assure adequate exposure using slow film, a bright monitor image and fast lens are required. The image, produced on the 6-by-8-inch rectangle has a highlight brightness above 100 foot-lamberts. The lens is a standard Kodak camera lens of two-inch focal length and maximum aperture f/1.6. The lens is operated at fixed focus of five feet and a fixed aperture of f2. The latter setting is not changed, since it would change the cone of light within the camera and would interfere with the proper operation of the shutter. If any change in the aperture is required, neutral-density filters are placed on the lens as required. Optical resolution of the lens is not critical. Any good
tack lens is satisfactory but projection lens are to be avoided.

Using this optical system and film, the full horizontal resolution of the original television image is preserved in the film. In fact it is possible to identify in the film images the fine-structure noise present in the original television image. The contrast range of the system is likewise limited by the television image, not the film. Using a conventional photographic gray scale of 11 steps between black and white, the monitor has been found capable of rendering 7 steps of gray, plus black and white. The latitude of the film is sufficient to cover this range by a wide margin.

The monitor brightness and contrast controls are adjusted by eye to give the most even rendition of the gray scale, as viewed on the film after processing. This process matches the transfer characteristic of the television system to the gamma characteristic of the film. Electrical gamma-correction circuits are also available in the equipment. Particular care was taken in the design and adjustment of the scanning circuits in the monitor to preserve a high degree of linearity. Figure 2 shows an interior view of the monitor.

The camera employs a rapid pull-down mechanism and a specially designed shutter which exposes two complete fields of television scanning on each frame of motion-picture film. An interior view of this camera is shown in Fig. 3. The shutter closes for exactly one-half of a television field, and the pull-down takes place in something less than one fifth of the complete pull-down-plus-exposure cycle. This cycle occurs at a rate of 24 frames per second, at a shaft speed of 1,440 revolutions per minute.

**Sequence of Operation**

The timing sequence and phase relationships of the television signal, the blanking cycle of the shutter, and the motion of the film during pull-down are shown in Fig. 4. At the top is a timing indication expressed in intervals of 1/120 second. This interval is a subdivision of both the 30-frame-per-second television-picture interval and the 24-frame-per-second film picture interval. The next line indicates the television blanking interval and the useful television picture interval. Here the television field interval of 1/60 second provides one half of the interlaced picture, and the succeeding 1/60 second field interval provides the other interlaced half. Accordingly, two fields of television scanning constitute one complete frame of television picture in an elapsed time of 1/30 second. On the next line is shown the camera-shutter characteristic, which must be very carefully adjusted. On the bottom line the film pull-down cycle is illustrated.

The most critical characteristic in the recording camera is the timing of the shutter-blanking and exposure interval. The absolute intervals are the most important, and if they are appropriately adjusted the exact phase relationship is not very critical. As shown in Fig. 4, the phase relationship has been so adjusted that one of the points for opening (or closing) the shutter is placed directly under the television blanking interval. The other shutter-point occurs approximately in the middle of the television field interval. If this shutter is not adjusted correctly, a bar, caused by overlapping or underlapping exposures, is likely to appear in the recorded film picture. Such a bar is noticeable as a flicker of several lines in the picture.

It is customary to drive a recording camera by synchronous motor. If the television signal and the recording camera are controlled by the same power lines, the camera runs in exact synchronism with the television synchronizing generator. In many cases, however, it is necessary to record programs which have originated in a region beyond the limits of the synchronized power lines. On nonsynchronous power supplies, two regions of overlap may appear and move up or down the picture at a rate equal to the difference frequency between the 60-cycle supply controlling the synchronizing generator and the 60-cycle supply driving the synchronous motor of the camera.

Many films have been recorded in the nonsynchronous manner. To do so successfully it is desirable that the shutter angles be accurately adjusted so that the overlap bars are eliminated. It is better to have a slight overlap, rather than an underlap, to minimize the bar effect.

To show the quality of pictures obtainable, Fig. 5 is a blown-up print of an original photograph taken on 35-mm film, while Fig. 6 is a photograph of the same subject taken from the face of a cathode-ray tube. Very little difference exists between these two photographs.

The motion-picture film compares favorably with the results obtained with a still camera.
SERRASOID

Design data for an improved four-tube phase-shift type modulator that initiates 100-percent modulation with noise 80 db down and 0.25 percent harmonic distortion in broadcast service. Low relative cost suggests potentially greater utilization of the educational frequencies. Variations of the basic circuit open new fields of application.

By J. R. DAY
Radio Engineering Labs., Inc.
Long Island City, N. Y.

THE development of a simple f-m modulator has been one phase of a broad program to enlarge the technical horizons of f-m broadcasting. In particular, it was aimed at providing one solution to the problems of relay and chain broadcasting. Such service requires that the noise background and distortion be very low in the individual links so that the final signal may still meet the relatively high standards required for any f-m broadcasting system. Such chain systems have been operated satisfactorily using available equipment, but it cannot be said that, in the more extensive chains, the limiting noise rests with the audio facilities at the origin. This latter condition has always been regarded as a minimum requirement of a really good f-m broadcast setup.

Careful examination of the problems in a reasonably extensive chain yields the conclusion that an 80 db ratio of 100-percent modulation to noise in the modulator would be satisfactory. In addition, a maximum figure of 0.25-percent harmonic distortion for 100-percent modulation with single tones from 50 to 15,000 cycles was set as a correlative objective. Since a practical modulator involves accessory circuits such as an audio amplifier, which can be expected to make some definite though small contribution to the numbers above, the actual net requirements on the modulation process are somewhat more severe than the overall figures. It is evident that such performance will also be of significant application in a single f-m broadcast setup, apart from the special question of relaying.

Means of generating frequency-modulated currents fall into two general classes, the reactance-modulated type, and the phase-shift type. In the first, the frequency of an oscillator is caused to vary linearly with modulation through the agency of a reactance tube or its equivalent, which is an integral part of the frequency-determining circuit. Because of the modulation and linearity requirement such an oscillator in general is not stable enough for broadcast service. Automatic frequency control is therefore employed. In the phase-shift type of modulator the frequency of the carrier oscillator is not varied, and therefore a stiff control such as a quartz crystal can be used to secure the desired stability, which then is completely independent of the modulation process. Modulation of the frequency in such a system is secured by varying the phase of the frequency-stabilized wave. The frequency will be deviated from its controlled value only during the time the phase is changing, and the deviation, other things being equal, is proportional to the rate of change of phase.

The Serrasoid is the latter type. Although it is capable of broader

The first successful method of producing frequency modulation was the phase-shift method. Despite certain shortcomings in inherent noise, distortion at the lower modulating frequencies, and a tendency of the center frequency to drift, it carried the burden of launching the f-m system successfully.

- The invention of the double channel modulator, which was brought to a high degree of perfection through the work of John Bose, eliminated these difficulties. It, however, had the commercial disadvantage common to all frequency modulators of requiring a large number of tubes. This disadvantage is not of much importance in transmitters of powers above 1 kw, as the cost of the modulator then becomes a relatively small part of the total. For transmitters of low power, however, the modulator becomes a major item. Herein lies opportunity for great improvement.

- I have always felt that the phase-shift method of producing frequency modulation would be the surviving method and that someone some day would overcome its greatest weakness by finding the means of increasing the initial phase-shift without compromising any of the requirements of distortionless noise-free f-m.

- This James R. Day has done. Not only has he done it without compromise, but he has in fact improved performance to hitherto unattained levels.

- The significance of this development is that by its simplicity and reliability it has opened up all sorts of new broadcasting possibilities. One can visualize the operation of unsupervised transmitters of a few watts power, controlled from pulpits, schoolhouse assembly halls, and similar places, the transmitter requiring no more attention than the common, everyday public address system.

- The invention has opened up some amusing possibilities. If, as seems likely, the Serrasoid becomes the accepted method of producing frequency modulation, the phrase-makers who have dubbed the phase-shift method the "indirect method" will find themselves in an awkward situation. Some of us have lived long enough to recall the days when the automobile was referred to as the "horseless carriage."

--E. H. ARMSTRONG

www.americanradiohistory.com
application, the numbers involved for the f-m broadcast case provide the clearest illustrative material. As noted above, frequency deviation is proportional to rate of change of phase. For sinusoidal modulation this is simply expressed by saying that the peak frequency deviation is equal to the product of the peak phase shift and the modulating frequency. The new circuit is conservatively capable of a peak phase shift of ±150 degrees, but ±90 degrees or ±1½ radians is used as the basis for 100-percent modulation at 50 cycles. For 1½ radians and 50 cycles the peak deviation therefore will be ±75 cycles. Since 100-percent modulation in f-m broadcasting is a deviation of ±75,000 cycles, a frequency multiplication of 1,000 is indicated. Actually, 972 is used since it can be factored into a convenient assortment of doublers and triplers. In all that follows we shall discuss a modulator for a frequency of 97.2 megacycles which starts at
a base frequency of 100 kilocycles.

Figure 1 is a schematic diagram of the essential parts of a complete broadcast Serrasoid. Audio amplifiers and frequency multipliers have been omitted since they are conventional and employ small standard type tubes. Tube $V_1$ is a pentode oscillator controlled by quartz crystal $Y$. This crystal operates very close to its series resonant frequency. The net reactance of the crystal arm may be conveniently varied by a series capacitor for fine frequency adjustment of about $\pm 0.005$ percent. This crystal is oven controlled in the broadcast case to a net stability of $\pm 0.0002$ percent, which is also the stability of the final carrier frequency. The operation of the oscillator is such that plate current is drawn only during a small part of the cycle. Negative-going pulses shown in Fig. 2A are generated at the plate of $V_1$. These pulses are differentiated by $C_{n}, R_n,$ and grid-cathode conductance of $V_{sa}$ to yield still shorter pulses several times the cutoff voltage of $V_{sa}$. The corresponding short positive pulses at the plate of this latter tube are bottom clipped (to clean the base line) by cathode follower $V_{sb}$. Resistor $R$ is selected so that this tube is biased beyond cutoff between pulses by the automatic grid bias of $C_s$ and $R_s$. The pulses at the cathode of $V_{sb}$ appear as shown in Fig. 2B. The two halves of $V_s$ perform the functions of a single pentode that might have been used in the same place, with the additional advantage that the final waveform is developed in a lower impedance than is practicable with a pentode.

### Linear Sawtooth Wave

According to the numbers of the illustrative case these pulses recur at a rate of 100 kilocycles, that is, corresponding points or events on consecutive pulses are 10 microseconds apart. Tube $V_{sa}$ constitutes a nonoscillatory sawtooth generator timed by the pulses from $V_{sb}$. The slowly increasing portion of the sawtooth has a slope corresponding to the charging of $C_s$. The sawtooth period coincides with the time between pulses when $V_{sa}$ has terminal bias, having been developed on $C_s$ by previous pulses. The quickly decreasing part of the sawtooth occurs at the time of positive pulses on $V_{sa}$, when $C_s$ is discharged nearly to cathode potential by the plate-cathode conductance. In round numbers the discharge point is about 5 volts from cathode or ground potential and $R_s$ and $C_s$ are adjusted to give a rising rate of about 4 volts per microsecond to the increasing portion of the wave. As will be shown the whole linearity of the modulator process depends on the straightness of this sawtooth wave. In its simple form, it would have too much exponential curvature to be useful. This condition is corrected by the bootstrap connection comprising the cathode follower $V_{sa}, R_s, C_s$, and $R_s$. The normally constant voltage at the positive end of $R_s$ has superimposed upon it the rising voltage on $C_s$ so that the drop on $R_s$ and hence the charging current is maintained practically constant. Resistor $R_s$ as in other bootstrap applications could be a diode with its anode at plate supply potential, but for the voltage magnitudes involved here the resistor is more than adequate. The d-c voltage at the junction of $R_s$ and $R_w$ is about +190 volts for a B+ value of 250 volts.

### Pulses are Frequency-Modulated

The sawtooth wave thus developed is directly coupled to the grid of $V_{sb}$. This tube is cathode biased by its plate current so that conduction begins when the sawtooth is about half way up; the passage from the beginning of plate current flow to grid current consuming about 0.25 microsecond. Because $C_s$ is large and holds the bias constant during the sawtooth period, grid current stops the charging of $C_s$ and the latter half of the sawtooth rise is clipped. The resulting waveform is shown in Fig. 2C the dashed line indicating the waveform without the direct coupling to the grid of $V_{sb}$. Thus, the plate current of $V_{sa}$ flows only during the

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**FIG. 1—The modulator proper showing the crystal oscillator, clipper, sawtooth generator and bootstrap cathode follower, and h-m pulse output tubes. The frequency multiplier stages that follow are conventional.**

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latter half of the sawtooth wave. If the bias for $V_a$ is varied, the leading edge of this current pulse will vary in time or phase, an advance resulting from a lowering of the bias and a retardation from an increase. It is in this way that phase modulation in the unit is accomplished.

Audio or program is applied at the indicated terminals. Values of $R_a$ and $C_a$ are so proportioned that for constant audio input amplitude versus frequency, the resulting amplitude at $C_a$ is inversely proportional to audio frequency over the range upward from 50 cycles. This circuit is included so that the peak phase shift shall be inversely proportional to modulating frequency and the resulting frequency response of the frequency modulation shall be flat. The function and the network are the familiar corrector present in all phase-shift type frequency modulators. In order that at 50 cycles the phase of the pulse edge be shifted $\pm 1\frac{1}{2}$ radians, approximately 50 volts rms is required at the input to the corrector. In the complete modulator a two-stage amplifier provides the gain to raise the standard input of $\pm 10$ dbm to this level. Since feedback is used in this audio amplifier to provide linearity, the effective modulation sensitivity is also stabilized at a marked degree. This sensitivity depends only on the audio gain and the stability of $R_a$ and $C_a$, and ordinarily is stable to within 1 percent for the standard ranges of temperature, line voltage, and tube changes.

Figure 2D illustrates the waveform at the plate of $V_a$, the dashed lines showing the extreme positions of the leading or negative going edge during 100-percent modulation at 50 cycles. For 100-percent modulation at 100 cycles the excursion is one half that shown, and so on. This wave is differentiated by $C_a$, $R_a$, and the grid cathode conductance of $V_a$, so that the latter is cut off for a short time each cycle beginning at the leading edge. The resulting positive-going pulses at the plate of $V_a$ are shown in Fig. 2E. These pulses are frequency modulated approximately $\pm 75$ cycles at 100-percent modulation. They are applied to the grid of the first of a string of frequency multipliers. The plate loads of this and subsequent multipliers are resonant at the various harmonics, and therefore, involve only sinusoidal c-w currents. In the broadcast version these multiplications are 3, 3, 3, 3, 2, and 2, for a total of 972 times, yielding a carrier frequency in this illustration of 97.2 megacycles with a deviation of $\pm 75$ kilocycles at 100-percent modulation.

Circuit Design Factors

Before proceeding to a discussion of distortion and noise in a system of this sort several salient features may be pointed out. First, in common with all phase-shift modulators, there is no interaction whatsoever between the functions of modulation and carrier-frequency control, and the final stability is exactly that of well engineered crystal control. Exclusive of the frequency control the modulation process is accomplished in three standard receiving type tubes operating under cutoff to saturation or cathode follower conditions. As a result the process is remarkably independent of tube changes or aging. There are no resonant circuits and no reactances. Largely to eliminate the commercial tolerances of resistors and capacitors, $C_1$, $C_4$, $C_9$, and $R_a$ are factory adjusted, and thereafter no adjustments even of a maintenance nature are necessary, except after outright component failure. Tubes $V_i$, through $V$, drain about 20 milliamperes at 250 volts.

Possible Variations

An interesting aspect of the development of this modulator lies in its apparent simplicity. Until certain special factors were fully appreciated performance was indifferent and the simultaneous attainment of low distortion and low noise hardly seemed practical without considerable elaboration. A good many detailed variations from the sample circuit shown are operative, and some yield high performance. But without the observance of certain principles, design can be surprisingly difficult. The important rules affecting linearity and noise are enumerated below.

Having selected the sawtooth waveform as the basic timing or phase-shifting mechanism, it developed that linearity could not be preserved if it was amplified or caused to appear as a current variation in a plate-loaded tube. It is not attractive but may have appeared at first. Other means of straightening the sawtooth beside the bootstrap arrangement shown are entirely practical provided the sawtooth waveshape as such is not amplified. In particular, in the modulation process the tube performing the timing, $V_a$, cannot carry currents of sawtooth shape and still preserve linearity in the timing process. It was found also that the amplitude of the current pulses in $V_a$ should be constant during the modulation cycle. To insure this condition the plate supply voltage is maintained constant by $C_5$. The supply voltage is low, about 30 volts, giving a small cutoff voltage.

Noise arises in such a system in the form of random variations in
the time of occurrence of corresponding events in consecutive cycles. Such timing variations ordinarily are the result of superposition of noise voltages on the desired wave-form. The noise voltages originate either in tube current variations or as Johnson noise in resistors. The effects of both kinds of noise are reduced by increasing the time rate of change of voltage in the sides of the pulses, and by maintaining low circuit impedances at certain points. For instance, impedances controlled by $R_a$, $R_b$, and $R_c$ are in a position to contribute to the residual modulator noise unless maintained below values appropriate to the pulse amplitudes appearing across them. This is another way of saying that the circuit bandwidth should be as great as possible so that the pulse rise-time is short. Noise originating from uniformly distributed random voltage variations causes frequency modulation noise with a triangular distribution spectrum, extending linearly up from zero at zero modulating frequency. For the band up to 15,000 cycles the integrated noise power from a given resistance is approximately 44 db greater than would be the case for a flat noise spectrum. The 75 microsecond de-emphasis in the f-m receiver reduces this effect by 13 db. The reduction factor is different if the original noise is other than triangular. For instance, Johnson noise in $R_a$ is modified in its spectrum by $C_v$, before it can phase modulate pulses determined by the sawtooth. It is a straightforward matter to show by calculation that if the linearity were secured without the bootstrap or its low-voltage equivalent, that is, by making the supply voltage very high, the noise generated by the necessary large resistor would be excessive by a considerable factor. Thus it comes about that the bootstrap or its low-voltage equivalent is uniquely essential to securing simultaneously low noise and low distortion. By similar reasoning it can be shown that the lowest noise is obtained when the corrector capacitor $C_v$ is directly at the modulator cathode. If the corrector were to be located at a lower level in the audio section, tube and Johnson noise originating after it would have a 31 db handicap and with practical tubes and circuit constants, this effect would be insurmountable. The possibility of noise phase modulation in the first tube after $V_p$ is minimized by making this a frequency multiplier so that the noise deviations are multiplied by a smaller factor than those originating in $V_p$ and earlier.

**Performance**

The general performance of the Serrasoid system in the particular case shown, and following the design rules noted can be summarized as follows. The linearity of the phase-shift process is readily made to be equivalent to less than 0.1-percent f-m distortion for peak phase shifts of ±135 degrees. It should be noted that nonlinearity in the phase-shift process results in f-m distortion proportional to the order of the harmonic generated. Thus 1 percent third harmonic expressed as distortion of the phase shift is equivalent to 3-percent distortion measured as frequency modulation. In the commercial f-m broadcast modulator the distortion is largely controlled by the included audio amplifier, and the overall figure is held to less than 0.25 percent for 100-percent modulation at 50 cycles. At high frequencies where the peak phase shift is less the distortion falls until it is entirely accounted for in the audio circuits. At the upper end of the audio spectrum, distortion owing to tuned circuits in the frequency multipliers rises slightly, but by reasonable design is held below 0.25 percent, measured without de-emphasis. It is much easier to contrive that the distortion be this low than it is accurately to measure it once secured.

The f-m noise originating in the modulator and in the band from 50 to 15,000 cycles, measured with 75-microsecond de-emphasis is somewhat better than 80 db below 100-percent modulation. This noise is made up of approximately equal contributions from the crystal oscillator plate circuit and the plate circuit of $V_p$. It can be reduced still farther by designing for greater pulse bandwidth and higher tube currents, and by the special artifices described below. Microphonicism is no practical problem at all with non-selected ordinary tubes. Because of the simplicity of the circuits involved shielding and isolation by ordinary means serves to suppress the noise effects of r-f feedback from high-level sections of the transmitter.

**Increasing Phase Shift**

There are two ways by which the total phase shift can be increased over the practical maximum of ±150 degrees. One of these is by cascading, or iterated modulation. The pulses at the plate of $V_m$ are similar in form and amplitude to those at the plate of $V_{aa}$. If, instead of coupling here to the grid of a multiplier, these pulses are fed to a duplicate of the circuit extending from $V_m$ to $V_{aa}$ inclusive, another complete modulation process will have been encompassed. One stage of such cascading doubles the peak phase shift with the same percentage of f-m distortion and yet raises the f-m noise by less than 3 db. Thus the effective signal to noise ratio is improved by at least 3 db. The price paid for this iteration is two and a half additional tubes and a doubling of the audio power required to modulate. The process can be extended beyond two modulations. The other method involves generating two or more interlaced sawtooths at submultiples of the crystal frequency by means of a step-counter frequency divider; separately modulating pulses from each of the proportionately longer submultiple sawtooths; and recombining the sets of modulated pulses. The submultiple frequency, of course, must be more than twice as high as the highest modulating frequency involved.

In general, by the use of cascading and interlacing, as noted, by the use of a modification of the scheme employed in the Armstrong dual channel phase shift modulator, and by several other arrangements too detailed to describe here, the application of this system can be extended to cover a very wide field.

Commercial versions of the new modulator have been in use for the past six months at W2XMN-W2XEA, Alpine, New Jersey, and in the studio-transmitter link used to program KSBR, Mount Diablo, California.

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The Editors Report on ELECTRONICS PARK

To build a combined headquarters, engineering heaven and de luxe manufacturing plant for its expanding electronics business, General Electric has invested heavily in a new plant at Syracuse. Here, along with the physical details, is the story of the people—the engineers, supervisors and workers—on whom hinges the future of Electronics Park

PART I—The Park and Its People

In the rolling farmland near Syracuse, N. Y., has arisen an industrial phenomenon, a 155-acre campus combining research, engineering and production on a scale never before seen in the electronics business. This is Electronics Park, the headquarters of the Electronics Department of the General Electric Company. Nine buildings have been completed, stocked with machinery and equipment, and brought to operating status.

The Park is no idle experiment in bigness. When the war ended, GE had a greatly expanded electronics business located in 22 plants—with no headquarters plant. The company's long experience in the lamp business—and electronics closely parallels it in many respects—pointed the way to a headquarters plant for engineering, manufacturing, sales and marketing operations. And so Electronics Park may be said to be a modernized version of Nela Park. Both have the "campus" atmosphere, the last word in engineering facilities coupled with manufacturing operations and many satellite plants in various parts of the country.

Compared to competitors' plant facilities, the Park undoubtedly appears to be a "luxury" operation to many industry visitors. Contrasted to this attitude
is the GE philosophy as expressed by Dr. W. R. G. Baker, vice-president in charge, who explains that management merely has provided the best possible postwar facilities and atmosphere for its engineers, office and production workers, and salesmen—all of which has already resulted in improved productivity as compared to similar GE electronics operations before the war.

The editors of ELECTRONICS undertook some months ago to study the operations at the Park. This report results from weeks of interviewing the engineers, the executives and the production workers. Its purpose is to describe features of the organization, its systems, techniques, facilities and methods. Some of these ingredients of creative productivity are, of course, equally applicable to many another plant or laboratory in the industry, and may well be adopted with profit by others.

The genesis of the Park goes well back into GE history. Since the early experiments of Langmuir, Alexanderson, Hull, Dushman, White, Coolidge and Whitney, electronic theory and practice had an important place in the GE picture. But electronics manufacture never loomed large in dollar volume compared with the company's apparatus business, for example. For years GE was completely out of the radio receiver business and practically all other phases of the electronics industry with the exception of building transmitters and receivers for the government and a comparatively small amount of industrial electronics equipment.

This was the result of arrangements approved by the government under the consent decree of 1932 whereby GE voluntarily liquidated practically all its previous activities in the field, most of which went to RCA—patents, products, machinery and engineers. GE went back into receiver production in 1937 at Bridgeport, Connecticut, squeezing into the household appliance plant. Since then, the various divisions of the Electronics Department have been living in other peoples' attics scattered over the eastern half of the country.

The vast expansion of electronic production brought to GE by the war further decentralized production. Even before the war's end, it was clear that the scattered electronic manufacturing plants could not be brought back to Schenectady, which was already over-crowded with nonelectronic activities. Planning for the Park began, in fact, as early as 1942.

Why Syracuse Was Chosen

The first big decision was to find a site that would serve as headquarters and an engineering center for the Electronics Department, and have a large enough manufacturing plant to take care of practically all business in a normal year. The four major considerations in choosing a location were: (1) availability of labor to support contemplated production; (2) availability of air, rail and highway transportation, hotels and other community facilities; (3) reasonably central location with respect to sources of raw materials and markets for finished goods; (4) sufficient nearness to the research centers of GE to permit frequent contacts.
Over a hundred communities were considered, some of which met all of the above requirements. Syracuse, however, had two plus values—a large group of employees that had operated the GE war plants at Thompson Road and Wolf Street, and convenient means for graduate study by engineers and other employees at Syracuse University. Therefore, Syracuse was chosen.

The 200,000 population of Syracuse is large enough and its industry sufficiently diversified so the Park's activities will not seriously affect the economy of the community. The city has a record of favorable union relations, and careful analysis shows that the Park can take a maximum of about 6,000 workers from the area without disrupting labor conditions in other Syracuse industries.

The site was picked next—155 acres of farmland about 5 miles northwest of the heart of town, on good roads and within the freight yard limits of Syracuse. Architects were engaged and commissioned to give GE a modern plant designed specifically for its electronics business.

Construction Problems

No job of this size could be undertaken without running into the usual labor difficulties. For example, the building design called for 1,800,000 bricks—presenting a tremendous job to get from the area enough bricklayers to finish the project. It was necessary, in fact, to obtain men from surrounding cities to handle the job.

Grading for Electronics Park was started in the fall of 1944, but the contractor worked only a few days before snow came. The ground was not seen again until the end of March, 1945. Construction started in September, 1945. In spite of difficulties of obtaining material as well as labor, the contractor started setting steel for the Transmitter Building in April, 1946. One year later this building was in operation, and production was humming. By early 1948 all main units were completed.

Units of the Park

The three largest units, the Receiver Building, Transmitter Building and Specialty Building, are combined engineering and sales offices and manufacturing plants devoted to their respective products. The remaining six buildings provide services and staff functions common to all activities. They include the Administration Building, Reception Building (which also includes an auditorium, the main hospital, employee relations offices, company store, classrooms, and a photo laboratory), the Laboratory Building, Service Building, Boiler House and Restaurant. Smaller units are available for special purposes, such as a hilltop test site for radar, and a nonmetallic building for testing radar antennas.

Construction of this plant required 500,000 blueprints, and over 100 engineers worked for a full year designing the layouts. Over 7,000 tons of steel were used in erecting the framework of the buildings and over 70,000 cubic yards of concrete were poured, much of it in bitter winter weather.

All offices and factory areas are air-conditioned. Fluorescent lighting and attractive tile floors are used in the offices and in all the factory buildings. The flooring in offices and labs is laid on concrete over a
system of six-inch floor ducts. This permits obtaining a new power or telephone outlet within a few inches of a desired new location anywhere on the floor. Partitions are the Hauserman metal type that can be set up, moved or removed almost overnight to accommodate the continually shifting office and lab requirements.

There are 57,000 square feet of windows in the Park. Supplementing the natural lighting are 28,000 lighting fixtures of the fluorescent troffer type, with 100-watt units in the factory areas and 40-watt units in office areas.

The roofing, except for copper flashing on the office buildings for appearance, is of precast concrete slabs and standard built-up tar felt and slack. A tunnel approximately a mile and a half in length interconnects all buildings and carries domestic water, steam, a condensate return and telephone lines.

At seven points in the Park there are driven grounds tied together by a 1-inch by 2-inch copper bus that runs through the tunnel system. Less than an ohm of resistance can be measured between any two of them. Each steel column in each building has its own copper conductor running to this ground system, as also do all water mains and all of the external shields for each shielded room.

The Boiler House has three 60,000 lb per hour oil-fired boilers which provide heating as well as process steam at an operating pressure of 75 lb. At present two 400,000-gallon fuel oil tanks are provided. Inasmuch as this huge project depends on a single 15-inch water line from Syracuse, a 1,200,000-gallon water reservoir will be installed to insure a continuous water supply for production needs and fire protection.

Power is received from the Central New York Power Corporation over two 115-kv lines. This voltage is reduced to 13.8 kv at a substation in the Park, for distribution to 35 unit substations located in penthouses on factory roofs and in basements of office buildings.

Within the Park there is a total of 31 miles of track and interconnecting switches, arranged so that incoming material can be unloaded at the receiving dock in the desired building while other freight cars are being loaded at outgoing platforms. One GE 50-ton Diesel-electric locomotive handles traffic after receipt from the railroad.

Because the winters in this part of the country have low temperatures and occasional heavy snows, the service group has 3 V-plows, 2 Snogos that pick up and blow snow to the side of the road, a Jeep sidewalk plow, and several bulldozers. Adequate space surrounds each building and the roads so that snow will never have to be hauled away by trucks. Inside the Park are over 54 miles of road, all paved with concrete and blacktop, plus about a mile of concrete walks going across the lawns.

The Management Team

By mid-1948 the Park was erected, staffed and operating. The plant is there, a large investment that has to be managed along creative, productive and profitable lines of action. The Park, in Dr. Baker's opinion, is only incidentally buildings, equipment and machinery. Primarily the Park is people—the ideas they have, the work they do, the decisions they make.

In an outfit of this size, decisions are always potentially dangerous. For example, it takes over 20,000 radio receivers of any new model merely to sample the Receiver Division's dealers. So the right decisions on chassis design, cabinet styling, quantities the market will absorb, and pricing all are extremely important.

The big decisions are made by the management team shown in the organization chart. The Electronics Department is one of the nine operating departments comprising GE, shown at the top of the diagram. Each operating departments that constitute General Electric Company, with divisions under his wing shown in the lower rows.

DECENTRALIZED OPERATION—Organization chart showing relationship of Dr. Baker's Electronics Department to the other eight...
THEY RUN THE SHOW—Five engineers and a salesman, heading the world’s largest concentration of electronic engineering and manufacturing facilities. Left to right: G. F. Metcalf of Specialty Division; A. A. Brandt, General Sales Manager; V. M. Lucas of Government Division; vice-president W. R. G. Baker; C. A. Priest of Transmitter Division; I. J. Kaar of Receiver Division. Not pictured is J. M. Lang of Tube Divisions, located in Schenectady rather than in the Park.

Department is in effect a separate business, independent in its engineering, manufacturing and sales, headed by a general manager who in most instances is a vice-president of GE. The departments are assigned budgets at the beginning of the year by the head office, and are responsible only for returning the budget, with a profit at the end of the year.

The Electronics Department management is divided into two teams, the staff divisions (advisory) and the operating divisions. The staff functions, shown in the third row of the diagram, include services common to all operations, and are largely nontechnical. For example, E. H. Vogel, manager of marketing on the staff, represents the vice-president and advises the operating divisions on such matters as general departmental and divisional sales policies, product planning and pricing, merchandising plans and programs, advertising for all products, and market research.

Similarly, the other staff divisions advise the operating divisions on all important decisions, and are brought into operation as their particular services and experience are needed.

The technical staff unit is the Electronics Laboratory, whose function lies midway between the pure research work carried on in Schenectady and the operating laboratories concerned with development specifically for production. Its job is to develop ideas from the pure research stage to the advanced development stage, and it serves all the operating divisions.

The operating divisions at the bottom of the chart are, like the company’s big departments, virtually independent businesses, working from a budget and returning it with a profit. Each division has its corps of engineers and production men, its own engineering labs and manufacturing plants, its own sales people. The heads of the divisions are thus primarily business men with broad management responsibilities. Like Dr. Baker, most of these men came up through the technical ranks of the company.

Operating Divisions

Largest of all the operating divisions is the Receiver Division, with close to 5,000 employees and about 1.5 million square feet of space. About half of these employees and 400,000 square feet of this floor space are in the Receiver Building in the Park, and the remainder is in satellite plants outside the park. This Division makes all kinds of radios and television sets en masse as its principal function and also supplies components, like loudspeakers, to other manufacturers.

Whereas many of its competitors procure the bulk of their engineering from the license laboratories to keep this expense at a minimum, the Receiver Division has preferred to stay in the engineering business and work to achieve the higher volume level required for the break-even point in order to absorb engineering costs. Since seasoned engineering organizations can-

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OUTPUT—Examples of many of the products made in the Park. In quantities ranging from one of a kind to hundreds of thousands, they fill freight cars and trailer trucks that leave the Park destined for distributors and customers throughout the nation. Products like large international broadcast transmitters and shortwave receivers are delivered to International G.E. Co. for export.

not be created overnight, the existence of a receiver engineering organization is important insurance for the future. Furthermore, GE derives a great deal of prestige, as well as some material gain, through introduction of engineering advances even though these are available immediately to competitors through cross-license agreements.

The receiver engineer must often work toward two entirely opposite goals at the same time. On the one hand, he tries to design a set so there are one or more subassemblies that can be put together separately out in the open, where the work is much easier than deep inside a crowded chassis. On the other hand, a subassembly involves extra expense for producing the separate chassis and for combining it with the main chassis, hence the ultimate goal is to get rid of separate units. The head end of a television receiver is an excellent example of a legitimate and economical subassembly because it involves assembling a dozen sets of tuned circuits positioned around a selector switch, followed by alignment of each tuned circuit.

The Transmitter Division, whose chief function is to build big electronisms, comes next with about 2,500 employees, 90,000 square feet of floor space for offices and development laboratories, and a manufacturing floor equal to 210,000 square feet. The Transmitter Division divides its allegiance approximately equally between government and commercial customers. This was the first of the manufacturing buildings in the Park to go into production.

Although deadlines, economic factors, and the matter of eye appeal plague engineers in the Transmitter Building, commercialism is not nearly so evident as in receiver engineering. The work of the transmitter engineer is more diversified. There are about 192 graduate engineers in this division, of which 126 are in the engineering groups, 37 in factory inspection and test groups, and 29 in field engineering.

The Specialty Division, with some 500 employees and over 100,000 square feet of space, makes special electronic items. Measurement equipment for the new field of nucleonics is now one of the items receiving high priority. The Specialty Building is in the center of the Park.

Finally there is the Government Division, which utilizes about 50,000 square feet of space throughout the Transmitter and Specialty Buildings, and, in addition, about 200,000 square feet in the Thompson road plant in Syracuse. It has every possibility of expanding as government contracts are received for electronic equipments needed by our armed forces. Most of this business involves radar and other highly complex electronic equipment; in line with tradition, GE accepts many tough engineering jobs from government agencies.

At the beginning of World War I GE was doing government electronic business and has been in it ever since. The Government Division is strictly a quality business in every sense of the word, since the best is none too good for our armed forces. Govern-
IDEAS, some well along in development, that may become the products of tomorrow:

- Low cost, simplified television receivers
- Color television, electronically on a single picture tube
- Portable fm receiver
- Radio remote control unit for appliances and for models
- Printed radio receiver, untouched by human hands
- Simplified superregenerative fm receiver circuit
- High-frequency heater for thawing frozen foods in homes
- Microwave 60-second electronic range for restaurants and homes
- Electronic equipment for guiding and controlling missiles and rockets
- Pocket-size atomic radiation detectors with alarm
- All-electronic aerial superhighways for air navigation and traffic control
- Magnetic learn-to-read unit that pronounces words printed on keys which move pickup head to different parts of magnetized paper disc
- Advanced radar navigators for airplanes and ships
- Higher-powered television transmitters
- Super-powered broadcast transmitters
- Facsimile equipment for police, industry
- Personalized two-way radio sets

Electronic equipment is built to customer's specifications; there are no standard lines. The customer here always wants something new—rarely if ever is a product reordered, because by that time either the requirements have changed or there have been improvements in the design.

Government engineering occupies the entire second floor of the Specialty Building, with another wing downstairs for its executives. When a design is finished and ready for production, some of the engineers move over to the Transmitter Building with it to see that production snags get ironed out promptly.

The General Sales Division management headquarters are in the Administration Building at the Park. It is responsible for the sale of the department's commercial products and for operation of the field sales organization in nine districts throughout the country, employing about 110 people. The manager of the division is also responsible for establishing adequate methods and channels of distribution, including distributor appointments and cancellations; for determining and administering commission plans for district managers and representatives; for the preparation of orders received and sales billed quotas for the districts and distributors; and for sales training programs for district representatives. He also shares with the product divisions the responsibility for product planning and pricing; merchandising plans and programs; production releases and scheduling.

Headquarters for the Tube Divisions of the Electronics Department are in Schenectady where one of the 5 tube factories of the divisions is also located. Original plans called for moving the divisions to the Park, in a separate building. The lack of labor available in Syracuse for all electronics manufacturing, and the cost of the move were heavy factors against it. Another factor was the close relationship between the industrial and power electronics tube work and the company's industrial machinery made or designed at Schenectady and sold through the Apparatus Department. These divisions make a large variety of industrial, transmitting, receiving and cathode-ray tubes in many satellite plants.

Plans for Expansion

The Electronics Department's policy is definitely to limit the Park operations to a payroll of roughly 6,000 front of the building. All moving-conveyor assembly lines for radio and television receivers are in 55,000 sq ft center section

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**Diagram:**

FIRST FLOOR PLAN

[Diagram showing plans and layouts of the building with labeled areas such as Stock Room, Tube Storage, Test Equipment Stores, and First Aid Offices.]

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**Diagram:**

SECOND FLOOR PLAN

[Diagram showing plans and layouts of the second floor with labeled areas such as Instrument Control and Final Test B, Television Lines 4, Tube Assembly, and Test Equipment Stores.]
employees, and to operate satellite plants for production beyond this point. For example, the Department has satellite plants in Buffalo, Clyde, Utica and Schenectady, N. Y., in Wabash, Indiana, in Owensboro, Ky., in Tell City and Huntingburg, Indiana, and in Irvington, N. J. These plants have, in all, 9,000 other employees and produce products like tubes, receivers and cabinets.

Expansion of the department's television receiver business this year has resulted in a plan to make all television receivers at the Park. By the year's end practically all radio receiver manufacture will be out of the Park in satellite plants and the entire Receiver Building manufacturing floor will be devoted to television. Since television receivers still need the attention of development engineers to keep things running, production in the Park will benefit from the close proximity of the television engineering and manufacturing groups.

The overall limitation placed on the Park's size by the availability of labor is an important advantage. The satellite plan of manufacture has an element of flexibility that would be missing in a larger concentration of facilities. Whenever more space is needed now, either temporarily or permanently, additional plants are acquired in cities having the required labor. Lines in heavy production, in which the engineering phases are essentially completed, get moved first to these outside plants.

SPECIALTY BUILDING LAYOUT—Specialty's engineers are downstairs, just off the manufacturing floor, because Government

Division offices and labs occupy the entire second floor. The Specialty Division factory is essentially a big job shop
PART II—The Engineering Organization

ENGINEERING is one of the keystones of the structure of Electronics Park. The manpower devoted to engineering is a high proportion of the total working force. The manhours devoted to engineering, in development and production, are proportionately high, and engineering costs follow suit. Add to this the fact that in no other industry is the utility and cost of the end-products more closely tied to the technical skill of the men who design and make them.

It is not strange, therefore, that a major portion of the effort in planning the Park went into providing the best engineering facilities available. But facilities have to be operated, so the story of the engineering organization starts with the men. How are they recruited and trained, how assigned to jobs, inspired to top effort? What are their pet gripes? These questions answered, it is pertinent to inquire what they have to work with, and what problems they wrestle with. In that order, then, let us consider the engineering organization of Electronics Park.

Recruiting and Training Men

Except in unusual cases the newly graduated engineering student has never faced the basic engineering challenge: with data not known to be sufficient, and with a time schedule not known to be adequate, he must design equipment for some new application without losing sight of the basic requirements of cost,
EFFICIENCY, and dependability. GE has come to regard this aspect of an engineer's training as its own responsibility. Each year it absorbs into its laboratories, offices, and factories hundreds of young graduates from all parts of the country and from all types of colleges.

Channelizing such widely divergent backgrounds into occupations best suited for each calls for a flexible training program at all levels of aptitude and specialization. The best-known aspect of this is the Test Program. With few exceptions, most GE engineers select their specialized field via this medium.

Finding a Niche

For a period of from one to two years each newly-graduated student engineer is assigned to many of the major departments. His responsibility is to test the products manufactured by those departments, and during the course of this work he observes the problems and methods that are peculiar to each activity. The average assignment period is three months. By the end of his test period he can select with some confidence the kind of work that offers greatest interest and opportunity to him. The majority of engineers at the Park are graduates of the Test Program. This system provides the Electronics Department with a continuing influx of young men with new ideas.

Electronics Park is, of course, one of the major steps for Test Program engineers. In addition, the Park has its own Test Program wherein graduates are transferred from building to building within the Park at approximately three-month intervals. This program is for those who have definitely chosen electronics as their life work.

Evening schedules of classes are provided at Syracuse University for engineers desiring to study toward their Master's and Doctor's degrees. These courses have been approved for benefits under the GI Bill. For other engineers, GE pays approximately two-thirds of their tuition if they complete their course satisfactorily. For those who do not, GE pays a third of the tuition. Courses are conducted at Electronics Park as well as in Syracuse University classrooms, and the thesis can be accomplished in any of the labs in the Park. At the present time, over 100 engineers at the Park are studying for advanced engineering degrees.

Another source for Electronics Department engineers is in Schenectady, where some thirty to fifty test engineers are selected throughout the company for an intensive course on engineering analytics. The course is a startling experience for every man who takes it. For four hours he is subject to intensive lectures by specialists called in from design sections or research laboratories. He is busy taking notes, for he knows that most of the material cannot be found in textbooks, and he likewise knows that the material might provide a clue to his weekly problem assignment—a clue which might reduce the 20 to 30 hours normally required for solution to 10 hours.
Only about half of those who complete the first year of this advanced engineering training will continue with it. The elimination is carried out in a spirit of mutual agreement; some have found the going too stiff, while others have taken up permanent jobs in a GE division where additional training of this nature is not essential.

**Types of Engineers**

There are at least seven distinctly different categories in which the graduate of the Test Program or the engineering newcomer can end up: Research, advanced development, product design, manufacturing supervision, field engineering, sales engineering and commercial engineering. Each calls for its own particular combination of aptitudes, personality traits, and engineering knowledge. Furthermore, the duties of each vary greatly with the divisions—Transmitter, Specialty, Tube, Receiver, Government, Laboratory or Sales.

The chap whose interest is chiefly in the highly theoretical aspects of a problem, almost approaching those of a physicist, invariably ends up as a research engineer in the Laboratory. He has few cost responsibilities, seldom a delivery date to think of and delves only into the laws of nature.

The fellow who likes to work with his hands may end up as a product design engineer. In this category are most of the engineers in the Park. They take an idea and a blank piece of paper and produce working models and blueprints for production. They have to consider costs, eye appeal, delivery dates, and a multitude of related practical factors. A product design engineer, also known as a development engineer, is assigned to develop a particular product for which there is an order or a possible market, and he sticks to that job until a finished working sample is produced—or rather works on it whenever he gets a chance, because there is always a fire to be put out somewhere in connection with production of things he previously designed.

The organizing type of engineer is likely to end up as a manufacturing supervisor or section engineer because he likes to work with people. A factory train-
WINDOWLESS HEAVEN—Shielded room inside one of the Receiver Division laboratories, with desk lamps for delicate tests when overhead fluorescents prove too noisy. All laboratories are air-conditioned, hence lack of windows here is no hardship.

ing course is conducted for the express purpose of developing men interested in both engineering and production.

Combine an interest in people with good engineering know-how, plus a love for change and travel, and you have the making of a field engineer. Combine a liking of people with a dislike for the slide-rule engineering of his college days, and you have a sales engineer, simultaneously looked up to and down at by his fellow engineers. He can be as much as 75 percent engineer and still be a topnotch salesman because of the market nature of the product he sells.

Add diplomatic qualities and market analysis to an ability to look ahead and you have the commercial engineer, who provides liaison between engineering, sales and advertising and is broadly responsible for consumer acceptance of a product. He is a main source of ideas for new products because he is continually in touch with customers' needs. Part of his work involves writing the specifications he considers desirable for a new product, and later making sure that the final product is good enough to merit customer acceptance.

The engineer is encouraged and aided in obtaining professional recognition and prestige by membership and committee participation in engineering organizations, by delivering talks and papers before engineering and other groups, and by writing articles and books.

The secret of getting top-level engineering productivity lies in morale, particularly in the inspiration which can be passed to and from the engineer and his immediate supervisor. Throughout the engineering organization at the Park, there are generally no more than 12 engineers, and often as few as 5, under each supervisor. This makes for rapid two-way communication of ideas, discussion of gripes, and correction of difficulties.

Morale-Building Techniques

Each supervisor is aided in working with his group by reference to a nine-point job program developed from a company-wide survey of employees. If productivity lags, the fault can usually be found in the fact that the company has not considered one or more of the nine elements inherent in a good job: Compensation, working conditions, supervision, job security, respect for basic human dignity, promotion practice, information on management aims, belief in the individual job's importance, and satisfaction in a job well done. Inevitably, GE loses some engineers to other firms. Such moves are seldom discouraged by the management, and as a result GE can claim to have trained the best engineers of many a competitor.

Beyond the salary question, the gripes are scattered...
FAMILIAR BREADBOARD—A pause for meditation often pays during the breadboard stage of developing a new electronic product. Here is the true old fashioned breadboard, using wood screws to hold the parts on the wood base.

HOT BOX—Here receivers and components can be tested or operated for hours at temperatures up to 150°F and humidities up to 100 percent, to simulate ambient conditions encountered in any part of the world where electronic equipment is used.

ROOM FOR RADAR—Nonmetallic structure nearing completion at back of Park, for testing huge radar antenna arrays regardless of outdoor weather conditions. Even sprinkler system inside is removable for sensitive tests.

REFINED BREADBOARD—A communication engineer in the Electronics Laboratory likes his breadboard circuits to be up in the air, accessible from both sides and supported by a relay rack. Other engineers fasten panels to small wood blocks.

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and to a large extent self-contradictory. One engineer goes so far as to measure with a recording thermometer the temperature of his air-conditioned office and to complain when it deviates beyond narrow limits, while another engineer objects that he cannot open the windows, sealed for the air-conditioning, to smell the clover on the Park grounds.

Regular meetings of all engineers in each division are held for discussions of any matter concerning the men and their relation to the company. Engineers interviewed say that these meetings are remarkable for their lack of double talk; an unpopular answer to a question is never evaded. Topics of discussion include salaries, employee benefits and services, the budget, profit and loss figures, plans for new products, and the competitive position of the Electronics Department with respect to the entire industry.

**Engineering Facilities**

The facilities for the engineering staff are of two types: an office and adjoining small laboratory where each engineer spends most of his working time, and specialized laboratories and a library.

The basic engineering office houses four to six men, and is approximately 12 by 23 feet in size. Adjoining it is a laboratory about 23 feet square, for the personal use of the men inhabiting the office. An elaborate system of conduits permits electric power of various voltages and frequencies to be brought out at each lab, as well as air under pressure, vacuum lines and specialized test signals, including video signals produced by the central video generator in the receiver plant.

The equipment in each lab depends on the particular problem at hand. In receiver development, signal generators, vacuum-tube voltmeters, Q-meters, and oscilloscopes are to be found in nearly every lab, and more specialized equipment is available wherever needed. Each engineer is encouraged to requisition test equipment whenever and wherever it will fill a need.

Many of the specialized facilities are located in the Laboratory Building. These include the Park library, a model shop staffed with skilled mechanics and wiremen, a small chemical laboratory for testing materials, a plating laboratory, painting laboratory, welding laboratory, metallurgical laboratory and photographic darkrooms.

Most of the development laboratories, particularly those devoted to receiver development, have individual shielded rooms within which may be found electrical quiet, so elusive near manufacturing plants. Specialized antenna erecting and testing facilities are also available in profusion. On top of the Receiver and Transmitter Buildings' roofs are a number of 30-foot steel poles mounted on gear-and-crank mechanisms which permit a single man to raise or lower them. A special nonmetallic building 60 feet high, for testing radar antennas without interference from metal objects, is located in one corner of the Park. This contains a steel monorail crane support and a sprinkler system, but these may be temporarily removed. Radar and similar line-of-sight transmitters may be tested in the clear at a site on top of a nearby hill.

One objection many engineers have to working in a large organization is the tendency toward excessive standardization of equipment and methods. The Park management has attempted to avoid this pitfall, as witness the case of the lab benches. Five distinctly different styles of lab bench are in use, one for each of the four divisions and one for the laboratory. One design could have been imposed by the management,
but the engineers couldn't get together on one design so Dr. Baker approved them all. Receiver benches are eight feet long, while Specialty benches are five feet long with drawers underneath at the right. The Receiver boys are quick to point out that the Specialty drawers are usually blocked by a soldering iron cord.

Six to twelve engineers share the same stenographer, an arrangement made possible by the fact that few of the engineers dictate correspondence and reports, preferring to write them out longhand for retyping. The stenographer is her own boss, an arrangement that avoids conflicting directions and leads to a display of tact on the part of the engineers.

Getting a Project Started

Ideas for new or improved products come from many sources. Perhaps the most valuable are those relayed from the consumer to the engineering staff via the commercial, field and sales engineering forces. Three noteworthy engineering developments of the Electronics Department, the self-contained antenna in standard radio sets, the variable-reductance pickup and the high-brightness television picture tube, all started with suggestions from customers. Not infrequently the engineers themselves come up with an idea for a new product, but usually the engineer thinks in terms of improvements rather than innovations.

Whatever the source, the idea for a new or improved product is channelled initially to the commercial engineers and the sales department. This custom is a reflection of Dr. Baker's settled policy of developing only products that can be sold at a profit. The commercial and sales groups, aided by the staff's marketing manager, study the suggestion, calculate its ultimate selling price, then judge whether the market will take it at that price. If the answer is favorable, the idea achieves the status of an engineering project involving analysis, circuit design and breadboarding to see whether the idea can be reduced to practice.

The projects thus approved go on a waiting list, from which they are removed in a priority rotation established by the division manager and his project committee. One of the divisions keeps track of available project engineers on a wall chart which shows the week-to-week progress of current work and thus gives some advance prediction of availability of engineers.

Often the work may be assigned to a project team, since it is not always possible to get the required combination of leadership, cost consciousness, engineering talent and originality in a single individual.

When the project engineer gets the project, with it goes a definite time schedule and cost budget. He is responsible to his supervisor for putting the project through within these established time and money limits, or else he must do a sales job to get more of each. The project engineer then requests other engineers to assist him in the work, and he's off to the races.

The first duty of a project engineer is to query the Laboratory in the Park to see if any new ideas are at hand or in the offing that can be applied to the job at hand. The Research Laboratory at Schenectady is also approached for this purpose, as is everyone else in the Park who may have thoughts or ideas to contribute. All this is routine, made compulsory to ensure that the development team starts where others left off, rather than from scratch. Commercial engineers in that particular activity are asked what competitors are doing. Competitive products may even be purchased and dissected as a prelude to creative development work.

With all the facts at hand, actual design starts. Mak-
FOR TELEVISION RELAYING—Parabolic reflector for microwave television relaying, ventilated to catch less wind. Engineer holds waveguide terminus that bounces signals back to reflector.
pass on whatever he's got to the next team in line. Separating the engineer from his brain child often requires real ingenuity on the part of the supervisor. No one can predict in advance how long it will take a particular engineer to develop an unknown new product to the stage where it is ready for production. Early estimates must be revised frequently as work progresses, and each revision makes the engineer less respectful of deadlines.

An engineer's goal is perfection. Knowing this, and knowing that perfection is never achieved, the wise supervisor works close enough with his men to know when the product is good enough, then takes it away by one means or another. It is rumored that one supervisor actually stole the finished sample while the engineer was out to lunch, and turned it over to production minus last-minute finishing touches.

The philosophy of the supervisor is to encourage his engineers to make and discover enough mistakes fast enough so that they can all be cleared up before production starts. Allowing an engineer to scratch his head carefully for an extra seven months during development is expensive, yet gives no insurance whatsoever against production troubles. Engineers are helped in this activity by an industrial design section which is primarily responsible for final appearance of the product, but also contributes to initial design innovations before the bugs are ironed out. Responsible to the manager of marketing, this section makes plastic pre-production models of portable radios and clay transmitter models, for instance. The hope and dream of the supervisor is that all early design bugs be little ones, such as are caused by tolerance clashes or mechanical misfits.

With electronic manufacturing back to its highly competitive pre-war status, quality of performance is no longer enough to insure sales. Overall appearance and styling must likewise be top-notch in the eyes of the customer, whether the product be a receiver, a transmitter, a tube tester, or even a tube. Today no design is permitted to leave a design section in the Park until it has been made up in model form from wood or plaster.

Even in the professional field of precision instruments, the engineer is faced with the problem of building a unit which will work and at the same time be commercially attractive. In time an engineer acquires this ability—a "must" to satisfy the commercial people and his designer's instinct.

Field Engineering Procedures

Whereas the Receiver Division sends out service manuals to take care of its troubles in the field, the Transmitter Division sends out a service man instead—an engineer who applies on the job those final touches that design engineers would like to do themselves. Field engineering achieves its greatest importance in the Transmitter Division, where each customer is fol-

**EVOLUTION OF A RADIO RECEIVER**

The development engineer here was asked to produce a table model set that would outperform competitive models. With a close deadline, the logical approach was to put in extra tubes and parts whenever in doubt. The resulting chassis, at extreme left, worked beautifully and was put into production, but manufacturing costs were out of this world because the chassis was flush level full of parts.

The engineer was kept on the job. One by one he removed bypass capacitors and isolation resistors, measuring effect on performance each time. At regular intervals a cost-reduction committee met to evaluate accumulated savings. By the time the engineer had half-emptied the chassis, the committee authorized launching of a new model (center chassis), and the assembly line was reprocessed for it.

Still costs were too high, so the project was continued. Soon the version at the right, stripped down almost to the bare chassis, will go into production.
The field engineer by necessity has a degree in electrical engineering, plus at least a year in the test course. His job is to supervise the installation of GE transmitters and other equipment, as well as to take care of troubles that develop in the field. Thus, a high degree of tact and diplomacy is required.

Knowing the field engineer's aversion to red tape, GE requires reports only once a week. Longhand reports in pencil are okay, with no copies. When these reports come in, they are typed up and copies are routed to all interested persons. They may suggest design improvements and point out defects just as would a supercritical customer. The tough job at headquarters is to determine who or what is at fault—engineering, production, the tubes in the product, or the customer.

**Responsibilities of the Laboratory**

Between the fundamental work of the Research Laboratory at Schenectady and the applied development of the Division engineers lies the field of activity of the Electronics Laboratory. Here programs of advanced development or applied research are generated in all lines of the Department's activities, working about three years ahead of production.

**PATENT LOG BOOK**—Each engineer has one, in which circuits, ideas for new products, mathematical developments, and inventions are jotted down for possible use by patent department. Each patent application is good for a $25 bonus. Top man patentwise at the Park is Bob Dome, with 52 to his credit. Patent logs are examined regularly by men assigned to patent department liaison.

The Laboratory was started during the war years, and much of its effort is still concentrated on development programs for the military. It is growing at a rate determined by its ability to recruit and absorb men with the peculiar qualifications for advanced development. The present staff consists of approximately 80 people, of whom about 40 hold engineering degrees. The remainder are laboratory assistants, model shop mechanics, and the necessary clerical help. In addition, there is continuing rotation of from 6 to 12 assigned people from the company's training programs. While most of them move on to new three-month assignments elsewhere in the Department or in the company, all are candidates for replacement in the Laboratory.

The responsibility of development engineers in the Laboratory Building is to think of the future and to take calculated risks in reducing research to practice as fast as possible, for the advancement of the electronic art and for the overall profit of the Department's operations. It is not expected that everything tried will work, nor is it expected that everything which works will get into production. All that is expected of the Laboratory is a continued output of ideas, ready for the next stage of development by the operating divisions.
PART III—The Production Technique

FINAL production blueprints are converted into finished products in the Receiver, Transmitter and Specialty Buildings. The differences in manufacturing techniques in these three buildings are directly related to the type of product manufactured. A girl on a receiver line may do her assigned work in 30 seconds, whereas a girl at a bench in the Transmitter Building may work for days on the same unit.

In discussing production at the Park, certain definitions are necessary. Production means getting ready for manufacturing—doing everything except putting together the product. It is primarily moving of materials so they will be at the right places at the right time. The receiving room and the stock room are in charge of the Production Supervisor. Manufacturing is making things. Production starts long before manufacture and goes on concurrently with manufacture. Inspection is mechanical, involving checking of such things as dimensions, finishes and tolerances. Test is both electrical and mechanical, involving checking of electrical values or electrical performance characteristics of individual components and both physical and electrical specifications of the finished products.

All four of these elements, integrated throughout all buildings, are the Park's manufacturing technique. Broad decisions as to which division will make a particular product or line of products are made generally by the vice-president in consultation with the interested division managers and their staffs. Within each division, committees headed by the manager and containing members of commercial, sales and engineering sections meet weekly to determine the future of a product. One purpose of these meetings is to schedule future production so as to keep labor requirements as nearly uniform as possible and within the allocated labor quota for the division. One rigidly enforced rule is that every promise of delivery of a design or a production quota must be confirmed in writing if initially made verbally. Enough differences of opinion rise in the normal course of events without having arguments over who promised what.

Incentive Pay

In all Divisions, as many assembly workers as possible are employed on a basis whereby they can earn extra pay for extra output. During the period when

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MASS PRODUCTION—General view of manufacturing floor of Receiver Building, with television receiver assembly lines in foreground. By Christmas every line here will be making televisions, and ordinary receiver production will be transferred to outlying satellite plants. Fluorescent lamps directly over each line and ceiling fluorescents provide 50 foot-candles at working level.

they are training for a particular assembly operation, they receive a guaranteed hourly rate. Their earning rate climbs gradually as they acquire proficiency in doing their assigned work. On operations involving team-work of many employees, group incentive pay is used.

Prices for incentive work are set either by time studies, by tables, or by comparison. All three methods take into consideration the native and acquired skill and knowledge of the employees, the amount of past training and education required, and the effort required in applying the skills on the job. The perfect system for measuring the relative amount of mental and physical effort required on various jobs has not yet been devised; perhaps it will never be, but the manufacturing staff is constantly working toward that end.

There is no attempt to lure labor from other manufacturers in Syracuse by offering higher wages. Records show scores of cases where workers left for higher wages only to come back a few weeks later to the clean working conditions, good lighting, air-conditioned comfort, and straightforward management at the Park.

Inspection of Parts

Inspectors in all divisions are on hourly pay to insure careful work, and many of them are engineering graduates. Inspection is based on modern techniques of statistical quality control sampling. As an example, if an incoming shipment contains 100 units the inspector will test 20 and pass all if there are no rejects. If there is one reject he tests 40 more, and passes the remainder if these 40 are all good. If he

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CUTTING RECEIVER ASSEMBLY COSTS

Steady introduction of manufacturing shortcuts, like welding of resistor leads and ground straps to chassis, does not offset increased hourly rates for labor.

Automatic receiver-building machines based on printing and spraying techniques are under investigation, but the high initial investment required is a major problem.

Simplifying and cleaning up circuit design is therefore the most fruitful avenue of cost reduction.

Standardization on higher-rating components permits high-volume purchasing savings that often actually reduce cost. Thus, half-watt resistors are the smallest used in receivers, and 600-volt paper capacitors are standard except for cathode and avc circuits.
finds more than one reject in the first 60, however, he either makes a 100-percent test or rejects the entire lot, depending on how badly the parts are needed.

Vendors who sell parts to the Park are rated every month on the quality of their product. Since the goal in the purchasing department is to have as many reliable vendors as possible on tap, for protection against shutdowns in any one vendor's plant, the purchasing staff will usually send representatives to the vendor's plant for a detailed look into the situation before black-balling.

**Receiver Division Problems**

The job of the Receiver Division is to manufacture radio and television receivers of uniformly high quality, according to schedules and at or below standard cost. After a receiver sample is delivered by Engineering, the Planning Section writes a detailed "process" (schedule of operations) and sets up the necessary physical facilities on the floor to care for the production of a given model. This process is based upon standard times and upon time studies made by the Wage Rate group. Concurrently Production takes over the vendors which have been established by the Purchasing group, schedules them and expedites material deliveries to meet the line schedules. As each given model progresses it is the responsibility of the Test and Inspection group to obtain, in conjunction with Planning, the necessary test and inspection facilities to care for the model adequately.

Before all the service divisions have completed their work, pre-production samples are built according to process insofar as possible and delivered to Engineering. Within two or three weeks thereafter a pilot run of 50 receivers is manufactured, using all the production facilities which will finally carry the processes, to check the equipment, allow training time for working leaders, and provide Test and Inspection Section with finished receivers for training purposes. This permits doing on a planned basis what is sometimes done on an unplanned basis at considerable extra cost.

After the pilot run, the line is manned. It becomes the responsibility of the Manufacturing Group to train new operators and to bring the line up to speed. Each line is provided with an organization chart showing the number of operators processed for the line, plus a line buildup schedule showing how many sets should be produced each hour during the period when the line is coming up to schedule. This training schedule is the result of considerable research; it is based on a formula which has been empirically derived to take into account such factors as the time-cycle, skill of workers, and rate of production desired.

Each line is divided into groups of ten to fourteen operators in charge of a working leader. These working leaders do the majority of training on the line. Absenteeism is cared for by training two or more girls to do the same job, enabling breaches in the line to be filled effectively.

Every attempt is made to allow nothing but quality
products to leave the assembly line. This is done by check and repair and repeated inspection both in and after the line. Receivers which are in difficulty are analyzed as rapidly as possible and sent to the repair group for modification. The controlling factor in the speed of all lines is quality. A line must stay below 10 percent rejections, and speed is held down until that quality level is realized. It has been found, however, that running a line below half speed does not accomplish a great deal in the way of training; the training is principally for speed, and not simply for memorizing a relatively simple operation.

Inspection cannot in itself insure quality because there is still the possibility of human error in the inspectors and final test men. Therefore, sampling inspection techniques are employed in the shipping room, where sealed cartons are actually opened and sets are tested again. This final inspector has the authority to shut down the entire production line until the trouble has been corrected if he discovers defective sets ready for shipment. Of course, he must be pretty sure of his ground when he shuts down a line because this makes many people above him unhappy.

Getting a television line started, as many manufacturers have learned, is more involved than ordinary radio production. To obtain large-scale manufacture for example, one line at the Park was re-processed four times, resulting in many new work assignments and redistribution of operators' positions. The final setup, however, employing three moving conveyor lines in series was soon producing 400 sets a day.

**Transmitter Division Production**

In contrast to the Receiver Division which deals in mass production for orders frequently running to hundreds of thousands of units, the Transmitter Division rarely has an order for over a hundred units. Furthermore, some of these units sell to the customer for well over $500,000 each. The transmitter manufacturing organization employs about 2,000 workers and has approximately 20 workers under each supervisor.

The two main types of products are radar units, communication transmitters and special electronic items for Government use, and a wide variety of products for commercial use, including broadcast equipment (a-m, f-m, television), communication equipment such as taxicab, police, aircraft and marine sets, carrier current communication and controls, electronic navigators, electronic heaters, and facsimile equipment.

Most of the component items required in the Transmitter Building are specially designed and must be made or procured in small quantities. The production section has the responsibility of procuring all items called for on the material lists furnished by the Engineering Section.

On items to be manufactured in the shop, the Planning Section works out each individual step in producing the item and sets a price for producing the item. From this, the price allowed each employee per piece for each step is set and vouchers are made up for use by the employees as pay vouchers. At the same time, raw materials needed are accumulated in the stock room after careful incoming inspection test.

The foreman in charge of assembly of a unit now has on hand the needed raw material, the components purchased outside, and the pay vouchers covering manufacture of components and assembly work. He starts one or two people on the smallest assembly, gradually building up his group to the required size for the order on hand. Finished subassemblies are
The test power house in the Transmitter Building provides a variety of voltages and frequencies, and these can be fed through a well-planned cable system to any test setup on the factory floor. Three temperature chambers are available for operating tests at extremes of cold, heat and humidity, as required for most government equipment and for some commercial equipment. Vibration and tilt tables that can duplicate the roll and pitch of a battleship, the vibration of an airplane engine, or the bouncing of a jeep over rough country are available for testing commercial as well as military equipments under simulated field operations. Shielded rooms permit measuring sensitivity and noise right on the factory floor. Dual lighting systems are provided in these rooms; fluorescent lights are normally used, but for delicate tests incandescent lamps can be turned on.

To insure maximum protection to the operator while conducting tests on live circuits, interlocked test cages, safety shields, a central grounding system, and many other safety devices are used. The success of these safety measures is indicated by the transmitter test section's record for 14 months of work—534,250 man-hours without a single lost-time accident among the employees.

Even the huge broadcast and shortwave transmitters are produced on an individual piecework basis computed according to the number of screws, wire, and parts each man installs. Workers with two distinct kinds of aptitude are used here. The true mechanic, who likes to mount things precisely and make them line up, is called an assembler and is used to do all of the mechanical assembly of a transmitter. The electrician type, on the other hand, likes to hook things up according to circuit diagrams; he is called a wire-
Building, and builds some associated with planning model shop is flexible. To a number of requirements, it may be snatched away from Specialty. Here the men usually work from samples rather than detailed drawings.

The goal is to get the time cycle for a particular operation down to a minimum. In the Specialty Division this can be anywhere from 3 minutes to 40 hours, in contrast to the Receiver Division's average cycle of less than a minute. The number of workers assigned to a particular order depends on daily production requirements as well as on the size of the order. So flexible is production planning here that a rush job can be got out practically overnight if need be.

Small orders, up to the limit of 25 units, are produced in Specialty's model shop, just off the production floor, where everybody is paid on an hourly basis. The secret of efficient production in Specialty's model shop is elimination of the paper work associated with planning of production and setting of piecework rates. An engineer develops a new product and turns it over to a wire man. He in turn wires up and builds a production sample, then teaches girls to make the rest of the run. All planning is done in the head of the wireman, with the girls memorizing their duties and using the production sample as their guide. With runs under 25, it costs more to break down the job on paper into individual assignments than the job is worth.

Conclusion

These, then, are the men and the facilities of Electronics Park. On them lies the responsibility and the challenge to substantiate Dr. Baker's theory that one can have the excellent accommodations of the Park and still meet competition. So far, the theory has stood the test of performance.

An article of this detailed nature, covering such intangibles as how engineers think, would have been impossible without the cooperation of a large number of people. A complete list of the names of those who contributed so freely of their time, their ideas and their data would fill this page, hence only a few can be mentioned. Appreciation is expressed to Dr. W. R. G. Baker for making this article possible; to E. L. Robinson for making preliminary arrangements; to Andy Tobin for scheduling the interviews and serving as guide during the entire period; to George Burns of Schenectady for photography; and to practically everyone in the organization chart of the Park for their help.—J. M.
Peek-to-Peak Voltmeter

Pulses and transients of short duration are measured by an instrument having extremely high input impedance. Pulse-stretching circuits are used and an amplifier feedback arrangement provides substantially zero-impedance output.

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In the design of electronic a-c voltmeters and ammeters, a desirable trend has been toward development of average or rms-reading instruments in order that the measurements may more accurately indicate actual power regardless of frequency or waveform.

There is also an increasing demand for instruments yielding peak or peak-to-peak indication of repetitive waveforms. This requirement is a more particular one in the instance where the average value over one cycle is negligibly small, as in the case of television synchronizing pulses, and in a wide variety of timing and controlling operations. Here, the energy level as represented by rms values may be unimportant, and the maximum (or minimum) excursion of the wave is the dimension to be measured together with wave shape and timing information.

In the design of electronic equipment such as high quality amplifiers, modulators, transmitters and recorders, it is the peak values of signal that extend beyond the linear range and cause undesirable transients, distortion and intermodulation. If the transients are of short duration, they are not measured by rms meters.

Measurement of the absolute indication of narrow voltage pulses imposes a rather difficult requirement on available materials and techniques. The voltmeter, to justify the term, must fully respond to the pulse without consuming it. The difficulty becomes immediately apparent when the usual diode peak-reading voltmeter is connected to a source of pulses of 2 microseconds width which are repeated say 10 times per second. Since the storage capacity in the diode circuit must be great enough to keep the output ripple small, the total energy continually dissipated by the diode load resistor must be supplied in less than 2 microseconds.

For example, if the peak 2-microsecond pulse voltage being measured is 10 volts, the energy in a 1-megohm diode load resistor will be $1 \times 10^{-7}$ watt. This continuous power must be supplied in a small percentage of the time (0.002 percent). To supply this continuous diode load power, the source being measured must supply an instantaneous power of 5 watts. Since this
is a rather high power level, neither the source being measured nor the diode of the voltmeter will handle it and the reading will be in error.

As the pulse width or the repetition rate is further diminished, the error is greater still. The effect is also more pronounced when the peak voltage being measured is below about 5 volts since then the curvature of the diode characteristic makes the diode impedance abnormally high and still further limits its peak power-handling capability. The combined effects described limit the best conventional diode peak voltmeter to measurements above a few volts and having a duty cycle not less than 0.1 percent.

The modern cathode-ray oscillograph yields both voltage and wave shape indications and with proper amplification and intensified trace formation, this instrument can identify practically any recurrent wave to the user when suitably calibrated. However, the combination of a stable electronic circuit and a precision meter will afford indications that can be made reliable within one or two percent whereas an accepted reading error of 5 percent accompanies the oscillograph indication. The latter figure may easily rise to 10 percent when the factors of calibration source error and its associated reading error are taken into account.

The basic design of the peak-reading voltmeter under consideration is the amplifier-rectifier type such as has been popular for a-c measurements in the past decade. Each portion of the present instrument, however, demands a new approach to secure the desired response to steep wavefronts and narrow peaks.

Rectifier

The circuit employed to increase the rectified energy available for driving the output meter is illustrated in Fig. 1. The input wave encounters a typical diode rectifier in the first stage. Capacitor $C_1$ is, however, smaller and higher in impedance than is usual, permitting the grid of triode $T_1$ to rise to the peak value of a sharp spike without rounding it off. This diode and capacitor combination functions as a pulse stretcher, the output voltage being depicted in Fig. 1, along with the graphical representation of voltages in the other stages. The time scale shown is an approximate one but serves to indicate the effective increase in energy.

Since the impedance of the voltage source at the grid of $T_1$ is relatively high, $T_1$ is used as an impedance step-down repeater amplifier to drive a second conventional diode rectifier $T_2$, with the relatively long-duration (stretched) pulse to charge its output load capacitor $C_2$. Since the signal pulse has been appreciably lengthened, the duty cycle of diode $T_2$ has been improved considerably and no difficulty is had charging $C_2$ to the full peak value of the signal voltage. Triode $T_3$ repeats this d-c voltage into a low-impedance measuring meter.

Capacitor $C_3$, together with $R_3$,  

![FIG. 1—Circuit and waveforms of pulse stretchers and impedance step-down repeaters](image-url)

![FIG. 2—in the preamplifier circuit, the use of feedback permits the amplifier to have substantially zero output impedance](image-url)
determines the time constant of the meter circuit and at the same time, the low-frequency limit of operation. With the component values shown, this circuit responds uniformly to pulses of the same peak level when the pulse width varies from a maximum (square wave) to a minimum of less than 2 microseconds at 20 pps.

To adapt this rectifier circuit to the widest variety of applications, an amplifier preceding it is a necessity. The amplifier designed for this purpose provides wide input voltage range coverage with simple switching, uniformly high input impedance and low output impedance, adequate output voltage swing and high stability.

The amplifier is required to provide a linear output versus input relationship over a 10 to 1 amplitude range to satisfy the decade switching feature (the indicating meter is of the logarithmic scale type calibrated from 1 to 10). Furthermore, the low-voltage limit must exceed several volts to avoid encountering the curved portion of the diode characteristic. Finally, the stability must be such as to introduce negligible errors when factors of line voltage variation and tube changes are considered.

The present design yields a peak-to-peak voltage swing of 9 to 90 volts and the sensitivity of the meter circuit is adjusted so that these figures correspond to minimum and maximum scale deflection respectively. The incorporation of about 25 db negative voltage feedback insures amplifier stability equivalent to the attenuator and output indicating meter tolerances (± 1 percent).

**Design of Amplifier**

Initial experiments with the rectifier section showed that the signal voltage source impedance to the rectifier must be kept low if optimum peak response is to be had.

This factor demands the application of an amplifier ahead of the rectifier section even if only as an impedance transformer. It further requires the amplifier to have an output impedance of about 100 ohms if C1 is to charge up to the peak value of a 1-sec pulse in 0.01 µsec (or 1 percent of this pulse interval). The latter figures do not include the forward resistance of the diode or inductance of wiring and circuit elements.

The requirement of low driving impedance has been met by a method which has received relatively little attention. By its use, the apparent output impedance of the amplifier may be reduced to zero (or may be made negative if desired to compensate for positive resistance in the diode).

Figure 2 shows the basic amplifier circuit. Negative feedback from the plate of output tube T1 to the cathode of the first amplifier stage T, causes output load variations to be reflected through the nominally high impedance of T1 into the amplifier circuit. In this way, the cathode current at the output stage is effectively modulated by output load variations.

If the output load is low, the output current and cathode current of T1 will be increased. The increased current of T1, results in an increased positive feedback voltage from the cathode of T1 to the cathode of T. This acts to effectively increase the output current.

The reverse of the above is true when the output load impedance is high. The proper amount of positive feedback as shown enables the amplifier to have substantially zero output impedance within the output current limits of T1.

The principle employed in reducing the output impedance of the amplifier had been suggested some years ago and had also seen practical application in loudspeaker amplifiers where excellent damping of cone resonances was observed. A typical voltage versus frequency characteristic for a sine-wave input is shown in Fig. 3.

**Second Amplifier**

Additional gain is obtained by a two-stage preamplifier similar to that shown in Fig. 2 but omitting the positive feedback feature. The use of two separate, independent, cascaded amplifiers of two stages each permits use of an attenuator between the units.

The range switch includes a section which is interposed between the units and provides 10:1 step-down from maximum gain. By employing this arrangement as the first step of the attenuator, any slight noise or hum appearing in the input tube is thus reduced 20 db on all ranges but the first. The other ranges are accommodated by attenuation in the input to the amplifier. With the proper choice of compensated resistor elements, this has been found to be a most reliable method of range multiplication.

In the final version of the voltmeter, a full-wave meter rectifier circuit is used so that peak to peak values are indicated by the meter. This is believed to be of greater interest in the majority of cases than half-wave operation where polarity of only one sign would be registered. The instrument shown covers a range of 0.001 volt to 1,000 volts peak to peak or 0.0035 to 355 volts in terms of rms values of a sine wave.

**References**


Saturable Reactors

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BEFORE launching into a discussion of the subject, it is desirable to distinguish between saturable reactors and magnetic amplifiers. Without attempting to formulate definitions of these established terms it is, nevertheless, desirable to review some of the accepted differences recognized by workers in this field. It is impractical, even artificial, to distinguish between these devices on the basis of construction, function, or circuitry. To delineate the areas covered by the two terms on the basis of common usage is futile because they are used interchangeably, the older term, saturable reactor, being the more widely recognized.

A clear means of demarcation seems to be that every magnetic amplifier includes, as an essential component, a ferromagnetic device with adjustable inductance. Commonly, the amplifier is supplied with power from an alternating current source so that this ferromagnetic device can be a saturable reactor, or transductor as it is termed in Europe. From this viewpoint, a saturable reactor is a part of a magnetic amplifier. This viewpoint is not essential, but if followed consistently could avert ambiguity.

Saturable Reactors

Several simple saturable reactor arrangements are shown in Fig. 1. The one in Fig. 1A can be made by connecting a pair of conventional two-winding transformers. The a-c or power windings may be connected in series or in parallel. The d-c or control windings are wound and connected with respect to the a-c windings that no net voltage of the fundamental power frequency appears across the control circuit terminals. The arrangements shown in Fig. 1B and 1C are quite similar in control characteristics to that at Fig. 1A. There are, however, slight differences involving transients and leakage reactances. Many variations of this basic circuit are possible, but all have similar performance characteristics. The manner of operation of the simple saturable reactor has been amply discussed in the literature and need not be reviewed nor enlarged upon here. The self-saturating type of reactor is of greater interest and, although it has been discussed in the literature, a brief explanation of Fig. 2 will show the essential features of its operation.

The circuit of Fig. 2A serves to demonstrate the operation of self saturation. While the circuit itself is of little practical value, it is the simplest self-saturating type of reactor circuit, and its oscillograms showing the effect of control premagnetization apply almost exactly to practical circuits. The circuit consists of a saturable reactor, a rectifier, a load and an a-c source all in series. The reactor has an auxiliary winding which is supplied with control current from a high-impedance source. The oscillograms in Fig. 2B show the load and supply voltages as functions of time and indicate the manner in which the load voltage can be adjusted by means of the control premagnetization. (The resemblance of this type of control to thyatron control is obvious.) Corresponding magnetic conditions in the core are shown in the lower oscillograms (Fig. 2C), which illustrate the effect of the control current on the minimum or initial flux density B0 and also upon the undirectional pulsating load current. Adjustment over the range of control shown in the diagram (Fig. 2D) is effective in changing the output in a 100-ohm load from 1.5 milliamperes to 150 ma. It should be noted that the maximum flux density at the minimum current or cut-off condition (Fig. 2E) is so adjusted that the hysteresis loop is symmetrical and shows a total excursion of flux density of just less than twice the saturation flux density of the material.

There is a rather sharp increase of the load current as the core flux density reaches saturation. Because of this action the circuit yields to analysis on the basis of sharp firing. Such analyses have been made and give calculated waveforms and transfer curves that are in fair agreement with measurements.

As previously mentioned, the single reactor is of little practical value unless provision is made for minimizing the fundamental component of current induced into the control

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and Magnetic Amplifiers

Use of saturable reactors as components of magnetic amplifiers is described. The author discusses effects on performance of core material and assembly, and points out importance of reproducibility of core materials and rectifier properties. Applications are described.

winding. This may be done by inserting a high impedance in the control circuit or by connecting two reactors or arranging several windings in such a way that the induced current is minimized. The last alternative is illustrated by the circuits of Fig. 1D and 1E. The circuit of Fig. 1D is called a doubler; it gives alternating-voltage output. The circuit of Fig. 1E is called a full-wave circuit; its output is d-c.

Effect of Core Material

The contrast between the sensitivity of the simple saturable reactor circuit and that of the self-saturating type may be seen in Fig. 3A. The transfer curves shown in this diagram were taken for two sets of reactors of approximately the same mean flux path, one constructed with standard E-l silicon steel laminations and the other with gapless medium-nickel iron alloy (Allegheny Ludlum 4750) ring laminations. In each case, data is shown for both the simple reactor circuit and the self-saturating type.

Two important differences are evident: (1) the increased sensitivity of the self-saturating circuit and (2) the improvement of performance obtainable with the better steel. With silicon steel, the self-saturating circuit is five times more sensitive than the simple reactor, while with the 4750 nickel steel gapless core, the self-saturating circuit for which data is shown is about 50 times more sensitive than the simpler circuit using the same core. Furthermore, in this same circuit, the 4750 iron has an advantage of 40 times in sensitivity over silicon iron. This makes evident the superiority of the better steel. Of course, the data are not strictly comparable because of the difference in geometry of the cores, but the curves shown may be taken as representative of conditions obtained in two types of cores which do have approximately the same mean magnetic path length. The peak ampere-turns of the load current is over 1,000 times the control ampere-turns for saturation for the self-saturating circuit with nickel-steel core, while the ratio in the case of the same circuit with the air-gap silicon steel core is approximately five for the particular set of data shown in Fig. 3A.

Similar contrasts of the sensitivity of the self-saturating circuit for other core materials, such as Permalloy, Permenorm 5000-Z and Supermalloy show increases in sensitivity over 4750 of the order of 2.5 times for the Permalloy and about 25 times for Permenorm.

The single-phase doubler and full-wave circuits may be arranged for polyphase operation. Several such circuits are shown in Fig. 1F, 1G, and 1H. The first (Fig. 1F) is a simple 3-phase Y-connection with the control windings arranged so that no voltage component of fundamental frequency appears at the control circuit terminals. Other circuits shown include (Fig. 1G) the 3-phase full-wave circuit and (Fig. 1H) the 6-phase circuit with interphase transformer. The polyphase circuits are commonly used for larger power outputs, particularly where fast response and optimum utilization of reactor structure are important. The latter condition develops in virtue of the fact that the several polyphase circuits have different internal impedances when made with identical reactors, permitting the load impedance, which may be fixed by external consideration, to be matched more closely.

Magnetic Amplifiers

Because the change in load current can be greater than the change in control current that produced it, saturable reactors can be used as amplifiers. To improve their performance, feedback is commonly used, particularly in the simple circuits that do not employ self-saturation. Usually the load current is rectified in a full-wave bridge and introduced in a special feedback winding on the reactor structure in such a manner as to aid the control current ampere-turns. Two single-
Phase feedback circuits are shown at Fig. 11 and 11. As in the simple reactor circuits, the main windings may be connected in series or in parallel, and the load may be placed in either the a-c or d-c circuit.

Transfer curves of a reactor with adjustable feedback are shown in Fig. 5B. The effect of increasing the positive feedback factor is shown by the increased slope of the transfer characteristic. Of course, this increase in sensitivity with positive feedback is obtained at the expense of the speed of response of the reactor circuit and the stability of the system in which the reactor is used. Negative feedback results in an extended range of linearity of the transfer curve.

In both cases, window space is occupied by the feedback winding, so that the reactor structure must be derated by an amount which increases with the degree of feedback. As an example, in order to provide 100-percent feedback, (feedback turns equal to main turns), a simple reactor would have to be derated by 50 percent. For simple reactors without self-saturation, the use of feedback permits convenient adjustment of sensitivity in the range between that of the simple reactor and that of the self-saturating type and even beyond. The characteristics of the rectifiers are not critical.

The use of large amounts of positive feedback results in a trigger action that is apparent in the +z curve of Fig. 3B. This trigger action can be exploited to advantage, as in the use of reactor circuits to give relay action which is quite sensitive and capable of high speed, shock-proof operation.

The performance of a magnetic amplifier system, particularly one of the self-saturating type, depends on the properties of the components which are used. The possibilities of the various circuit arrangements have been explored and the limitations on performance are known. In the self-saturating circuit, performance depends as much on the characteristics of the rectifier as it does on the properties of the magnetic core material. In discussing the performance of magnetic amplifier circuits, I shall mention the effect of both rectifier and core material characteristics and I shall attempt to do so upon two different levels: (1) what is now commercially feasible with normal manufacturing and quality-control techniques and (2) what seems to be the ultimate in performance of the best of present materials on a laboratory basis.

The principal performance characteristics of magnetic amplifiers include power gain, power output, speed of response, and weight per unit output. Other factors which may be of interest are shock resistance, ambient temperature limits, stability and linearity.

For optimum performance, the magnetic core material should have the following characteristics: (1) high saturation induction for low pounds per watt, (2) high differential permeability in the second and third quadrants of the hysteresis loop for maximum sensitivity, (3) high resistivity and ability to be made in thin laminations for low eddy-current shielding to give fast response, and (4) stability of magnetic characteristics under changing temperature and mechanical strain and shock conditions.

To be suitable for use in the commercial manufacture of reactors for magnetic amplifier circuits, the core material should have other characteristics in addition to those required for optimum performance. In the first place, it is of the utmost importance that the magnetic core material have properties which are reproducible between different batches and are the same for all the material in each batch. This is the single most important requirement for high-permeability core material for magnetic amplifiers.

Core Assembly

Considerable handling is involved in stacking laminations and in placing a winding upon the stacked core, therefore, it is desirable that the core materials be reasonably free from adverse effects resulting from moderate mechanical stresses. It does not seem feasible at present to consider the use of toroidally-shaped tape cores for low-level amplifiers (0.1 to 10 watts output) and there is no method presently available, to my knowledge at least, of obtaining satisfactory stacking factors with unit cores that are assembled before annealing and are used just as they come from the oven.

It is also necessary that the laminations have adequate interlamination resistance, which may be developed in stacks made of laminations with commercially available film coatings of the oxide type. Present practice consists of insulating the laminations before assembly with clear lacquer or impregnating the core after assembly with a wax.

The structure of magnetic amplifier cores has been a matter of discussion for some time. Performance-wise, there are only minor differences between the core-type reactor arrangement, the three-legged reactor, and the four-legged reactor. For laminated, gapless cores, the simple arrangement using core-type reactors seems most practical. The limits on performance of circuits using reactors of this kind, particularly those made with high permeability core materials, are fairly well known, and the effects of core and copper geometry upon the various performance factors are understood in a general way. While the question of core and copper geometry for optimum performance remains an open one, rather definite conclusions may be eventually
reached following a critical study of the problem. Early work along these lines indicates the feasibility of such a study.

Development work has been done on the basis of somewhat more limited objectives. A time constant of 1 cycle on a power supply period basis for the transient response of practical amplifiers is the present limit, while power gain, which is affected by the desired time constant, may be approximately one or two thousand if quick response is not desired. The watts per pound figure may be taken as approximately thirty for low-level 400-cycle reactor circuits. With rectifiers, mounting brackets and resistors included in an amplifier assembly, the watts per pound may become ten or fifteen for low-level, 400-cycle units. If these three factors are the only ones of importance, that is if cost and space are not involved, it seems quite feasible to reach rather definite conclusions concerning optimum core geometry. If, on the other hand, space is also important and high gain may be sacrificed, the rectifiers would be of different design, as would the optimum core shape.

Reproducible Core Material

The importance of the reproducibility of magnetic characteristics of the core material for magnetic amplifiers is shown by Fig. 3C. This graph shows measured magnetization curves of several samples of high permeability core materials, all of approximately eighty-percent nickel. The solid lines represent the catalog information given by the manufacturer as the average and extremes of the normal magnetization curve. The dashed-line curves show several measured curves for cyclic magnetization and indicate that the extremes given by manufacturer are not at all pessimistic. A range of maximum reversible permeability of 85,000 to 25,000 it seem to exist in the measured curves, which were taken for representative samples. A range of maximum normal permeability of 300,000 to 60,000, or 5:1, is shown in the data.

The sensitivity of a magnetic amplifier circuit using reactors made with Hymu 80 or Mumetal, materials similar to that of Fig. 3C, depends on the slope of the upper branch of the hysteresis loop, particularly in the region of zero magnetic flux density and the coercive force value of magnetic intensity. The slope of this portion of the hysteresis loop is dependent to a large extent upon the maximum value of the normal permeability. Changes of normal permeability in the ratio of 5 to 1 result in changes of magnetic amplifier sensitivity of approximately the same ratio. This condition is intolerable from the standpoint of large-scale manufacture of magnetic amplifier systems with fixed or published characteristics. Variations of this kind and magnitude are not amenable of compensation by other than laboratory methods which are often too costly for this type of product.

I think it safe to state that those who are interested in the manufacture of magnetic amplifier components and systems would be gratified if means were found to manufacture a core material with characteristics reproducible to plus or minus ten or even twenty percent, even if this were done at the expense of radically reduced values of maximum permeability and increased cost. As a matter of fact, I feel that this would be a more valuable contribution to the art than the development of core materials of even greater permeability than those presently available.

Characteristics of Rectifiers

The performance of the rectifiers used in saturable reactor systems, particularly those employing the self-saturation feature, affects the characteristics of the circuit. The question of rectifier performance is one which parallels in importance that of the magnetic properties of the core materials. Explicit characteristics desired of rectifiers for magnetic amplifier applications are: (1) sturdiness and (2) low forward combined with high back resistance.

Sturdiness, reliability and long life are essential because magnetic amplifier applications often involve conditions of high-intensity shock and require operation without replacement of parts or servicing for 10,000 hours or more. Because none of the components, except possibly the rectifier, are difficult of manufacture to meet these requirements,

FIG. 3—(A) Core material and circuit de-
termines response of amplifiers. (B) Positive feedback gives snap action; negative feedback improves linearity. (C) Properties of cores vary between samples. (D) Rectifiers are also important

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the use of dry-disc rectifiers rather than electronic units is usually indicated. At any rate, they are in common use in magnetic amplifier circuits.

Low forward resistance and high inverse resistance are desirable for obtaining maximum sensitivity consistent with the properties of the magnetic core material. Low forward resistance results in an increase of output for a given control signal. The lower back current resulting from the use of high inverse resistance rectifiers results in less demagnetization output for a given control current.

Figure 3D shows the characteristics of two small, commercial rectifiers. The rectification ratios are seen to lie between 1,000 and 2,000, while the forward-versus back-current ratios are 50 and 65. It is desirable for magnetic amplifier circuits that the current ratio be raised to 500 to 1,000. Such a ratio is not considered unobtainable for special-purpose units by rectifier manufacturers. Commercial requirements in the field of dry-disc rectifier units have been so unlike those for the special units discussed, that there has been little development work aimed at the special characteristics required of rectifiers for reactor circuits. No doubt such improvement in rectifiers can be made without an overly extended development program.

Rather large changes of operating temperature should not be reflected in equivalent changes of electrical characteristics of the rectifiers, particularly the inverse resistance, nor should the rectifier characteristics change radically over the period of their useful life. Rectifiers should have the maximum inverse voltage rating consistent with a high value of forward-versus back-current ratio so that they are light in weight and give optimum amplifier sensitivity. They should not change when unused or should recover rapidly from nonuse such as shelf storage or equipment idleness. Like core materials, rectifiers for magnetic amplifiers should have reproducible characteristics as commercially available units with published resistance characteristics. This requirement is particularly true of the low-level units, espe-

FIG. 4—Presaturated reactors and magnetic amplifiers have been used in various applications, as these simplified diagrams show: (A) line voltage regulator, (B) automatic battery charger, (C) theater lighting control, (D) constant potential rectifier, (E) welding rectifier, also shown in block form (F), (G) servo motor power amplifier, and (H) two-stage audio amplifier.
cially sensitive types, but is not of great consequence at higher power levels, present published rating data being sufficient.

Applications of Magnetic Amplifiers

Just as the saturable reactor is a basic component of the magnetic amplifier, so the magnetic amplifier can be used as a basic subassembly in various equipments. The characteristics of the amplifier will be determined by the equipment with which it is to be used, and the amplifier will have to be designed accordingly.

One of the commonest applications of saturable reactors is for line voltage regulation in which the self-adjusting property of the reactor is used in place of a manually adjusted tap on a transformer to compensate for input voltage or load current changes. The next step in complexity is a single saturable reactor to substitute a separately controlled reactor (Fig. 4A). Line-to-line voltage regulation is obtained by an autotransformer which is a pre-saturated reactor controlled by a magnetic amplifier operating from voltage changes across the output. A bleeder reactor prevents the regulator from losing control at no load.

Automatic battery chargers have long used magnetic amplifiers, especially in Europe. In this application the requirement is to maintain constant charging voltage and to limit the current (at the beginning of the charging cycle) to a safe value. A doubler circuit (Fig. 1D) and a full-wave rectifier can be combined to perform this function (Fig. 4B). Variations in output voltage and input current (coupled to the magnetic amplifier through a transformer) operate the control winding.

Another popular application is in theatre lighting control (Fig. 4C). A low-power control circuit, excited from the power line, produces the direct current to govern a magnetic amplifier of the full-wave type (Fig. 1E), which is also excited from the power line. The output of the amplifier in turn regulates the saturation of the main reactor in series with the lamp bank. Because the primary control circuit and the magnetic amplifier are both excited from the same power line, effects of fluctuations in supply voltage can be counteracted to some extent. The line voltage has to be about 10 percent higher than the rated operating voltage of the lamp bank to allow for the drop in the main reactor.

The functions of voltage regulation and rectification can be combined in a single unit. A 3-phase unit is suitable for many applications as controlling the speed of a large d-c motor (Fig. 4D), obtains the fixed reference voltage through a constant voltage transformer across one of the power phases. This voltage is rectified and the current so obtained is used to control three full-wave magnetic amplifier operating from a 3-phase transformer and interphase transformer (compare with the single-phase circuit of Fig. 1E). To increase the sensitivity of the system, the positive feedback is used, and to improve transient response, damping windings in series with a capacitance are added. The output voltage (motor speed) can be controlled by the potentiometer in the constant-voltage circuit.

Some applications require that the output be stabilized against several possible variations. The battery charger (Fig. 4B) is one example of this case. The welding rectifier (Fig. 4E) is another example. The output current must be stabilized against changes in output load (current and voltage) and line voltage. The 3-phase doubler circuit has three control windings. One winding is excited by rectified 3-phase voltage from the supply line, the second is excited by current proportional to the load current, and the third by current proportional to the load voltage. All of these control currents pass through a common potentiometer by which the welding current can be set. A potentiometer across the output further provides adjustment of the voltage-proportional control current for no-load reference. Four sets of rectifiers are required: the self-excitation rectifiers of the doublers, the power rectifiers in the output, and the two sets of rectifiers for input voltage and output current for the control windings. A single rectifier suffices for the output voltage control circuit because it is already across the power rectifiers (but a rectifier is necessary to provide high impedance to induced reverse currents). A block diagram (Fig. 4F) shows the nature of the feedback paths of this system.

The foregoing systems have operated at 60 cps. Fast response is not required of them and it is most convenient to excite all elements of the system from the same supply. However, if fast response is necessary, a higher operating frequency should be used because then, for the same impedance, the inductances of the windings can be less, which reduces the time constant of the system. In general, equivalent magnetic amplifiers operating at different frequencies can respond in the same number of cycles, thus the higher frequency unit has the faster response.

A fast-acting servo amplifier can be operated from a 400-cps source (Fig. 4G). A 2-phase system is frequently used with a 2-phase induction motor, although a 3-phase system would be similar. Doubler in push-pull with each other produce a null so that the system has a quiescent point between forward and reverse motor drive. The control windings are excited by electronic tubes; the rheostats in the cathodes permit balancing the amplifier at the required null, or varying the null. Primary control of the amplifier is, as usual, through the grids of the tubes.

An audio amplifier (Fig. 4H) illustrates the use of high-frequency excitation to obtain fast response. Essentially each of the two stages is a carrier-type amplifier. Two pairs of doublers, connected in push-pull to reduce even harmonic distortion as well as to provide symmetrical operation, are excited from a 10,800-cps source (180th harmonic of 60 cps). These two stages are connected by an interstage transformer. Pairs of full-wave rectifiers are used before the interstage and output transformers. A single-button carbon microphone feeds the 5-milliwatt input transformer to develop full power in the 5-ohm 6.5-watt voice coil of the loudspeaker. The operating points of the reactors of each stage are set by a bias battery and biasing resistors.
Television Synchronizing

Horizontal and vertical driving pulses, the composite blanking signal and the composite synchronizing signal, all within FCC and RMA specifications, are produced. Linearity test signals can be mixed with blanking for testing picture monitors and receivers; simultaneous cathode-ray monitoring of all frequencies is provided.

The instrument to be described provides the means for insuring synchronism between the scanning of a picture at the receiver and the scanning of a subject at the transmitter. Features are provided that are not usually found in a synchronizing generator which are specific aids in television station operation and maintenance.

The generator meets the RMA recommendations for the standard signal, that is, the horizontal and vertical driving pulses, the composite blanking signal and the composite synchronizing signal. Linearity test signals are provided at 900 cycles and at 157.5 kc mixed with blanking by means of a switch for use in testing scanning linearity of picture monitors and television receivers. These produce 15 horizontal bars and 10 vertical bars on a raster permitting a rapid check of sweep linearity. In addition, the 157.5-kc test signal serves as an accurate 10 percent H (6.35 µsec), electronic marker for use with an ordinary oscillograph in the precise setting of pulse widths and front porch.

The leading edges of the equalizing pulses are also the leading edges of horizontal and vertical synchronizing pulses, thus insuring perfect interlacing.

Two 3-inch cathode-ray tubes permit simultaneous monitoring (without switching) of all frequencies in the synchronizing generator. Thus, frequency counts may be checked or adjusted without the use of an external oscilloscope.

A crystal oscillator at 157.5 kc or a highly stable self-excited oscillator at 157.5 kc may be selected by a switch for the master oscillator. The self-excited oscillator is used in synchronizing the generator, by means of the provided lock-in circuit to the 60-cycle power line or to a remotely generated synchronizing signal.

Negative feedback is used in many of the circuits to minimize the effect of changes in tube characteristics and variations between tubes. A double-regulated supply is used having an internal impedance of less than 0.15 ohm.

Circuit Breakdown

The generator consists of the following units:
1. Timing generator
2. Blanking-driving unit
3. Sync shaping unit
4. Regulated low-voltage supply
5. High voltage supply for the cathode-ray monitors
6. Power control panel containing switches and fuses.

Figure 1 is a block diagram showing the interrelation of the units in the development of the standard signals. Accurately timed signals at 157.5 kc, 31,500 cycles, 15,750 cycles, 900 cycles and 60 cycles are developed in the timing generator for use in the other units.

The blanking unit utilizes the 60-cycle signal and the 15,750-cycle signal in the development of verti-
Signal Generator

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cal driving and horizontal driving pulses and in the development of the composite blanking signal. It also uses the 157.5-kc signal and the 900-cycle pulses in the development of the composite linearity test signal which becomes available mixed with blanking.

The sync shaping unit utilizes the 31,500-cycle pulses and the 15,750-cycle pulses with suitable delays (for accurate synthesis of the horizontal and vertical sync pulses) in a specially designed delay line contained in the blanking-driving unit for the formation of the high-frequency components of the composite synchronizing signal. The 60-cycle pulse from the timing generator is used undelayed in the development of the low-frequency component of the composite synchronizing signal.

To meet the severe requirements of the RMA-recommended synchronizing signal generator signals, there must be precise time relationship among the pulses developed by the timing generator. This may be obtained by starting at a high frequency and by suitable frequency division deriving the lower frequency pulses. An alternate method is to begin with the lowest frequency and obtain the higher frequency signals by suitable frequency multiplication. In the timing generator shown in Fig. 2, the former method is used because it may be effected by simpler circuits.

In the circuit diagram of Fig. 2, the two basic oscillators are the 6AC7 crystal oscillator and the 7F8 master oscillator, both operating at 157.5 kc. The 6SN7 blocking oscillator frequency dividers are used to derive the lower frequencies required. The first division is by 5 to 31.5 kc, the equalizing pulse frequency. From 31.5 kc there is one division by two to 15,750 cycles, the horizontal rate, and another division by seven to 4,500 cycles. The frequency of 4,500 cycles is divided by five to 900 cycles, one of the linearity test signal frequencies.

Division of 900 cycles is done by five to 180 cycles which is in turn divided by three to 60 cycles, the field repetition rate. Sawtooth waveforms at 60 cycles and at 900 cycles are fed respectively to the deflecting plates of the low-frequency and the high-frequency cathode-ray monitors, to serve as time bases for the presentation of the count-down frequencies on the monitor screens.

**Frequency Indicators**

Figure 3 shows the presentation on the screens of the cathode-ray tubes. The left-hand screen is that of the high-frequency monitor whose horizontal time base is 900 cycles. The dots represent the master oscillator or crystal oscillator frequency 157.5 kc. There are five dots along each line or step in the vertical "ladder" indicating a division from 157.5 kc to 31,500 cycles.

The bright dots on the high-frequency monitor correspond to the 15,750-cycle horizontal repetition rate. There are seven steps in each of the ladders, indicating a frequency division from 31,500 cycles to 4,500 cycles; in other words each ladder represents 4,500 cycles. The presence of five ladders for each cycle of the time base points to a frequency division from 4,500 cycles to the time base frequency of 900 cycles.

On the right-hand or low-frequency monitor, the ladder steps represent 900 cycles. Since there are five of them to each ladder, the indication is frequency division...
from 900 cycles to 180 cycles. The three ladders per cycle of the time base indicate a frequency division from 180 cycles to 60 cycles.

The blanked out section in the middle of the low-frequency scan being derived from the power line further confirms the time base of 60 cycles and indicates synchronism with the line. When the generator is not locked to the 60-cycle power line, the blanked out section moves across the time base. This presentation has been found highly useful in the analysis at a glance of synchronizing generator failures due to improper timing.

The type of blocking oscillator frequency divider circuit used is the cathode-tuned circuit stabilized type, Fig. 4. Firing of the blocking oscillator results in a surge of current through the cathode circuit which is normally tuned to a frequency half that of the trigger repetition rate. This results in a ringing of the tuned circuit due to its Q. The cathode voltage waveform is that of a damped sine wave lasting for 2½ cycles (for a 5 to 1 count down) before the blocking oscillator fires again. The grid to ground and the grid to cathode voltage waveforms are shown in the diagram of Fig. 4. As indicated, discrimination is very good against all trigger pulses other than the one producing proper count down.

In the design of the timing circuits, extreme care was taken to minimize any possibility of frequency modulation of the timing pulses. Considerable attention was paid to the chassis layout especially with respect to keeping high level pulse points away from the afc circuit. The blocking oscillator grids are returned to +250 volts giving a steep capacitor voltage discharge waveform and consequently improving freedom from jitter.

The source of B voltage is a double-regulated power supply with an output impedance of less than 0.15 ohm. This eliminates the possibility of extraneous signals modu-

FIG. 2—Timing generator circuits of the Du Mont TA107 A/B sync generator

FIG. 3—Presentation of count-down frequencies on cathode-ray monitors
To conform to the strict requirements of the RMA recommended synchronizing signal, it is good design practice to use the same signal for the formation of the leading edges of all of the pulses which make up the synchronizing signal. In the synchronizing signal generator under discussion, the leading edges of the equalizing pulses are used to form the leading edges of the horizontal and the vertical synchronizing pulses. This is done by adding a horizontal component and a vertical component, both of which have been delayed a precise time by a lumped LC delay line in the blanking unit, to the equalizing pulses and clipping the result as indicated in Fig. 6.

Two separate delay lines are used, one for the 31,500-cycle signal and the other for the 15,750-cycle signal. Each line consists of 70 $\pi$ sections with a total delay of 10 percent of the horizontal period or approximately 6.5 microseconds. Provisions are made for tapping connections in any one of the sections in both lines. This permits very accurate shaping of the sync pulses as well as very precise setting of the front porch. Multivibrator stability is in part a function of the trigger pulse rise time. To maintain as short a rise time as practical in the delayed 15,750 and 31,500-cycle trigger pulses, the delay line is designed for a frequency band of over three megacycles. Figure 6 shows the schematic of a single section of the delay line.

**Equalizing Pulses**

The equalizing pulses shown as $G$ in Fig. 5 are generated directly by multivibrator $V_n$ in the sync shaping unit, block diagram of Fig. 5. They are amplified and limited by $V_m$ and mixed with the
other synchronizing signal components in the plate circuits of $V_m$, $V_s$, and $V_v$.

**Horizontal Pulses**

Figure 5 is a timing diagram indicating the synthesis of the composite synchronizing signal from its various components. The horizontal pulses are formed by adding delayed 15,750-cycle pulses to the equalizing pulses, amplifying, limiting and keying-out undesired 31,500-cycle pulses. The result before final clipping is shown at $U$ of Fig. 5.

Tube $V_s$ in Fig. 5 is the horizontal pulse multivibrator whose output (O in Fig. 5) is permitted to clear through $V_s$ only during the horizontal pulse interval.

The 15,750 cycle pulses ($Q$ in Fig. 5) are then amplified and limited in $V_s$ and mixed in the common plate circuit of $V_m$ and $V_v$ with the vertical and equalizing pulse components of the composite synchronizing signal. The first and last sections of $U$

in Fig. 5 show the horizontal component of the mixed signal at $V_s$. The raised portion of this component indicates the overlap between the equalizing pulse and the delayed horizontal pulse. This is later clipped off in limiters $V_s$ and $V_m$ as shown in the first and last sections of $V$ in Fig. 5.

The keying out of the horizontal pulses during the equalizing pulse interval is accomplished by the gating of keyer tube $V_s$, by pulse $P$ in Fig. 5 derived from the equalizing pulse interval multivibrator $V_s$, through amplifier $V_e$. The elimination of unwanted equalizing pulses is obtained by first pushing them down into a region lower than that of the desired horizontal pulses by means of 15,750-cycle pulses shown as $T$ in Fig. 5 and later removing them by clipping. Waveform $T$ is derived from the alternate equalizing pulse keying multivibrator $V_s$ through keying tube $V_e$ and amplifier-limiting $V_e$. The pushed down equalizing pulse is shown in the first and last sections of $U$ in Fig. 5.

The elimination of alternate equalizing pulses must not take place during the equalizing pulse interval. For this reason keying tube $V_e$, by means of the equalizing interval pulse $P$ permits the alternate equalizing pulse keying signal $S$ to be applied only during the horizontal pulse interval. The output of $V_s$ is $T$ in Fig. 5. The duration of the horizontal pulses in the output signal $V$ is 8 percent of $H$ (+0 –1 percent).

**Vertical Pulses**

The vertical pulses in the composite synchronizing signal consists of a group of six at a 31,500-cycle rate. The group repeats itself once each scanning field, see center section of $V$ in Fig. 5. The duration of each pulse is 43 percent of $H$ where $H$ is the line period and the group must appear during the vertical blanking interval between the first and second group of six equalizing pulses.

The timing of the vertical pulse interval is determined by the trailing edge of a pulse, $J$ in Fig. 5, three lines wide from the 60-cycle vertical pulse centering multivibrator $V_m$. The vertical pulses are generated at a 31,500-cycle rate in the vertical pulse multivibrator $V_m$. These are shown at $I$ in Fig. 5. One of its pulses, upon coincidence with the trailing edge of the vertical centering pulse $K$, is permitted by keyer tube $V_s$, to trigger the vertical pulse interval 60-cycle multivibrator $V_m$ whose pulse width is normally set equal to three horizontal lines or the interval required by six vertical pulses at the 31,500-cycle rate.

Waveform $L$ in Fig. 5 is the output of $V_m$. The vertical pulse interval gate, in turn, permits the vertical pulses to be amplified by keyer tube $V_m$ only during the vertical pulse interval. The result is $M$ in Fig. 5. In turn, the six vertical pulses during the vertical pulse interval are amplified and limited by tube $V_v$ and appear in the common plate circuit of $V_m$, $V_v$ and $V_m$. Thus, into a common plate load are fed the horizontal pulses during the horizontal pulse interval from tube $V_m$, the equalizing pulses during the equalizing pulse interval from tube $V_v$, and the six vertical pulses during the vertical pulse interval from tube $V_v$. The mixed signal, $U$, is amplified and limited by $V_v$ and $V_v$, and appears at the cathode and plate of output tube $V_v$ as a positive and negative composite synchronizing signal. Figure 5 shows the final sync output signal at $V$.

The block diagram of the blanking-driving unit is shown in Fig. 7.
The 15,750-cycle pulses trigger the horizontal blanking multivibrator \( V_h \) whose output is fed into blanking mixer \( V_m \). The 60-cycle pulses trigger the vertical blanking multivibrator \( V_v \) whose output is fed to the grid of the second triode of blanking mixer \( V_m \). In the blanking position of the linearity test switch, the mixed vertical and horizontal blanking signals are limited and amplified in tube \( V_n \) and applied to the grid of blanking output tube \( V_v \). At the cathode and plate of output tube \( V_v \), appear respectively the positive and negative composite blanking signals.

The 157.5-ke signal derived from the timing generator is amplified and shaped in \( V_v \) and mixed in \( V_n \), with the 900-cycle pulse derived from multivibrator \( V_m \). In the **blanking and linearity bars** position of the linearity test switch, these are inserted into the blanking signal in the common plate load of blanking mixer \( V_v \) and linearity mixer \( V_m \). The mixed blanking and linearity test pulses are clipped in limiter \( V_n \), and applied to the grid of output tube \( V_v \). In this position of the switch the output signals at \( j_h \) and \( j_v \) consist of the composite blanking signal mixed with vertical and horizontal linearity signals. In the **linearity bars** position of the selector switch only linearity test signals are permitted to appear at the blanking signal output jacks. Figure 8 shows a test pattern generated by an iconoscope film chain driven by the sync generator. The linearity test switch is in the **blanking and linearity bars** position.

The horizontal driving pulses originate in the 15,750-cycle multivibrator \( V_v \) and are directly applied to the grid of the horizontal drive output tube \( V_v \). They appear as positive and negative horizontal driving signals respectively at \( j_h \) and \( j_v \). In a similar manner the vertical driving pulses originate in the 60-cycle multivibrator \( V_v \); the output is applied directly to the grid of vertical output tube \( V_v \). Vertical driving pulses appear in positive and negative polarity at jacks \( j_h \) and \( j_v \). At Y and Z of Fig. 5 are shown the waveforms of the horizontal and vertical driving pulses produced by the circuits.

**Power Supplies**

The high-voltage supply is used to provide the accelerating potential for the cathode-ray tube monitors in the timing generator.

A double-regulated low-voltage supply is used to provide 250 volts and 350 volts for the three signal units. This supply has an output impedance of less than 0.15 ohm at 1,000 cycles. The change from no load to full load at 400 milliamperes results in a change of only 0.1 volt at the output. A block diagram of the low-voltage supply is shown in Fig. 9. Transients from the ordinary power supply filter circuit are eliminated by use of an "electronic choke" in the form of a first regulator for the 350 volts ahead of the final regulator for the 250 volts.

A number of these synchronizing generators have been in operation during the past two years with excellent results.

**Acknowledgment**

Acknowledgment is made to the following men of the Du Mont Laboratories who took part in the development and product design of the synchronizing generator: H. Beste, L. Durgin, C. Quirk and L. Spooner, and to N. Accardo and M. Demeyer, who aided materially in the test of models.
Single-Sideband CRYSTAL FILTERS

X-cut crystals are used in multiple-section filters for the upper and lower sidebands and the carrier frequency. The carrier filter has a passband 16 cycles wide between 3-db points and the sideband filters are flat within 0.6 db for nearly 6 kilocycles

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Engineering Products Dept.
RCA Victor Division
Radio Corporation of America
Camden, New Jersey

ONE PROBLEM involved in the development of an improved type of radio receiver for twin-channel, single-sideband reception was the design and construction of three crystal filters.

These were used to separate the carrier from the sidebands of an amplitude-modulated wave train at an intermediate frequency of 100 kc and to isolate each of the two sidebands.

Specifications called for a carrier filter less than 25 cycles wide at points whose response was 3 db down from maximum, and 175 cycles wide at points 50 db down, with a maximum attenuation of over 70 db available.

Since both speech and musical programs were to be received with high fidelity, each sideband (channel) filter was specified to have a passband 6 kc wide, flat within ±0.5 db except at the edges where a 2-db drop from maximum response could be tolerated. These edges were taken to be 100 cycles and 6 kc respectively from the intermediate carrier frequency of 100 kc.

A maximum relative attenuation of at least 85 db was desired at all frequencies separated by more than 4 kc from the passband midfrequency. This would provide for a 40-db attenuation of adjacent-channel signals of equal strength in addition to a possible unfavorable selective fading differential of 45 db between the two channels.

A piezoelectric crystal such as quartz acts electrically like the LC circuit shown in Fig. 1. For a range near the resonant and antiresonant frequencies of this electrically equivalent circuit, the crystal presents a reactance whose variation is shown by the full-line graph of Fig. 4. Suppose that two crystals are so cut that the resonant frequency of one coincides with the antiresonant frequency of the other. The reactances of both crystals are then as depicted by the full-line and dashed-line graphs of Fig. 4.

Theory

If these crystals be connected in a bridge circuit similar to Fig. 6, or its equivalent lattice, Fig. 2, we have the structure of a simple narrow bandpass filter. The dashed-lines in Fig. 2 indicate lattice arms of the same type as those actually shown. In Fig. 6, the dashed-lines indicate that XX are the two halves of a single crystal having divided plating. Likewise for YY.

The bridge circuit of Fig. 6 is that of a pure reactance bridge. This will be perfectly balanced when the reactance between points 1 and 2 of the circuit is equal to that between 1 and 4 and of the same sign. The same is true for the reactance between 2 and 3 and that between 3 and 4. There are two frequencies at which this will occur. On Fig. 4, these are designated $f_{\omega_1}$ and $f_{\omega_2}$ for the attenuation (theoretically) reaches an infinite value at these frequencies. Actually, the attenuation will merely rise to a maximum value, called an attenuation peak, at each of the two frequencies of balance as shown in Fig. 5. As the frequency of an input signal is increased from $f_{\omega_1}$, toward $f_s$, the attenuation will continuously decrease until it (theoretically) reaches zero at $f_s$, the series-resonant frequency of one of the pairs of crystals.

For frequencies between $f_s$ and $f_c$ the reactances of the two pairs of bridge arms are at each point of opposite sign. Hence, signals whose frequencies lie within this range will pass through the filter (theoretically) with no attenuation. Actually some attenuation is experienced in this range, the amount depending on the Q factor of the crystals and associated circuit elements. For this reason, characteristics of the filters developed in this work are shown as relative attenuation versus frequency rather than actual attenuation. The region between $f_s$ and $f_c$, as shown in Fig. 5, is the passband of the filter.

In practice, capacitors $C_d$ are placed in parallel with input and output terminals of the filter. Others, $C_s$, of much smaller capacitance, are connected from input to output as bridging capacitors.

The parallel capacitors adjust the separation between resonant and antiresonant frequencies of the bridge arms and hence control the width of the passband. The bridging capacitors change the shapes of the reactance graphs of the bridge arms somewhat, thereby changing the frequencies at which the two reactance curves cross where of like

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sign. Adjustment of the bridging capacitors, therefore, controls the frequencies of the attenuation peaks of Fig. 5.

The resonant and antiresonant frequencies of a quartz crystal are separated by only about 0.4 percent of resonant frequency (for X-cut crystal). Since, as seen in Fig. 4, the passband is only double this amount, some other circuit element must be introduced if wide passbands are desired. Such an element may be an inductance placed in series or in parallel with each crystal of the circuit. These two types of connection result in filters having low image impedance and high image impedance, respectively.

To avoid stray couplings in the channel filters herein described, a reasonably low image impedance was chosen. This choice called for a coil to be connected in series with each crystal of the filter circuit. The widening of the filter passband by the use of coils is due to the fact that their addition produces a large increase in the separation of resonant and antiresonant frequencies of the bridge arms and furthermore extends the upper edge of the passband considerably beyond the higher of the two antiresonant frequencies of the bridge circuit, Fig. 9 and 10.

For the passband region, the image impedance of the filter is a pure resistance whose value changes from near zero at the passband edges to a maximum midway between them. Terminating resistances considerably lower than the midband impedance are used in the filters actually built to secure a better average impedance match over the whole passband.

If all the coils used in the wide-band filter are wound to have equal resistances, or if supplementary resistors are inserted to make all arms of the equivalent bridge circuit have equal resistances, it is possible to consider these resistances as being brought outside the bridge circuit proper and incorporated in the terminating resistors. This leaves the bridge as a pure reactance bridge. Under this condition neither the sharpness of the cutoff at the passband edges, nor the steepness of the attenuation characteristic of the filter is impaired by the resistances of the coils inserted in the filter lattice.

Mason\(^1\) has given mathematical formulas from which the values of the circuit components of a filter section can be computed after certain constants have been chosen. These are (1) the frequencies of the edges of the passband, (2) the

---

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<th>Frequency (kc) of Lower Side</th>
<th>Difference cps</th>
<th>Frequency (kc) of Upper Side</th>
<th>Difference cps</th>
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<td>+10</td>
<td>99.890</td>
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<td>Average</td>
<td></td>
<td>Average</td>
</tr>
</tbody>
</table>

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Table I—Effect of Temperature on Attenuation Characteristic

\(^1\)Mason, L. W.: \"Microwave Filter Design,\" \(1950.\)
frequencies of the peaks of infinite attenuation, and (3) the midband image impedance of the desired filter. The formulas refer to the electrical equivalents of the crystal filter lattice as shown in Fig. 3 and 8.

A sample 6-kc filter calculation using the wideband filter formulas, resulted in the following values. Chosen

\[
Z_0 = 2,000 \text{ ohms}
\]

\[
f_s = 99.50 \text{ kc}; f_m = 106.70 \text{ kc}
\]

\[
f_{\alpha 1} = 98.70 \text{ kc}; f_{\alpha 2} = 107.50 \text{ kc}; f_{\alpha 3} = \infty
\]

Having obtained the values of the equivalent electrical components of a crystal filter section, the next step is to transfer the computed series resonant frequencies \( f_s \) and \( f_m \) of the crystals to actual dimensions of the quartz crystals themselves. Equations for accomplishing this depend up on the type of crystal cut decided upon.\(^{\text{a}}\)

Calculated

\[
L_0 = L_3 = 44.22 \text{ mh}
\]

\[
C_0 = 32.84 \mu \text{fd}; C_3 = 54.88 \mu \text{fd}
\]

\[
L_1 = 20.70 \text{ h}; C_2 = 0.1206 \mu \text{fd}; f_2 = 100.70 \text{ kc}
\]

\[
L_2 = 18.53 \text{ h}; C_1 = 0.1234 \mu \text{fd}; f_1 = 105.28 \text{ kc}
\]

The \(-18.5\text{-deg X-cut crystal had previously been generally used as a filter crystal due both to its high Q and freedom from the troublesome face shear mode of oscillation. However, this cut has quite a large temperature coefficient of over 20 parts per million per degree centigrade.}\(^{\text{b}}\)

The \(+5\text{-deg X-cut crystal with a width-to-length ratio of 0.35 has a temperature coefficient of only about 4 parts per million per degree centigrade.}\(^{\text{c}}\) Moreover, it is easily cut from the mother quartz (involving rotation only about the X or electrical axis). It has the disadvantage of having a relatively large coupling to the face shear mode when wide crystals are used.

Because of the two advantages mentioned, the \(+5\text{-deg X-cut crystal was chosen for the present filter construction. A single-section channel filter was found to have a spurious resonance due to the coupling to the shear mode. The response occurred at a frequency approximately 116 percent of the passband midfrequency and reduced the attenuation to within 11 db of that of the passband itself.}\(^{\text{d}}\)

When a filter of four sections was tested, however, no observable indication of any secondary response at all was present. This is evident in the graphs of Fig. 14 and Fig. 15 where the attenuation is 87 db or greater for all frequencies more than 1.2 kc (1.1 percent) higher than the upper edge of the passband. This desirable result was due to the slight differences in crystal frequencies for the four filter sections resulting from the choice of different peaks of maximum attenuation for each section.

By the use of equations given by

![Diagram of double-section 6-kc channel crystal filter](image-url)

*Top and bottom views of two-section 6-kc bandpass crystal filter chassis*
Atwood \(^5\) we find for the +5-deg X-cut crystal that \(f = 110.5 \gamma /y'\) kc.

This equation is strictly accurate for only very narrow crystals, of which \(y'\) is the length. The crystals were designed to have a width/length ratio of about 0.35 in order to secure the +5-deg X-cut crystal minimum temperature coefficient of 4 parts per million per degree centigrade previously mentioned. As X-cut crystals of larger and larger widths are used, the crystal frequency constant decreases somewhat from that of a very narrow crystal.\(^6\) For a width/length ratio of 0.35 the decrease is 1.8 percent. Hence the equation is modified for the crystals used in the present project to

\[
f = 108.5 \gamma /y'\) kc.
\]

A preliminary study of the effect of interelectrode and stray capacitances together with midband frequency and bandwidth requirements for the 6-kc bandpass filters dictated the use of very thin crystals. Having chosen a minimum feasible thickness and a width/length ratio of around 0.35 the equivalent motional capacitance of a sample crystal was found by measurement of its static capacitance together with its resonant and antiresonant frequencies. Substitution of this value for \(C_2\) or \(C_3\) in Mason’s equations determined the image impedance \(Z_i\) of the filter. This value of \(Z_i\) was, therefore, used in calculating all the electrical components of the 6-kc bandpass filters.

**Construction of Channel Filters**

To obtain the sharp cutoff and large attenuation required by the specifications, a filter of four sections was built for each of the 6-kc channel filters. Two shielding cans were used as containers for each complete filter, each can containing two filter sections. After the filter was mounted, dry air was passed through the can which was then hermetically sealed.

Each single-filter section consists of two crystals with divided plating, two coils in shielding cans, each equipped with adjustable powdered-iron cores, two small, fixed, molded-mica capacitors and a tiny bridging capacitor. The latter is formed by two short lengths of bus bar mounted about 1-inch apart on the bottom of the Bakelite crystal mounting base.

The circuit of each double-section filter is shown in Fig. 12. Resistor \(R_s\), shunted between the interconnection of each two sections and the chassis, together with the resistances of the input and output coils, provides a T pad to serve for interstage impedance matching. External terminations were used with each double section filter.

Each series coil is a universal-wound coil on a ¼-inch-diameter

---

**FIG. 13—A double-section 20-cycle crystal filter.** Capacitors \(C\), control passband width. \(R_1\) and \(R_2\) are terminating resistors. \(R_3\) and \(R_4\) are interstage impedance-matching resistors and \(X\) are +5-deg X-cut crystals. These components are shown in the illustrations on this page.
isolantite form. The coil is equipped with an adjustable powdered-iron core, and in use is mounted in the shielding can.

Construction of Carrier Filter

The narrow-band filter for the 100-kc intermediate-frequency carrier was much simpler in design and construction than the channel filters described above.

Calculated values of the motional capacitance together with the chosen theoretical passband width of 40 cycles, and the chosen frequencies of the attenuation peaks, determined the value of image impedance.

Here, again, as for the 6-kc channel filters, terminating resistors of smaller size than the image impedance were used to give a better impedance match throughout the passband. Figure 13 is a schematic diagram of the wiring of this double-section narrow-band filter.

Each single section consists merely of two divided-plating crystals, two small mica capacitors and the terminating resistors. The three resistors (at the center of the under-chassis view) constitute a pi-type attenuation pad of about 7 db between the two sections. Input and output terminating resistors are mounted externally to the shield can.

Results and Conclusions

Each of the two complete four-section 6-kc channel filters had an insertion loss within the passband itself of about 24 db. To compensate for this loss, the filter was fed from and into vacuum-tube circuits. The tube supplying the signal to the input of the filter was a 6J5 used in a cathode-follower circuit for easy impedance matching. The output of the filter was fed to a 6SK7 pentode amplifier. The result was a gain within the passband of 1.5 db measured from input to cathode follower to output of the pentode amplifier. The same type of tube-circuit arrangement was used with the carrier filter.

The attenuation characteristics of the lower and upper channel four-section crystal filters are shown in Fig. 14 and 15. The average characteristics are as follows:

Width of passband between points 2 db down, 5.94 kc; 2-db point adjacent to carrier, 134 cycles from carrier, passband flat within ±0.6 db over a bandwidth of 5.73 kc; bandwidth at 85 db down, 8.10 kc; attenuation greater than 87 db for all frequencies separated more than 4.17 kc from the passband midfrequency. Tests of the 6-kc channel filters at 25C and 50C respectively show a slight narrowing of the passband with rise in temperature averaging about two-and-one-half cycles per centigrade degree of temperature change. This is shown in Table I.

In Fig. 16 are shown two passband and attenuation characteristics of the double-section carrier filter. These were measured respectively at 25C and 50C. A rise of temperature is observed to cause the characteristic as a whole to shift to slightly lower frequencies. The shift averages only 0.44 cycles per deg. The bandwidth of the filter characteristic measured at room temperature is 16 cycles at a relative attenuation of 3 db, 22 cycles at 6 db, 86 cycles at 50 db and 180 cycles at 78 db. The latter attenuation is maintained for all frequencies outside the 180-cycle band mentioned.

The author desires to express his appreciation for helpful guidance, valuable suggestions, and continued interest to E. D. Blodgett, Thomas Jacobi and L. L. Lakatos of the Engineering Products Department of the RCA Victor Division. He is also thankful to the staff of the RCA Crystal Engineering Department for preparation and mounting of the crystals, and to the RCA-Victor Division of the Radio Corporation of America at Camden, New Jersey, whose facilities made possible the development herein described.

REFERENCES

CINCH-ERIE "Plexicon"
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A joint development of ERIE RESISTOR CORP.
and CINCH MANUFACTURING CORPORATION

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No. 8661, height 1\(\frac{1}{4}\)"
No. 16G12564, height, 2\(\frac{1}{4}\)"

This schematic diagram shows the basic design principle. The silvered ceramic condensers are shown in yellow. Note that the condenser completely surrounds the tube pin, and that specially designed tube prong terminals are used.

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Tele Service Areas

By JOHN H. BATTISON
Allocations Engineer
American Broadcasting Co., Inc.
New York, N. Y.

The accompanying charts, based upon FCC assumptions and data, provide a quick approximation of television service areas for the 5,000 µV per meter (solid line) and 500 µV per meter (dashed line) contours. Receiving antenna height is assumed to be 30 feet above average terrain.

To determine the distance from a channel 2 20-kw transmitter 2,000 feet above average terrain to the 5,000 µV per meter contour, enter the appropriate chart at the left and follow the effective radiated power line across to its junction with the solid curve for 2,000 feet. Then read off the distance in miles (29 miles, in this case) from the scale at the top of the graph.

The 500 µV contour from a similar transmitter would be found at 60 miles, using the dashed line for height and the lower scale of miles.

Power and antenna height necessary for desired coverage can also be determined from the charts.
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ELECTRONICS — October, 1948
Airborne Magnetometer

Measurements accurate to one part in 50,000 of the earth's magnetic field are made with the airborne magnetometer developed by the Gulf Research and Development Co. engineers and geologists and recently demonstrated at Westchester County airport. The instrument is currently being used in prospecting for oil and mineral deposits. The odds of finding oil have been improved from approximately 16:1 to 5:1 by the use of such reconnaissance tools as airborne magnetometers, gravimeters and seismographs. Novel magnetic and circuit techniques are used in the magnetometer to obtain its high sensitivity.

Operating Principle

Geologists have used the correlation between the magnetic field of the earth at its surface and the underground rock formations for many years. For these measurements on the ground, a delicately balanced instrument was used, but to survey large or rugged areas took a great deal of time and effort.

Several difficulties arise if a conventional magnetometer is used in an aircraft. Accelerations of the instrument must be counteracted. This requirement limits the design to one having no moving parts. Because of the speed of motion, the instrument must be automatically recording; an operator could not take readings fast enough in a plane flying at 120 mph. The magnetic fluctuations to be measured are so slight that they could be masked by unbalanced magnets and currents, so the instrument must be suspended a considerable distance from the mother plane.

To meet these requirements, a sensing element of the flux-gate type was developed, and by 1941 had been perfected sufficiently for airborne use. During the war the instrument was used for locating submerged submarines, for which application it needed to be sensitive only to short, intense discontinuities in magnetic field. It has been further refined to give an absolute indication and to hold its calibration.

Basically the sensing element consists of two thin cores of highly permeable alloy on which are wound two separate coils as shown in Fig. 1A. The sensitivity of the element is obtained by exciting these identical coils with alternating current (1,000 cps).

As long as the impedances presented by both coils are equal, the voltages across the two primaries will be equal, whether the cores are saturated or not, because both cores will become saturated simultaneously, although with opposite polarities. However, if the element is placed in a fixed magnetic field, the
THE IMC ENGINEER IS
On Your Staff
but not on your payroll

TUNE IN THE ELECTRICAL INSULATION HEADQUARTERS

Because your IMC engineer represents not just one, but most of the recognized leading manufacturers of electrical insulation—each specializing in his own particular product—his experience in the insulation field is more complete. As a specialist in electrical insulation, he and the IMC organization behind him are qualified to . . .

1. Assist you in the selection of the best insulating materials for the job.
2. Familiarize you with their proper application.
3. Suggest ways to eliminate waste.
4. Increase your production.

two cores will become magnetically biased so that one will enter saturation in the direction of the external field before the other enters saturation in the opposite direction. Thus there will be a moment when the two coils do not present equal impedances.

A short voltage pulse will occur across a secondary winding (or its electrical equivalent) because of the phase shift of the moment of passing the knees of the magnetization curves of the two cores. For small external fields, the amplitude of this pulse is proportional to the field strength (The Gulf Airborne Magnetometer, R. D. Wyckoff, Geophysics, p 182, April, 1948).

Auxiliary Circuits

To use such an element in an airplane requires several auxiliary circuits. Figure 1B shows the detector circuit with which the pulses are picked off the sensing element by a differential transformer and converted to direct current by cathode followers. By design of the sensing circuit and coupling transformer, sufficient voltage is obtained at the input to the differential cathode-follower circuit so that no subsequent amplification is necessary.

Because of the permeability of the cores of the magnetometer head, the unit is saturated by relatively weak fields. To prevent saturation and also to provide a range

(continued on p 140)
Pick the power you need
take the performance for granted

8 WATTS

755A
Combines outstanding quality with low cost and small space requirements. Frequency range 70 to 13,000 cycles. Coverage angle 70°, 8¾" in diameter, 3¼" deep. Requires only 2 cubic feet of enclosure space.

20 WATTS

756A
Ample power capacity for the great majority of applications—plus high performance. Frequency range 65 to 10,000 cycles. Coverage angle 60°, 10¾" in diameter, 3¾" deep. Requires only 2 cubic feet of enclosure space.

30 WATTS

728B
Ideal for use wherever extra high power is needed. Frequency response 60 to 10,000 cycles. Coverage angle 50°, 12 11/32" in diameter, 3 25/32" deep. 3 cubic feet of enclosure space.

These three direct radiators will meet practically all your requirements—in broadcast stations, wired music, program distribution and sound systems, high-quality home radios and record players. Pick the ones you need on the basis of power requirements. You'll find superior quality of reproduction in all of them.

Get the full story of this Western Electric line from your local Graybar Broadcast Representative—or write Graybar Electric Company, 420 Lexington Avenue, New York 17, N. Y.

Western Electric
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DISTRIBUTORS: IN THE U. S. A. —
Graybar Electric Company.
IN CANADA AND NEWFOUNDLAND—
Northern Electric Company, Ltd.
Magnetic Field Patterns Shown by Electron Microscope

EXTENSION of the experimental method adapted at the National Bureau of Standards for visually studying magnetic fields provides a powerful means for investigating space-charge fields, fields produced by contact potentials, configurations inside waveguides, and the microstructure of metals. The method, developed by L. L. Marton, is the electronoptical analogy of the Schlieren effect in optics. By it, static magnetic and electric fields can be examined without the disturbing effects of probes; it is being used to measure the magnetization of wire used for sound recording and for storing data to be used by electronic computers.

Dark-Field Image

Figure 1A shows an image produced by the modified electron microscope used in the quantitative study of magnetic fields. The electronoptical arrangement by which this image is produced is shown in Fig. 1B. Electrons from source A are normally brought to a focus by lens C at point D. However, if there is a disturbing field at B such as a magnetized wire, it will distort the electron trajectories so that a dark image of the obstruction will be formed on screen E placed in the conjugate plane. The lens will also bring to focus on this plane an image of the disturbing field. A stop intercepts the undisturbed electrons focused at D. The dark-field image at E is made visible by a fluorescent screen or is recorded as a micrograph. Figure 1C is an approximate picturization of the action involved.

Figure 2 shows the image produced when a presaturated thin laminar steel sample with a feather edge is placed in the electron microscope between the source and the lens. The objective lens was slightly misaligned in making this picture to bring one edge of the objective parallel to the observed edge. In this way the direct rays were intercepted by the objective aperture, only the electrons scattered at the edge of the specimen reaching the final image plane to form the image. The faint pattern at right angles to the edge of the bright line, visible wherever the line is interrupted, is assumed to be due to the fringe field of ferromagnetic domains or of grain boundaries. In this way a visual representation of fringe fields from the small domains of spontaneous magnetization in ferromagnetic materials is
Radio frequency circuit design often requires the accurate measurement of Q, inductance, and capacitance values. For this application, the 160-A Q-Meter has become the universal choice of radio and electronic engineers throughout the country.

Each component part and assembly used in the manufacture of this instrument is designed with the utmost care and exactness. Circuit tolerances are held to values attainable only in custom built instruments.

Consider, for example, the Q tuning capacitor assembly of the 160-A Q-Meter, specially manufactured for maximum range, low loss, and minimum residual inductance. The ultimate design of this unit was reached only after months of intensive engineering research to produce the finest in performance, quality, and workmanship.

This is but one of the many desirable features of the 160-A Q-Meter which contribute to its outstanding accuracy and dependability.

Be sure to include the 160-A Q-Meter in your new equipment plans for 1948.

Write for Catalog "E"

---

Shown above is the Q tuning capacitor assembly of the 160-A Q-Meter. Note the following design features of this unit—features which insure reliable, trouble-free operation.

A. Parallel connection of dual rotor and stator assemblies minimizes internal inductance and resistance.
B. Spring silver fingers contact both sides of silver disc to provide low series resistance.
C. Three point pyrex ball stator suspension reduces losses and permits accurate stator alignment.
D. Four point panel mounting designed to produce maximum structural rigidity and capacitance stability.
E. Precision-cut brass gear and stainless steel shafts, mounted in oversize bearings, assure long, trouble-free service.
F. Common stator mounting for main and vernier stator plates reduces loss and internal series resistance of vernier capacitor section.
G. Positive shaft stop protects main rotor assembly and gears against mechanical overload.

**SPECIFICATIONS**

- **Oscillator Frequency Ranges**: 50 kc. to 75 mc. in 8 ranges.
- **Oscillator Frequency Accuracy**: ±1%, 50 kc. — 50 mc.  
  ±3%, 50 mc. — 75 mc.
- **Q Measurement Range**: Directly calibrated in Q, 20-250. "Multiply—Q—By" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q range to 625.
- **Q Measurement Accuracy**: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.
- **Capacitance Calibration Range**: Main capacitor section 30-450 mmf, accuracy 1% or 1 mmf whichever is greater. Vernier capacitor section ±3 mmf, zero — 3 mmf, calibrated in 0.1 mmf steps. Accuracy ±0.1 mmf.

**DESIGNERS AND MANUFACTURERS OF THE Q METER — QX CHECKER — FREQUENCY MODULATED SIGNAL GENERATOR — BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING INSTRUMENTS**

---

**160-A Q-METER**

50 KC. to 75 MC.

ELECTRONICS — October, 1948
obtained from which the field distribution and domain sizes can be computed.

The Eriscope Camera Tube

By Boyd France

McGraw-Hill World News
Paris, France

HIGH RESOLUTION AND SENSITIVITY are obtained in the French television camera tube called the eriscope. Like the image orthicon, this tube separates the functions of forming and scanning the image. Comparative tests of the eriscope and the image orthicon conducted at the Zurich Polytechnical School indicated that the eriscope had the greater resolution; it produced sharper images with greater tonal range and halftone definition and less spotting. All tubes now coming from the production line of the Société Radio Industrie de France have a definition of 800 lines, some are capable of 1,000 lines. All these tubes being made currently are for the state television company. The tests also showed that the image orthicon is the more sensitive. For picking up outdoor scenes with the eriscope, 100 lux is sufficient. Under artificial light it is necessary to increase the illumination to 500 lux because the tube is less sensitive to red than to blue light.

Forming and Scanning the Image

By separating the functions of converting light images into electrical ones and of scanning the electrical images, the elements of the camera tube can be designed independently for maximum efficiency. The transparent photosensitive cathode, whose position is shown in the accompanying diagram, is an alloy of cesium and antimony. The optical image is formed on the interior surface of this cathode thus emitting electrons in proportion to the incident photons. These electrons are accelerated by an anode at 400 volts above the photocathode, the two electrodes forming a divergent lens for the electrons. A magnetic focusing coil gives the electrons a trajectory such as that shown in the diagram.

In this way the optical image has been converted into an electrical image which in turn has been focused on the scanning target at the far end of the tube. The target is a semiconductor made of a sheet of mica coated thinly with metallic cesium. The electrons from the photocathode form an electrical image on this target corresponding to the optical image. The target is then scanned by a beam of electrons from an electron gun in the arm of the tube. This beam is magnetically focused to a spot whose size determines the resolution of the tube, and is magnetically scanned over the image on the target. With a beam 0.10 millimeter in diameter it is possible to obtain a definition of 400 lines using an 80 square millimeter target. Higher resolutions are obtained by finer focusing.

The beam is charged to the same potential as the target. As it reaches the target, electrons are deflected from it in proportion to the surface charge of the target. These deflected electrons are picked up by an anode on the surface of the tube producing the output signal, which is amplified externally. The undeflected portion of the beam momentarily erases the target image.

The Miller F-M Circuit and Its Use in Railroad Radios

By F. L. Bargellini

Florence, Italy

The increasing development of communication systems using frequency or phase modulation has stimulated the invention of several forms of modulators. In practical use these modulators suffer from poor carrier stability or great complexity in their stabilizing circuits, and limited ranges of linearity. Because of inadequacies in the reactance-tube modulators being used in experiments with railroad radiophones, especially microphonics in the reactance tube, another type of frequency modulation circuit was devised.

Miller-Effect Modulator

Important properties of a frequency modulator are: (1) inertialless linear frequency controlling element, (2) simple production and injection of voltage for stabilizing carrier frequency, and (3) stability in the presence of mechanical vibration. Requirement (1) calls for an electronic modulating element of considerable simplicity. (The reactance tube suffers from the fact that it can never be a pure reactance, always having some residual resistance.) Requirement (2) is more simply satisfied if the frequency modulation is produced directly rather than indirectly as in some systems. A triode more adequately fills requirement (3) than a multigrid tube.

The means taken to meet these requirements is shown in Fig. 1. By it, a pure reactance can be injected into the oscillatory circuit. The quadrature current is simply obtained from the grid-cathode space current of a triode that is excited by the controlled resonant L-C circuit and that has a purely resistive load. Analysis of the cir-

(continued on p 186)
achieving a new high of efficiency!

U.I.C. CERAMIC HiLoad CAPACITORS

for R.F. Heaters and Transmitters

U.I.C. of England, pioneers in the manufacture of Ceramic Transmitter Capacitors, are foremost in the application of aerodynamic principles to capacitor design. The new aerodynamic shape of U.I.C. "Hi-Load" Capacitors gives optimum cooling in still air. With forced draught their high R.F. ratings can be multiplied. All three types of mounting assist cooling and cater for a variety of applications, such as single stand-off tag fitting, parallel and series banking for very large powers, and lead-through types for anode by-pass.

Examples from a wide range of Types

<table>
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<tr>
<th>Type</th>
<th>HLS2031</th>
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<th>HLT2021</th>
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<td>7.5KV</td>
<td>7.5KV</td>
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<td>1½&quot; x 3½&quot;</td>
<td>1½&quot; x 3½&quot;</td>
</tr>
</tbody>
</table>

* Lead-through type, all other examples tag type.

UNITED INSULATOR CO. LTD

TOLWORTH - SURBITON - SURREY - ENGLAND

ELECTRONICS - October, 1948
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

Polystyrene Capacitors
Solar Mfg. Corp., 1445 Hudson Blvd., North Bergen, N. J., now has available a complete line of polystyrene-film dielectric capacitors. Typical applications include timing and integrating circuit capacitors, r-f padding capacitors and coupling capacitors in extremely high-gain amplifiers. Complete list of standard ratings is given in catalog bulletin SPD-600.

Klystrons
Radio Corp. of America, Harrison, N. J. First of a line of Klystron tubes for use in microwave relay equipment are types 2K26 and 2K25. These tubes can be used both for transmission and reception, serving as local oscillator in the latter service.

Conical Antenna
Telrex Inc., 26 Neptune Highway, Asbury Park, N. J. Model 4XTV antenna gives conical performance without the bulk of solid spinnings. It features gain, bandwidth and resolution.

Impedance Meters
Sperry Gyroscope Co., Great Neck, N. Y., announces a series of nine instruments for determining impedance by measuring standing wave ratios and node positions in microwave transmission lines.

They can also measure relative power, attenuation and wavelength in the line. Accuracy is 2 percent for 650 to 40,000 mc. Catalog sheets are available.

Molded Transformer Cores
Stackpole Carbon Co., St. Mary's Pa. Cores are available for horizontal deflection and flyback transformers. Two standard types are available. Type 10034 is a large rectangular unit with sliding hub designed for universal use with any television tube. A smaller spool type 10748 is recommended for tubes smaller than 10 inches where space is at a premium.

F-M Tape Recorder
Amplex Electric Corp., 125 Howard Ave., San Carlos, Calif. Designed expressly for f-m broadcast service, the new Ampex tape recorder has a response within plus or minus 1 db between 30 and 15,000 cycles as well as other features designed for broadcast facility. Tape speed is 30 inches per second and the unit has a time capacity of 35 minutes.

Keyboard Oscillator
Weinschel Engineering Co., Dept. E, 123 William St., New York 7, N. Y. This stable oscillator with low distortion is of the resistance-tuned type using negative feedback. Pushbuttons on the panel provide frequency variation. The unit...
CK 5702/CX
2E35.36
CK5744/CK619CX
CK5702/CK6.5CX
TYP.
No.
1UBIS
Description:
Triode, Output Pentode
SUBMINIATURE
RF
Output Pentode
Sx10-s
Low Double Output Pentode
Output Pentode
SPECIAL
Characteristic of CK656
RF Pentode for pocket radio
Output Pentode
Output Pentode
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Output Pentode
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Output Pentode
ELECTRONICS — October, 1948
RAYTHEON MANUFACTURING COMPANY
SPECIAL TUBE SECTION
Newton 58, Massachusetts
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www.americanradiohistory.com
can be used as a signal source for distortion or bridge measurements, and also as an interpolation oscillator. Frequency range is from 1 cycle to 100 kc.

Capacitance Bridge

GENERAL RADIO Co., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1611-A capacitance test bridge measures over the range 1 μf to 10,000 μf. Accuracy of ± (1 percent + 1 μf). Dissipation factor range is 0 to 60 percent. Frequency of the test voltage is 60 cycles. A feature of the bridge is the zero-compensating circuit that balances out the initial capacitance and dissipation factor at zero setting of the dials.

Variable Waveform Generator

CENTRO RESEARCH LABORATORIES, Briarcliff, N. Y. The variable waveform generator is an audio generator whose output waveform is built up by addition of a fundamental wave and four sequential harmonics. The harmonics are precisely synchronized and variable over 360 degrees. Level of the fundamental and of each of the harmonics is independently variable.

Rodent Control

LFG CORP., 65 Broad St., Rochester 4, N. Y. The Guard consists of a metal case housing a framework that supports electronic unit, motor for driving the electrocuting arms, mirrors for the light system, and other components. In action, the unit is placed over a rat run and is actuated by breaking of a light beam by a passing animal. It is gently squeezed, electrocuted, and ejected to the side. Total death cycle is about 24 minutes.

Visual Alignment Generator

PHILCO CORP., Philadelphia, Pa., Model 7008 is a new visual alignment generator equipped with crystal-tiode high-frequency probe for use in examining the response curve of individual stages and the 4.5 mc video trap. It can also be used to obtain correct termination of r-f transmission lines or measure standing wave ratio.

Portable Tape Recorder

WEBSTER ELECTRIC Co., Racine, Wisconsin. The Ekotape recorder and reproducer uses magnetic tape with a fast forward speed and fast re-

Electronic Thermostat

SPENCER-KENNEDY LABS., INC., 10 Follen St., Cambridge, Mass. Model 400A bridge-controlled thyratron thermostat is designed for use with furnaces, molds, chemical baths, ovens, and similar devices. Two types of control are possible, by means of a resistance thermometer, or by change of resistance of the heater winding itself. Temperatures from 20 to 1,200 C can be maintained to an accuracy of plus or minus 0.1 C when a resistance thermometer is used.

Projection System

RADIO CORP. OF AMERICA, Camden, N. J. Model TLS-86 is a reflective optical projection system employing an all-electronic tuning system.

Television Signals

TELEQUIP RADIO Co., 1901 South Washtenaw Ave., Chicago 8, Ill. A combination sync generator, mono-

(Continued on p 206)
As of September 1st, aluminum prices are again increased. This means higher cost for the principal raw material used in the manufacture of AUDIODISCS. In fact, the cost of the aluminum base has always been the main item in the cost of production. Thus, any increase in aluminum prices is of major importance.

But beyond the cost of raw materials and labor there is a basic factor which determines the cost of manufacturing professional recording discs. This factor is the extent to which the particular process of manufacture enables the producer to turn out a large proportion of first quality discs. There are several methods of production used. None of these will give anything like a 100% yield. It is, however, obvious that as the percentage of yield increases there is a resulting drop in the average cost of aluminum, lacquer and labor.

Fortunately, our patented, precision-machine process—now used for over a decade and continuously improved—gives a more consistent yield of high quality discs than any method of production now used. And we have tested every other process in use.

So our position with respect to the present increase in aluminum prices is this:

1. We are not increasing prices of AUDIODISCS as of September 1st.

2. We shall make every effort to absorb this new aluminum price raise and thus continue our prices at the present level. Our calculations indicate that with some improved efficiency, now under way, and continued large volume production, we shall be successful in this hold-the-price effort.

Audiodiscs are manufactured in the U.S.A. under exclusive license from PYRAL, S.A.R.L., Paris.

Audio Devices, Inc., 444 Madison Ave., N.Y.C.

Export Dept: Rocke International, 13 East 40th St., New York 16, N. Y.

they speak for themselves audiodiscs
NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

Australia’s rural radiophone; course in automatic control; radio net for India planned; radio license increase

West Coast IRE Convention

The program of technical sessions of the IRE West Coast Convention to be held September 30 to October 2, 1948, at the Hotel Biltmore, Los Angeles, Calif., has been announced as follows:

Thursday, Sept. 30
1:00 P.M. to 4:45 P.M.—Chairman—Bernard Walley of RCA Victor, Los Angeles.

A Low Cost Program Switching System, by J. Gifford and A. P. Chessny of Langvin.


Operation of AM Broadcast Transmitters into Sharply Tuned Antenna Systems, by W. H. Doherty of Bell Telephone Laboratories, Whippany, N. J.

1:15 P.M. to 4:45 P.M.—Chairman—H. R. Wilson of Boeing Aircraft Company, Seattle.

The Outlook for Electronic Computers, by J. L. Barnes of the University of California at Los Angeles.


Design and Use of the Beveac, a General Purpose Electronic Digital Computer, by Dr. Herbert Zagor of Reeves Instrument Corporation, New York City.

Friday, Oct. 1
9:00 A.M. to 11:40 A.M.—Chairman—D. O. Steele, Chairman Portland Section IRE.

A New Type of Direct Reading R. F. Phase Meter for Low Level Signals, by M. E. Goldstein of Naval Research Laboratory.


Propagation Measurements at High Radio Frequencies over Flat Desert Terrain, by J. F. Day and L. C. Trolese of Naval Electronics Laboratory.

2:30 P.M. to 5:15 P.M.—Chairman—L. E. Reikena of University of California.

Final details for West Coast IRE Convention are discussed by L. W. Howard (left) president of Triad Transformer and West Coast Electronics Manufacturers president, Robert L. Sink (standing) of Consolidated Engineering, and Convention chairman Loyd Sigmund, chief engineer at KMPC.

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October, 1948 — ELECTRONICS

www.americanradiohistory.com
The Motorola "Handie-Talkie" unit is smaller, lighter, because...

...it uses 2 Sylvania Germanium Diodes!

The Motorola "Handie-Talkie" unit has a range in excess of two miles. Yet it weighs less than ten pounds; overall dimensions are only 10" by 12 5/8" by 3 1/2".

An important factor in the smallness and lightness of this efficient unit is the use of two Sylvania Germanium Diodes in the receiver discriminator circuit. These diodes not only eliminate extra tubes, but, by reducing current drain, permit the use of smaller, lighter batteries. Motorola's own estimate of the difference if tubes were used instead: 10% increase in size, 15 to 20% in weight!

Perhaps you too, like Motorola and many others, can simplify the design of your equipment—or improve its performance—through the use of Sylvania Germanium Diodes. Start your planning by getting our literature.
Television for Australia

TELEVISION ISN'T QUITE Down Under yet. The Commonwealth Postmaster General has invited bids for two experimental television transmitters, one each for Sydney and Melbourne. These would bring a third of Australia's population within line of sight.

A home television set with a 9-inch screen could be produced by Philips' Australian branch plant in about a year for $325, a spokesman of the company stated. But before the sets can be built, the government must promulgate transmission standards.

There is every indication that both television and f-m are to be a state monopoly; a-m radio is not completely nationalized yet, and a large number of commercial stations remain in operation.

Short-Wave System for East Africa

CONSTRUCTION WORK has begun on the first of 48 Marconi shortwave transmitters to be installed in East Africa to provide ground-to-air (Continued on p 258)
Audio Transformers for Uniform Response Low Distortion in 3 Frequency Ranges

Full Frequency Range
30 to 15,000 Cycles, provides uniform response over this entire band with ± 1/2 db up to 10 watts of audio power, within ± 1 db over 10 watts. Standard RMA impedances. Hum balancing coil structures and nickel alloy shielding. Included are Input, Output, Driver, and Modulation Transformers; Modulation Reactors. Sealed in Steel construction, stud mounting, with pin-type terminals.

Public Address Range
50 to 10,000 Cycles, frequency response within ± 1/2 db up to 10 watts of power, within ± 1 db over 10 watts, throughout this range. Secondary impedances match 600 and 150-ohm lines, 16, 8 and 4-ohm reproducing systems. Listed are Driver and Output Transformers. Sealed in Steel construction, flange mounting, with solder lugs or wire leads.

Communications Range
200 to 3,500 Cycles, affords response with variations not exceeding ± 1 db over the range of voice frequencies. For use with 600 or 150-ohm lines. Input, Output, Driver and Modulation Transformers offered. Sealed in Steel construction, flange mounting, with wire leads or solder lugs.

Chicago Transformer
Division of Essex Wire Corporation
3501 Addison Street • Chicago 18, Illinois

Electronics — October, 1948
TUBES AT WORK
(continued from p 126)

control, a direct current is fed to an auxiliary coil on the head to buck out a portion of the earth's field. Thus the magnetometer is called upon only to measure the small unbalanced field. This bucking current is obtained automatically by a stepping switch actuated by the recording galvanometer as it reaches the end of its scale, shown in Fig. 2.

It is necessary that the sensing element be always oriented parallel to the earth's field for the recordings to have significance. This positioning is accomplished by a pair of servos driving gimbals that are at right angles to each other. The sensing element is mounted on these gimbals.

Two auxiliary sensing elements can be used to detect the orientation of the earth's field. If the output from one of these auxiliary units is zero, it must necessarily be perpendicular to the earth's field. Thus these units are mounted mutually perpendicular to the sensing unit. The servo motors drive the auxiliary units to the positions at which their outputs vanish, thus placing the sensing unit parallel to the field. To avoid difficulties from the aircraft's magnetic field, the sensing element and its associated orienting mechanism are housed in a bomb-shaped "bird" that is lowered by its connecting cable to about 65 feet from the plane. The measuring and controlling circuits and recorder are carried in the cabin.

Reconnaissance Technique

Airborne magnetometers are calibrated at the laboratory and sent out to the field to be used in locating areas that can be expected to

FIG. 2—Block diagram shows how pulses from sensing element are converted into direct current and fed to the recorder, and how a balancing current is obtained to restrict the range over which the head must operate.

Unique design and spring suspension prevent it in this Ward Leonard Relay

The generous wipe imparted to the contacts of Ward Leonard Heavy Duty (105) Relay by its unique design and spring suspension, results in freedom from contact "freezing" or welding.

This mighty midget will perform motor starting functions ordinarily assigned to larger relays.

Ward Leonard relays are "Result-Engineered". By modifying a basic design, Ward Leonard can give you the results of a special... for the price of a standard.


"FREEZING" is expensive

WHERE
BASIC DESIGNS IN ELECTRIC CONTROLS ARE RESULT-ENGINEERED FOR YOU

WARD LEONARD ELECTRIC COMPANY
RESISTORS - Rheostats - RELAYS - CONTROL DEVICES
Have the facts at your fingertips

When you write for your reference folder, let us know if our Field Engineering can be of assistance at this time.

With this compact folder, you can obtain information on TAMCO products readily. When you want approximate physical properties, a chemical analysis, or commercial applications of specific products—clear concise charts provide them at a glance. That's why you will want this helpful booklet whether you are interested in TAM ceramic, chemical or metallurgical products. Address your request to our New York City office.

More detailed information on Titanium or Zirconium products is available also upon request. These data have been compiled to meet the demand for authentic information on these products from the source most closely identified with their development. It may prove advantageous to discuss certain problems and applications with our sales engineers.

TITANIUM ALLOY MANUFACTURING COMPANY
Executive and Sales Offices: 111 BROADWAY, NEW YORK, N.Y. General Offices and Works: NIAGARA FALLS, N.Y.
AGASTAT relay is an important instrument in electronic circuits requiring time delay... from .1 second to 5 or more minutes.

Instantaneously recycling, reliable and efficient. Available in standard types and with special mounting and terminal arrangements. Mounting and contact information, type description, etc. on request. Address Agastat Division.

AMERICAN GAS ACCUMULATOR COMPANY
1027 NEWARK AVENUE • ELIZABETH 3, NEW JERSEY

RADIO MANUFACTURERS:
Take Advantage of
SAMS' EXPERT SERVICE DATA PREPARATION FACILITIES

If you are interested in effecting significant economies in the preparation and printing of your service data manuals, you will want to follow the lead of other major manufacturers. More and more manufacturers of radio receivers, record changers, recorders and similar equipment, are turning to us for the preparation and publication of service manuals and literature. Our laboratories prepare complete, accurate, logical service data, relieving your service and engineering divisions of all burdensome details. Specimens of current work prepared for major manufacturers are available on request. Inquiries invited.

Address Your Inquiries to
Howard W. Sams & Co., Inc.
Indianapolis 7, Indiana

October, 1948 — ELECTRONICS
Truarc saves 5 minutes, 9 cents in materials per unit without re-design of electric sanders

OLD WAY
Special 1/4" cap screw and 1/4-28 fibre-insert nut holds idler arm and pulley assembly on Model A3 "Take-About" Sander, Porter-Cable Machine Company.

NEW WAY
Simple 1/4" C.R. shaft, grooved in automatic screw machine, equipped with Waldes Truarc Retaining Rings. Bowed external ring (#5101-25) at top exerts resilient pressure taken up by Standard external ring (#5100-25) at bottom. Assembly is secure against vibration, can be easily taken apart and re-installed many times with same Truarc rings.

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

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

Send us your drawings. Waldes Truarc engineers will be glad to show how Truarc can help you.
Gives Maximum Reproduction of Micro-Groove Record Fidelity

The Shure "900MG" Pickup is an ideal instrument for tracking on the new micro-groove records. It tracks at 7 grams... has a needle force of 9 grams as added safety factor... uses a special offset osmium-tipped needle with a point radius of only .001"... and has an output of 1 volt! The Shure lever system has been adapted in the development of this new pickup — providing a high needle compliance. Listen to it—you will be thrilled with the results!

Model "900MG" Code: RUZUZ List Price: $12.50

SHURE BROTHERS, Inc.
Microphones and Acoustic Devices
225 W. HURON ST., CHICAGO 10, ILL. • CABLE ADDRESS: SHUREMICRO

TUBES AT WORK (continued)

contain oil-bearing strata. A flight crew surveys a region by flying a grid pattern consisting of flights about 75 miles long and a mile or so apart. The pilot flies the plane back and forth along such a grid, keeping accurately on course by means of two transportable shoran stations. The flight director aboard the craft constantly checks the shoran indications so that later, in plotting the measurements on a map, they can be accurately located.

To further correlate the plane's position with ground position, a continuous strip film picture of the terrain is made so that land marks can be readily identified. The shoran indications, strip film and magnetometer recordings are all correlated by recording identical serial numbers at each position at regular intervals.

Later the measurements are transferred to maps thus forming magnetic profiles of the district. On the assumption that the magnetic fluctuations that have been observed are caused by changes in the depth of the igneous bed (or basement) rock, the geologist predicts in what places domed formations likely to contain oil will be found.

Of course other magnetic disturbances might have produced the observed contours. The know-how of geologists consists in recognizing the characteristics of the different factors that influence the slight local field contours.

Once a region has been located that appears a likely prospecting area, seismographic parties make detailed examinations to verify the inferences. These two techniques, magnetometer and seismograph surveying, relying heavily on electronics, are proving extremely valuable in the race to find oil as fast as it is being consumed.

RPM Counter

TURBINE components for new jet engines are whirled at close to 100,000 rpm and in temperature of 1,750 degrees F at Boeing Airplane Co. propulsion laboratory in proving jet engines under development.

An electronic rpm counter measures the speed of the wheel as it spins. One end of the spinning
Whatever the requirements — there's an AMERTRAN for every electronic application

Perhaps your transformer problem calls for design and development. Maybe you require large transformers in small quantities. Or possibly you'd like to obtain the benefits of mass production and need transformers in large quantities.

No matter what your transformer requirements, you will find AmerTran engineers can solve them — efficiently and economically.

In almost half a century of specialization, we have acquired a "know-how" and "can do" which are unsurpassed in the transformer industry. Typical applications of this background are the transformers shown on this page.

Our experience is ready and waiting to go to work on your transformer problem. Call in AmerTran today to tell you how we can give you the transformers you need . . . when you need them . . . at prices made possible only by real manufacturing efficiency.

AMERICAN TRANSFORMER COMPANY
178 EMMET STREET • NEWARK 5, N. J.

Liquid Immersed Plate Transformers—AmerTran oil and Abestol immersed, for indoor and outdoor service — precise overvoltage protection by means of bushing mounted sphere gaps.

"W" Dry-Type Transmitter Components—Economical self-cooled transformers and reactors — for more efficient rectifier operation.

Hermetically Sealed Transformers—Highly resistant to moisture, shock, pressure and temperature variation. Either liquid-immersed or compound filled.

Transtat Type TH for 3 to 20 KVA—Manually operated a.c. voltage regulator providing acless, stepless control. Brush track on coil periphery where it may be banded to insure trouble-free operation under exacting conditions of service.

ELECTRONICS — October, 1948
Over 20 years of fabricating experience

- PLASTIC FABRICATING -
  BAKELITE AND FIBRE FABRICATED PARTS
  PUNCHING, DRILLING, MILLING, AND ENGRAVING
- BAKELITE SHEETS, RODS, TUBES -

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12 VESTRY ST.
NEW YORK 13, N. Y.

STANDARDIZED READY-TO-USE METAL EQUIPMENT
ADAPTABLE FOR EVERY REQUIREMENT

Par-Metal Equipment offers many features, including functional streamlined design, rugged construction, beautiful finish... plus ADAPTABILITY. Eliminate need for special made-to-order units on many jobs.

Engineers and manufacturers will effect economies with Par-Metal Products, which are available for every type of job from a small receiver to a deluxe broadcast transmitter.

Professional techniques and years of specialization are reflected in the high quality of Par-Metal...

CABINETS • CHASSIS • PANELS • RACKS

Write for Catalog

DIRECT WRITING RECORDERS

Galvanometer available separately if desired

While designed primarily for use in the Sanborn direct-writing electrocardiograph (the Viso-Cardiette) this assembly (or the galvanometer alone, if desired) has sufficient potential value for varied industrial applications to warrant this announcement of availability for non-medical uses.

The complete unit illustrated comprises the galvanometer and writing arm, with associated paper drive (No. 572M - 500). The galvanometer and writing arm are available as a separate unit (No. 572M - 300). Recording stylus available in two types: line line writing approximately 1/3 mm wide; line line writing approximately 1 mm wide (No. 572M - 300). Recording paper can be furnished in 200 ft rolls, 6 cm wide (No. 572M - 300).

TABLE OF CONSTANTS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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<tr>
<td>Sensitivity</td>
<td>10 mm/1 cm</td>
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<tr>
<td>Coil resistance</td>
<td>3,000 ohms, center tapped for push-pull operation</td>
</tr>
<tr>
<td>Critical damping resistance</td>
<td>500 ohms</td>
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<tr>
<td>Undamped fundamental frequency</td>
<td>45 cycles/sec</td>
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<tr>
<td>Stylus heater requires from external source</td>
<td>1.25 volts, 3.3 amps, AC or DC</td>
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<tr>
<td>Maximum undistorted deflection</td>
<td>2.5 cm, each way</td>
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<tr>
<td>Marker requires from external source</td>
<td>1.25 volts, or 1.5 amps, AC or DC</td>
</tr>
<tr>
<td>Chart ruling from center</td>
<td>25 mm/sec</td>
</tr>
<tr>
<td>Chart ruling from internal source</td>
<td>1 mm intervals</td>
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In the development stage are other Sanborn "medical recording" instruments which have apparent industrial applications. These include an Electromanometer for direct measurement of "pressures", and several models of multi-channel (2 to 6) recorders, both direct recording and photographic.

For complete information write, giving details of proposed application to

INDUSTRIAL DIVISION
SANBORN COMPANY
39 Osborn St.
Cambridge 39, Massachusetts

October, 1948 — ELECTRONICS
SIMPSON MODEL 221 ROTO-RANGER
HIGH-SENSITIVITY A.C.-D.C. VOLT-OMH-MILLIAMMETER

Here is the only multiple scale test instrument of its kind in the world. It definitely reduces the possibility of errors by providing a single scale for each range of this finest of volt-ohm-milliammeters. As the selector switch is moved to the range desired, an ingenious gearing mechanism rotates a drum, bringing into place behind the meter window the proper scale for that range. Here is the equivalent of 25 separate instruments combined in one sturdy and compact unit. (18 scales; 7 additional direct reading ranges through use of high voltage and output jacks.) The patented Roto-Ranger principle eliminates the confusion of numerous readings on one scale, and the multiplying factors common to ordinary multi-range testers, by providing a separate scale for each range. There are no cramped calibrations in these full sized Roto-Ranger scales. Each is designed as it would be for a separate instrument.

SIMPSON ELECTRIC COMPANY
5200-5218 W. Kinzie St., Chicago 44, Ill.
In Canada: Bach-Simpson, Ltd., London, Ontario

Ranges

<table>
<thead>
<tr>
<th>A.C. Voltages</th>
<th>D.C. Voltages</th>
<th>Milliamperes, D.C.</th>
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<tr>
<td>2.5, 10, 50, 250, 1000, 5000</td>
<td>2.5, 10, 50, 250, 1000</td>
<td>10, 100, 1000</td>
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<tr>
<td>2.5, 10, 50, 250, 1000</td>
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<td>2.5, 10, 50, 250, 1000</td>
<td>2.5, 10, 50, 250, 1000</td>
<td>10, 100, 1000</td>
</tr>
</tbody>
</table>

Size: 12½” x 10½” x 5½”
Weight: 8 lbs. 9 oz.
Price, complete with test leads and 28-Page Operator’s Manual: $69.85

High voltage probe (25,000 volts) for TV, radar, x-ray and other high voltage tests, also available.

Ask your Jobber, or write for complete descriptive literature.
Spin pit for testing turbine parts. Speed is measured by an electronic rpm counter. The mercury flash lamp held by the Boeing engineer permits photographs at 0.2-microsecond exposure.

The turbine shaft is divided into two sections, half black, half white. A phototube, focused on the shaft, sends a current impulse to recording instruments each time the black portion passes its scanner. Timed and checked electrically, the speed is controlled within one-half of one percent accuracy.

The spinning is done in pits made up of layers of steel plate, with maple blocks on the inside. The steel shells test turbine components. Power for the tests is derived from compressed air, driving a small turbine which, through a shaft, is attached to the test article. A hoist supports the heavy weight of the cap plate, air turbine and accessories. The entire assembly is lowered into the pit, clamped in place and the air evacuated.

One pit has built-in heating coils of nichrome steel wire imbedded in clay holders to maintain constant temperatures of up to 1,750 deg F. Automatic controls keep temperature to preset levels and also record the whole test. Highspeed rotation and extremely high temperatures combine to prove each new development in turbine parts before incorporation in an actual engine.

High-speed photographs, made with an ordinary 8 x 10 view camera, enable engineers to study test wheels as they break. A small mercury lamp is the light source for the one five-millionths of a second flash. The tripper con-
You may build the best appliance of its kind on the market—but if it sets up local radio interference—you'll have tough sledding against today's keen competition. Your customers are demanding radio noise-free performance in the electrical equipment they buy.

The answer, of course, is to equip your products with C-D Quietones. Why Quietones? First, because they're the best-engineered noise filters—second, because they guard your product's reputation by giving long trouble-free service—third, because they're designed and built to meet manufacturers' specific needs—efficiently and economically.

The Shape and Size YOU need!

PARAMOUNT
SPIRAL
WOUND
PAPER TUBES

All Sizes In
Square and Rectangular Tubes
Leading manufacturers rely on the quality and exactness of PARAMOUNT paper tubes for coil forms and other uses. Here you have the advantage of long, specialized experience in producing the exact shapes and sizes for a great many applications. 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.
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Manufacturers of Paper Tubing for the Electrical Industry

New...Improved
ATTENUATORS
by TECH LABS

"New Times—New Modes", says old proverb. These new attenuators were born to meet new war-created demands. They represent a new medium frame size: Type 800 (2½" dia.) and a larger size: Type 900 (3" dia.). The Type 800 is supplied as potentiometer, rheostat, ladder and T-pad up to 20 steps. The larger size Type 900 is similarly furnished with up to 45 steps. Write for new bulletin.

TECH LABORATORIES, INC.
Manufacturers of Precision Electrical Resistance Instruments
337 CENTRAL AVE. • JERSEY CITY 7, N. J.

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MANUFACTURERS OF PRECISION
EYELETS and MULTIPLE
PLUNGER PRESS PRODUCTS

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- GROMMETS
- EYELETS
- SOLDERLESS LUGS
- TERMINALS
- TERRULES

EYELETS: Eyelets can be produced with square, hexangular or round barrels with heads to match or in any wanted combination.

METALS: Available metals in .006 to .032 AWG. Accurately fabricated on eyelet machines or by plunger press to meet any requirements in...

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- COPPER
- BRASS
- STEEL
- NICKEL-SILVER

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STANDARD OR MADE TO SPECS...
Many standard shapes in stock but we specialize in fabricating special needs. Send in your blueprints for prices, deliveries, and engineering advice.

CARBY MFG. CO., INC.
62 COTTAGE PLACE
WATERBURY 5, CONNECTICUT

October, 1948 — ELECTRONICS
Another FEDERAL First!  
INTELIN K-109  
Crimped Type Coax

...for permanent automotive lead-ins

Efficiency — combining low loss and low capacity for high fidelity transmission with minimum attenuation and signal distortion

Flexibility — new ease of handling, installing and maintaining

Shielding — for freedom from interference

Permanent Conductor Set — for electrical and mechanical stability

Spring Action — Eliminates necessity for providing slack in conductor when connecting terminals. Minimizes conductor breakage at the terminals.

PATENT PENDING.

Check those important electrical and mechanical advantages. Check the exclusive Federal design. Here at last is a combination of low capacity and high impedance ... buggy whip flexibility with a conductor that soaks up vibration and won't break away from terminals.

Federal's new Intelin K-109 Crimped Type Coax has everything for rugged service. It is also recommended for aircraft and marine antenna lead-ins ... for inter-stage audio connections in general radio and electronic equipment.

Perhaps you see other uses for K-109. For full technical information and prices, write to Department D-613.

Federal Telephone and Radio Corporation

ELECTRONICS — October, 1948
Want the Most Efficient Transmission Line for Your Station?

WTAD-FM did. That's why they selected Andrew 6½” coaxial transmission line. In spite of the 800 ft. long run, including a 750 ft. run up the tower, the overall efficiency is 90%!

Not only is this 6½” line the most efficient standard RMA line used in broadcasting, but it offers the additional advantage of very high power handling capacity. It will handle up to 166,000 watts at 100 MC with unity standing wave ratio, allowing a wide margin for future power expansion.

Fabricated by Andrew in twenty foot lengths with connector flanges brazed to the ends, sections can be easily bolted together with only a couple of small wrenches. Flanges are fitted with gaskets so that a completely solderless, gas-tight installation results.

Still another advantage to buying Andrew equipment is that Andrew engineers are available to properly install it. NO OTHER TRANSMISSION LINE MANUFACTURER OFFERS YOU THIS COMPLETE INSTALLATION SERVICE!

Here's what Mr. Leo W. Born, Technical Director of WTAD-FM, writes about Andrew installation service:

"You will be interested to know that the installation of the Andrew coaxial line made by your organization has been giving us trouble-free performance of high efficiency in the daily operation of WTAD-FM.

Knowing the great difficulties involved in the installation of such a large line on a 750 foot tower over a period of such inclement weather conditions, I feel that the excellent operation of the line is indeed a tribute to the men of your company who were on the job. Such performance is not accidental and we congratulate you on a tough job well done."

This again emphasizes Andrew's unique qualifications: Unsurpassed equipment and complete engineering service.

Want the Most Efficient Antenna Equipment for Your Station? Want Experienced Engineers to Install It? Write Andrew Today!

Andrew Corporation
Transmission Lines
Antenna Equipment
363 East 75th Street, Chicago 19
Eastern Office: 421 Seventh Avenue, New York City

Tubes at Work (continued)

sists of double concentric copper screens which line the test pit. At burst, the pieces of the test wheel crash into the screens, pushing them into contact and completing the flash circuit. By this technique, any portion of the wheel which breaks loose under such punishment immediately takes its own picture and establishes the point of failure.

The spin pits test the turbine wheels for the effects of weight and tensile strength of the materials; for rim-loading by their blades; profile, or cross-sectional shape; design of the shaft holes in their hubs.

Metal Picture Tube

A sixteen-inch cathode-ray tube having a metal shell is being made available to receiver manufacturers.

The envelope of the new tube consists of a cone of spun chrome steel alloy. A glass neck houses the electron gun assembly to permit customary mounting and operation of the focusing and deflection coils. The glass neck flares outward to a diameter of about four inches and meets the metal cone in a butt joint. Sealing the metal, which has the same coefficient of expansion as the glass, is accomplished with the aid of induction heating.

The glass front of the picture tube is drawn glass, polished on both sides, and this too is sealed to the metal cone with induction heating. The curvature of the glass face is such that nearly
ONE-PIECE NYLON SUPPORT NUT
simplifies coil assembly... speeds up production

Single molded nylon unit replaces complex assemblies of 3 to 5 parts

Square shank of nylon nut, molded as one unit but consisting of four separate prong-shaped legs, is inserted in square hole of supporting plate. Since nylon itself is an insulator, the nut does not require a grommet. And Du Pont nylon remains stable at temperatures ranging from -60°F. to 200°F.

Tuning slug (A) and screw (B) are rotated, impressing thread shape of screw into nylon shank. Prong-shaped legs of shank flare outward, securing nut to plate. Nylon develops torque on screw thread to hold slug in adjusted position, despite vibration and variations in plate thickness and size of hole.

Coil form fits snugly in nylon nut... firmly gripped externally by six thin, flexible "fingers" on the inside wall of the support nut. The hollow tube is held securely in place by pressure of the nylon "fingers," although wall thicknesses of the tube may often vary as much as 1/32 of an inch.

CAN NYLON HELP YOU MAKE A BETTER PRODUCT?

Here's a new, all-nylon coil support for radio and television sets. It does the same job that once required a complex assembly of 3 to 5 parts... yet it consists of only one molded nylon nut! The result—reduced parts inventory, quicker assembly, faster production.

In developing this new product, the manufacturer found all the desired properties in Du Pont nylon. Its light weight, strength in thin sections, resiliency, stability and insulating properties permit a new, multi-purpose design. And nylon's unique workability assures efficient, economical molding of the intricately shaped unit. It's one more case where an electrical manufacturer makes a better product with Du Pont nylon.

This Du Pont plastic can be molded or extruded. When designing electrical parts or wires, don't overlook its remarkable properties. Write for free booklet, "65 Success Stories of Product Improvement." Filled with helpful facts. Just address: E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Room 1410, Arlington, N. J.

CHECK THESE 7 BASIC FEATURES OF NYLON FOR ELECTRICAL USES

- Good flexibility
- High tensile strength
- Extreme toughness
- Abrasion resistance
- Resistance to permanent set
- Chemical resistance
- Ability to be molded or extruded
PRECISION POTENSIOMETERS
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 ±0.5%. Overall dimensions are 4½'' diameter x 4 11/32'' long plus shaft extension ¾'' diameter x 11'' long.

Write for Bulletin F-58

THE GAMEWELL COMPANY
Newton Upper Falls 64, Massachusetts

FABRICATED SHEET METAL PRODUCTS
to your specifications...

COMPLETE facilities under one roof for quantity mass production—including welding, baking and finishing. Whistler and Wiedermann equipment for short runs. Tool and die engineering and designing.

Substantial sheet steel inventories permit speed, service and cooperation. Large assortment of stock and special dies for the radio and electronic field. Production and engineering under the personal direction of Mr. E. B. Gunzburg, president—who has had 34 years' experience in sheet metal fabrication.

Quality chassis, metal cabinets, instrument housings, panels, boxes, metal parts and stampings—sample models—in stainless steel or in any metal or any gauge. Close tolerances guaranteed.

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ART-LLOYD METAL PRODUCTS CORP.
2973 Cropsey Ave.

Telephone: ESplanade 3-2400

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If you like a duller surface, for clear, hard pencil lines, try Imperial Pencil Tracing Cloth. It is good for ink as well.

IMPERIAL TRACING CLOTH

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE
Pictured here is a tuning-fork frequency standard with accuracy guaranteed to one part per million per degree Centigrade. The fork is temperature-compensated and hermetically sealed against variations of barometric pressure. This standard, when combined with basic equipment, facilitates accurate speed and time control by mechanical, electrical, acoustical or optical means.

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

The 16-inch tube has a deflection angle of 53 degrees and, for critical resolution, deflection coils designed for this angle are recommended. However, coils designed for conventional tubes having a deflection angle of 50 degrees have been found to provide good resolution. Operating voltage of the second anode is recommended at about 10 kv although the tube is tested at 15 kv.

The potential of the steel shell is also 10 kv and it is planned to make available an insulating sleeve. A Tenite coating on the sleeve and an Aquadag layer might then be used to form a filter capacitor for the high-voltage power supply as is conventional practice with the 10BP4 and 10FP4. (Electronics, p 186, April 1948).

The metal tube is manufactured by Tel-O-Tube Corp. of America, at Paterson, N. J. and is used in a table model receiver of Starrett Television Corp. of New York.

Amplitude Selective Amplifier

By Charles E. Lowe
Penton, Michigan

Amplitude selective amplifiers are now being used in special electric motors, calculators, and computers, Radar, and fire control instruments, potentiometers, and other electro mechanical devices.

Our engineers will be pleased to make recommendations to meet your requirements. We would also be pleased to submit quotations to cover your specifications.
Give your timers extra life with Telechron motors

There's longer service in any time switch or timer powered with an H-4 or H-5 Telechron synchronous electric motor. Efficient, dependable lubrication is assured by a special terminal-shaft bearing incorporating an oil gland that extends motor life.

These dependable, self-starting motors are designed for general-purpose time switches, dishwasher timers, stoker and oil-burner controls, appliance timers, defroster timers, fast battery chargers and many other timing and switching devices. They operate in perfect synchronism with any commercial frequency...can't run fast or slow.

The H-4 motor is available in terminal-shaft speeds from 3 to 6 rph. The H-5 motor is available in terminal-shaft speeds from 1 to 6 rph. Their conservative torque ratings at 60 cycles range from .20 pound-inch at 6 rph. to .50 pound-inch at 1 rph. Like all Telechron motors, they are precision-built for long, dependable service by the largest producer of synchronous electric timing motors for over 25 years. Every one is Underwriters Laboratories approved. Why not talk over your special needs with Telechron's application engineers? Address Motor Advisory Service, Dept. M, Telechron Inc., Ashland, Massachusetts.

A General Electric Affiliate.
AMPERITE DELAY RELAYS

FEATURES:
- Compensated for ambient temperature changes
- Hermetically sealed; not affected by altitude, humidity.
- Explosion-proof...
- Octal radio base...
- Compact, light, rugged, inexpensive.
- Circuits available: SPST Normally Open; SPST Normally Closed.

PROBLEM? Send or "Special Problem Sheet" and Bulletin.

AMPERITE REGULATORS

The simplest, lightest, cheapest, and most compact method of obtaining current or voltage regulation. For currents of 0.060 to 8.0 Amps...

When space is a factor...

STANDARD PIEZO CO.

When space is a factor...

Office & Development Laboratories
CARLISLE, PENNA.
The Sperry Klystron Tube to generate ultra-high-frequency microwaves...

The Sperry Klystron Signal Source to "power" them...

The Sperry Microline to test and measure them...

These Sperry products equip the research or development engineer with every essential for development or design in the microwave field.

The Sperry Klystron Tube has already opened up new vistas in navigation, aviation, medicine, radio, telephone, telegraph and other major applications. It is ready for many new local oscillator or high power uses.

The Sperry Microline includes practically every type of instrument for quick precision measurements in the microwave frequency bands.

This Sperry service—beginning with a source of microwave energy, the Klystron, and following through with every facility for measuring microwaves—opens up almost unlimited possibilities for industry.

We will be glad to supply complete information.

SPERRY GYROSCOPE COMPANY
DIVISION OF THE SPERRY CORPORATION · GREAT NECK, N. Y.
NEW YORK · LOS ANGELES · SAN FRANCISCO · NEW ORLEANS · CLEVELAND · SEATTLE

ELECTRONICS — October, 1948
Engineered to the Highest FM and AM Broadcast Standards

NEW! High Fidelity Dynamic

BROADCAST Microphones

FEATURES LIKE THESE WIN TOP RATING
by Station and Network Engineers!

Flat ou to 15 kc! Extremely high output! Impedence selector! Dual-type shock-mount! Remarkably rugged! Individually calibrated!

Developed in cooperation with station and network engineers, the new "650" and "645" meet exacting requirements of modern high fidelity FM and AM broadcast service. Proved in studio and remote use. Polar pattern is non-directional at low frequencies, becoming directional at high frequencies. Recessed switch gives instant selection of 50 or 250 ohms impedance. Exclusive Acoustalloy diaphragm withstands toughest use. Many other important features assure the ultimate in broadcast quality. Satin chromium finish. Fully guaranteed.

Model 650. Output level -46 db. List .......... $150.00
Model 645. Output level -50 db. List .......... $100.00

Broadcast Engineers: Put the "650" or "645" to the test in your station. Know the thrill of using the newest and finest. Write for full details.

NO FINER CHOICE THAN

Electro-Voice

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TUBES AT WORK (continued)
differentiation through the mutual inductance of the output winding, coupled to the bridge proper, created an output signal inconsistent in waveform. As a result, the speed of the motor did not bear a simple direct relationship to the primary control displacement and the final calibration of the system became partially dependent upon an unreliable and erratic variable.

Presence of the second harmonic of the bridge excitation frequency in the bridge output signal was a necessary evil of the bridge design. Since it was designed to respond to minute direct currents in its input winding and to sense their direction as well as their amplitude, it was necessary to polarize the bridge arms with direct-current magnetization. In this way the aiding or opposing of this steady flux by the flux set up by the small current from the primary conversion element produced effects that indicated the direction of such current by the phase relationship of the output signal to the bridge excitation frequency. This latter frequency was also one of the phases of the motor excitation.

The sensing of reversal of input current direction by the bridge was indicated to the drag cup motor by a 180-degree change in phase of output signal. A balance for the bridge occurred with no incoming current from the conversion element or with the bridge input terminals shorted. At balance, the opposing alternating-current fluxes from the two bridge arms failed to give zero signal balance indication.

Since each half cycle of the opposing fluxes operated in separate directions along the B-H curve of the core from the operating point set up by the d-c polarization, the peak amplitudes of each half cycle of flux were not equal. Because of this difference, cancellation was not complete, and during every half cycle of the excitation frequency such a left-over bundle of flux appeared to cyclically excite the output winding. Thus, a second harmonic signal is generated. This signal reached its maximum value at the time of the null for the motor-operating signal.

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TUBES AT WORK (continued)

motor is subject to a braking action in the presence of such harmonics, distortion, or spurious frequencies, and mainly suffers a loss of efficiency and is not made usable. Because of the limitations on the amplifier at a time when its sensitivity should be increased and the very irregular action of the servo-system as the control signal waveform varied, steps were taken to eliminate this nuisance.

Application of tuned circuits and of notch filters helped but reliability under varied conditions of operation was not obtained.

Circuit Operation

In the process of amplitude discrimination, the output signal of the bridge is first amplified and then the fundamental frequency is separated from the envelope of the second harmonic. The output of the amplifier goes through essentially the same waveform changes as the input signal with the exception that the output signal change occurs long before the same degree of input signal change. Watching the input and output signal simultaneously on a pair of oscilloscopes, one can observe only a slight change in the waveform of the input signal while the output signal is changing from complete second harmonic to complete fundamental. The change in output signal during the transition is continuous in that one frequency increases in amplitude while the other is decreasing.

At bridge balance, the amplifier still passes second harmonic signal, however, it is now limited to a much narrower range in the bridge calibration. The increased sharpness of bridge balance indication welcomes the damping action induced on the motor armature by the second harmonic drag. Thus the braking action of the second-harmonic signal of the motor operating frequency may be used for slight anti-hunting purposes to inhibit overshooting.

Bridge Signals

Figure 1 shows the changes in the bridge output from a balanced condition to one of complete unbalance. At Fig. 1A, the balanced bridge indication is an approximate sine wave, a second harmonic
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ELECTRONICS — October, 1948
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FIG. 1—Bridge output signals showing transition from second harmonic to fundamental to indicate various degrees of unbalance

of the bridge excitation frequency. All of these peaks are of equal height. In Fig. 1B the peaks alternate in height and indicate a slight bridge unbalance for this is a sign of the fundamental making its appearance from the null value. In Fig. 1C, the unbalance has progressed to almost complete disappearance of the second harmonic component. In Fig. 1D, the final output of complete unbalance is an approximate sine wave which has a phase determined directly by which of the alternate set of peaks in Fig. 1B increased in height. If the bridge unbalance had progressed in the opposite direction, the resulting complete unbalance signal would have had a phase difference of 180 degrees from the phase shown.

A slight phase shift in the fundamental frequency occurs as the fundamental takes form. The shift makes this degree of reversal possible from the low and high peaks transition into the final frequency. This shift occurs as the fundamental slides over sidewise on the time
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For complete information on the single sideband selector write: General Electric Co., Electronics Park, Syracuse, N.Y.

TUBES AT WORK (continued)

essentially equal to the signal amplitude. The time constants of \( R_C \) and \( R_C' \) should correspond to a frequency much lower than the frequency to be passed by the amplifier. A time constant of 0.1 second was found to be satisfactory in discriminating out a 60-cps signal from the envelope of the second harmonic.

Values of \( C_t \) and \( C_r \) are equal and their time constant individually in connection with resistor \( R_s \) should correspond to a frequency of thirty cycles. The value of \( C_t \) is found by experiment. In combination with the inductance presented by \( T \), it reshapes the output signals of the transformer to the closest approximation of a sine wave that conditions permit.

Amplifier Operation

If the output signal of the bridge to the amplifier is as shown in Fig. 3A, then the output of tube \( V \), acting as an amplifier is an amplified replica of the signal at the input to the grid of the following tube \( V_2 \). This is indicated by Fig. 3B.

The output of \( V_2 \), appearing across \( R_3 \) in the absence of the integrating capacitor, \( C_3 \), is as shown at Fig. 3C. This signal may have almost exactly rectangular waveform as indicated since the tips of the positive peaks are flattened by grid current into the high-resistance grid circuit. Also, the small portion of the waveform between cut-off bias and zero bias intercepted on the transfer characteristic of the tube has its curved sides straightened by the curvature of the characteristic.

The introduction of the integrating capacitor, \( C_3 \), changes the vertical edges of the rectangular pulses to exponential type curves. This is shown by the difference between the dashed lines and the solid curves in Fig. 3D. The combined effect of \( C_3 \) and the inductance of \( T_1 \) are shown by the approximate sine waves of Fig. 3E as they finish the reshaping of the pulses into a motor-operating signal of greater efficiency. This signal has its phase directly related to the higher peaks of the second harmonic signal. In this manner the bridge output phase relationship is maintained so as to provide directional response of the
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TUBES AT WORK

(continued)

FIG. 3—Bridge signals of slight unbalance indication passing through the discriminator amplifier to be discriminated into a signal of complete unbalance

drag cup motor to the direction of bridge unbalance.

Advantages

From the change in the output to input signal waveform of Fig. 3, it will be noted that only a slight bridge unbalance is needed to give the identical change of signal arrived at through complete bridge unbalance as shown in Fig. 1. Although straight amplification of the null signal along with automatic control of amplifier gain might give almost equivalent results, if the unwanted harmonic signals are first removed, there are other important advantages of this system that make it very desirable.

If a measure of the sensitivity of the bridge circuit is assumed to be in the displacement of the bridge variable necessary to change the output signal from a complete null for the fundamental frequency, while the harmonics are present at a maximum, to the condition where the fundamental is a maximum and no harmonics are present, then, amplification of the bridge output signal is obtained in terms of a small-
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Heavy-duty, general purpose (WO-60C)—A "work horse" that withstands shock, dampness, dirt, fluctuating voltages. Plug-in (5") C-R tube permits change to various screen persistences. Vertical and horizontal amplifiers practically identical. Useful range: 0.5 to 300,000 cycles. Frequency response: ±10% from 5 to 80,000 cycles. Sensitivity: 0.656 peak-to-peak volt per inch. Exceptionally good phase-shift characteristics. Shown above measuring the vibration of a synchronous motor.

Portable, wide range (WO-79A)—Packed with laboratory features. Ideal for h-f circuits, television. Range: vertical amplr. ±2 db from 10 cycles to 5 mc. Horizontal amplr: ±2 db from 10 cycles to 500 kc. Vertical deflection sensitivity: 0.18 rms. volt per inch. New (3") C-R tube features small bright spot and distortionless focusing. Triggered sweep with delay network...saw-tooth time base. Easy signal expansion to twice screen diameter. Shown above testing a television receiver.

D-c and low-frequency a-c (WO-27A)—This oscilloscope also observes a-c and d-c simultaneously. Frequency range: 0 (d-c) to 100,000 cycles. Flat to zero cycles. Uses direct-coupled balanced amplifiers. Timing range: 1 to 30,000 cycles. Single-sweep and blanking circuits permit observation and photographic recording of one-time, high-speed transients. Vertical amplifier sensitivity: 0.064 volt (d-c) per inch. Shown in picture above measuring strain of test specimen in tension.

Last word in versatility (Laboratory-type 715-B)—Permits close study of very short, sharp-fronted pulses and unusual wave forms. Steady, clear traces even of random signals. Vertical amplr: ±1 db from 5 cycles to 11 mc. Horizontal amplr: ±2 db from 3 cycles to 500 kc. Vertical deflection sensitivity: 0.36 rms. volt per inch...saw-tooth and triggered sweep...time-interval markers (one microsecond). Handles almost any job in oscillography. Shown aligning a distribution amplifier.

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HARRISON, N. J.

ELECTRONICS—October, 1948
TIME as a factor of CONTROL in Industry

THERMEX opens up new opportunities in Plastics Molding...TIMED by CRAMER

Almost instant heating of preforms prior to molding is possible with the Thermex Red Head high frequency dielectric heating unit, a development of The Girdler Corp. for use in the molded plastics industry.

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FIG. 4—Discriminator action allowing input frequency to pass through amplifier or displacement producing a given change of signal. Or in other words, the Q of the bridge is increased.

The circuit automatically introduces gain control in that the grid bias continually adjusts itself to signal levels. Final maximum output is soon reached with a small input signal and overloading of the output does not occur on larger signals. But perhaps the greatest good is achieved because the tips of the peaks of waveforms of radically different shapes can be somewhat depended upon to produce pulses in the discriminator plate circuit of the same phase and shapes. Hence, a certain amount of flexibility is added to the servo-system in allowing the input to the amplifier to operate at different levels of signal distortion.

Discriminator Action

The dynamic transfer characteristic of the discriminator tube is shown in Fig. 4 and 5 to clarify the separation of signals by this action. In Fig. 4, the peaks of the incoming signal are all of equal amplitude. These peaks manage to maintain the grid bias sufficiently low enough to permit the positive tips to just exceed zero bias and

FIG. 5—Discriminator action allowing only input frequency of highest peaks to pass through amplifier

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So draw grid current to recharge the grid circuit negatively. Only that portion of the waveform projecting above the cut-off bias is capable of influencing the plate current of the tube.

In Fig. 5, the positive peaks of the signal alternate in amplitude. If the lower peaks are below cut-off bias they have no effect upon plate current. The higher peaks manage to exceed the zero bias value and draw grid current to maintain an average grid bias proportional to their amplitude. In this case the frequency of the output plate current pulses corresponds to the frequency of the fundamental modulating the envelope of the second harmonic, and no second harmonic is present in the output since there are no plate current pulses to represent it.

The smaller the percentage of the signal amplitude that corresponds to five volts the sooner the early stages of bridge unbalance indication can be completely amplitude discriminated. With the circuit shown it was possible to cause all vestige of second harmonic to disappear and the fundamental to become a maximum with one twenty-fifth of the former required pri-
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ELECTRONICS — October, 1948
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Type BH6 is available up to 100 MC and can be furnished to meet all standard specifications, military or commercial. This means your design considerations can be simplified by elimination of unnecessary multiplier stages. Write for information covering latest recommended oscillator circuits and associated crystal data.

Figure 7—Experimental circuit of amplifier for portable use

Stray 60-cycle pickup was not the nuisance under this system that it was under ordinary voltage amplification. Such pickup did not modulate the second harmonic nor could it otherwise interfere with the higher level grid signals put into use by this method.

Radically different waveshapes may give fundamentally the same output pulses in the discriminator plate circuit. The curves that are shown in Fig. 6 show how this may be possible. Those parts of the curves between the two lines representing cut-off bias and zero bias determine the frequency of the output pulses. The tips of such wave variations are very similar in shape and become even more so in the plate circuit of the discriminator as they draw grid current and are altered by curvature of the transfer characteristic.

In Fig. 7 an experimental circuit for adaptation to portable use is given with the values for circuit components. Only the amplifier unit alone is shown since the input and output controls are part of other developments.

To one accustomed to thinking of amplification strictly in terms of actual amplitude or power increase, it is surprising to see the output signal anticipate the input signal in changing its waveform while no apparent change occurs in the input.
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Electronics — October, 1948

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DPA-37 is easy to operate—There are a minimum of steps necessary for taking a pressure reading. Just two dial adjustments—and the pressure is obtained by multiplying the dial reading by the scale factor. No calibration charts needed.

DPA-37 is easy to maintain—All circuit tubes and nearly all other parts are standard radio type for simple, inexpensive maintenance. Less-than-normal loads on component parts assure long life for the circuit.

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THE ELECTRON ART (continued)
r-f chokes to separate the r-f and a-f portions of the circuit. The battery provides the proper bias for maximum linearity between a-f input, internal resistance of the load tube, and frequency deviation of the oscillator. Drift of the oscillator’s center frequency is easily counteracted by superimposing a compensating voltage obtained by usual automatic frequency control techniques on the battery voltage. Although the frequency stability of this circuit is inherently comparable to that of all direct f-m circuits, the simplicity of this circuit reduces the difficulties of stabilizing frequency. Of course, the frequency of the oscillator can be stabilized by a quartz crystal, in which case the Miller effect modulator can produce phase modulation, which can be used directly or fed to multiplier stages.

Experiments with Radiophone

This new modulator circuit has been used in equipment built for the Italian State Railways to determine the feasibility of very high frequency radiotelephone communications between a moving train and a fixed ground station. Troubles from microphonics en-

FIG. 2—Frequency modulation radiophone train antenna was located near locomotive to create most adverse noise problem for purposes of testing
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counted with reactance-tube modulators were eliminated by using the Miller effect modulator and frequency stability was better. These tests were made on carrier frequencies around 110 mc with 40 watts output from the transmitters. For tests the antenna on the train was purposely placed on the coach next to the electric locomotive, as shown in Fig. 2. The electrified sections of the right-of-way use 3,000-volt overhead lines; a train is drawn by a 3,000 hp locomotive.

The transmitter consisted of a Miller effect modulator using a 12J5GT and a 12A117GT, a 12A6 oscillator multiplier, 12A6 frequency doubler, 832 frequency tripler, and 829B power amplifier. A total frequency multiplication of 18 is obtained to produce a modulation index of 4, which is sufficient to give suitable noise suppression despite the adverse antenna location and the change in signal strength because of the cuts and built-up suburban districts through which the 24 miles of track between Rome and Tivoli pass.

Repeated tests on this line have consistently indicated the possibility of establishing satisfactory commercial quality radiophone communication between the moving train and a fixed station at Rome with the exception of those places where the line enters tunnels of considerable length near Tivoli.

Precision Circuit Printing

By CLIFTON TUTTLE
VICE PRESIDENT, RESEARCH & DEVELOPMENT
KENTON INSTRUMENT CO., INC.
Huntington Station, N.Y.

Printing electronic circuits has two advantages: it decreases the size and weight of the circuit chassis and components, and it makes production more economical through elimination of wire soldering and lessening of the numbers of units rejected because of errors in manual assembly. Both advantages are either directly or indirectly enhanced by the ability to reproduce conductive patterns with geometrical precision.

The process developed by this company is capable of high resolution of details in the production of
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The Kollsman Synchronous Differential solves many difficult problems for the design engineer. It is an electro-mechanical error detector with mechanical output for use in position or speed control servo systems.

This unit is composed of two small synchronous motors and a mechanical differential in a completely enclosed frame. The \( \frac{1}{4} \)" threaded output shaft turns at a rate equal to \( \frac{1}{2} \) the difference of the individual speeds of the two motors. When the input frequencies are equal, the shaft remains stationary.

The efficiency of this unit is greatly increased by the use of hysteresis-type motors. These motors yield the greatest running torque found in self-starting synchronous motors. The units now being produced are designed to operate from a three-phase source over a 15-60 cycle frequency range with an input voltage of .007 times the frequency, in cycles-per-minute. Similar units wound for higher voltages and two- or single-phase operations are also available.

The Synchronous Differential is but one of a complete line of special purpose motors developed by Kollsman for remote indication and control applications. Write for further information to: Kollsman Instrument Division, Square D Company, 80-64 45th Avenue, Elmhurst, N. Y.
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For insulation problems of even more difficult nature, VARGLAS Silicone-impregnated Sleeving and Tubing offer a range of reliable, super-performance insulating materials that successfully work through temperatures from 500°F down to -85°F. These war-developed insulators won their ratings through meeting the drastic demands of military aircraft for high dielectric, low-space, dimensionally stable insulating media that could serve in all temperatures encountered from sea-level to substratosphere zones. We also supply VARGLAS treated and untreated Lite-wall Sleevings (ECC-A and ECC-B).

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THE ELECTRON ART (continued)

faithful and strongly adhering replica of the original image in relief. The definition of detail in this new pattern is influenced only by the photographic image definition and the fineness of the powder used in the replacement step. At this point in the process, the pattern, if it is conductive, can be extrapolated to build any desired thickness.

Because the original base, film or plate, is usually mechanically or electrically unsuitable for the ultimate use of the circuit or pattern, a final step is usually required. The entire pattern is transferred to a new base material. Several different types of transfer material are possible. It may be a thermoplastic or thermosetting resin or a ceramic.

Most experience has been with transfer to a thermosetting polyester resin. The resin may be clear or mixed with a filler such as asbestos fiber. To accomplish the transfer step, the image-bearing film is placed face upwards on a flat or curved plate. A hollow rectangle of polyvinyl-alcohol sheeting is placed around the part to serve as a dam for the viscous casting resin, and the polyester co-polymer with a slight amount of added catalyst is poured over the surface. The material, while in its viscous state, fills the interstices between the pattern segments. After the resin sets, the pattern becomes mechanically imbedded and probably chemically bonded to the polyester resin.

As a final step, the casting is lifted from the base plate and the original film base is removed with a differential solvent which leaves the resin base untouched. The pattern surface is then flush with the base surface in which it is imbedded.

Aside from the obvious applications of the described technique to the now conventional printed circuit production, it is possible that other uses may occur to the engineer. There may be, for instance, some applications in the scientific instrument and optical fields.

A few of the applications that have been considered are: (1) formation of complicated conductive patterns to be used as commutators, (2) making tapered re-
Every day, *Indiana* permanent magnets are opening new fields, bringing new opportunities to science and industry. From magnetic can openers to cosmic ray research, these permanent magnets—of new designs and increased efficiency—enable equipment to do a better job. They add new functions... step up performance... cut costs. These magnet developments can mean extra profits for you—for “packaged energy” may have direct application to your own methods and products.

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**The Electron Art**

(continued)

sisters of any complex function for resistance pots in computer systems, (3) making durable and decorative nameplates and dials for instruments, (4) making grid patterns for radioactivity and x-ray screens, using lead, gold or the new Hevimet alloy as the powdered metal, (5) making thermocouple or thermistor-bolometer elementary mosaics, and (6) production of optical grids of greater durability and stability than photographic grids. The first two applications require smoothness durability of the conductive coatings to withstand the action of a moving stylus. Tests have been carried up to several hundred thousand actuations of a rheostat stylus over such surfaces with success.

A dividend of the method, not stressed in the above description, is economy on short runs made possible by lowered (almost negligible) tool costs. Practically the only expense in changing from one part to another or from one circuit configuration to an entirely different one is the draftsman’s work of drawing new copy.

Photographic illustration of the results of this process are not particularly informative because the finished product looks like the original drawing. The accompanying photograph serves chiefly to indicate the type of circuits than can be rendered in this medium. The author expresses his gratitude for the cooperation and support of the Squier Laboratory of the Signal Corps in the pursuit of this project.

**The Synchrostop Timer**

**By Walter R. Berg**

Ordnance Research Laboratory
The Pennsylvania State College
State College, Pennsylvania
(Now with Dictograph Products, Inc.
Jamaica, N. Y.)

In viewing rotating machines by standard stroboscopic methods constant manipulation of the light source frequency is necessary in order to prevent the stroboscopic image from changing position. Furthermore, it is practically impossible to orient the image to a specified angular position manually. The circuit shown in Fig. 1 automatically holds the stroboscopic image at a
Arnold's business is permanent magnets, exclusively—a field to which we have contributed much of the pioneering and development, and in which we have set peak standards for quality and uniformity of product.

Our service to users of permanent magnets starts at the design level and carries on to finish-ground and tested units, ready for your installation. It embraces all Alnico grades and other types of permanent magnet materials—any size or shape—and any magnetic or mechanical requirement, no matter how exacting.

Let us show you the latest developments in permanent magnets, and how Arnold products can step up efficiency and reduce costs in your magnet applications. Call for an Arnold engineer, or check with any Allegheny Ludlum representative.

THE ARNOLD ENGINEERING CO.
Subsidiary of
ALLEGHENY LUDLUM STEEL CORPORATION
147 East Ontario Street, Chicago 11, Illinois

Specialists and Leaders in the Design, Engineering and Manufacture of PERMANENT MAGNETS
Here is one of the finest and most complete lines of standard transmitter components available today. Built to the same well-known high standards as N·Y·T custom-built units, they bring to the design engineer the full economy of standardized construction. Superbly constructed, inside and out, each unit fully reflects the years of experience that have made the name NEW YORK TRANSFORMER synonymous with quality, integrity and dependability wherever inductive components are used.

FIG. 1—Circuit diagram of synchronizer that provides phase adjustment throughout 360 degrees

fixed angular position over wide variations in the speed of the rotating member. By means of coarse and fine phase shift controls the stroboscopic image can be held in any position over the entire 360 degrees.

A three-phase generator must be coupled to the shaft of the rotating member. The coarse phase shift, which is a six-position switch, selects each of the generator's three phases at 0 or 180 degrees, which affords a total variation of 360 degrees in six discrete steps of 60 degrees each. The fine phase shift control is a potentiometer which allows complete phase variation over any 60-degree step. By means of a double triode the voltage from the phase shift network is half-wave grid rectified, amplified, and clipped. The resulting wave form has the steep wave front that is necessary to trigger most types of stroboscopic circuits.

The Synchrostrob was designed to trigger the contactor input of a General Radio Strobotac which, in turn, can be used to trigger a General Radio Strobotron if greater light intensities are desired. Other
High Vacuum Metallurgy is not new as laboratory technique. It is new as a practical industrial operation.

For the first time, National Research Corporation offers its services to design and build, to your requirements, furnaces which operate in the micron pressure range. Pressures run as low at $10^{-4}$ mm. Hg. absolute.

Six years' experience in the engineering and construction of High Vacuum metallurgical equipment is at your disposal. Write National Research Corporation.
types of stroboscopic light sources can also be triggered with this circuit.

**SURVEY OF NEW TECHNIQUES**

Tracers for industrial research are being used in a large scale experiment conducted in the Cleveland plant of Republic Steel Corp. by Arthur D. Little Inc. Although 75 percent of radioactive tracers are still used in biological work, this industrial study is indicative of the potentiality of tracer technology in other fields. The experiment was conducted to determine methods for keeping undesirable sulfur out of steel. Sulfur enters steel from the coke, with the ore, limestone, scrap, or fuel oil. Some of it leaves the furnace in slag and flue gases. To tell where the sulfur in the finished steel came from, radioactive sulfur was introduced into the coke. The portion of sulfur in the finished steel that was radioactive was then known to have come from the coke. In this manner the contributions made by the various sources can be assessed. The tests indicated that there is no advantage in buying low sulfur coal from which to make the coke. Other applications of radioactive tracers in industry include automatically controlling Bessemer converters by introducing a known percent of radioactive phosphorus and metering the process to determine when the proper grade steel had been obtained. The major advantage of radioactive tracer research in industrial plants is that the experiments are carried out in the plant at operating scale; small scale laboratory experiments do not always correlate with factory results.

Synthetic mica, known as fluorine-phlogopite mica, has the desirable characteristics of muscovite and phlogopite forms of natural mica and is suitable for use as insulator and dielectric. Inherent in the synthetic process is the possibility that further research may reveal ways of directly fabricating mica components. The research and development program for the production of synthetic mica, jointly sponsored now by the Office of Naval...
NEW OSCILLATOR with Greater Accuracy • Less Distortion • Better Zero Adjustment • New Operating Conveniences

CHECK THESE SPECIFICATIONS

✓ FREQUENCY RANGE: 20 to 20,000 cycles.
✓ FREQUENCY CONTROL: main dial true logarithmic scale 12 inches long. Frequency-increment dial calibrated from +50 to -50 cycles.
✓ FREQUENCY CALIBRATION: can be standardized within 1 cycle at any time by setting instrument to line frequency or zero beat.
✓ ZERO BEAT INDICATOR: neon lamp for zero beat at line frequency or zero scale.
✓ FREQUENCY STABILITY: drift from cold start less than 7 cycles in first hour and completed in 2 hours.
✓ OUTPUT IMPEDANCE: 600 ohms, either grounded or balanced-to-ground, and essentially constant at all output voltages.
✓ OUTPUT VOLTAGE: approximately 25 volts open circuit. For matched resistive load voltage varies less than ±0.25 db between 20 and 20,000 cycles.
✓ OUTPUT CONTROL: calibrated from +25 db to -20 db referred to 1 milliwatt into 600 ohms.

THE Type 913-A Beat-Frequency Oscillator, introduced by General Radio in 1942 immediately set a standard of excellence because of its high frequency stability, low distortion and constant output. Since then two improved models have increased its utility and acceptance.

The new Type 1304-A Oscillator is so different from the original that it is essentially a new instrument with many refinements in the circuit, in the oscillator, addition of buffer amplifiers, improved mixer and new amplifier. It is the finest beat-frequency oscillator obtainable.

Included in the features of the new instrument are:

- Cycles Increment Dial.
- Higher Accuracy of Calibration — adjusted to ±(0.5 cycle + 1%) ... closer than zero beat can be established with the beat indicator.
- More Accurate Zero Adjustment — line voltage is fed into beat-indicator circuit, permitting oscillator output to beat with line frequency to calibrate instrument within 1 cycle.
- Improvement in Distortion Below 100 Cycles — through new circuits and buffer amplifiers.
- New Gear-Drive Dial — better bearings ... smoother running gears ... less backlash ... illuminated dial.

Check the abridged specifications at left. You’ll agree that you cannot buy a more adaptable instrument.

TYPE 1304-A BEAT-FREQUENCY OSCILLATOR

$450.00

GENERAL RADIO COMPANY

Cambridge 39, Massachusetts

90 West St., New York 6 320 S. Michigan Ave., Chicago 5 950 N. Highland Ave., Los Angeles 38

ELECTRONICS — October, 1948

www.americanradiohistory.com
THE ELECTRON ART

Research, the Navy Bureau of Ships and the Army Signal Corps, was initiated at the Colorado School of Mines; the Owens-Corning-Fiberglas Corp. is retained under a consulting contract, and pilot plant production is being conducted by the Interior Department’s Bureau of Mines Electrotechnical Laboratory, Norris, Tenn. Knowledge of the production of silicate mineral crystals large enough to be split into sheets at the Kaiser-Wilhel Institute and the Siemens-Halske Concern in Germany has encouraged this development of synthetic mica.

INFRARED SPECTROSCOPY has been simplified by the development of a method for growing large crystals containing 42 percent thallium bromide and 58 percent thallium iodide by Francis Phelps and of polishing the soft semiplastic crystals by Edgar Robertson, both of the National Bureau of Standards. The prism so made has the large index of refraction of 2.6 in the visible region and 2.2 at 40 microns. The refraction changes greatly with temperature. This new prism extends the observable range to 40 microns (potassium bromide crystals permitted observation only to about 24 microns). Investigations in this unexplored region have already shown polystyrene and polyethylene to be very transparent and that many compounds containing chlorine, bromine, and sulfur have bands in this region.

EXPERIMENTS in pulse code modulation can be readily carried out by a technique developed by D. B. Smith working under Prof. W. H. Radford at MIT. In place of the pulse coding tube developed by Bell Labs. (ELECTRONICS, p 126, Dec., 1947), a conventional cathode-ray tube can be used to code the signal. A coding mask, cut the same as the aperture plate, is placed in front of the cathode-ray tube screen. A phototube receives coded impulses of light as the beam sweeps across the screen at levels determined by the instantaneous sampled amplitude of the signal. With this relatively simple apparatus one can study pulse code modulation systems. At MIT the equipment is being used to investigate the trans-
Now, to help you fight corrosion, dust, lint, fungus, and heat, General Electric announces a completely new line of selenium rectifier stacks. Each stack in this new line is a complete unit—ready for immediate installation—immersed in oil, hermetically sealed in a metal container, and protected by a tough, over-all coating.

For cool operation, the oil in these new General Electric rectifiers flows freely around the rectifier cells to dissipate heat during continued service. For easy assembly, the units have tinned soldering lugs, glass welded for a tight seal.

Tell G.E. your problem of d-c supply Whenever you strike the problem of deciding which type of rectifier is best for your purpose—call on General Electric for an answer. General Electric engineers can give you an impartial solution, because G.E. makes all three—selenium, copper-oxide, and Tungar—and now the new oil-filled selenium rectifiers.

For information on rectifiers—from the size of an aspirin to the size of a garage—or for data on the new, oil-filled, hermetically sealed selenium rectifiers, write to Section A21-1031, Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

GENERAL ELECTRIC
THE ELECTRON ART

mission of music by a 5-pulse code.

Corona at high altitude can be suppressed, in the case of ceramic bushings and other insulations upon which are imposed high potential gradients, by application of a semiconducting coating to the entire exposed insulation surfaces. The technique may be applied to such high-voltage equipment as radar and is particularly advantageous when used on airborne electronic equipment where space and weight must be held to a minimum. Coating solder-seal bushings of hermetically sealed components with material having a surface resistivity of about 3,000 megohms per square inch sufficiently distributes voltage stress to increase the high altitude a-c corona starting voltage by 200 percent or more and the average flashover voltage by 120 percent; d-c corona and flashover points are raised 70 percent. Similar improvements are produced on bushings at sea level. The magnitude of the resistivity of the semiconducting coating is such that there would be no serious current drain on actual electronic equipment treated in this manner.

Methods of detecting inception of corona, measurements of improvements obtained, and an analysis of electrostatic field configurations in the vicinity of a typical bushing have been described in High Altitude Flashover and Corona Correction on Small Ceramic Bushings, by W. W. Pendleton, A.I.E.E. Proc., 1947.

HIGHEST POWERED MAGNETRON developed so far for microwaves produces 60 kilowatts at 1,000 megacycles (1 kmc). Unlike most conventional tubes, the cathode is unheated, emission being produced by cathode bombardment with high-speed electrons each one of which releases three or four secondary electrons. The water-cooled tube was developed by the General Electric Research Laboratory under Signal Corps contract. Dr. R. B. Nelson, G. E. scientist, told a group of vacuum tube researchers convened at Ithaca in June that the limit to the power that can be produced at this high frequency is not yet in sight.
Phil-trol ACTUATORS

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For maximum power, reliable operation and efficient performance, specify Phil-trol Actuators. Exclusive design features incorporated in one-piece solid frame construction make Phil-trol Actuators strong, durable units for a wide range of solenoid uses.

Outstanding construction features include: One-piece 1/8" iron frame, dovetailed and staked into end plate for a secure bond and extra strength; Plunger and plunger stops are made from specially processed steel and are available in three types of end shapes; Standard coils are fiber bobbins wound with enameled copper wire, and impregnated with insulating varnish; Entire frame and plunger stop are cadmium plated and plunger is chrome plated for smooth operation.

Five standard sized Phil-trol Actuators are available in either A. C. or D. C. desired voltage. Designed for "pull" application, they may be converted to "push" with but slight efficiency loss.

Phillips engineers, located in cities listed below, will be glad to assist you in determining solenoid requirements. Special Phil-trol Actuators are designed to specification.

Send for Phil-trol Actuator Bulletin

Phil-trol RELAYS:

There is a complete line of Phil-trol Relays, all engineered to the highest standards, for electronic and industrial control, signal and traffic control, radio, communication, aircraft and other applications. Send for new Relay Catalog.
National Switch Insulation is a highly efficient "sandwich" material consisting of a Phenolite core—for dimensional stability even under humid conditions—permanently bonded and molded with Peerless Insulation (Fish Paper) surfaces, to provide high arc (tracking) resistance.

This product is used effectively to insulate electrical switches and equipment where high dimensional stability and arc resistance are required in proximity to current-carrying components.

For full details call or write

NATIONAL VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE
Offices in the Principal Cities

NEW PRODUCTS
(continued from p 134)
scope, picture generator, and distribution panel is available in combination or separately. The equipment produces synchronizing, driving, and blanking signals useful to manufacturers of television receivers. Two monographs giving further details have been published.

Pilot Light
DIAL LIGHT CO. OF AMERICA, INC., 900 Broadway, New York 3, N. Y. Designed particularly for use with the NE-51 neon lamp, the new Multivue cap refracts light in such a way as to improve effectiveness of the low-wattage neon lamp in pilot light service.

Loudspeaker Baffle
VIBRALOC MFG. CO., 3597 Mission St., San Francisco, Calif. The new general purpose loudspeaker baffle with Acousticurve design is adaptable to table, wall, or corner mounting. It may be had in a variety of
ELECTRONICS — October, 1948
For PERFORMANCE That Is Precisely Predictable

Special purpose transformers which meet the most rigid specifications are a Raytheon specialty. What more exacting test can you imagine than wartime service in naval SG and SO radar . . . for which Raytheon Transformers were used exclusively?

Raytheon can furnish custom-engineered transformers designed to fit your special needs . . . in the size, type and quantity you require. As one of the oldest and largest producers, Raytheon has the experience and facilities to design, test and deliver transformers that you can incorporate in your product or equipment with complete confidence.

More than 30,000 successful designs have proved that Raytheon quality means peak performance. May we prove it to you with sample models engineered precisely for your most exacting requirements? Handy forms in Bulletin DL-K-301 make it easy to specify your needs. Write for your copy.

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Excellence in Electronics
RAYTHEON MANUFACTURING CO.
Waltham 54, Massachusetts

...and VOLTAGE STABILIZERS

Bulletin DL-V-304 tells the complete story on the new line of high performance, space and weight saving Raytheon Voltage Stabilizers. Write for it today.

NEW PRODUCTS (continued)

sizes and finishes. A catalog sheet is available.

Portable Sound System

RADIO CORP. OF AMERICA, Camden, N. J. Type SP-15A portable sound system consists of an aerodynamic mike, a high-output amplifier and a heavy-duty alnico permanent magnet speaker. It operates on 100-watt, 50 to 60-cycle power supply. Complete system weighs 45 pounds.

Tube Base Diagrams

RADIO CORP. OF AMERICA, Camden, N. J. The new Triple Pindex is actually three separate booklets in one spiral-bound cover, permitting instant location and simultaneous study of any three tube base diagrams from over 475 types. Listings are arranged in dictionary fashion. Price is 75c from distributors.

Industrial Rectifier

NATIONAL ELECTRONICS, INC., Batavia Ave., Geneva, Ill. Type NL-649 is a 2-ampere, single-ended industrial rectifier tube. It is mercury vapor filled permitting a peak inverse voltage rating of 900 volts and can be used in 250-volt d-c ap-
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PHALO TWINS TRANSMISSION LINE
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PHALO RAINBOW CABLE

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Manufacturers of Insulated Wire, Cables, Cord Sets
and Thermoplastic Tubing.
Astatic FL-33 PICKUP
FOR COLUMBIA MICROGROOVE RECORDS

Astatic takes extreme pride in presenting its PICKUP for use with the sensational new Columbia LP Records. This is not just another version of what related equipment for Microgroove Records should be—but the actual playing arm designed to meet the precise requirements of Columbia’s new recordings. The new pickup is manufactured to meet the specifications by Columbia to insure maximum quality performance of the Columbia LP Microgroove Record. Available, then, in the Astatic FL-33 Pickup and LP-33 Crystal Cartridge, is the ultimate of Microgroove companion equipment. Here is the professional playing arm, and its replacement cartridge, alone capable of getting the most out of LP Records. And that “most” is truly incomparable—a reality, depth and clarity of tone, a flawless fidelity of reproduction never before obtainable from commercial records.

FEATURES OF ASTATIC’S FL-33 PICKUP—THE PERFECT COMPANION FOR COLUMBIA LP RECORDS
1. Five-Gram Needle Pressure, of prime importance with the new, lower-radius needle tip. 2. Permanent Sapphire Needle with .001” Tip Radius. 3. Approximately One-Half Volt Output. 4. Frequency Range 30 to 10,000 c.p.s. 5. Novel Design at Base Unifies Tone Arm Resonances and Assures Perfect Tracking. 6. LP-33 Cartridge, with Permanent Sapphire Needle, instantly replaceable in FL-33 Pickup on slip-in principle of modern fountain pen. “LP” means long playing, low pressure.

ALSO AVAILABLE is the LP-78 Cartridge that fits the FL Arm, but having a .003” radius needle; thereby, playing 78 RPM Records. By merely slipping in either cartridge you have the proper pickup for 78 or 33-1/3 Records.

FL FILTER
An important accessory that goes hand-in-glove with Astatic’s FL-33 Pickup, for best performance with high quality speakers, is the FL Filter. Controls pickup response—Eliminates high frequency peak.

Industrial Timers
MONTGOMERY MFG. Co., 549 W. Washington Blvd., Chicago 6, Ill., has introduced two synchronous program timers, models TP and TS, designed especially for manufacturing establishments where permanent conduit or BX installations in standard switch box cases are desired. Model TP, for bell ringing, can make a single circuit contact at any 5-minute interval in 24 hours and repeat each day. Model TS incorporates a holding circuit which it closes on the first impulse and opens on the succeeding impulse.

Radio Noise Filters
THE FILTRON Co., 38-25 Bell Blvd., Bayside, L. I., N. Y. Type FA204

Listed in the Radio Industry Red Book
PIONEER EQUIPS GROUND *STATIONS WITH
Wilcox Type 378A Package Radio

PACKAGE DESIGN SPEEDS YOUR INSTALLATIONS
The Type 378A is complete from microphone to antenna, ready for connection to power mains. It is designed for aeronautical VHF ground-air communications at smaller traffic centers.

PROVEN COMPONENTS INSURE QUALITY AND PERFORMANCE—The Type 305A VHF Receiver and Type 364A VHF Transmitter (50 watts) are the principal components of the 378A. Long used separately and field-tested by leading airlines, these units are now available in package form.

NEW AIDS TO CONVENIENT OPERATION
The telephone handset with its convenient push-to-talk button, serves as both headphone and microphone, with an auxiliary loudspeaker for incoming calls. The 378A includes desk front, message rack, and typewriter space—there are no accessories to be added.

LOCAL OR REMOTE CONTROL—If desired, the control panel can be removed and the 378A remotely controlled, either by re-installing the panel at the operating position or by simple adaptation to your existing control equipment.

*Pioneer aircraft are also 100% equipped with the new WILCOX Type 361A Airborne VHF Communication System.
No Rabbits!

...but we do make coil windings...

Magic has no place in our scheme of things. We make no extravagant claims. We DO wind the best coils which 31 years of experience, skilled operators, latest equipment and professional know-how can produce. We should like to serve YOU.

Are you fussy? Then try us!

COTO-COIL CO., INC.
COIL SPECIALISTS SINCE 1917
63 Pavilion Ave., Providence 5, R. I.

---

C-R Stethoscope
Feiler Engineering Co., 947 George St., Chicago, Ill. The new five-inch cathode-ray oscilloscope combined with stethoscope is designed for f-m and television servicing. It can also be used for a-m and audio work. Price is $89.95 list.

A-F Microvolter
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Type 546-C Microvolter represents a redesign to standardize its output level at 600 ohms. Sensitivity, frequency response, and distortion

Radio interference filter is but one of a wide variety of Filtrons for suppression of noise. Featured are high attenuation, small size, light weight, and hermetic sealing. Rating of the unit illustrated is 2.5 amperes, 50 volts d-c.
Use one alone—

or stack 'em like hot cakes...

**I-T-E OVAL RESISTORS SAVE SPACE!**

When space is limited—as in aviation, sound, or electronics applications—I-T-E Oval Resistors and Oval Resistor Assemblies may be the solution you're looking for.

Specially designed to meet the exacting and changing needs of the electronics industry, these modern, wire-wound power resistors are distinguished by their high unit-area wattage ratios, which are due in part to the heat dissipation qualities of the mounting brackets.

An I-T-E Oval Resistor—or an assembly of I-T-E Oval Units—has a much higher wattage rating than that of a conventional round resistor of comparable size. You save space and, at the same time, gain the dependable performance of I-T-E quality resistors.

No matter what your resistor problem is—space, exacting service, or dependable performance—be sure to investigate I-T-E Oval Resistors. Complete technical information, as well as valuable application data, are contained in the new I-T-E Resistor catalog. Send for it today.

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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&quot;</td>
<td>15000</td>
<td>2 3/4&quot;</td>
</tr>
<tr>
<td>316 Oval</td>
<td>55</td>
<td>3 1/4&quot;</td>
<td>25000</td>
<td>4 1/4&quot;</td>
</tr>
<tr>
<td>424 Oval</td>
<td>65</td>
<td>4 3/4&quot;</td>
<td>35000</td>
<td>5 1/2&quot;</td>
</tr>
<tr>
<td>600 Oval</td>
<td>75</td>
<td>6&quot;</td>
<td>50000</td>
<td>6 3/4&quot;</td>
</tr>
</tbody>
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The Leader In Technical Excellence

I-T-E CIRCUIT BREAKER CO., RESISTOR DIVISION, 19TH & HAMILTON STREETS, PHILADELPHIA 30, PA.

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NEW PRODUCTS (continued)

characteristics have also been improved. Output voltage range is 0.1 microvolt to 1.0 volt open circuit for an input of 2.2 volts across 600 ohms. Accuracy is ± (3 percent + 0.5 μV) for output levels above 1 microvolt at frequencies below 20,000 cycles. Up to 100,000 cycles the accuracy is ± 5 percent. Distortion introduced by the instrument is about 0.2 percent.

Variable Resistor

P. R. MALLORY & CO., INC., Indianapolis, Indiana. The new Midgetrol measures 15/16 inch and has a number of other features such as a flat shaft, or a special phenolic shaft for television applications. Specification sheets and a descriptive folder are available.

Crystal Oven

JAMES KNIGHTS Co., Sandwich, Ill. A new crystal oven recommended for broadcast or standard frequency applications has a large 7-pin base, 6.3-volt heater, and operating temperature 50±° C. The crystals are electrostatically shielded.

Pressure Element

COMMERCIAL RESEARCH LABORATORIES, INC., 20 Bartlett Ave., Detroit 3, Mich. A new Type 5 direct pressure element replaces type 3 pressure element and type 3 gas sampling valve. Owing to the new design, the element is open for less
The NEW "dag" CRT Wall Coating

for all CRT glass envelopes

Here's an entirely new CRT Wall Coating, developed by Acheson Colloids specifically and solely for use on CRT glass envelopes.

"dag" CRT Wall Coating is very easily applied . . . adheres tenaciously to all types of glass . . . does not yield objectionable by-products on heating.

Prominent cathode-ray tube manufacturers have already found this opaque, electrically conductive "dag" CRT Wall Coating eminently satisfactory, especially in tubes intended for television reception.

Let Acheson Colloids help you with your CRT wall coating problem. Mail the coupon today for information on this or other electronic applications of "dag" colloidal graphite dispersions.

Give me information on "dag" colloidal graphite dispersions for:

- Wall coating of CRT's
- Electrostatic shielding
- Corona prevention
- Dry-film lubrication
- Copper oxide rectifier disc coating
- Electrical resistances
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Port Huron
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recording of electrical phenomena from
D.C. to 100 c.p.s. help in your research?

It's a fact—permanent, instantaneous
ink-on-paper recordings by Brush Oscillographs
make their use almost unlimited!

Accurate recordings of voltages, pressures,
radiation intensity and countless other phenomena can
be made over a frequency range of D.C. to 100 c.p.s.
Either A.C. or D.C. signals can be measured.
Whenever desired, recordings may be stopped for
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Investigate Brush measuring devices
before you buy . . . they offer
more for your money.
Why not have a Brush repre-
sentative call? At no obligation,
of course.

Just call or write—today—you'll find it worth a few
seconds' time!

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INDUSTRIAL INSTRUMENTS DIV. • CRYSTAL DIVISION

Canadian Representative: A. C. Wickman, (Canada) Ltd., P. O. Box 9, Station N, Toronto 14

than 0.001 second permitting its
use in tests on high-speed engines
over the whole engine cycle.

Television Capacitors

SPRAGUE ELECTRIC Co., North
Adams, Mass. A new line of capac-
itors designed for television serv-

ice is rated at 85 C up to 450 volts.
Shelf life of these electrolytic units
has been improved.

LP Needles

ELECTROVOX Co., INC., 66 Franklin
St., East Orange, N. J. Microgroove
needles of sapphire and osmium

alloy needed for the new long playing
records are available in two
styles illustrated.

Signal Generator

FERRIS INSTRUMENT Co., Boonton,
N. J. Model 24-B a-m and f-m sig-
nal generator provides frequencies
from 5 to 220 mc with either in-
ternal or external modulation. It is
designed primarily for production
checking f-m and television receiv-
ers. Any seven spot frequencies in
the range are available with an
Even where climates quickly kill cables, the ether is always ready to carry a Standard Multiplex Telephone Trunk Link.

The system is easy to install, thoroughly reliable in operation, and simple to service.

Each equipment deals with up to 24 channels which handle any kind of A.F. traffic in the 300-3400 c/s range, including teleprinter and automatic telephone signals.

Time-sharing Multiplex ensures low crosstalk and noise levels, and fading does not affect speech levels. A UHF carrier is used and the normal line-of-sight range may be extended by automatic repeaters.

Complete terminal equipment occupies a double cabinet 7' wide x 2' 4" deep x 6' 6" high, and aerials may be up to 100' away from the equipment.

Write for our Bulletin No. 511 which gives further facts and figures.
for POWER, SIGNAL and CONTROL CIRCUITS in AIRCRAFT and ELECTRONIC EQUIPMENT

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Ruggedness for AIRCRAFT SECURITY...

Stronger shells, stronger insulation, lowest resistance contacts with wiring solder pockets aligned for quick, convenient connections. Built to quality standards beyond the already rigid specifications for AN Connectors. Amphenol pioneered in the engineering of this rugged and efficient line of connectors for use in military aircraft. To be sure of top performance, specify Amphenol AN Connectors and Fittings.

Write for the new AN Catalog A-l. It's abundant with the latest connector information and contains timesaving listings and indexes for the engineer and buyer. Mail your request on company letterhead to Department 13-B.

AMERICAN PHENOLIC CORPORATION
1830 SOUTH 54TH AVENUE, CHICAGO 50, ILLINOIS

COAXIAL CABLES AND CONNECTORS - INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT - ANTENNAS - RADIO COMPONENTS - PLASTIC FOR ELECTRONICS

NEW PRODUCTS (continued)

additional number by changing coil drums. The instrument has a built-in power supply. Details of the various features are available.

Special Amplifier

BROWNING LABORATORIES, INC., Winchester, Mass. Amplifier TAA-16 is used in the determination of voltage standing wave ratio when used with square law detector probes and slotted waveguides. Two inputs are available. Operations can be wide band or highly selective as needed. There is an integral power supply, electronically regulated. Full-scale meter readings are obtained with 15 microvolts input under wide band operation.

Isolation Transformer

RADIO CORP. OF AMERICA, Camden, N. J. The type WP-24A Isotap variable-voltage isolation transformer has been designed for speedy receiver servicing. Choice of test voltages provided consists of 117-
In addition to the power stacks illustrated Seletron Selenium Rectifiers are furnished in small sizes. Specify SELETRON SELENIUM RECTIFIERS FOR RADIO AND TELEVISION APPLICATIONS.

<table>
<thead>
<tr>
<th>CODE NUMBER</th>
<th>5L1</th>
<th>5M1</th>
<th>5P1</th>
<th>5R1</th>
<th>5Q1</th>
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<tbody>
<tr>
<td>Current Rating</td>
<td>75 ma.</td>
<td>100 ma.</td>
<td>150 ma.</td>
<td>200 ma.</td>
<td>250 ma.</td>
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<tr>
<td>Plate Height</td>
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<td>1&quot;</td>
<td>3/16&quot;</td>
<td>1 1/2&quot;</td>
<td>1 1/2&quot;</td>
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<tr>
<td>Plate Width</td>
<td>7/8&quot;</td>
<td>1&quot;</td>
<td>3/16&quot;</td>
<td>1 1/4&quot;</td>
<td>1 1/2&quot;</td>
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</table>

Built on Aluminum

The pinch hitter who swats the ball over the heads of the outfielders for a homer has "the extra something that spells top performance."

In any field it's the extra something that makes top performance possible.

Nowhere is this rule more forcefully demonstrated than in Seletron Selenium Rectifiers. Their extra rugged construction and high precision standards have enabled them to establish unbeatable performance records in every type of application. Efficient—dependable—durable, under the severest service conditions.

Leading engineers and designers specify and recommend Selenium Rectifiers.

Furnished in a wide range of voltages and currents to meet individual requirements.

Write today for catalog. Address Dept. ES-10

SELETRON DIVISION
RADIO RECEPTOR COMPANY, INC.
Since 1922 in Radio and Electronics
251 WEST 19TH STREET. NEW YORK 11, N. Y.
The basic Magnecorder recorder mechanism (PT6-A)

The New 3 Element
MAGNECORDER

The Magnecorder meets the highest broadcast standards, and it costs you less. You buy and combine only the units you need:

Magnecorder (PT6-A) — Basic recorder mechanism.
Portable Mixer-Amplifier (PT6-P) — Recording and reproducing portable field amplifier. Can be used as high-quality remote amplifier. Mixes three low-level microphones.
Rack Mount Amplifier (PT6-R) — Recording and reproducing amplifier for studio rack mounting. With PT6-A makes complete studio recorder-reproducer.

It's Portable! It's Flexible!

Weight — PT6-A, 23 pounds; PT6-P, 29 pounds.
Wow and Flutter — .2%
Frequency Response — 40 to 15,000 cycles; + or — 2 db.
Tape Speed — 15 inches or 7½ inches per second (interchangeable).
Motor — Synchronous 1/50 HP.
Single Control.
Rewind — 45 seconds.
Reels — Standard 7-inch 8MM film reels.
Current failure never throws tape. Instantly interchangeable from portable to rack mounting.

Write today for detailed specifications

New Products (continued)

Grid-Controlled Rectifier

ELECTRONS, INC., 127 Sussex Ave., Newark, N. J. announce development of the type 5528 (C6L) temperature-free grid-controlled rectifier tube designed especially for high power servomotor control or inverter applications which must operate at up to 800 cycles. It features 60 second heating time, a peak inverse voltage of 500 v, 6.4 amperes steady d-c current, and 77 amperes peak.

Magnetometers

THOMAS E. SMITH, 122 East 42nd St., New York 17, N. Y. Presence and polarity of magnetic fields can be determined using model GW-2 gradientometer that can also be switched for use as a magnetometer. The device has been designed for investigating magnetic fields in aircraft frames.

New-Record Pickup

ASTATIC CORP., Conneaut, Ohio. Type FL-33 pickup and LP-33 crystal replacement cartridge have been designed particularly for use with new long-playing records. The
No one is in a better position to cut your electrical contact and precious metal costs than General Plate... pioneers in laminated metals. Through long years of experience in the manufacture of precious to base metal combinations... and work with leading manufacturers of electrical and industrial products, General Plate gives you laminated metals that provide economical solutions to your problems.

General Plate Laminated Stock saves money because it eliminates a large waste of expensive silver. By bonding silver or other precious metal to inexpensive base metal you get the high cost metal only where it's needed. The laminated construction not only lowers costs but increases operating life and makes fabrication of parts easier.

General Plate Laminated Stock is available in sheet, inlaid stripes, elevated stripe, edge lay, as well as tube and wire... buttons for spot welding or soldering; rivets—or as completely fabricated parts made to your specifications. Write for information or engineering assistance.

GENERAL PLATE Laminated STOCK

GENERAL PLATE DIVISION
of Metals and Controls Corporation
310 FOREST STREET, ATTLEBORO, MASSACHUSETTS

ELECTRONICS — October, 1948
COSMALITE* COIL FORMS

Each specially designed and produced by us to give exceptional performance, and at a saving in cost to this country's leading manufacturers of radio and television receivers.

Your specifications as to punching, threading, notching and grooving are followed with the most exacting care. Ask about our many stock punching dies available to you.

Are you familiar with our #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.

* Trade Mark Registered

Test Instrument

SIMPSON ELECTRIC Co., 5200 West Kinzie St., Chicago 44, Ill. Model 221 Roto-Ranger is a high-sensitivity a-c and d-c volt-ohm-milliammeter equipped with rotating dials.

Its many applications include measurements of a-f diode balancing circuits, grid currents of oscillator tubes and power tubes, a-c diode currents and high-mu plate voltage. Direct-current sensitivity is 20,000 ohms per volt.

Microcurrent Measurement

WALLACE & TIERMAN PRODUCTS, INC., Belleville 9, N. J. announce a portable d-c recorder for measuring microcurrents and voltages where exact range may be selected.
DeJUR INSTRUMENTS
... designed for exacting performance

DeJUR—one of America's foremost names in high precision electrical components is now able to make prompt deliveries on standard and special types of equipment. Every instrument built conforms with JAN I-6 and JAN R-19 specifications as well as A.S.A. standards.

Functional designing, ruggedness, accuracy and dependability are all characteristic DeJUR features. Among the many types of precision instruments offered are:

- Voltmeters
- Microammeters
- Ammeters
- Volume Indicators
- Milliammeters
- Potentiometers
- and many others.

We solicit your inquiries and the coupon below is for your convenience.

DeJUR RHEOSTAT-POTENTIOMETERS
There are models for electronic devices, radio transmitters, dynamic voltage control, portable power amplifiers, mixing panels, spot welding, motor control, etc. Available in standard, multiple or ganged units, and units with special resistance values and tolerances.

DeJUR ELECTRICAL INSTRUMENTS
The DeJUR 1 1/2-inch Model 112 Meter, measuring only 1 3/4 inches square and 25/32-inch deep is capable of doing a man-sized job where space is at a premium. This meter is built with fine watch precision. Available in standard ranges.

DeJUR-AMSCO CORPORATION
Manufacturers of precision equipment for over a quarter century

Please send me information regarding the instruments indicated:

- Voltmeters
- Ammeters
- Milliammeters
- Microammeters
- Volume Indicators
- Potentiometers
- Other

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Firm
Street
City
State

DeJUR-AMSCO CORPORATION
45th St. and Northern Blvd., Long Island City 1, N. Y.
Haydon engineers, in conjunction with the Eagle Signal Corporation, specified and produced to order the timing motor used in the Eagle's Microflex timer. The Microflex provides an exact adjustable delay between the closing of a control circuit and the subsequent opening or closing of a load circuit...a timer for industrial use where accuracy and dependability are paramount.

The Microflex is but one example of Haydon's timing flexibility...based on teaming timing needs with such standard features of all Haydon motors as:

- Adaptability for individual requirements...60 standard speeds and other variations.
- Accuracy for all timing purposes
- Ruggedness for maximum service

Thousands of industrial applications have proved the advantages of Haydon timing motors...designed to fit your particular timing needs...showing that it takes teamwork to make timing accuracy profitable.

If it's time for timing, it's time for Haydon. Engineering Data Catalog and expert field service available on request. For immediate reference, see Haydon Catalog, Sweet's File for Product Designers.

Write 2410 Elm Street, Torrington, Connecticut

NEW PRODUCTS (continued) by the user. The unit is of the moving magnet, interchangeable coil type and is designed for continuous duty. Minimum full scale range is 0 to 0.1 milliampere and maximum is 0 to 12 amperes. Sensitivity is 1 part in 1,000.

Transcription Player
CALIFONE CORP., 1041 N. Sycamore Ave., Hollywood 38, Calif. introduce a new portable transcription player. It reproduces with both 16-in. transcriptions at 33 1/3 rpm and regular phonograph records at 78 rpm. It features a wow-free 9-in. turntable, a pickup with replaceable permanent needle, a wide range amplifier and a heavy duty 6-in. speaker.

Small Radiation Meter
TRACERLAB, INC., 55 Oliver St., Boston 10, Mass. The Model SU-1A small portable radiation survey meter facilitates measurement of radiation in places difficult of ac-
Simultaneous visual display of reflected energy from antennas and terminations when used with standard oscilloscopes. Band width of display 30 mc anywhere between 10 and 250 mc. Completely electronic. Includes no slotted lines, moving parts, bridges or other frequency sensitive devices. Oscilloscope display indicates amount of reflected energy vs frequency. Precision frequency meter indicates frequency anywhere along the oscilloscope display. Reflection coefficients as low as 0.01 can be observed. Internal delay cable allows display of energy from terminations of nominal 53.5 ohm impedance. External delay cable may be used to display reflected energy from terminations of any practical impedance. Reflection coefficients, standing wave ratios, absolute value of terminating impedances can be calculated from display—by use of auxiliary variable frequency signal source, the phase angle of the reflection coefficient and resistive and reactive components of terminating impedance may be calculated.

Price $695 f.o.b. factory

MEGA-SWEEP pulse modulated by the MEGA-PULSER

The MEGA-SWEEP, a wide range sweeping oscillator has been widely used as a source of frequency modulated test signal. Its features include a wide sweep (up to 50 mc), low amplitude modulation while sweeping (less than 0.1 db per megacycle), negligible output signal at frequencies other than sweep band, low output impedance (50 ohms) and numerous others. It has been advertised as covering the frequency range of 50 kc to 500 mc since this range covered most requirements. By simple internal adjustment which can be made either by the customer or at our factory, its range can be extended to 1000 mc. The MEGA-SWEEP is therefore applicable to the proposed high frequency television bands and other high frequency work. By simple connections and adjustments the MEGA-SWEEP can serve as a carrier source when pulse modulated by the MEGA-PULSER, providing ultra narrow pulses r.f. at any frequency to 1000 mc.

Price $395 f.o.b. factory

THE MEGA-MATCH (Standard)

The MEGA-MATCH (Modified) meets all of the specifications and includes all the features of the standard model between 10 to 500 mc. With a slight increase in minimum observable reflection coefficient, this model can be used up to 1000 mc. Hence a visual display of reflected energy over band width up to 30 mc can be obtained from 10 to 1000 mc. This performance provides an instrument suitable for use in testing antennas, terminations, and r.f. input circuits in the proposed high frequency television bands and for other high frequency work. A convenient panel connector makes the MEGA-SWEEP which forms part of both the standard and modified models of the MEGA-Match available as a sweeping oscillator.

Price $895 f.o.b. factory

Note: Standard models now in customers' hands modified at factory at price of $520 f.o.b. factory.

THE MEGA-MATCH (Modified)

The MEGA-Match (Modified) can be covered as impedance output. By the Mega-Pulser, frequency work. The Mega-Pulser provides very narrow pulses (0.025, 0.05, 0.1 and 0.25 microseconds wide), and numerous others. Can be externally triggered by either positive or negative pulses. Output pulses 0.5 microseconds and greater flat-top, rise and fall time all output pulses 0.01 microseconds. Provides a spectrum which more than covers present or proposed television video amplifiers. The Mega-Pulser may be used to pulse modulate the MEGA-Sweep with sweep width adjusted to zero. This combination provides a pulse modulated carrier up to 1000 mc for studying transient response of broad band r.f. circuits.

Price $195 f.o.b. factory

WRITE FOR FULL SPECIFICATIONS

KAY ELECTRIC CO., 25 MAPLE AVE., PINE BROOK, N. J.

Telephone: Caldwell 6-3710

ELECTRONICS — October, 1948

225
A Ballantine
ELECTRONIC VOLTMETER

For every requirement

ALL MODELS HAVE THE
SIMPLIFIED
LOGARITHMIC SCALE

Ideal for the Accurate measurement of AC voltages in the Audio, Supersonic, Carrier Current and Television ranges.

Use of Logarithmic voltage scale assures uniform accuracy of reading over whole scale while permitting range switching in decade steps.

Each Voltmeter equipped with an output jack so that the instruments can be used as a high-gain stable amplifier.

SPECIFICATIONS

MODEL 300
RANGE—0.01 to 100 volts.
FREQUENCY—10 to 150,000 cycles.
ACCURACY—2% at any point on scale.
AC OPERATION—110-120 volts.

MODEL 304
RANGE—0.01 to 100 volts.
FREQUENCY—30 c.p.s. to 5.5 megacycles
ACCURACY—0.5 DB.
AC OPERATION—110-120 volts.

MODEL 302
RANGE—0.01 to 100 volts.
FREQUENCY—5 to 150,000 cycles.
ACCURACY—2%, at any point on scale.
DC OPERATION—self-contained batteries.

Send for Bulletin for further description

NEW PRODUCTS (continued)

Regulated Power Supply

THE HOWARD CO., 934 Argyle Road, Drexel Hill, Pa. The new 300-volt, 200-ma power supply is regulated within 1 volt from zero to full load with line voltage variation from 105 to 125 volts. Ripple is less than 10 millivolts at full load with 115 volts input.

Microgroove Changer

WEBSTER-CHICAGO CORP., 5622 Bloomingdale Ave., Chicago 39, Ill. Model 133 has been designed to play new long-playing records at 33.3 rpm. The unit will handle up to ten 12-in. or twelve 10-in. records for a total playing time of four hours. Retail price is $38.75.

High-Fidelity Recording

PRECISION AUDIO PRODUCTS, INC., 1133 Broadway, New York 10, N. Y. The Wiremaster, a new wire recorder, has 13 tubes with push-pull 6V6 output and records and reproduces a frequency response of 40 to 10,000 cycles. Its 8-in. extended...
AIRCRAFT MANUFACTURERS RELY ON...

FILTRONS

...TO SOLVE THEIR RADIO NOISE PROBLEMS

Filtron's Engineers, recognized authorities in the noise-suppression field, are available—immediately—to measure the RF interference caused by your product, and to specify a standard Filtron, or design the proper filter to meet Army, Navy, Air Force or FCC interference specifications.

Filtron will design the RIGHT filter for your circuit conditions, with exactly the right attenuation, ampere rating, voltage drop, temperature rise, mechanical arrangement, and space and weight limitations. Filtrons of any current or voltage rating will be designed to meet your application.

Filtron's production capacity and skill will meet your delivery requirements.

All measurements are made in our new modern specially-designed shielded Radio Noise Suppression Laboratory.

"Filtron," the largest exclusive manufacturer of Radio Noise Filters, offers you the PROMPT services of their Engineers and facilities to make your product "Noise Free."

Filtron will design the RIGHT filter for your circuit conditions, with exactly the right attenuation, ampere rating, voltage drop, temperature rise, mechanical arrangement, and space and weight limitations. Filtrons of any current or voltage rating will be designed to meet your application.

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"Filtron," the largest exclusive manufacturer of Radio Noise Filters, offers you the PROMPT services of their Engineers and facilities to make your product "Noise Free."

Filtron STOP CONDUCTED AND RADIATED INTERFERENCE AT THE SOURCE

THOUSANDS OF FILTRONS—radio interference filters—are standard equipment on the majority of current aircraft production. Thousands of others are in use in vital equipment where radio interference must be suppressed.

Filtron's experienced Engineers, recognized authorities in the noise-suppression field, are available—immediately—to measure the RF interference caused by your product, and to specify a standard Filtron, or design the proper filter to meet Army, Navy, Air Force or FCC interference specifications.

Filtron will design the RIGHT filter for your circuit conditions, with exactly the right attenuation, ampere rating, voltage drop, temperature rise, mechanical arrangement, and space and weight limitations. Filtrons of any current or voltage rating will be designed to meet your application.

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"Filtron," the largest exclusive manufacturer of Radio Noise Filters, offers you the PROMPT services of their Engineers and facilities to make your product "Noise Free."

THE FILTRON CO.
INCORPORATED
38-25 BELL BOULEVARD
BAYSIDE, NEW YORK CITY, N.Y.

LARGEST EXCLUSIVE MANUFACTURER OF RADIO NOISE FILTERS

ELECTRONICS—October, 1948
At long last—

The G.M. counter tube reaches maturity in the new all metal *THYRODE 1B85

The new THYRODE is a precision counter tube, designed to utilize quantity production methods. The .005 inch aluminum wall, rib re-enforced, adds strength to its inherent stability and accuracy.

Priced at $7.50

CHARACTERISTICS

Overall length ........... 4-1/8 inches
Active length ........... 2-3/4 inches
Shell diameter .......... 3/4 inches
Absorption ............. 30 mgm/cm²
Operating voltage ....... 900 volts (center of plateau)
Plateau length .......... 200 volts
Plateau slope ............ 3% / 100 volts
Temperature range ....... 5° C. to 70° C.
Life ..................... 10⁶ counts

*THYRODE
A Victoreen trademark for radiation counter tubes

Victoreen radiation measuring instruments for laboratory and field determinations together with such components as the VX series subminiature electrometer tubes, vacuum sealed hi-meg resistors and G-M counter tubes have made notable contributions to the present refinement of radiation instrumentation.

Victoreen
5806 Hough Avenue
Cleveland 3, Ohio

Literature

House Organ. Micro Switch, Freeport, Ill. Micro Tips, vol 1, no. 2 contains a number of suggestions for use of snap action switches including one for pushing the dog out after dinner.

Portable Flaw Tester. Sperry Products Co., Danbury, Conn. The new portable SR05 Supersonic Reflectoscope is pictured in reprint 3013 and further described in bulletin 3001.

Wire Dereelers. Rea Magnet Wire Co., Inc., Fort Wayne, Indiana, has put out a two-color, 4-page brochure on a line of magnet wire dereelers that load quickly and give visibility in the running position.

Special Tools. Palnut Co., 61 Cordier St., Irvington 11, N. J. Special adaptors for many ordinary hand tools to adapt them to speedier assembly with Palnuts only are described in a 4-page brochure.

General Price List. Andrew Corp., 363 E. 75th St., Chicago 19, Ill. Bulletin 10A is a comprehensive tabulation of all transmission range speaker is in a separate cabinet to avoid vibration and acoustical feedback. By panel controls the user can record on wire directly from the self-contained radio or phonograph. Spools are available in 15, 30 and 60-minute lengths.
MAILING LISTS THAT WORK...

McGraw-Hill Industrial Mailing Lists are a direct route to today's purchase-controlling executives and technicians in practically every major industry.

These names are of particular value now when most manufacturers are experiencing constantly increasing difficulty in maintaining their own lists.

Probably no other organization is as well equipped as McGraw-Hill to solve the complicated problem of list maintenance during this period of unparalleled changes in industrial personnel. These lists are compiled from exclusive sources, based on hundreds of thousands of mail questionnaires and the reports of a nationwide field staff, and are maintained on a twenty-four hour basis.

Investigate their tremendous possibilities in relation to your own product or service. Your specifications are our guide in recommending the particular McGraw-Hill lists that best cover your market. When planning your industrial advertising and sales promotional activities, ask for more facts or, better still, write today. No obligation, of course.

DIRECT MAIL DIVISION  
330 West 42nd Street  
New York, 18, N. Y.
OSCILLOSYNCHROSCOPE
Model OL-15B

Designed for maximum usefulness in laboratories doing a variety of research work, this instrument is suited to radar, television, communication, facsimile, and applications involving extremely short pulses or transients. It provides a variety of time bases, triggers, phasing and delay circuits, and extended-range amplifiers in combination with all standard oscilloscope functions.

THESE FEATURES ARE IMPORTANT TO YOU

- Extended-range amplifiers: vertical, flat within 3 db 5 cycles to 6 megacycles; horizontal, flat within 1 db 5 cycles to 1 megacycle.
- High sensitivity: vertical, 0.05 RMS volts per inch; horizontal, 0.1 RMS volts per inch.
- Single-sweep triggered time base permits observation of transients or irregularly recurring phenomena.
- Variable delay circuit usable with external or internal trigger or separate from 'scope.
- Sawtooth sweep range covers 5 cycles to 500 kilocycles per second.
- 4,000 volt acceleration gives superior intensity and definition.

For complete data, request Bulletin 4810-MO.

SQUARE-WAVE MODULATOR AND POWER SUPPLY

Model TVN-7

Here is the heart of a super high frequency signal generator with square wave, FM, or pulse modulation. Provides for grid pulse modulation to 60 volts, reflector pulse modulation to 100 volts, square wave modulation from 600 to 2,500 cycles. Voltage-regulated power supply continuously variable 280-480 or 180-300 volts dc. For additional data and application notes, see Bulletin 4810-MM.

NEW PRODUCTS (continued)

line, antenna, and related equipment, with type numbers, descriptions and prices for over 600 items. A cross index is enclosed with the bulletin.

Fiber. Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N. Y. Various types and grades of fiber rod are summarized and listed in a recently issued brochure.

Fasteners. Shakeproof Inc., 2501 North Keeler Ave., Chicago 39, Ill., has issued a booklet entitled "Fastening Suggestions" that describes a number of special fastener problems and their solution.

Shielded-Section Capacitor. Cornell Dubilier, South Plainfield, N. J. A shielded multiple section capacitor type MC-9A65 has four 0.02-microfarad sections with voltage ratings for 500 v d-c. Details are given in sheet NB-107.


Battery Terminal. James A. Stanley Co., 277 Broadway, New York 7, N. Y. A brochure can be had describing the new B-319 battery terminal that employs a spring-tension connection to a storage battery terminal post. The new terminal is particularly useful in mobile radio installations.

A-C Motor Control. Louis Allis Co., Milwaukee 7, Wis. Characteristics of the Ajusto-Spede are presented in four pages. The device is characterized as an a-c motor having infinitely adjustable speed.

MEMO TO PRESIDENTS
WHO WATCHED
THE BAND GO BY!

Here's one parade that isn't "all over but the shouting" after the band has passed. It's the Payroll Savings Plan for the regular purchase of U.S. Security Bonds by employees.

Though the formal spring campaign to sell Bonds is over, any company can still move forward with the parade. Right now thousands of companies are putting additional push behind their Payroll Savings Plans. Managements of many companies that have not yet participated are now installing the Plan.

It's a "look-ahead" plan, that benefits employee, company, and nation. Every $3 invested in Bonds pay $4 at maturity. Personnel records in the plants with active P.S.P. programs show improved employee attitudes—evidenced by less absenteeism and fewer accidents—as the individual's sense of security grows with Bond purchases. And every Security Bond dollar built up in the Treasury retires a dollar of the national debt that is potentially inflationary. It means less bidding-up of prices. Moreover, Bond buyers are better citizens because they have a tangible stake in the nation's future.

It's just as easy to take action now as when the campaign was at its height. Just call your Treasury Department's State Director, Savings Bonds Division, and ask for the material that helps to get a Payroll Plan started or to keep it rolling.

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.
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. (Bulletin SP165)

S8-C General Purpose, 24 to 36 elements, otherwise same as type S8-B. (Bulletin SP165)

S8-D General Purpose, 12 to 24 elements, similar to type S8-B except without automatic controls. (Bulletin SP175)

S12-A Small Portable, General Purpose, the smallest complete 12-element oscillograph. (Bulletin SP167)

S6-A Geophysical, 12 elements.

S6-B Geophysical, 24 elements.

S14-A Student's Oscillograph, 6 to 12 elements, ultra-simple, low in cost. (Bulletin SP183)

S15-A Portable Self-Powered, 6 elements, for use where very small size is essential and power is not available. (Bulletin SP193)

SC16-A Cathode Ray, 6 elements, very high frequency response and writing speed, record speed to 6000 inches per second. (Bulletin SP194)

RS9-A Automatic Oscillograph, 12 elements, for switchboard or portable use, for automatic recording of faults or staked system testing, high-speed starting. (Bulletin SP196)

Whatever your requirements may be there is a Hathaway oscillograph for you

Write for Technical Bulletin

Hathaway Instrument Company
1113 S. Clarkson Street, Denver 10, Colorado

October, 1948 — Electronics

shows the various uses for type 20 AP5 photoelectric counter designed particularly for case and bottle counting, textile and leather piece goods, as well as freshly painted and hot objects.

Electrosensitive Papers. Alfax Paper and Engineering Co., 40 Riverside Ave., Brockton, Mass. Papers for all kinds of recording devices that employ electrolytic papers are described in a mimeographed brochure that gives characteristics and prices.

Hardware and Parts. General Cement Mfg. Co., Rockford, Ill. A new 64-page catalog recently issued lists radio and electronic products, chemicals, hardware, kits, insulation, and other items of interest in the electronics field.

Meters. Millivac Instruments, PO Box 3027, New Haven, Conn. Type MV717A vacuum-tube millivoltmeter and type MV73A multipurpose vacuum tube meter are both pictured in brochures recently made available from the company.

Marking Machines. Adolph Gottscho, Inc., 1 Hudson St., New York 13, N. Y. An 8-page catalog describes 18 different marking and code-dating machines that are useful in packaging all types of electronic equipment.

Molded Cores. Lenkurt Electric Co., 1113 County Road, San Carlos, Calif. "Trancors by Lenkurt" is the title of a new 24-page folder describing a complete line of molded magnetic cores, core assemblies, coil assemblies, and filters.

Speaker Folder. Altec Lansing Corp., 250 West 57th St., New York 19, N. Y. A two color folder announces a new line of general purpose loudspeakers. Frequency response curves and methods of obtaining the curves are presented. Available cabinets are also illustrated.

Contactors. Ward Leonard Co., 31 South St., Mount Vernon, N. Y. For the bigger transmitters and heavy industrial control equipment engineers will want to see
For years, Watertown has been tackling jobs like this one for R-B-M Division of Essex Wire Corporation, Logansport, Indiana, and coming up with the right answer.

R-B-M needed molded plastic parts for two new devices recently announced — reversing and non-reversing industrial contactors. These contactors are used on hoists, overhead doors, machine tools and other industrial equipment where long dependable service is mandatory.

Melamine was selected for the job — it safely withstood all the elements of tropical warfare in vital aircraft engine parts, and its high arc resistant characteristic makes it ideally suited for electrical insulation.

Melamine, while more difficult to mold and machine than phenolic or cold molded insulation, is preferred as its slightly higher cost is more than offset by its superior insulating quality. Watertown engineering developed a method to mold these complex parts with all their slots, holes, recesses, studs, bosses and metal inserts at a reasonable price.

Experience since 1915 with every type of plastic and countless jobs involving compression, transfer or injection molding enable Watertown engineers to tackle just about anything involving plastics. Perhaps you have a problem, too.

THE WATERTOWN MANUFACTURING CO.
777 ECHO LAKE RD., WATERTOWN, CONN.

For years, Watertown has been tackling jobs like this one for R-B-M Division of Essex Wire Corporation, Logansport, Indiana, and coming up with the right answer.

R-B-M needed molded plastic parts for two new devices recently announced — reversing and non-reversing industrial contactors. These contactors are used on hoists, overhead doors, machine tools and other industrial equipment where long dependable service is mandatory.

Melamine was selected for the job — it safely withstood all the elements of tropical warfare in vital aircraft engine parts, and its high arc resistant characteristic makes it ideally suited for electrical insulation.

Melamine, while more difficult to mold and machine than phenolic or cold molded insulation, is preferred as its slightly higher cost is more than offset by its superior insulating quality. Watertown engineering developed a method to mold these complex parts with all their slots, holes, recesses, studs, bosses and metal inserts at a reasonable price.

Experience since 1915 with every type of plastic and countless jobs involving compression, transfer or injection molding enable Watertown engineers to tackle just about anything involving plastics. Perhaps you have a problem, too.

THE WATERTOWN MANUFACTURING CO.
777 ECHO LAKE RD., WATERTOWN, CONN.

For years, Watertown has been tackling jobs like this one for R-B-M Division of Essex Wire Corporation, Logansport, Indiana, and coming up with the right answer.

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THE WATERTOWN MANUFACTURING CO.
777 ECHO LAKE RD., WATERTOWN, CONN.
FOR FINER LATERAL REPRODUCTION
(and other benefits explained in Bulletin No. 3)
COLUMBIA BROADCASTING SYSTEM
and
AMERICAN BROADCASTING COMPANY
(as well as hundreds of independent stations)
have placed

GRAY TRANSCRIPTION ARMS and EQUALIZERS
on every transcription table

Ideal for the New Long Playing Micro-Groove Records
The Gray Transcription Arm gives you improved quality of reproduction, greatly extended life of stylus and recording, economical operation, as well as low first cost. Due to such features as adjustable stylus pressure, frictionless motion, self-leveling base and the accommodation of any standard cartridge, arm obsolescence is precluded.

The Gray 2601 4-position Equalizer for GE Cartridge, finest performance and workmanship, ideal response curves. Matches pickup to microphone channel.

Write for our Bulletin #5 on Selected GE Producers, with Diamond Stylus for almost unlimited life.

GRAY RESEARCH & DEVELOPMENT COMPANY, Inc.
16 ARBOR STREET
HARTFORD 1, CONN.

Keep high voltage off your test instruments!

use REINER
HIGH VOLTAGE MULTIPLIER LEADS
accurate within 2% before the wire lead of the cord is reached, leaving the tip of the lead relatively "cold". Supplied in standard scale ranges from 5,000 to 30,000 volts and in sensitivities of 5,000 to 25,000 ohms per volt. Write for price and application chart—bulletin #111.

REINER H. V. M. LEADS are available in the necessary ranges for all popular V. T. Voltimeters. Special ranges and sensitivities can be supplied on order. WRITE FOR BULLETIN #111.

Reiner ELECTRONICS CO., INC.
152 West 25th St., New York 1, N. Y.

SAFE... SIMPLE
HIGH VOLTAGE TV TESTS
TO 20,000 VOLT'S
WITH THE NEW
REINER OS SERIES TV
SUPER HIGH VOLTAGE SAFETY TEST PROBES

Now... the TV high voltage test problem solved with safety and operational confidence.

A super high voltage, custom-molded test probe, "Application Engineered" for the job... tested on the job... approved for the job.

Designed for SAFETY FIRST.

Rapid removal and interchange of the cartridge multiplier permits the TV probe to be used with more than one multi-range test set, via purchase of appropriate cartridge.*

Keep high voltage off your test instruments!

Series TV High Voltage Test Probes are now on display at leading radio parts distributors and are available as follows:

TVP—High Voltage Test Probes LESS multiplier cartridge. $12.35 Net
TV-1—Model TVP WITH Cartridge for Precision Series EV-10 VTVM. $13.48 Net
TV-2—Model TVP WITH Cartridge for Precision (or any) 20,000 ohms per volt test set with built-in 6000 V. D.C. range. $13.48 Net
*Stock and special value multiplier cartridges available to match popular high sensitivity test sets.

Series TV High Voltage Test Probes provide direct kilovoltmeter facilities with existing high sensitivity test sets, and VTVM's such as the "Precision" models described below: Write for illustrated 1948 catalog describing complete line of electronic test instruments.

MODEL 85—
Lab. Type 20,000 ohms per volt AC-DC test set. 34 rotary selective ranges to 6000 V., 60 Megs., 12 Amps., 70 DB., 1/2" meter. $38.75

MODEL 85B-L—
20,000 ohms per volt Multi-Master, AC-DC V-O-M. 34 push-button operated ranges to 6000 V., 60 Megs., 12 Amps., 70 DB., with large 7" meter. $46.95

MODEL EV-10-MCP—
Multi-range, zero-center VTVM plus AC-DC V-O-M facilities to 6000 V., 2000 Megs., 70 DB. With large 7" meter. $99.95

MODEL 10-S4-P—
Electronamic Tube Tester, and 20,000 ohms per volt AC-DC V-O-M. Ranges to 6000 V., 12 Amps., 60 Megs., 70 DB. 1/2" meter. $134.40

Export Division, 458 Broadway, New York City,
U. S. A. Cables, MORHANEX

October, 1948—ELECTRONICS
copies of bulletins 4452 and 4453 describing heavy-duty solenoid contactors.

High-Frequency Resistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Complete specifications and characteristics for type MP high-frequency resistors are given in a 4-page technical data bulletin F-1.

Motor Controls. Square D Co., 4041 N. Richards St., Milwaukee 12, Wis. New products and modified listings for holders of the Electric Motor Control catalog were issued as of July 28, 1948.

Crystals. Reeves-Hoffman Corp., 321 Cherry St., Carlisle, Pa. A catalog covers the complete line of quartz crystal units for calibration, mobile, aircraft, and commercial crystal applications. Bulletin RHC features a small universal holder for frequency coverage from 50 kc to 100 mc.

A-M Transmitters. Radio Corp. of America, Camden, N.J. A 24-page descriptive brochure provides comprehensive information on 5-kw and 10-kw a-m broadcast transmitters. It is profusely illustrated with schematic diagrams, specifications, layouts, and photographs. Write Department 516.

Capacitor, Tetrode, and Socket. Eitel-McCullough, Inc., San Bruno, Calif. Variable vacuum capacitors that can be mounted singly or in gangs, the type 4-400A r-f amplifier power tetrode, and the special air-system socket are all pictured in brochures available from the company.


Custom Build
Your Own
Terminal Blocks
with
CURTIS TYPE "M"
Build-Up
TERMINAL BLOCK
KITS

Curtis Type "M" Terminal Blocks are now available in convenient kits . . . with sufficient components to make up a number of custom or one-time blocks. Easy and quick . . . you can build blocks with an assortment of terminals from 2 to 12. Molded terminals provide ample insulation from metal base. Type "M" kits are the answer for engineering, research, maintenance and repair. Order your supply today!

Write for your copy of Bulletin DZ-122

Separate voltage supplies eliminated

Four commonly used voltages from a single compact unit! Separate voltage supplies, ordinarily derived from three or four cumbersome power units, now concentrated in one! That is what the Kepco Multiple Power Supply brings to busy engineers in the industrial laboratory, for greater convenience and speed in experiments and research work.

Any voltage you need is instantly available through the Kepco Multiple Power Supply—for heater, plate and grids—for studying the characteristics of vacuum and gas filled tubes. Contains:

Two continuously variable B supplies from 0 to 300 volts or currents up to 120 ma.
One continuously variable C supply from minus 50 to plus 50 volts at 5 ma.
One heater supply delivering 6.3 volts at 5 amperes.

The two B supplies originate from a common power transformer; the C supply originates from a separate power transformer and rectifying circuit. B supplies cannot be burned out even if terminals are shorted. Control circuit eliminates the use of heavy duty power potential dividers.

Complete voltage control from front panel, including power switch and pilot light indicating "Off" and "On." All voltages brought out to binding posts along lower edge of front panel.

Strong construction; all component parts of highest quality. Dimensions: Length 16"; height 8"; depth 8 3/4". Weight 28 lbs.

Complete details on request
Kepco Laboratories, Inc.
145-14 41st Avenue,
Flushing, N. Y.

Kepco ELECTRONIC INSTRUMENTS

Type "M" Blocks are designed with ample clearance and creepage distances for use in circuits carrying up to 300 volts, 15 amps.

KeepsType MULTIPLE SUPPLY

originates from a separate power transformer and rectifying circuit. B supplies cannot be burned out even if terminals are shorted. Control circuit eliminates the use of heavy duty power potential dividers.

Complete voltage control from front panel, including power switch and pilot light indicating "Off" and "On." All voltages brought out to binding posts along lower edge of front panel.

Strong construction; all component parts of highest quality. Dimensions: Length 16"; height 8"; depth 8 3/4". Weight 28 lbs.

Complete details on request
Kepco Laboratories, Inc.
145-14 41st Avenue,
Flushing, N. Y.

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.

Use Model AP-1 for analyzing . . .
• Harmonics • Intermodulation • Vibration • Noise • Acoustics • Materials

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.

Visit our Booth #7 National Electronics Conference

October, 1948 — ELECTRONICS
micro-miker are briefly listed on a specification sheet.

Components. Aircraft Radio Corp., Boonton, N. J. A series of bulletins made up in catalog form covering a wide variety of test equipment, microwave accessories and electronic component parts. Photographs and mechanical drawings are included.

Wire Catalog. Alpha Wire Corp., New York 13, N. Y. A complete line of wire and wire products for the radio, automotive and electrical industries is covered in the twelve-page catalog no. 48. Specifications for each type are given.

Coil Winding. Universal Winding Co., P.O. Box 1605, Providence 1, R. I. Information covering improvements in coil winding equipment and new ideas in the winding operation may be found in a series of single sheet publications.

Capacitor Information. Herlec Corporation, 422 North Fifth St., Milwaukee 3, Wisconsin, recently issued two new catalog sheets. One deals with types, physical dimensions and standard values of bypass and audio coupling capacitors together with diagrams of "Bulplates," incorporating several capacitors. The other gives a general description, specifications, and instructions for ordering metal cup capacitors.

Antennas. Tricraft Products Co., 1535 N. Ashland Ave., Chicago 22, Ill., presents in a 16-page booklet the electrical performance data on the models 300 and 400 all-wave television and f-m antennas. Two descriptive catalog leaflets are also included.

Machining Plastics. Monsanto Chemical Co., Springfield, Mass. Bulletin 52 tells how to do it if the cost of a polystyrene plastic article is below that warranting the use of an expensive mold.

Tube Applications. Radio Corp. of America, Harrison, N. J. Several new tube application notes numbered AN-134 through AN-137 have recently been issued dealing with adjustment of filament voltage.

SELECTION by TEST means FINER SPEAKERS for YOU

FROM the primary elements that enter into the assembly of a General Electric speaker, down to the completed unit, tests are made continuously to maintain quality standards.

Before it is shipped, every G-E speaker is given a final test—buzz, spurious response and acoustical characteristics are carefully checked.

Every speaker must meet that final test satisfactorily before it can be shipped. Such care in checking results in greater acceptance, customer satisfaction—and volume sales for you.

To all the outstanding features in G-E speakers add the one element that assures those features—for your benefit . . . for customer confidence . . . Tests.

Write today for all the information you require on G-E quality speakers—or enclose your order. General Electric Company, Electronics Park, Syracuse, New York.
Write today for Bulletin 408 containing complete information and specifications on the Type 410-A R-F Oscillator

NOTE THESE FEATURES

- 100 kc to 10 Mc
- High output—approximately 30 volts
- 50-60 Ω output impedance
- Internal modulation
- Output voltmeter
- Excellent stability
- Accurate, individually calibrated frequency scale.
- Expanded frequency scale.

NEW R-F OSCILLATOR

for general laboratory use and as a signal source for R-F bridges

ALTEC LANSING NOW "PACKAGES"
ALL COMPONENTS FOR A COMPLETE HIGH FIDELITY RADIO-PHONOGRAPHER SYSTEM TO BUILD INTO YOUR HOME

The Altec Lansing Custom-in-Built Music System consists of the famous Altec Lansing Duplex speaker, a special Altec Lansing amplifier, a newly designed TRF Altec Lansing AM-FM tuner, and the Webster 70 record changer with GE variable reluctance pick-up. Integrated with the structure of your room, this system transcends completely the inherent acoustical and electronic limitations of conventional radio-phonographs, eliminates radio "furniture," and reproduces the full range of sound (35 to 16,000 cycles). It achieves the highest faithfulness to living sound now known to science. Built-in Altec Lansing Daylight Television can also be included. Complete installation instructions come with each system.

A brochure will be sent on request.

ALTEC LANSING
custom-in-built home music system

Where SPACE and PERFORMANCE are Vital
DUMONT OFFERS

Proof of the pudding is in the eating.

TINYMITES are the largest selling miniature paper capacitors in the world.

- Good for 100°C
- Leads CANNOT pull out
- CAP. from .0001 to 2 MFD from 100 volts to 1000 volts.

Send for list and prices.

ALTEC LANSING CORPORATION
1058 MAIN STREET, WALTHAM 54, MASS.
Midwest Office: Alfred Crossley & Associates, 549 W. Randolph St., Chicago 6, Ill.

ALTEC LANSING ELECTRIC CORP.
MFR's OF CAPACITORS FOR EVERY REQUIREMENT
308 DYCKMAN ST., NEW YORK, N. Y.

October, 1948—ELECTRONICS
NEW PRODUCTS (continued)

of the 1B3 by observation of filament temperature, reduction in peak inverse voltage rating, overload protection for horizontal deflection circuits, and single-section filament operation of 3S4 and 3V4.

Marine Radiophones. Rex Bassett, Inc., Fort Lauderdale, Fla. A folder lists the various two-way marine radiotelephones for tug boats, fishing vessels, tankers and yachts.

Tubes. Radio Corp. of America, Harrison, N. J. Specification sheets on the type 812-A power triode, type 672-A thyratron, and the type 4X500A power tetrode are now in printed form.


Synthetic Elastics. E. I. duPont de Nemours and Co., Inc., Fairfield, Conn. Properties and uses of Fairprene, a synthetic elastic composition are described in a 12-page manual. Each of the three groups of Fairprene products is illustrated.

Air-spaced Cables. Transradio Ltd., 188A Cromwell Road, London SW7, England. Publication 27 lists new types of Co-Ax air-spaced articulated r-f cables. They can be used for flexible high-power transmission lines, very low-capacitance cables, and photocell leads.

Transformers. Electro Engineering Works, 6021 College Ave., Oakland 11, Calif. Using modern techniques, this company makes all types of radio, industrial, audio, and other transformers as

INSURE ACCURACY AND RELIABILITY IN Hipot INSULATION TESTERS

The "Hipot" Test Stick is used to test Bushings and Insulators on high voltage transmission lines from 11 to 230 KV. It consists of telescoping bake-lite stick sections each containing a series of S.S. White Resistors to step the voltages down to minute values for measurement.

The manufacturer, Canadian Line Materials, Ltd., Toronto, Canada says—"We have always found S.S. White Resistors of highest quality. They have characteristics which insure consistently accurate and dependable readings on the indicating instruments."

WRITE FOR BULLETIN 4505
It gives essential data about S.S. White Resistors including construction, characteristics, dimensions, etc. Copy with price list on request.

S.S.WHITEx INDUSTRIAL DIVISION

ELECTRONICS — October, 1948
Cyclohm 2500 Motors are designed with greater precision and compactness than any other motors of their type—and the result is greater output . . . perfect rigidity . . . quieter performance. Synchronous type for instruments, timing devices and facsimile operations . . . Non-Synchronous for general applications . . . Speed Reducer for work requiring slow speeds and high torques. Ball bearings or sleeve bearings.

300 IN. OZ. AT 1 RPM
with gear unit
Various speeds, voltages and frequencies available. Write for complete information.

CYCLOHM MOTOR CORP.
Division Howard Industries, Inc.
5-17 46th Road, Long Island City 1, N. Y.

Cyclohm
SYNCHRONOUS - NON-SYNCHRONOUS - SPEED REDUCER
MOTORS

HEAT RESISTANT WIRES FOR EVERY APPLICATION . . .

TOUGH and RUGGED

Do your new circuit designs call for heat resistance wire that's tough and rugged—wire that can take it day after day through countless hours of operation? Then check Lewis Asbestos Covered Wire before you specify. Regardless of what your wire problem is—dropping excessive voltages—filament dropping resistor in the line—high current conductors, it doesn't matter, just . . .

Let Lewis Build The Wire For You
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

If you need Radio Parts...

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 DOT Fasteners

October, 1948 — ELECTRONICS
well as magnets and saturable reactors, according to a catalog sheet just issued.

**Industrial Glass.** Kopp Glass, Inc., Swissvale, Pa. A new 24-page bulletin just printed in color describes glass products for industry, including some for the electronics field.

**Vibration Control.** Vibrashock Division of Robinson Aviation, Inc., Malcolm Ave., Teterboro, N. J., announces a new catalog, particularly for product design engineers, showing complete suspensions for the mounting of equipment in standard and special sizes. The many factors entering into vibration control are treated.

**Insulation Testing.** Associated Research, Inc., 231 S. Green St., Chicago 7, Ill. Bulletin 302 explains the applications and use of the model 404 Hypot, an instrument which independently tests breakdown, leakage, and shorting of insulation with the use of lights to discriminate between them. Range is from 0 to 4,000 volts.

**Plastics.** General Electric Co., Chemical Dept., Pittsfield, Mass. Bulletin CDP-578 is a 15-page illustrated description of molded and laminated plastics. Also discussed are sealing caps and sleeves, mycalex, silicone rubber, and h-f insulation. Property tables are included for reference.

**Permanent Magnets.** General Electric Co., Chemical Dept., Pittsfield, Mass. CDM-12 is an 16-page illustrated bulletin describing cast and sintered Alnico, Cunife, Cunico, Vectolite, Silmanal and various permanent magnet holding assemblies. Special alloys are also discussed.

**Interlock Switch.** Micro Switch, Freeport, Ill. Data sheet no. 45 describes the 1AC1 and 1AC2 interlock door switches designed for use on h-f radio, radar, x-ray and television equipment cabinets, induction heating equipment, and electronic controls of all types.


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**HARDWICK, HINDLE**

**Tubular Rheostats**

These fine sliding contact rheostats are widely used in laboratories. They serve as rheostats or potentiometers; portable, easily mounted, with fine gradations of adjustment.

These sturdy, improved tubular rheostats are used for accurate adjustment of voltage or current in meter-checking laboratories; as field rheostats for generator and motor control; as filament and plate control in radio and audio transmitting and amplifying apparatus; for control of illumination and heat control in electric furnaces and ovens; as well as in general laboratory use.

Available in 3 sizes: 200, 400 and 750 watts with any one of 3 types of control.

Hardwick, Hindle resistors and rheostats offer many exclusive advantages. We ask you to give our engineers an opportunity to discuss your specific requirements.

**HARDWICK, HINDLE, INC.**

**Rheostats and Resistors**

Subsidiary of

**THE NATIONAL LOCK WASHER COMPANY**

NEWARK 5, N. J. Established 1886 U. S. A.
The Advance Hermetically Sealed Relay

Hermetically sealed ADVANCE relays maintain their original efficiency under conditions that soon ruin or dangerously impair other types of relays. Dust, moisture, oil, or fungus cannot reach precisely adjusted parts. There can be no failure due to arcing, or condensation in the low atmospheric pressure of high altitudes. Important, too, is the fact that these relays are "Tamper-Proof"!

ANY Advance relay can be furnished in hermetically sealed containers on special order. Built to Army and Navy specifications upon request. Write today for further details and catalog of complete line.

ADVANCE ELECTRIC & RELAY CO.
1260 West 2nd Street, Los Angeles 26, Calif.

By a Wide Margin—the BEST!

The Fisher

NOISE SUPPRESSOR* AND AMPLIFIER

- For the ultimate in record reproduction without scratch, without rumble, coupled with an amplifier of professional quality, there can only be one choice—THE FISHER. Less than 1% distortion at 20 watts, 17 tubes, two-chassis construction, two gate indicators, high quality preamplifier for G.E. and similar pickups, three inputs, uniform response 20-20,000 cycles. Available for 10-day trial, if desired.

PRICE $254.50 • IMMEDIATE DELIVERY • WRITE FOR DETAILS

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MANUFACTURERS:
QUICKER!
MORE ACCURATE!

TELEVISION SET Alignment & Adjustment

TIC PRECISION GENERATORS

TYPE 2000
BAR & DOT GENERATOR
Efficient push-button unit for swift, precise adjustment of horizontal & vertical sweep linearity of television receivers. Used in conjunction with Standard Synchronizing Signal and Monoscope Generator or other pattern or picture signal generator. Requires only 5¾" of standard rack space. Five convenient push-buttons allow instantaneous selection of: + Standard blanking + Vertical bars only + Horizontal bars only + Vertical & horizontal bars + Complete dot pattern. Has phasing control for adjustment of vertical bar position. Power supply is self contained.

TYPE 1900
CRYSTAL CONTROLLED MULTI-FREQUENCY GENERATOR
A 10 frequency, 400 cps modulated crystal controlled oscillator, ideal for production line adjustment of stagger tuned I.F. amplifiers in television sets. Available with crystals ranging from 17 to 40 mc, provided to exact frequency and in sequence specified by customer. Each frequency is immediately selectable by means of a push button. Output adjustable. Power supply is self contained.

Write for bulletins 2000 & 1900

TEL Instrument Co., Inc.
50 PATERSON AVE.
East Rutherford, New Jersey
Rutherford 2-9720

October, 1948—ELECTRONICS
is a four-page folder devoted to the Electromatic low-capacity universal testing machine. The unit gives wide spread ranges of 250 to 1, extension ranges of 200 to 1 and straining ranges of 400 to 1. Complete specifications are listed.

Waterproof Connectors. Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif. A new 6-page bulletin W-248 gives dimensional data on the three sizes of type W waterproof connectors, together with photos of underwater geophysical applications. These plugs and receptacles are built to withstand pressures up to 250 pounds or approximately 550 ft underwater for all types of circuits in radio, sound, or power.

Electrical Connectors. Mines Equipment Co., Dept. 12, 4215 Clayton Ave., St. Louis 10, Mo. Bulletin MC108 illustrates and describes in detail a line of molded neoprene rubber electrical connectors and associated equipment. Products are identified by short three-letter symbols. Tabular index is included.

Cylindrical Capacitors. Cornell-Dubilier Electric Corp., South Plainfield, N. J. Descriptive bulletin NB-105 treats of the compact cylindrical-type capacitors, RC-111 and RC-112. Ratings are 0.005 µf at 6,000 volts d-c and 0.05 µf at 6,000 volts d-c, respectively. They are designed for safe operation from −55 to +100 C, are hermetically sealed, and Dykanol impregnated and filled.

Technician’s Catalog. Walter L. Schott Co., 9016 Santa Monica Blvd., Beverly Hills, Calif. The 1948 catalog lists and describes a complete line of hardware, chemicals, tools, finishing materials, and service items for the electronic technician. Prices are included.

Insulation Tester. Herman H. Sticht Co., Inc., 27 Park Place, New York, N. Y. Illustrations, general description, outstanding features and specifications of the Minor Megohmer insulation tester are found in bulletin 450. The portable instrument weighs three pounds. It has a d-c generator with a 500-volt d-c output, and measures up to 50 megohms.
Additions and Corrections

PRODUCT LISTINGS

The following listings are to be used in conjunction with the June 1948-1949 ELECTRONICS BUYERS' GUIDE for information on manufacturers' names, addresses and products omitted or incorrectly listed in that issue.

AMPLIFIERS—Audio Frequency
Allied Radio Corp., 853 W. Jackson Blvd., Chicago 7, Ill.
Planet Radio Mfg. Corp., 858 Euclid Ave., Cleveland 1, Ohio

AMPLIFIERS—Audio Input Systems
Allied Radio Corp., 853 W. Jackson Blvd., Chicago 7, Ill.

AMPLIFIERS—Decade
Keithly Instrument Co., 1595 Crawford Road, Cleveland 6, Ohio

AMPLIFIERS—Fascimile
Acme Teletronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

AMPLIFIERS—Peak Limiting
Acme Teletronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

AMPLIFIERS—Photocell
Acme Teletronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

AMPLIFIERS—Wideband
Tel-Instrument Company, Inc., 50 Patterson Ave., East Rutherford, N. J.

ANTENNAS—Television
Intra-Video Corp. of America, 831 Madison Ave., New York 21, N. Y.

ATTENUATORS

CAPACITORS—Oil Impregnated

CAPACITORS—Paper Tubular

CAPACITORS—Wax Impregnated

CHOKES—Filter
Empire Coil Co., Inc., 238 Huguenot St., New Rochelle, N. Y.

COIL ASSEMBLIES
Fugle-Miller Laboratories, 238 Main St., Metuchen, N. J.

COILS—Antenna
Fugle-Miller Laboratories, 238 Main St., Metuchen, N. J.

COILS—Choke
Empire Coil Co., Inc., 238 Huguenot St., New Rochelle, N. Y.
Fugle-Miller Laboratories, 238 Main St., Metuchen, N. J.

COILS—Magnet
Fugle-Miller Laboratories, 238 Main St., Metuchen, N. J.

COILS—Multiple Wound
Fugle-Miller Laboratories, 238 Main St., Metuchen, N. J.

COILS—Pickup
Fugle-Miller Laboratories, 238 Main St., Metuchen, N. J.

COILS—Power & r-f Coils & Windings
Fugle-Miller Laboratories, 238 Main St., Metuchen, N. J.

COILS—r-f & i-f Receiving & Transmitting
Fugle-Miller Laboratories, 238 Main St., Metuchen, N. J.

COILS—Relay & Solenoid
Fugle-Miller Laboratories, 238 Main St., Metuchen, N. J.

COILS—Television Focusing
Fugle-Miller Laboratories, 238 Main St., Metuchen, N. J.

COILS—Transformer Coils & Windings
Fugle-Miller Laboratories, 238 Main St., Metuchen, N. J.

COMMUNICATION SYSTEMS—Fascimile
Acme Teletronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

CONNECTORS—Cable Connectors & Couplings

CONTROLS—Alarma System
Photobell Company, 116 Nassau St., New York 1, N. Y.

CONTROLS—Counter
Photobell Company, 116 Nassau St., New York 1, N. Y.

CONTROLS—Fluid Conductivity
General Controls Co., Glendale, California

CONTROLS—Inspection
Photobell Company, 116 Nassau St., New York 1, N. Y.

CONTROLS—Photoelectric
Photobell Company, 116 Nassau St., New York 1, N. Y.

CONTROLS—Skew
Acme Teletronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio
(Continued on page 247)
For new simplicity, wide range, and high accuracy in the control of modern electronic circuits...

Provides many times greater resistance control in same panel space as conventional potentiometers!

If you are designing or manufacturing any type of precision electronic equipment be sure to investigate the greater convenience, utility, range and compactness that can be incorporated into your equipment by using the revolutionary HELIPOT for placement of potentiometer control applications...and by using the new DUODIAL turns-indicating knob described at right.

Briefly, here is the HELIPOT principle... whereas a conventional potentiometer consists of a single coil of resistance winding, the HELIPOT has a resistance element many times longer called helically into a case which requires no more panel space than the conventional unit. A simple, foolproof guide controls the slider contact so that it follows the helical path of the resistance winding from end to end as a single knob is rotated. Result... with no increase in panel space requirements, the HELIPOT gives you as much as 12 times the control surface. You get far greater accuracy, finer settings, increased range—with maximum compactness and operating simplicity!

COMPLETE RANGE OF TYPES AND SIZES

The HELIPOT is available in a complete range of types and sizes to meet a wide variety of control applications...

**MODEL A:** 5 watts, 10 turns, 45" slide wire length, 1½" case dia., resistances 10 to 50,000 ohms, 360° rotation.

**MODEL B:** 10 watts, 15 turns, 140" slide wire length, 3½" case dia., resistances 50 to 200,000 ohms, 5400° rotation.

**MODEL C:** 3 watts, 3 turns, 13½" slide wire length, 1½" case dia., resistances 5 to 15,000 ohms, 1080° rotation.

**MODEL D:** 15 watts, 25 turns, 234" slide wire length, 3½" case dia., resistances 100 to 500,000 ohms, 9000° rotation.

**MODEL E:** 20 watts, 40 turns, 373" slide wire length, 3½" case dia., resistances 150 to 500,000 ohms, 14,400° rotation.

Also, the HELIPOT is available in various special designs... with double shaft extensions, in multiple assemblies, integral dual units, etc.

Let us study your potentiometer problems and suggest how the HELIPOT can be used—possibly is already being used by others in your industry—to increase the accuracy, convenience and simplicity of modern electronic equipment. No obligation, of course. Write today outlining your problem.

*Data for Model A, 1½" dia. Helipot. Other models give even greater control range in 3" case diameters.*

The inner, or Primary dial of the DUODIAL shows exact angular position of shaft during each revolution. The outer, or Secondary dial shows number of complete revolutions made by the Primary dial.

A multi-turn rotational-indicating knob dial for use with the HELIPOT and other multiple turn devices.

The DUODIAL is a unique advancement in knob dial design. It consists essentially of a primary knob dial geared to a concentric turns-indicating secondary dial—and the entire unit is so compact it requires only a 2" diameter panel space!

The DUODIAL is so designed that—as the primary dial rotates through each complete revolution—the secondary dial moves one division on its scale. Thus, the secondary dial counts the number of complete revolutions made by the primary dial. When used with the HELIPOT, the DUODIAL registers both the angular position of the slider contact on any given helix as well as the particular helix on which the slider is positioned.

Besides its use on the HELIPOT, the DUODIAL is readily adaptable to other helically wound devices as well as to many conventional gear-driven controls where extra dial length is desired without wasting panel space. It is compact, simple and rugged. It contains only two moving parts, both made entirely of metal. It cannot be damaged through jamming of the driven unit, or by forcing beyond any mechanical stop. It is not subject to error from backlash of internal gears.

TWO SIZES—MANY RATIOS

The DUODIAL is now available in a 2" diameter model and soon will also be available in a new 4½" diameter model for main control applications. Standard turns-ratios include 10:1, 15:1, 25:1 and 40:1 (ratio between primary and secondary dials). Other ratios can be provided on special order. The 10:1 ratio DUODIAL can be readily employed with devices operating fewer than 10 revolutions and is recommended for the 3-turn HELIPOT. In all types, the primary dial and shaft operate with a 1:1 ratio, and all types mount directly on a ¼" round shaft.

Send for this HELIPOT AND DUODIAL CATALOG!

Contains complete data, construction details, etc., on the many sizes and types of HELIPOTS... and on the many unique features of the DUODIAL. Send for your free copy today!

**THE HELIPOT CORPORATION, SOUTH PASADENA 2, CALIFORNIA**

Due to circumstances beyond control the above advertisement did not appear in the 1948 Buyers' Guide issue of ELECTRONICS. You may wish to file this data with your Buyers Guide issue
PROBLEM: A group of physical chemists doing research in semi-conductor properties required a very low ripple compact adjustable power supply, capable of providing 0-30 KV DC.

MAJOR SPECIFICATIONS
Input: 115 volts, 50/60 cycles; 150 volt-amperes.
Output Voltage: Low range, 0-3 KV; High range, 3-30 KV Positive grounded.
Output Current: 75 µa available at 30 KV.
Ripple: Less than 0.01% at 50 µa and any voltage.
Size: 21" x 15" x 15".

Power supplies up to 200,000 volts DC, regulated or unregulated, built to specifications. Compactness, low cost and rapid delivery featured.

Submit your high voltage power supply requirements to us for a prompt bid on price and delivery.

OTHER BETA PRODUCTS INCLUDE:
KILOVOLTMETERS: Up to 50 KV at 50,000 volts per volt, 20 µa drain.
PORTABLE POWER SUPPLIES: Adjustable from 0 to 30 KV DC. Regulated and unregulated units available.
ELECTRONIC MICROAMMETERS: 0.01% full-scale to 100 µa full-scale in 3 decade ranges. Cannot be damaged by overload.
ELECTRONIC Rheostats: Resistance continuously variable from above 100,000 megohms to below 100,000 ohms. Good for voltages up to 15 KV.

Send for descriptive literature

Sales engineers throughout the country are at your service to discuss our products more thoroughly with you.

BAACH-INTERNATIONAL
EIGHT HEAD HOT-CUT FLARE MACHINE
Automatic throughout.
Can be synchronized with automatic stem machine.
Cuts off and flares in one operation.
Production 1250 flares per hour. For miniature flares, fluorescent starters, standard size lamps, fluorescent and radio tubes.
RANGE OF MACHINE
Glass tubing
Length of flares
Forms flares up to
Net weight
Gross weight
Dimensions
24"x24"x72" high

INTERNATIONAL MACHINE WORKS
Manufacturers of High Vacuum Pumps, Automatic Machinery for Incandescent Lamps, Electronic Tubes since 1916.
2027 - 46TH STREET
NORTH BERGEN, N. J., U. S. A.
Tel. Union 3-7412
Cable Address "International" North Bergen, N. J.

From every angle you'll find Essex Extra Test Magnet Wire a smooth product to use in your winding department. In the battle for profitable production it minimizes time lost because of hard and springy wire...tacky insulation film...poor size uniformity from spool-to-spool...and frequent tension adjustments. The chances are, Essex Extra Test Magnet Wire can prove its superiority for you.

ESSEX WIRE CORP.
FORT WAYNE 6, INDIANA
Plants: Asheville, N.C.; Detroit, Mich.; Fort Wayne, Ind. Warehouses and Sales Offices: *Atlanta, Ga.;* Boston, Mass.; *Chicago, Illinois; Cleveland, Ohio; Dallas, Texas; Dayton, Ohio; *Detroit, Mich.;* Kansas City, Mo.; *Los Angeles, Calif.;* Milwaukee, Wis.; *Newark, N.J.; Philadelphia, Pa.; Portland, Ore.; St. Louis, Missouri; San Diego, Calif.; San Francisco, California

ECLIPSE ANNOUNCES
A NEW LINE OF DELUXE DESK PANEL CABINET RACKS
• Available in six sizes from 8½" panel space to 35". All units 12" deep.
• Block or grey ripple finish, as specified.
• Rigidly constructed of 16 gauge steel.
• Panel mounting holes tapped 10-32 for either Western Electric or Amateur mounted panels.
• All doors provided with flush catches.

These cabinet racks are the newest product in a quality line of metal equipment. A partial list of products includes chassis, panels, cases, standard and deluxe cabinets, sloping front cabinets, amplifier foundations and standard and deluxe cabinet racks. Each item is made in a variety of stock sizes, and is adaptable to fit every requirement.

CATALOG SENT ON REQUEST
ECLIPSE MANUFACTURING CO., INC.
CABINETS • PANELS • CHASSIS
202 East 137th Street
New York 42, N. Y.
ADDITIONS AND CORRECTIONS (continued)

CONVERTERS—_f_m_
Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland, Ohio

FILTERS——Band Elimination
Filtron Co., The, 38-25 Bell Blvd., Bay-
side, Long Island, N. Y.

FILTERS——Band Pass
Filtron Co., The, 38-25 Bell Blvd., Bay-
side, Long Island, N. Y.

FILTERS——Electric Wave Section
Filtron Co., The, 38-25 Bell Blvd., Bay-
side, Long Island, N. Y.

FILTERS——Noise
Filtron Co., The, 38-25 Bell Blvd., Bay-
side, Long Island, N. Y.

FILTERS——uhf & vhf
Filtron Co., The, 38-25 Bell Blvd., Bay-
side, Long Island, N. Y.

FORKS——Electrically Driven Tuning
Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland, Ohio.

GALVANOMETERS
Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland, Ohio

GENERATORS, SIGNALS—_r_f_
Tel-Instrument Company, Inc., 60 Paterson Ave., East Rutherford, N. J.

GENERATORS, SIGNAL—Sweeping
Tel-Instrument Company, Inc., 60 Paterson Ave., East Rutherford, N. J.

GENERATORS, SIGNAL—Television Synchronizing
Tel-Instrument Company, Inc., 60 Paterson Ave., East Rutherford, N. J.

GENERATORS—Television Linearity Checking
Tel-Instrument Company, Inc., 60 Paterson Ave., East Rutherford, N. J.

HEARING AID CHOKES
Microtone Company, The, 4602 Nicollet Ave., Minneapolis 9, Minn.

HEARING AID TRANSFORMERS
Microtone Company, The, 4602 Nicollet Ave., Minneapolis 9, Minn.

HEARING AIDS
Microtone Company, The, 4602 Nicollet Ave., Minneapolis 9, Minn.

LOUDSPEAKERS
Best Manufacturing Co., Inc., 1200 Grove St., Irvington 11, N. J.

LUGS AND TERMINALS

METAL PARTS—Small Metal Stamp-

ings

METERS—Photoelectric Reflection
Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland, Ohio

MICROWAVE TRANSMISSION LINKS & MICROWAVE ACCESSORIES
Technicraft Laboratories, Inc., Box 1988, Waterbury, Conn.

W hen you invest in a Racon Horn or Speaker you get all-around super-efficiency—qualities that can not be duplicated by units of conventional type. Such units may resemble Racon units externally but only a Racon has the internal construction features that bring you top performance.

Racon superiority is the result of Advanced Engineering — improvements developed in the Racon Laboratories by Racon Engineers through tireless research and testing.

For unmatched performance, long life and economy install a Racon.

PERMANENT MAGNET HORN UNITS
These units, highly popular in all types of service, embody many improvements. Two groups, with Alnico V Magnets and Alnico Blue Dot Magnets. All steel parts plated to prevent corrosion. Also fitted with corrosion proof metal or plastic diaphragms. Voice coil impedance on all units: 15 ohms, except dwarf size—which is 8 ohms. Special ohmages on request.

NOW FURNISHED WITH WATERPROOF CASING
All units, from junior to giant size, may now be had with heavy spun aluminum case, forming a close fitting hermetically sealed, watertight housing for outdoor use. Waterproof type at slight extra cost.

Write for Catalog or Complete Racon Line
RACON ELECTRIC CO., INC.
52 E. 19th Street, New York, N. Y.
For Radioactivity Measurements!

- Direct Decimal Scale Registration
- Scaling Factors of 10, 100 and 1000
- Low Resolution Time — 5 Microseconds
- Self-Contained Mechanical Register
- Regulated High Voltage Power Supply
- Provision for Clock Time
- High Sensitivity — 0.25 Volt
- Stable, No Adjustments
- High Quality Construction

THE NEW POTTER DECADE SCALER
Model 2092—$495.00

For complete literature or consultation on high speed counting, timing and control problems call or write Department 6P, today.

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INCORPORATED
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ADVANCE — AMPHENOL — AEROVOX — ASTATIC
ALTEC-LANSING — BRUSH
B & W — BLILEY
BIRN BACH — BROWNING
BURGESS — CARDWELL-RAKE
CENTRALAB — CIN AUDAGRAPH — CORNELL-DUBLIER
EIMAC — ELECTROVOICE — GE — JFD — IRC — JENSEN
MALLORY — LITTLEFUSE — MEISSNER — MILLEN
MILLER — NATIONAL — OHMITE — RCA — SANGAMO
SHURE — UTAH — STEVENS — STANCO — WELLER
UNIVERSITY — SYLVANIA — THORDARSON — WEBSTER
PICKERING — ICA — PRECISION — UNITED ELECT.

CALL JACK KIRSCHBAUM AT DIGBY 9-4714

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INCORPORATED
82 CORTLANDT STREET, NEW YORK 7, N.Y.

Steps to Higher Production and Lower Cost

1. Consult the Milford free engineering service

2. Choose one of 15 basic Milford rivet setting machines — offering unlimited versatility.

3. Select exactly the right semi-tubular or split rivet or cold-headed fastener from Milford's complete line.

MALFORD RIV-IT & MACHINE COMPANY
1000 MERWIN ROAD, MILFORD, CONN.
1000 WEST RIVER ST., ELYRIA, OHIO

October, 1948 — ELECTRONICS
MEASUREMENTS—Fixed Frequency
Arkwright Co., Providence, R. I.

The Big Six Reasons Why
Arkwright Tracing Cloths Excel

1. Erasures re-ink without feathering.
2. Prints are always sharp and clean.
3. Tracings never discolor or go brittle.
4. No surface oils, soaps or waxes to dry out.
5. No pinholes or thick threads.
6. Mechanical processing creates permanent transparency.

If a drawing is worth keeping — it is worth making on dependable Arkwright Tracing Cloth. The trifling extra cost insures years of permanence — no chance of becoming dogeared and torn by use nor opaque and illegible by age, as perishable tracing paper is apt to do. Arkwright is woven, bonded and processed for enduring transparency. It is real economy — good business — to use Arkwright, always!

Send for generous working samples of Arkwright and judge its superiority over any substitute. Arkwright is sold by leading drawing material dealers everywhere. Arkwright Finishing Co., Providence, R. I.

American Radio History
PIPE COUPLINGS

ELECTRICALLY HEATED PRESSURE HEADS

CONTINUOUS FILM RECORDING CAMERAS

AND EQUIPMENT FOR CATHODE RAY OSCILLOGRAPHY, ETC.

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

MODEL 204A
REGULATED POWER SUPPLY

0-500 VOLTS D.C. AT 300 MA. WITH POSITIVE OR NEGATIVE GROUND

The Model 204A Regulated Power Supply will provide from 0-500 volts of well regulated and well filtered D.C. The output voltage is continuously variable without switching and either positive or negative side may be grounded.

SPECIFICATIONS:

OUTPUT VOLTAGE
Low A.C. Voltage: 6.3 Volts A.C. at 6 amps. center-tapped, unregulated

REGULATION
Within 1% for voltage between 0-500 volts, from no load to full load.
Within 1% for line voltage variations from 100 to 125 volts at full load current for any voltage between 30-500 volts and within 2% at 10 volts.

HUM VOLTAGE
Within 10 Millivolts at any voltage or load within ratings.

LINE INPUT
105-125 Volts A.C. 50-60 cycles.

OUTPUT TERMINATIONS
High and low voltage outputs available from front and rear of unit. Positive or negative terminal of high voltage output may be grounded as desired.

Detailed specifications will be forwarded upon request without obligation.

ELECTRONIC MEASUREMENTS COMPANY
RED BANK · NEW JERSEY

What are Your TRANSFORMER SPECIFICATIONS?

Would a slight change from the "standard" electrical specifications improve the performance of your finished product? If so, get in touch with Acme Electric engineers for assistance in designing a "special" transformer from standard parts.

For television, radio, and other electronic applications, Acme produces a wide variety of transformers all with different specifications from standard parts. This means better performance, better quality and often at economy prices.

ENCLOSED TYPES

The dies for making transformers that fit into this enclosed case, alone would cost you thousands of dollars. Acme produces to save you this expense.

Here is a typical air-cooled design which can be produced to meet a variety of applications. Write for Bulletin 168A for further details.

ACME ELECTRIC CORP.
3110 Water St. · Cuba, N. Y.

October, 1948 — ELECTRONICS
Joint Army-Navy R93 Specification

COMPARATIVE DATA

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JAN R93 and SHALLCROSS Akra-Ohm

Accurate Fixed Wire Wound RESISTOR TYPES

Write today for Shallcross Resistor Engineering Bulletin R giving full details on Akra-Ohm Resistors for every need and including mounting and terminal design; dimensions; power dissipation; resistance alloys; moisture and fungus-proofing and hermetic sealing data; temperature coefficient of resistance and maximum resistance charts.

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For all purposes

We are now ready to supply your needs
Your specifications for quotations will be
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EXCLUSIVE SPECIALTY

Since 1933 PYROFERRIC has been the
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quency, “Q”, resistance and physical
strength . . . to fit any circuit.

PYROFERRIC, with its background of re-
search and experience, will gladly consult
with you on your IRON CORE requirements.

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621 EAST 216 ST., NEW YORK 67, N. Y.

TO CHARGE MAGNETS!
ECONOMICALLY!
EFFICIENTLY!
QUICKLY!
SAFELY!

MORE AND MORE
COMPANIES ARE
ADOPTING THE
RFL MODEL 107
CHARGER

This portable, packaged unit
will charge all kinds and shapes
of magnets. Unique “flux-
guide” fixtures developed by
our engineers take full advan-
tage of the charging current
and accommodate multipole
and oddly shaped magnets.
The charger weighs 75 pounds,
can be moved about, and
saves much valuable space.
Plugging into any 110 volt AC
outlet, it is completely safe and
simple to operate for produc-
tion charging by unskilled per-
sonnel.
The descriptive folder, E-10,
gives complete information on
the charger, shows typical fix-
tures and lists some of the
many manufacturers, airlines,
repair services and laboratories
who use the Model 107. Write
for this folder today and feel
free to outline your magnet
charging problems without ob-
ligation.

RADIO FREQUENCY
LABORATORIES, INC.
Boonton, New Jersey

October, 1948 — ELECTRONICS
Pickering reproducers have always been built to the highest standards of the critical listener willing to pay a premium for excellence in record reproduction.

The growing demand for Pickering quality and the resulting increase in production have made possible substantial price reductions.

Revised manufacturing techniques have enabled us to actually improve quality and lower prices at the same time.

We take great pleasure in giving our customers the benefit of lower production costs.

**Model S-120M**
with .0027" Sapphire Stylus  
Former List Price—$25.00  
Now $16.50

**Model D-120M**
with .0025" Diamond Stylus  
Former List Price—$60.00  
Now $41.50

**NEW...** to the line of Pickering Cartridge Reproducers is the Model D-140S for the new long playing MICROGROOVE type disc recordings. The D-140S has a diamond stylus of .001" radius, tracks with a pressure of 5 grams and, like all Pickering Cartridges, incorporates all of the known requirements for perfect tracking, minimum record and stylus wear, and distortion-free reproduction.

**Model D-140S** with .001" Diamond Stylus  
$60.00 List

**Oceanside, Long Island, N.Y.**
ADDITIONS AND CORRECTIONS (continued)

Cathode Ray Tube Side Contacts
General Electric Co., Tube Div., Schenectady 5, N. Y.

Grids and Supports
General Electric Co., Tube Div., Schenectady 5, N. Y.

Heat Radiators
General Electric Co., Tube Div., Schenectady 5, N. Y.

Metal Supports
General Electric Co., Tube Div., Schenectady 5, N. Y.

Micro Supports
General Electric Co., Tube Div., Schenectady 5, N. Y.

Water Jackets
General Electric Co., Tube Div., Schenectady 5, N. Y.

Wire Ports
General Electric Co., Tube Div., Schenectady 5, N. Y.

TUBES—Phototubes and Photocells
American Scientific Co., P. O. Box 1, High Bridge Station, New York 24, N. Y.

WASHERS—Metal

WAYGUIDES—Flexible
Technicraft Laboratories, Inc., Box 1988, Waterbury, Conn.

WAYGUIDES—Rigid
Technicraft Laboratories, Inc., Box 1988, Waterbury, Conn.

WIRE—Fine Wire Specialties

NAMES and ADDRESSES

Acme Telechronix, Div. of NEA Service Inc., West Third and Lakeview, Cleveland 13, Ohio
Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.
American Scientific Co., P. O. Box 1, High Bridge Station, New York 24, N. Y.
DeJur-Ameco Corp., Northern Blvd. at 44th St., Long Island City, N. Y.
Electro-Nulco, Div. of Eastern Instruments, Inc., 1314 Avenue, Brooklyn 10, N. Y.
Electronic Instrument Co., Inc., 377 Blake Ave., Brooklyn, N. Y.
Futron Co., The, 38-25 Bell Blvd., Bayside, Long Island, N. Y.
Fugis-Miller Laboratories, 388 Main St., Metuchen, N. J.
General Electric Co., Tube Div., Schenectady 5, N. Y.
Intra-Video Corp. of America, 811 Madison Ave., New York 21, N. Y.
Kurman Electric Co., Inc., 35-18 37th St., Long Island City 1, N. Y.
Lewiston Company, 4020 Nicollet Ave., Minneapolis 9, Minn.
Motorola Inc., 3801 Euclid Ave., Cleveland 3, Ohio
Mystic Co., 3801 Euclid Ave., Cleveland 3, Ohio
National Tube Co., 116 W. Ruby Ave., Palisades Park, N. J.
New York Telephone Co., 30 E. 42nd St., New York 17, N. Y.
Planet Radio Mfg. Corp., 3808 Euclid Ave., Cleveland 3, Ohio
Shevers Inc., 46 W. 46th St., New York 19, N. Y.
Technicraft Laboratories, Inc., Box 1988, Waterbury, Conn.

Superior Tube Co.

ELECTRONICS DIVISION
2500 Germantown Avenue
Norristown, Pa.

Superior Tube Co. is a member of the West Corp. of Companies. Call PACIFIC TUBE COMPANY, 3170
Trade Mark, S. E. M. Trade Mark, S. E. M.
3170 South Los Angeles 22, Calif.

254

THE LATEST— Lockseam* RECTANGULAR NICKEL CATHODES

Here are the "new shapes", in which Superior Lockseam* nickel cathodes are
available. Full information on dimensions, tolerances and materials will be
supplied upon request.

Superior—The name in small parts (10 to 100) up to 10 l. d. w. g.

October, 1948 — ELECTRONICS

www.americanradiohistory.com
SYNCHRONIZING GENERATOR
Model PT 101—Television

FEATURES
• Built-in 3" oscilloscope with synchronized sweeps for viewing Timing and Video output pulse wave forms.
• Synchronous marker sweep for checking pulse width and rise time.
• Extreme stability, insured by deriving all pulses from the master oscillator tube.
• Means for checking synchronizing pulses in odd and even fields.

SPECIFICATIONS

TELEVISION MONOSCOPE SIGNAL SOURCE
Model PT 102
• Composite Video Signal
• Wide Band Video Amplifier, 6 DB down at 100K
• Dual outputs for feeding two 75 or 100 lines.
• Black positive or Black negative output.
• Resolution greater than 100 lines.

INPUT: Vertical and Horizontal blanking pulses, Camera and Kinescope Blanker Pulses.
OUTPUT: Composite Video Signal, 3 volts 100 ohm line 115 volts 60/60 cps. Complete with tubes and up- and high line and low voltage power units.

9 FERRY STREET
NEW YORK 7, N.Y.

FOR INSTRUMENTATION AND OTHER CRITICAL APPLICATIONS
IN-RES-CO wire wound resistors are engineered for the manufacturer maintaining a reputation of top quality and performance in his equipment. They cover a full range from 1 watt to 10 watts and .01 ohm to 1.5 megalohms. Conservative ratings assure maximum long life; trouble free service. Write for catalog today on company letterhead.

IN-RES-CO APPLICATION-DESIGNED RESISTORS
INSTRUMENT RESISTORS CO., 1056 COMMERCE AVE., UNION, N. J.
TROUBLE-FREE OPERATION

Specify

N•W•L
CUSTOM-BUILT
TRANSFORMERS

AND ELECTRICAL COILS

Over 25 years' experience in the manufacture of special transformers at cost that compares favorably with standard types. Built-in quality proved by years of actual use.

PROMPT DELIVERIES!

NOTHELFER
WINDING LABORATORIES
9 ALBERMARLE AVE., TRENTON 3, N. J.

IF IT'S ELECTRONIC . . .
B&W CAN MAKE IT FOR YOU!

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

Three B&W plants, comprising 150,000 square feet, completely equipped with a competent engineering staff, machine shops, tool room (including all machines for drilling, milling, turning, stamping and forming metals and plastics), and a complete woodworking shop are at your disposal. Your inquiries are welcome. Write Department EL-108 for prompt reply.

BARKER & WILLIAMSON, Inc.
237 FAIRFIELD Ave.
UPPER DARBY, PA.

ADDITIONS AND CORRECTIONS (continued)

Tele King Corp., 601 W. 26th St., New York 1, N. Y.
Tel-Meter Corp., 851 Madison Ave., New York 21, N. Y.
Te-I-Instrument Co., Inc., 50 Paterson Ave., East Rutherford, N. J.

TRADE NAMES
ADDITIONS and CORRECTIONS

AMERTRAN
American Transformer Co.

DURATIP
Weller Mfg. Co.

EMPIRE
Empire Coil Company, Inc.

FLEXITIP
Weller Mfg. Co.

INDUSTRIAL TELECKIVERS
Industrial Television, Inc.

KNIGHT
Allied Radio Corp.

MULTIVIDEO
Industrial Television, Inc.

SOLDERLITE
Weller Mfg. Co.

SPEED IRON
Weller Mfg. Co.

SYNCHRON
Hansen Mfg. Co., Inc.

TECH LAB
Tech Laboratories, Inc.

TELEPHOTO
Acme Teleonix, Div. of NEA Service, Inc.

Due to an error, the listings of the General Controls Co. of Glendale, California incorrectly referred to an advertisement on page 11 which was an advertisement of the General Control Company. 1204 Soldiers Field Road, Boston 34, Mass. There is no connection between the two companies.

Due to an error, the listings of the Northern Radio Co., 314 Bell St., Seattle 1, Wash. incorrectly referred to an advertisement on page 190 and 191 which was an advertisement of Northern Radio Co., Inc., 143-145 W. 22nd St., New York 11, N. Y. There is no connection between the two companies.

Electronic Controls Co. of New York advertisement incorrectly listed as Page 224 instead of Page 244.

Manufacturers of glass bonded mica were incorrectly listed, they should have only included the following:

Electronics Mechanics, Inc.
70 Clifton Blvd.,
Clifton, N. J.

General Electric Co.
Chemical Dept.,
Pittsburg, Mass.

Mycalox Corp. of America
80 Clifton Blvd.,
Clifton, N. J.
RAWSON METERS

Types:
- 501A
- 501C

Accuracy: 1/2 of 1%

MULTIMETERS and REGULAR METERS
AC and DC types, high accuracy, multiple ranges, 2 microamperes to 1 ampere DC, 2 milliamperes to 3 amperes AC.

ELECTROMETERS
Ranges 150-v. to 35,000-v. AC or DC. Resistance exceeds million megohms. Can measure static electricity.

FLUXMETERS
Laboratory and production measurements on magnets and magnetic circuits. Single push button return-to-zero.

WATTMETERS
High sensitivities, low power factors. New types soon to be announced.

RAWSON ELECTRICAL INSTRUMENT COMPANY
111 Potter St., Cambridge, Mass.
Representatives:
Chicago Los Angeles New York City

KOBZY Quality
GETS WIDE APPROVAL...

LAMINATIONS... HOUSINGS... CONTACTS... LUGS
MISCELLANEOUSE METAL STAMPING PARTS...

Here is the quality that comes from years of experience and modern facilities. We work very closely with our customers, designing to their specifications. Our mechanical engineering department is able to tool up for special parts. Put your needs up to us for entirely satisfactory results.

Send for your copy of our new catalog.

KOBZY TOOL COMPANY
1539 DAYTON ST. CHICAGO 22, ILL.

PROMPT DELIVERY!
Stainless Steel MACHINE SCREWS and Rivets

Screws, nuts, washers, pins — Allmetal carries the largest stock in the country of stainless steel fasteners and screw machine parts. Our complete facilities for heading, tapping, drilling, reaming, slotting, turning, stamping, broaching and centerless grinding make possible prompt delivery of specials, too. Write for our free 82-page catalog today.

We also carry:
- Cap Screws
- Nuts
- Taper Pins
- Bolts
- Socket Screws
- Cotter Pins
- Washers
- Wood Screws
- Pipe Fittings

Send for FREE CATALOG
Allmetal Screw Products Co., Inc.
33 Greene Street, New York 13, N. Y.

Now you can have
* DYNAMIC NOISE SUPPRESSION
with Your Present Radio-phonograph or Amplifier

These 3 simple steps add realism to your music reproduction.
1. Plug in the “Little Wonder” Dynamic Noise Suppressor between your pick-up and amplifier.
2. Plug in the socket adapter to the power-tube socket.
3. Insert the matched low-needle-talk pick-up in your pick-up arm.

That's all that is necessary to reduce background noise with negligible loss of depth and brilliance... giving you a gratifying sense of “presence” in your music reproduction.

LOW PRICE $82.50 list
Includes tubes, matched pick-up, remote control, cables, fittings, adapters, instructions.

*Licensed under U.S. and foreign patents pending and issued.

HERMON HOSMER SCOTT, INC.
“PACKAGED ENGINEERING”
385 PUTNAM AVE. • CAMBRIDGE 39, MASS.
Automatic Frequency Control

on DC to AC CONVERTERS

AVAILABLE IN 22 TYPES AND 3 FRAME SIZES BY

Gothard

DC to AC Rotary Converters having Automatic Frequency Control are now being offered in all models. Input voltages from 6 to 230 V DC; output: 110 to 1000 VA at 60 cycles, 90 to 800 VA at 50 cycles.

SPECIALY DESIGNED for Television Sets, AC Radios, Radio-Phonographs and Recorders. For use where the power source is direct current: such as ships, vehicles, trains, office buildings, and urban DC areas.

GOTHARD Manufacturing Co.
2114 Clear Lake Ave,
Springfield, Illinois

Export Division: 25 Warren St., New York 7, N. Y.

For Faster, Neater Equipment Marking, Use DECALS

Decimeter Decals provide the newest, most convenient and economical method for marking electronic equipment. They are easy to apply—no holes to drill—and they adhere to any surface, including wrinkle and crackle finishes. Decals often fit spaces too small for other types of marking. Decimeter Decals are inexpensive—a wide assortment can be stocked for low cost.

Decimeter Decals are printed in neat, opaque letters in a tough, clear protective coating of outstanding durability. They have a high degree of resillince to wear and abrasion. Over 275 different decals are available, including television titles, dial plates, radio titles, call letters and high-voltage signs for safety. Decimeter Decals are of the self-adhering “flip-off” type, and require no cement.

Speedy application plus the low cost of individual Decimeter Decals mean substantial savings in marking any type of electronic equipment. Write for folder 4B which lists complete line available and net prices. We will also enclose handy order form for your convenience in selecting your own assortment.

Australia’s Rural Radiophone

FIRST INSTALLATIONS are now being made in the Broken Hill district in New South Wales, of a radiophone set which will link Australian ranchers to the telephone network. The equipment was developed by the research laboratories of Electronics Industries Ltd., Melbourne, in cooperation with the Commonwealth Postmaster General’s Department.

The subscriber merely lifts a standard telephone handset from the instrument and depresses a key to connect him with the operator. Calls are accepted for any point in Australia and most overseas countries.

The base station transmitter is amplitude-modulated and has an output of 200 watts. It covers subscribers within a range of 200 miles. Subscriber sets are operated from a 12-volt storage battery and transmission is also by a-m.

Automatic Control Course

INSTRUMENTATION for the process industries will be the subject matter of a third short course to be conducted by Texas A & M College in cooperation with several industrial concerns at College Station, Texas, October 26-28. Manufacturers of instruments and automatic controls are participating by showing educational exhibits.

The program will be of special value to instrument, process design

(continued from page 138)
ULTRA SENSITIVE D.C. AMPLIFIER

An Electronic Replacement For Sensitive Galvanometer Systems

The Model 53 Breaker-type D.C. Amplifier was developed for the measurement of d.c. and low frequency a.c. voltage in the microvolt and fractional microvolt region. It is compact, portable, and makes an excellent replacement for the suspension galvanometer. The output of the amplifier is sufficient to operate standard meters and recording devices directly. It has been employed for the amplification of infra-red detectors, thermocouples, voltaic photocells, and the like, both in research and industrial applications.

Among the advantages of this amplifier are the following:
1. Noise level that approaches the theoretical limit imposed by Johnson noise.
2. Extremely low zero drift (less than .005 µV after warmup).
3. Freedom from the effects of vibration such as found in moving vehicles.
4. Response characteristics permitting overall amplification flat from 0 to 10 cycles per second.
5. Reliability, as demonstrated by units which have been in continuous operation for several years.

THE PERKIN-ELMER CORPORATION

A wealth of data to help you plan—design—construct MICROWAVE EQUIPMENT

HERE'S a goldmine of data that saves you time and effort—puts at your fingertips the specific material you want when you're planning, designing and constructing microwave equipment. This book is packed from cover to cover with authoritative reference data on coaxial lines and flexible cables—practical structures and components of wave guides—dielectric materials and their properties—cavity resonators, etc. ... all considered from the ultra-high-frequency point of view.

Just published!

MICROWAVE TRANSMISSION DESIGN DATA

By THEODORE MORENO, Project Engineer, Sperry Gyroscope Company; Research Associate, Massachusetts Institute of Technology. 250 pages, 202 illustrations; $4.00

This book brings you vital information to aid you in the engineering design of all kinds of microwave equipment. It discusses briefly transmission line theory—from the high frequency point of view—then brings you the practical working data you need on the job. Over two hundred diagrams—graphs—charts—tables etc. illustrate the text matter, making it clear and easy-to-follow. The material is concise—well-organized—usable ... the kind of information an engineer must have to design a transmission system employing microwave.

Read the chapter headings.
1. General Considerations for Microwave Transmission Lines
2. Attenuation, Impedance Matching, and Reflections on Transmission Lines
3. Impedance Relations on Transmission Lines
4. General Formulas for Coaxial Lines
5. Flexible Cables
6. Coaxial Line Structures and Transformers
7. General Formulas for Wave Guides
8. Attenuation in Wave Guides
9. Obstacles, Discontinuities, and Junctions
10. Microwave Waveguide Structures
11. Wave Guides Fitted with Dielectric Material
12. Dielectric Materials
13. Cavity Resonators

SEE IT 10 DAYS FREE • MAIL COUPON

MCGRAW-HILL BOOK COMPANY
1333 6th Street, N.Y.C. 18

Send me Moreno's MICROWAVE TRANSMISSION DESIGN DATA for 10 days' examination on approval; I promise to return book promptly. (Postage paid on each copy.)

Name:
Address:
City and State:
Company:
Position:

L-10-48

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and operating engineers. Lectures have been scheduled to cover such subjects as measurement and control of temperature, pressure, liquid level and time.

Registration fee is $5.00. Further information may be obtained by writing Professor P. G. Murdoch, Chemical Engineering Department, Texas A & M College, College Station, Texas.

Plan Radio Net for India
To RELIEVE the overburdened telegraph system in India, a radio communications network covering the ten leading cities is due to be set up shortly. Official estimates are that initial cost will be about $1,800,000 and annual recurring costs about $210,000.

Each of the ten cities will have a 10-kw high-speed short-wave transmitter and a triplex diversity receiver. Both will be teleprinter-equipped.

Radio License Increase
MORE THAN 635,000 separate radio authorizations, covering stations and operators, were outstanding with the FCC at the close of the fiscal year. This represents an increase of nearly 90,000 over the previous year. Breakdown is as follows:

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>As of June 30, 1947</th>
<th>As of June 30, 1948</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadcast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM</td>
<td>1,795</td>
<td>2,014</td>
</tr>
<tr>
<td>FM</td>
<td>918</td>
<td>1,050</td>
</tr>
<tr>
<td>TV</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>TV (experimental)</td>
<td>81</td>
<td>124</td>
</tr>
<tr>
<td>Educational</td>
<td>38</td>
<td>46</td>
</tr>
<tr>
<td>International</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>Remote Pickup</td>
<td>553</td>
<td>672</td>
</tr>
<tr>
<td>Other</td>
<td>33</td>
<td>26</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>3,551</td>
<td>3,967</td>
</tr>
<tr>
<td>Nonbroadcast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aeronautical</td>
<td>10,843</td>
<td>20,853</td>
</tr>
<tr>
<td>Marine</td>
<td>10,755</td>
<td>15,024</td>
</tr>
<tr>
<td>Public Safety</td>
<td>4,357</td>
<td>4,502</td>
</tr>
<tr>
<td>Land</td>
<td>3,792</td>
<td>3,132</td>
</tr>
<tr>
<td>Transportation</td>
<td>1,573</td>
<td>2,825</td>
</tr>
<tr>
<td>Industrial</td>
<td>1,019</td>
<td>1,648</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>76,000</td>
<td>74,434</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>115,137</td>
<td>126,844</td>
</tr>
</tbody>
</table>

**OPERTORS**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>As of June 30, 1947</th>
<th>As of June 30, 1948</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amateur</td>
<td>80,000</td>
<td>77,923</td>
</tr>
<tr>
<td>Commercial</td>
<td>235,000</td>
<td>245,000</td>
</tr>
<tr>
<td>Aircraft</td>
<td>25,000</td>
<td>70,524</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>305,000</td>
<td>303,447</td>
</tr>
</tbody>
</table>

* Estimated.

The station figures do not represent the actual number of transmis-
Proof of Performance...

The fact that over 50% of the purchasers of the Tektronix Type 511 Oscilloscope have re-ordered additional instruments after having placed a Type 511 in service provides positive evidence of the usefulness and value of this instrument.

The above category of Type 511 users includes the foremost Universities, Nuclear Physics groups, Industrial and Governmental research organizations throughout the country. A list of these in your vicinity will be provided upon request.

Type 511 Features

- Continuously variable sweep speed, 1/10 second to 1 microsecond (10 cm).
- Direct reading sweep speed indication.
- Sweep magnifier for any 20% of normal sweep.
- Triggered, recurrent or single sweeps.

Price $795.00 f.o.b. Portland

Your inquiry will bring more detailed information and name of the nearest Field Engineering Representative.

TELEVISION
HIGH VOLTAGE METER
0 to 30 KV

AN ABSOLUTE MUST FOR TELEVISION WORK

Meter Specifications

Voltage Range: 0.05 Kilovolt at 50,000 ohms per volt sensitivity. Sensitive to high voltage currents with very high inputs.

Paddle Switches: Terminals providing means of applying direct current from ground with maximum safety, which may be operated with out arcing while the voltage is being applied. OFF position of this switch holds the sensitive meter element for transporting.

Special Terminals: Provided for connecting to observe percentage of ripple, also wavefront and frequency of ripple while loading voltage. The result may be seen as either degree or percentage of ripple.

Message: A square wave 1" meter with an easy to read scale. Overall size of case: 7" wide, 10" long, 5" high. Net Price $149.95 in lot of 25. Please add $5.00 for freight (add $6.50 for freight in lot of 25).

RESEARCH & DEVELOPMENT ENGINEERS

PhD's, Master, Bachelors in Physics or E. E.

Long established electro-mechanical engineering organization is expanding its electronic department to include research and development on missiles, microwave systems, radar, communications, navigational devices, antennas, and associated equipment.

A few exceptional positions are open for top-flight sen/or engineers. Must have extensive experience on analysis of electronics systems, and ability to create new basic approaches to involved engineering problems. Commercial and university background desired. Please furnish complete resume, salary requirements and availability to: Personnel Manager.

Engineering Division

W. L. MAXSON CORPORATION

460 West 34th Street
New York 1, New York
NEW! FEATHER WEIGHT
SOLDERING IRON

AT LAST! An iron so light, so well balanced its weight is hardly noticeable. When you pick it up, when you work with it, you'll know why HEXACON calls it FEATHER WEIGHT. It's the perfect iron for long, delicate work where fatigue works against quality. It can work for you—improving and speeding production. More comfortable and practical than a pencil iron. No transformer required. Price only $5.00.

HEXACON ELECTRIC CO.
130 W. CLAY AVE., ROSELLE PARK, N. J.

HEXACON MODEL 30H. Weight 5½ oz. (less cord). 40, or 60 Watts. Both ½" and ¾" tips furnished. Ask for literature on complete line of screw tip, plug tip and hatchet irons.

U.H.F. STANDARD SIGNAL GENERATOR MODEL 84

SPECIFICATIONS
CARRIER FREQUENCY: 300 to 1000 megacycles.
OUTPUT VOLTAGE: 0.1 to 100,000 microvolts.
OUTPUT IMPEDANCE: 50 ohms.
MODULATION: SINENWAVE: 0 — 30%, 40%, 1000 or 2500 cycles. PULSE: Repetition—60 to 100,000 cycles. Width—1 to 50 microseconds. Delay—0 to 50 microseconds. Sync. input—amplifier and control. Sync. output—either polarity.
DIMENSIONS: Width 26", Height 12", Depth 10".
WEIGHT: 125 pounds including external line voltage regulator.

NEWS OF THE INDUSTRY

HYCROINER - MASS INSTRUMENTS, INC., New York City, has been organized for the development and manufacture of photoelectric colorimeters, photometers and related equipment in the electronic instrument and clinical fields.

MAYFLOWER ELECTRONIC DEVICES, INC., West New York, N. J., has formed a client research department to engage in research on dielectric heat and electronic sealing.

ELTRAN CORP., St. Anne, Illinois, has purchased the business of Radell Corp., Indianapolis, Indiana, to complete its line of loudspeakers.

CUTLER-HAMMER, INC., Milwaukee, Wisconsin, manufacturers of electrical apparatus, has acquired the business of the West Electric Products Co., Los Angeles, Calif.

COOK RESEARCH LABORATORIES, Chicago, Ill., has begun construction of a one-story addition to its present facilities. The new building will approximately double the floor space available for design, development, instrumentation and testing.

INTERNATIONAL TELEVISION CORP. recently purchased the Minerva Radio Corp. plant at 238 William Street, New York City. The additional 50,000 sq ft of space will facilitate full-scale production of a complete line of television receivers.

AMERICAN STANDARDS ASSOCIATION, INC., is the new name of the ASA New York City. The incorporation recognizes the enlarged activities...
producing

DI-FORMED PAPER TUBES

at no extra cost!

Precision DI-FORMED Paper Tubes have made a most important improvement throughout coil industry. Now ALL coil manufacturers and users can take advantage of the opportunity to obtain Precision DI-FORMED square and rectangular paper tubes for coil bases, at no extra cost!

Results: greater strength—automatic stacking—elimination of coil forming after winding—closer engineering of coils, saving wire. Precision characteristics, spiral winding, better insulation, space and weight saving are improved. Tubes also made round, oval, any shape.

Write for samples—also new Mandrel List. Many new sizes.

PRECISION PAPER TUBE CO.

2041 W. Charleston St.,
Chicago 47, Ill.
39 CHAPEL ST.,
HARTFORD, CONN.

The theory and application of electronics in industry

INDUSTRIAL ELECTRONICS REFERENCE BOOK

By Electronics Engineers of the Westinghouse Electric Corp.

This book was compiled to answer the need for complete and clear information on the application and design of industrial electronic equipment. Written by a group of engineers, each an expert in his particular branch of electronics, the Industrial Electronics Reference Book contains the most recent information on the subject. The material is directed at the practicing engineer. Its aim is to give him a better understanding of the scope and limitations of electronic apparatus as it is applied to industrial processes.

1948 680 Double-column Pages $7.50

ON APPROVAL COUPON

John Wiley & Sons, Inc.
680 Fourth Ave., New York 14, N. Y.

Please send me, on 10 days' approval, a copy of INDUSTRIAL ELECTRONICS REFERENCE BOOK. If I decide to keep the book, I will remit $7.50 plus postage; otherwise I will return the book postpaid.

Name
Address
City
State
Zone
Employed by

Offer not valid outside U. S.) K-10-44
**High Sensitivity . . . Logarithmic AC VOLTMETER**

**50 MICROVOLTS TO 500 Volts**

MODEL 47 VOLTMETER

Self-Contained ALL AC Operated UNIT

An extremely sensitive amplifier type instrument that serves simultaneously as a voltmeter and high gain amplifier.

- Accuracy ±2% from 15 cycles to 30 kc.
- ±2% from 30 kc. to 100 kc.
- Input impedance 1 meg. ohm plus 15 wat. shunt capacity.
- Amplifier Gain 40000

Also MODEL 45 WIDE BAND VOLTMETER .0005 to 500 Volts!

5 Cycles 1600 kc.

A few of the many uses:

- Output indicator for microphones of all types.
- Gain and frequency measurements for all types of audio equipment.
- Acceleration and other vibration measuring pickups.
- Sound level measurements.
- Logarithmic Sensitivity

Write for Complete Information

Instrument Electronics

41-17A Douglaston Parkway
DOUGLASTON, L. I., N. Y.

---

**Baer**

offers accurate fabrication of phenol and vulcanized fibre!

SEND BLUEPRINTS AND SPECIFICATIONS—NO OBLIGATION!

**N. S. BAER COMPANY**

MONTGOMERY ST., HILLSIDE, N. J.

---

**Baer** facilities are unexcelled for stamping, punching, drilling, tapping, shearing, milling, boring and sawing.

---

**NEWS OF THE INDUSTRY**

(continued)

and responsibilities of the organization.

**Pickard & Burns, Inc.**, consulting engineers, recently moved to new quarters at 240 Highland Ave., Needham, Mass.

**General Instrument Corp.**, radio and television components manufacturer, is now controlled by a group headed by C. Russell Feldman, founder of Transitone, and Richard E. Laux, formerly vice-president in charge of operations of Colonial Radio Corp., Buffalo, N.Y.

**General Electric Co.**, Electronics Park, now has a new division called the Industrial and Transmitting Tube Division. It will consolidate all sales, design engineering and manufacturing activities related to the former Power Electronics Division.

**Sperry Products, Inc.**, manufacturers of ultrasonic instruments and hydraulic remote controls, have moved from Hoboken, N. J., to new quarters in Danbury, Conn.

**General Electric X-ray Corp.**, Milwaukee, Wis., has furnished a two-million-volt x-ray machine for The Babcock & Wilcox Company to examine welds in high-pressure, high-temperature boiler drums 4½ to 64 inches thick. The machine’s exposure time for a 5½-inch plate is 6 minutes when using a film distance of 6 feet. It is the first of its size to be used exclusively for testing welds in pressure vessels. The special new 70 by 30-foot building in which the house will accommodate drums up to 13 ft in diameter and 70 ft long.

**Wheelco Instruments Co.** recently opened a new office at 138 East Becher St., Milwaukee 7, Wisconsin.

**PERSONNEL**

**Martin Kiebert, Jr.** recently joined Raymond Rosen & Co., Philadelphia, to take charge of the engineering, design and sale of all telemetering equipment.

**Elton W. Jones**, formerly assistant professor of electrical engineering...
Look to Illinois for a complete line of electrolytic capacitors for every electronic application. When you need a capacitor that has superior ability to withstand extreme temperature changes; that's manufactured to exacting specifications; that's time tested through 14 years of high quality production experience—you want an Illinois condenser!

Write for our latest catalog.

ILLINOIS CONDENSERS

BELONG
IN THE BEST
Electronic Sets

ILLINOIS CONDENSER CO.
1616 NORTH THROOP STREET  •  CHICAGO 22, ILL.

SMALL PARTS
Filaments, anodes, supports, springs, etc. for electronic tubes. Small wire and flat metal formed parts to your prints for your assemblies. Double pointed pins. Wire straightened and cut diameter up to 1/8-inch. Any length up to 12 feet.

LUXON fishing tackle accessories. Inquiries will receive prompt attention.

ART WIRE AND STAMPING CO.
227 High St. Newark 2, N. J.

CAPITOL RADIO ENGINEERING INSTITUTE
An Accredited Technical Institute
16th and Park Rd., N.W. Dept. E-10
Washington 10, D.C.

Advanced Home Study and Residence Courses in Practical Radio-Electronics and Television.
Approved for Veteran Training.

DUAL SPEED HYSTERESIS
Synchronous Motors

1/20 H.P., 1/60 H.P. M. Reversible Continuously
1/4 HP. 1/10 HP.

NO NOISE
NO VIBRATION
NO HUNT and "WOW" ELIMINATED
INDEPENDENT of LOAD INERTIA

Applications:
Disc, wire and film recorders
Sound cameras and projectors
Facsimile equipment
Timing devices
Stroboscopic work
Teletype equipment

We can furnish on quantity orders combinations of any two of the following speeds:
600 R.P.M.
900 R.P.M.
1200 R.P.M.
1800 R.P.M.
3600 R.P.M.

Instantly reversible with D.P.D.T. switch! H.P. ratings 1/150 to 1/30 depending on speed combination selected. Round Frame, Rigid Base.

The hysteresis design of these new Synchronous Motors lowers noise and vibration level to a fraction of that normally present in conventional salient pole construction. Unaffected by load inertia.

These Hysteresis Motors are now standard equipment on many high quality Recorders.

(capitalization and formatting corrected)

EASTERN AIR DEVICES, INC.
130 FLATBUSH AVENUE
BROOKLYN 17, NEW YORK

ELECTRONICS — October, 1948

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www.americanradiohistory.com
at Pennsylvania State College, was recently named associate professor at Illinois Institute of Technology.

R. Jack West, associated with Wired Radio of Canada Ltd. since 1935, was recently appointed vice-president of the company.

Charles A. Nuebling, formerly with Servo Corp. of America and Sperry Gyroscope Co., is now director of electronics for W. L. Maxson Corp., New York City, which recently expanded its engineering activities to include radar and associated high-frequency research and development.

George M. Lebedeff, quality control specialist and formerly chief engineer of Heintz & Kaufman Ltd., has joined Lenkurt Electric Co., San Carlos, Calif., as a carrier engineer.

Ladislaus Marton, chief of the electron physics section, National Bureau of Standards, has spent the summer in Europe surveying current work in the field of electron microscopy.


Harold W. Schaefer, until recently in charge of engineering development and research, has been appointed assistant manager of the Westinghouse Home Radio Division, Sunbury, Pa. During the war he was associated with the OSRD in charge of engineering manufacturing of the proximity fuze.

R. W. Ferrell, former counsel for General Electric's Electronics Department at Syracuse, N. Y., has been appointed assistant manager...
Focus attention at the point of sale with Central's custom-built "spot" merchandisers. These self-sufficient silent salesmen identify your product, create a desire for it, ... and sell! Any size, shape or style can be created for you by our master designing department ... creators of metal products and displays for top manufacturers for over 36 years.

Write today for descriptive folder.

CENTRAL
Sheet Metal Works, Inc.
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NEWS OF THE INDUSTRY

(continued)
of the receiver division at Electronics Park.

EDWIN F. STEVENS, formerly chief engineer of International Electronic Laboratories and Lon-Ga-Tone, Inc., is director of sales engineering and research of the newly formed client research department at Mayflower Electronic Devices, Inc., West New York, N. J.

HOBART C. MCDANIEL, formerly commercial engineer with Westinghouse Lamp Division in Bloomfield, N. J., has been appointed manager of the technical press service in the public relations department of Westinghouse Electric Corp., Pittsburgh, Pa.

A. A. EMLIN, formerly vice-president in charge of engineering at American Transformer Co. and then at Newark Transformer Co., has joined the engineering staff of the Peerless Electrical Products Division of Altec Lansing Corp., New York City.

A. A. Emlen
A. E. Cullum, Jr.

A. EARL CULLUM, JR. has been awarded the Presidential Certificate of Merit for meritorious service from August 1942 to February 1946 in his work in radio and radar countermeasures as associate director of the Radio Research Laboratory at Harvard University.

BENJAMIN A. FISHER, formerly professor of electrical engineering at the University of Denver, was recently appointed associate professor at Illinois Institute of Technology.

MAXWELL K. GOLDBEIN, associated with the Naval Research Laboratory since 1939, has been named to organize and direct the Programs Research Unit of the Research Group of the Office of Naval Research. He holds the Distinguished Civilian
REVOLUTIONARY New SOLDERING IRON

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www.americanradiohistory.com
Service award for his work on the radio direction finder and a commendation from the Chief of Naval Research for his contribution to navigation systems in all-weather flying.

CARL D. PIERSON, JR. has been appointed instructor in electrical engineering at Illinois Institute of Technology. From 1941 to 1948 he was senior engineer and division engineer of the Belmont Radio Corp. in research and development.

LEANDER W. MATSCH, former supervisor in electrical engineering research at the Armour Research Foundation, is the recently appointed professor of electrical engineering at Illinois Institute of Technology.

A. M. ZAREM, inventor of the Zarem camera used in the photographic microtime technique developed at the Navy Test Station in Pasadena, Calif., has been appointed chairman of physics research and manager of the new Los Angeles Division of the Stanford Research Institute.

RAY DAVIS KELL, director of television research at the RCA Laboratories, Princeton, N. J. was the 1948 recipient of the Stuart Ballantine Medal of the Franklin Institute for outstanding pioneer work in television and for his efforts in the development of color television.

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Features Five Connections
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Electronic metal-detecting wheelbarrow used by H. O. Stockwell for fragments of a meteor reported to have exploded in mid-air in Norton, Kansas
NEW BOOKS

Alternating-Current Circuit Theory


THIS FIRST VOLUME in Harper's new Electric Power Series is intended as a textbook for the third-year engineering course in a-c theory. Its content was developed over a ten-year period of alternate writing and classroom testing, to provide a basic text that would serve as a background for all the major fields of specialization in electrical engineering.

Topics covered include sine wave and vector representation of a-c, algebra of complex numbers, I, E, P and energy relations in R, C and L, solution of circuits, Fourier series, transients, mesh equations, network theorems, wye and delta connections, measurements, matrices, steady state operation of transmission lines, and electrical filters. Many problems are provided, including some that are intentionally made too long or too difficult for the usual homework assignment; these require extra time or extra help from the instructor.—J.M.

Elements of Electrical Engineering


The transition from abstract science courses to applied engineering courses is made less abrupt by this book. It contains a fusion of basic and applied material, presented to guide students in learning to approach concrete problems from their background of fundamental concepts.

The first two chapters concern electrical quantities and laws, and the second two concern conductors, insulators, and methods of measuring networks. Thus from chapter to chapter there is a progression from the abstract to the applied. Also within chapters the same development has been followed. The chapter on electromechanical action, for example, begins with con-
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NEW BOOKS (continued)

Considerations of ionic formation and concludes with the cause, effect, and cure of electrolytic corrosion of buried pipes; the bulk of the chapter is devoted to batteries.

This book is also indicative of the growing importance of electronics. The title and position of the author in his department are significant; also, in this book the bulk of which is devoted to electric machines the concluding chapter is on electronics for both communication and industrial applications.—F. H. R.

Books Received for Review

IONOSPHERIC RESEARCH AT WAT- ERLOO, OBSERVATORY. West- on, Australia, June 1948-June 1948. By L. V. Berkner and H. W. Wells, Carnegie Institution of Washington Publication 176, Washington, D. C., 1948, 420 pages, paper binding $5; in cloth $25. This is the main study of the results of studies together with brief description of equipment and methods used. A bibliography of publications on ionospheric research by authors in the Department of Terrestrial Magnetism is also furnished.

RADAR. By Orrin G. Dunlap, Jr., Harper & Brothers, New York, 1948 (revised), 258 pages, $5.00. A popular account of all types of radar equipment and the story of its development. The revised edition explores postwar advances and indicates the many peace-time uses of the technique.

TELEVISION . . . HOW IT WORKS. By John F. Rider and others. John F. Rider Publisher, Inc., New York 1948, 203 pages, $3.75. A paper bound volume printed on 8 1/2 x 11 in. stock. Elements of transmitting equipment are described in order to facilitate an explanation of the overall system. The bulk of the material covers different aspects of receiving equipment from the point of view of the service man.

ANTENNA MANUAL. By Woodrow Smith, Editors and Engineers, Ltd., Santa Barbara, Calif., 1948, 306 pages, $6.50. Written for the average radioamateur rather than the engineer, this book sums up the elements of propagation before launching into a nonmathematical description of manufacture of antennas and methods of feeding power to them. Waveguides and antennas for microwave are purposely omitted.

TELEVISION ENCYCLOPEDIA. By Stanley Kemper, Fairchild Pub. Co., N. Y., 415 pages, $6.50. Chronological history of television from 500 BC to 1947—17 pages; Biographical sketches of contributors to development of television—17 pages; Bibliography of technical and nontechnical term used—256 pages; Sylvia Sales market survey—17 pages; Broken down by field—17 pages.

BATTLEFRONTS OF INDUSTRY. By David G. Woodbury, John Wiley & Sons, Inc., New York, N. Y., 1949, 414 pages, $7.50. Role of Westinghouse in World War II, covering design and production of everything from electric torpedoes to the machinery for producing the atomic bomb, with anecdotes of problems encountered and solved in the labs, in the factories, and on the warfronts.


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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.

Wow

DEAR SIRS:

In the article “Wow Meter for Turntable Testing” in the March issue, Messrs. Sansbury and Pappenfus discuss the many sources of audible wow in phonograph record reproduction. While the elimination of wow in the mechanism used to drive records is important, it is far more important at this stage of development of the record art to give attention to the wow resulting from eccentricity in the centering of the record spindle hole with respect to the grooves, a fault given only passing mention in the article.

I am not sufficiently familiar with the production techniques of the industry to be able to say just why it is that so many commercial records are so noticeably defective in this respect, but there are few defects more in need of correction.

The authors set up a criterion of a permissible frequency variation of three tenths of one percent.

This means that at a radius of five inches on a record, the eccentricity of the spindle hole would have to be kept within about one sixty-fourth of an inch in order that there should be no perceptible wow. At smaller distances from the center the tolerance is proportionally reduced.

When one notes that eccentricities of as much as one thirty-second of an inch are common and even larger amounts not infrequent, it is readily understood that wow should be so often evident. It is my guess that by far the greatest amount of wow found in home reproduction and in broadcast records is due to this eccentricity.

I believe further that a great deal of poor reproduction not ordi-
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Back Talk

(continued)

narily attributed to wow should be so attributed. Wow is most evident when sustained musical notes are being reproduced. For music without sustained notes or for speech, the only audible effect for a nonexpert may be a sense of flatness or general displeasure.

For these reasons, and because it seems to me that there should be no great technical obstacles preventing it, the record manufacturers should make a determined effort to improve hole centering accuracy and should reject as defective any records not passing a reasonable specification for it.

T. H. PROJECTOR
National Bureau of Standards
Washington, D. C.

Citizens Transceivers

DEAR SIRS:

It has been called to my attention, relative to my article on Citizens Band Transceivers in August 1948 ELECTRONICS, that the BC-645, under conditions of extremes of temperature or humidity, variations of plate voltage or filament voltage, or age, may shift its transmitted frequency beyond the maximum specified for FCC Class B equipment. This has not been verified by the author, but any prospective users of this equipment should be warned that such shifts may exist.

It must be borne in mind, in fact, that the frequency-determining elements of the BC-645 transmitter are solid, tuned lines, not crystals, and that crystal stability cannot be expected of this equipment.

I do not believe that the statements in my article are erroneous, but no attempt was made to subject the equipment to a complete set of tests representative of those required for FCC type approval of commercial equipment.

WILLIAM B. LURIE
Bronxville, N. Y.

THE EDITORS are often called upon to forward mail to authors . . . a recent epistle turned out to be a wedding invitation from a reader, a high government official of a European country, who recognized the byline of his distant relative.
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**LARGEST STOCK OF TUBES IN THE COUNTRY**

**ALL BRAND NEW—STANDARD BRAND**

**MINIMUM ORDER $5.00**

**QUANTITY PRICES ON REQUEST**

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**N. Y. C.**

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RCA 630 T.S. POWER TRANSFORMER
This transformer designed for heavy duty television service. Primary 115 V., 60 cy.
Sec. 220-0-220/600 mv. @ 20 ma.
Sec. 325-0-325 mv. @ 10 ma.
Sec. 420-0-420 D.C. @ 6 ma.
List price $40.00. Your cost $17.95

PLATE TRANSFORMER
Primary 220 or 110 V., 50/60 Cy.
Sec. 2000 CT @ 1 amp. Used in a bridge circuit, this transformer will deliver 2000 V., DC @ 487 ma.

SILYN MO TO RS
CLOSE OUT SPECIAL
Synchronous Type
Pair in Series for 110 V., AC.
Type 15/64" long, 3/8" dia.-50 v. $9.95 pr.
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PLATE TRANSFORMER
Primary 220 or 110 V., 50/60 Cy.
Sec. 2000 CT @ 1 amp. Used in a bridge circuit, this transformer will deliver 2000 V., DC @ 487 ma.

No. T-4408 TRANSFORMER
Here is a rugged transformer built in army style and hermetically sealed with Franklin Terminals for easy soldering. Primary 115 V., 60 cycles.
Sec. No. 1 B.S. v. @ 56 ma.
Sec. No. 2 5.4 v. @ 56 ma.
Sec. No. 3 6.3 v. @ 4 a.
Weight 10 lbs.
Your cost $2.49

NO. T-4106 FILAMENT TRANSFORMER
HERMETICALLY SEALED 115V., 60 CYC.
PRIMARY
Sec. No. 1 6.3 V. @ 3 Amp.
Sec. No. 2 2.5 V. @ 2 Amps.
Western Electric D Spec 10/17 Inv.
ulated for high voltage reverse peaks—designed to light incandescent and 2x2 tube.
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FIELD STRENGTH METER
Frequency range 3.5 through 145 mc—panel switched (8 bands) complete with tube and telescopic ant. Will measure standing waves—quite sensitive at upper frequencies.

No. T-4848 TRANSFORMER
Here is a transformer versatile enough to run almost any piece of surplus or new equipment you—bimetal and D.C. voltages.
Sec. No. 1 225-0-225 mv. @ 10 ma.
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Sec. No. 3 13.8 v. @ 3 amp.
Sec. No. 4 5 1/2 V. @ 10 amps.
A real steal $7.95

CONDUCTOR 4 MID—1000 working volts—DC
3 1/2" wide x 4 1/2" high x 1 1/2" deep...

ANTENNA LEAD IN BOWLS
Made of genuine Pyrex—5" in diameter; brass rod with hardware and waterproof rubber gaskets.

SPEAKER 6" Speaker Complete with Output Transformer—1500 OHM Field—Complete with single output—5000 OHM for 6V, 43 etc.—a good buy @ each

No. T-3001 OVERCURRENT RELAY
Automatic reset—Over- loaded coil is 3000 ohms — Can be shifted for any current rating—Protect those expensive dual filament tubes, to button. Reset coil is 120 V., 50 cycles...

ARTIFICIAL DIY ANALOGS—SCHOOLS—AMATEURS
Let us quote on components and equipment that you require. We have too many items to be listed on this page. Please your name on our mailing list now for new catalog.

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ELECTRONICS — October, 1948

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PARABOLOIDS
Ideal for microwave experimental work.
Spun Magnesium dibes
Reinforced with Phenolic Resin
17½" Diameter x 4" Deep
Two sets mounting brackets on rear.
Open center hole 1½" x 1½"
Per Pair, Brand New .. $8.75

MERCURY CONTACT RELAY
Western Electric D-168479
For applications in all types of high speed switching devices. Long service life, high operating speeds, large current and voltage handling capacity, uniform and constant operating characteristics under adverse atmospheric conditions. Sealed mercury-wetted contacts in gas-filled glass envelope. Free from moisture, dirt, corrosion and atmospheric pressure. Single pole double throw contacts.
1000 hours life at 60 operations per second. Two coils at 700 shunts, and 2500 shunts. Operating current, coils series aiding—0.6 mils. Release current, coils series aiding—0.2 mils. Four page Technical Data on request.
Brand New in Original Cartons, $4.75

STEPDOWN TRANSFORMERS
Input: 220V, 20 AMP. 60 CYCLES
Output: 110V, 20 AMP. 60 CYCLES
All models designed to operate with standard 110V, 20 AMP. 60 CYCLES terminals. Ideal for laboratory and radio-frequency applications. Brand New...

SELENIUM RECTIFIER
Bridge Type
Input: 36 V. AC
Output: 28 V. DC, 1.1 Amps
Brand New $2.75

SO-1 Radar Antenna

RADAR ANTENNAS
Following types available, brand new in original export packing cases:
SO-1 (10 cm) ..................... $149.50
SO-3 (3 cm) ....................... $238.50
SO-10 (10 cm) .................. $129.00
TDY (10 cm) ...................... $85.00
ALL BRAND NEW EQUIPMENT

RADAR EQUIPMENT
Radar Repeater Adapters, Antenna Control units with PPI units, Transmitter-Receiver units, etc. for SO Radar.
All Brand New Equipment.
Complete Set SO-3 Taper Spares comprising a complete 3 CM Radar installation and large quantity of spares. Consists of 26 cases of equipment.
Brand New ........... $2,500.00
Spare parts for SG 1 Radar in stock

RADAR TUBES
4C35, 2J32, 3B34, 3C45, 7BP7, 9LP7, etc.

DYNAMOTORS—500 Watt Navy Type CAJO-211444
Input: 105-130 Volts D.C., 6 amps. Output 15 or 26 Volts D.C. (28 V. at 20 amps.) in series or 12 V. at 40 amps. in parallel. Designed for radio use, fully R.F. filtered, complete with separate Square D line switch box.
BRAND NEW $58.50

SYNCHROS
(Selens, Autosyns, etc.)
Navy types: 1F, 5B, 5CT, 5DG, 5G, 5F, 5SDG, 5SG, 5DF, 7G, etc.
Army types: 2FSF1, 2J5F1, 2J5F3, CAL 19300, C 78414, C 78863, C 78411, etc.

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Army types: 2FSF1, 2J5F1, 2J5F3, CAL 19300, C 78414, C 78863, C 78411, etc.

KOLLKSMAN COMPASSES
Type B-16 complete with spare pilot lamp...
BRAND NEW $9.75

METER SHUNTS
10 Amp. 50 Mv.
BRAND NEW $1.00
Raytheon RECTICHLGERS

Input: 115 VAC, 60-cy. 1 Ph.
Output: 48 V, DC at 3 amps regulated and adjsutable. Charges 23 to 24 cell battery or may be used direct as battery eliminator.

The Raytheon Recticharger is designed to supply current at a constant voltage to any load within its rating, and in addition to supply current to a storage battery connected across its load, of sufficient amount to maintain full charge. The function of the battery is to supply surge current due to sudden changes in load and to supply current above the rating of the Recticharger for temporary overload, and to act as a "stand-by" source of power in event of commercial power failure.

BRAND NEW

GE BATTERY CHARGER

Input: 115 V, 60-cy. 1 Ph.
Output: Charges 24 cell battery at from 1 to 10 amps rate.

Complete with spare fan and fuses. Brand new in original packing carton. Transformer operates from various supply voltages. Eight secondary taps for adjusting charging rate.

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All-prices quoted are for Tuckahoe, N. Y. About 20 miles N. of N. Y. C.

5 WAVERLY PLACE

PHONE—TUCKAHOE 3-0044

TUCKAHOE, 7, NEW YORK

Western Electric POTENTIOMETER

No. KS-18

The d-c potentiometer consists of a closed type die-cast aluminum alloy frame consisting of a continuous resistance winding in which electrical power is supplied through two fixed taps 190 degrees apart. Two rotating brushes 180 degrees apart and bearing on the resistance winding and two take-off brushes are provided for measuring the position. Varying the position of the brushes raises the output voltage in accordance with a definite ratio.

The potentiometer is wired for 24-volt direct current, is arranged for panel or standard mounting, is approximately 3-11/16 inches in diameter, 3 inches deep, 1/4 inches wide, and has an approximate weight of one pound. External connections are made through a standard A.S.A. connector.

Brand New

SOUND POWERED TELEPHONES

Type TF-3

For two-way signalling or intercommunication. No batteries needed. May be used on metallic or grounded signal circuits, by means of wires, cables or circuits using local-battery telephones, switchboards, two-way ring-down trunk circuits of common battery switchboards, etc. Connections are made with waterproof fabric cases with adjustable carrying straps.

Brand New

R. F. LINE FILTERS

Solar Eliminators

115 volt, 10 amperes

Brand new

ACME HI-VOLT TRANSFORMERS

Primary: 115 V, 60 cycles

Secondary: 600 V, C.T., 500 V.A.

Brand new in sealed cases

POTENTIOMETER

15,000 ohms, complete with engraved dial assembly.

Brand New

PHONE JACK ADAPTER P-106

Coax connector, bare end.

Price $1.35

SOUND POWERED TELEPHONE HANDSETS

W. E. Type TS-10M

Complete with 7 ft. cord

Brand New

10 CM WAVEGUIDE

Solid bronze, 90° elbow fiberglass bend.

Brand New

All merchandise guaranteed to be new, delivery subject to prior sale.

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MAGNETRON TO WAVEGUIDE coupling with 721-A grid, 500-Watt ratings, 7.50. 10 cm. END FIRE POLYROD. 1.75 ea.

MAGNETRON TO WAVEGUIDE 10 CM. CENTERLINE

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SEARCHLIGHT SECTIOND

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REGULATORS

SCR 610 portable transmitter -receiver, 27 to 38.9 mc,
crystal controlled, using FM for efficient operation.
Unit consists of Xmtr-rcvr BC 659 and power supply
PE 97
operating from 6 or 12 vdc. Slightly
used. excellent condition. Less xtals
$21.00
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PRECISION CAPACITORS

VOLTAGE

SCR 610 11-10 METER
PORTABLE/MOBILE XMTR-RCVR.

19/GT CONSOLE

Supervisors Panel. Includes jack
and key panels. relays, and line

terminating facilities. Originally
used to monitor and patch up
Unes in plotting shelter, and to
switch outside to lines. Used
with radar set AN/CPS-5. Dimensions: 60" H a 28" L x 18"
W. New, export packed.

Mfg. Raytheon: Navy
CRP -301407: Pri: 92138 v, 15 amps, 57 to
63 cÿ, 1 phase. See:
115 v, 7.15 amp. .82

KVA, .96 PF. Contains the following
components:
REGULATOR TRANSFORMER: Raytheon v.11M-9545.
Pri: 92-138 v. 60 cy, 1 PH. Sec: 200/580 5.5/5.26
emu*, 4000 v rms test.
FILTER REACTOR: .156 by, 5 amps, 4000 v test. Raytheon U% 9547.
amps;
6
TRANSFORMER:
et Wt. aPProx.
mps. Size: 12"x120" x 29".
250 Lbs.
with
Entire unit enclosed in grey metal cabinet $99.50
mounting racilities. New, as shown

POWER EQUIPMENT

volts a.c. 60
Step down transformer: Pri: 440/220/110
cycles. 3 EVA. Sec. 115 v. 2500 volt insulation. Sizeze

RADAR SETS

12" x 12" x 7"

IFF SET. Consists of BC 1267 xmtr-rcvr,
remote antenna controller and indicator I-221,
power supply RA 105-A. 1 kw. pulse oscillator
operates on 154-186 mc. Operates from 117 v.,
145

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Uses 61.446 as pulsed oscillator, 5" "A" scope.
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SE IO CM. SURFACE SEARCH RADAR W.B.,
20,000 to 80,000 yds. range. 250 KW. pk power
input to 706 magnetron. Thyratron modulator,
variable pulse rate. Complete set including spare
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price and additional information.
60

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Heavy duty rugged plywood. Crated in 3 sections with
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$40.00 per set
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Mal. Type G534C, 12 vdc, 5 pin
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.70
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2C22
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3C24
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306
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559
562
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7.00
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2.85
4.95
3.75
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3.50
12.00
8.00
39.50
50.00
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25.00
3.60
.69
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1.75
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BIRTCHER TUBE CLAMPS
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ohms.
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$4,50
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hy, 200 ma 5 .75
.01 hy, 2.5 amp..5 1.50
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$ 2.45
17 ma
.35 hy, .35 amp..5 7.50

20,000 ohms, 10%. 8 watt
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Dual 250 ohms, 25 watt
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511.2
5130
6AC7
6AK5
6C4

6G
616
6K7
6L6GA
6SC7
6SL7
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703-A....
704-A....
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Complete Line of D.C. Relays in Stock
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cycle. Max. output: 11'
All unliv, 100 amp.
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1.75 amp. 3 KV ins: 5 v, 3 amp; 8.5 v, 8.5 amp:
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6.5 v. 1.2 amp
352.7096: Prl: 115/80 v, 400-2400 cy. Sec: 2.5 v,
1.75 amp. 3 KV ins; 5 v, 3 amp; 6.5 v, 6.5 amp:
$3.95
6.5 v, 1.2 amp
$5.95
177 ma, 1710 vet, 177 nia
D-166333: Í'ri: 115 0, 400-2400 cy. Sec: 6.3 v, 0.9
$2.79
amp, 7.7 y, 0.385 amp
GE # 7471957: Pri: 100/110/120/130 v, 400-2400 co.
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See:
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Pri:
115
v,
#12033,
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250 ma
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6
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Input

Output

Type
Volts Amps
BD 77KM 14
40

Volts Amps

PE 73
DM 21
DM 21CX
DM 25
DM 28R
DM 33
DM 42

28

28
14

46

1000 .350
235 .090
235 .090
250 .050
275 .070
540 .250
515 .110
1030 .050

PE 55
PE 86
PE 101

12

25

14

28
12

28

19

3.3
1.6
2.3
1.25
7

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1000

2/8
28
C

13/26

500 .400
250 .060
400 .135
800 .020
6.3
9 AC 1.12
3.25 375 .150
1.75 285 .075
1.2
250 .060
4/2
500 .050
275 .110
9.4
500 .050

1.25

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5 amp.
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range of 200 to 600 yds. and free. range of 16 to
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35L6
35Z5
.66
45 (Spec).
.59
501.6..... .79
39/44.... .49
35/51.... .72
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3.85
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2 to 100,000 microvolts output, continuously variable.—Operates on 115 V, 60 cycle AC—push button selector for 18 frequencies from 450 K.C. to 22 M.C.,...with or without 400 cycle 30-20-1 cycle, is...frequency may be varied ±10% by screwdriver adjustment.

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Type PX-12-7 M.A. mov...a volt internal coil which can be easily re...ammeters & voltmeters with leather case & canvas carrying strap.

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2x 25mfd. 600v 3.75 25mfd. 2000v 4.75
2x 33mfd. 600v 4.00 33mfd. 2000v 4.95
2x 50mfd. 600v 4.50 50mfd. 2000v 5.25
2x 100mfd. 600v 5.00 100mfd. 2000v 5.75
2x 150mfd. 600v 5.50 150mfd. 2000v 6.25
2x 200mfd. 600v 6.00 200mfd. 2000v 6.75
2x 250mfd. 600v 6.50 250mfd. 2000v 7.25
2x 300mfd. 600v 7.00 300mfd. 2000v 7.75
2x 400mfd. 600v 8.00 400mfd. 2000v 9.00
2x 500mfd. 600v 9.00 500mfd. 2000v 9.75
2x 600mfd. 600v 10.00 600mfd. 2000v 10.75
2x 800mfd. 600v 12.00 800mfd. 2000v 12.75

ARMY PARTS SALVAGE SCOOP
NET $2.95. TWO FOR $5.00
Army PE-157 Vibrator-type power supply, 2 volt.
6 volt type. Chock full of transformers, resis-
tors, condensers, tubes, etc. One relay, which
is a 10,000 plate type, is worth more than the
sole price of another handy dual section
seleum rectifier rated at 1/3 amps. Has a handy
handle-engaged lid metal case. 8x6x13. A red hot value priced less vibrators
and speaker.

All Prices Subject To Change Without Notice
All merchandise guaranteed. Mail orders promptly
filled. All prices F.O.B. New York City. Send
money orders or postage stamps to cover C.O.D.
Minimum order $5.00. 20% Deposit re-
quired with all orders.

RADIO HAM SHACK Inc.
63 DEY STREET • NEW YORK 7, N.Y.
ELECTRONICS — October, 1948

www.americanradiohistory.com
1.5 KV PLATE TRANSFORMER
1800-0-1800 volts at 1.5 amps. Tapped at 1750 and 1250. Prr. 110/220 volts 60 cycle input. Core of separate windings. Built to rigid standards by Amertron. Suitable for radios, transmitters, induction heating, etc.

50 MICRO AMP METER
This is the exact meter used in the G.E. model YMW-1A Lab-Type Unimeter.
- 50 Microamp Measurement ± 2%
- 2500 Ohms Resistance ± 2%
- Knife Edge pointer
- Uncrowded Multi-Range Scale
- 4 x 4½" Bakelite Case
- 50 Microamp scale available at 25¢ additional

AN/APT-2 AIRCRAFT RADAR JAMMER
425-750 mcs. Contains 10 tubes: 1X37(2)-709(2)-709(2)-709(2)-709(2)-709(2)-709(2)-709(2)-709(2)-709(2)-709(2).
SILRY (13-262-133-262)-133A-133A-133A-133A-133A-133A-133A-133A-133A-133A-133A. Comes in black and 400 cycle swr supply complete with all tubes etc. BRAND NEW...$19.95 each

MEGOMH METER
Industrial Instruments Model L2A1-110/220 volts 60 cycle input. Direct reading from 0-100000 megohms on 4" meter. Can be extended to 500000 megohms with external parasitic. Sloping hardwax cable. Need 10x5"x19". Brand new with tubes plus running spare parts including meter tubes.

SPERTI RF VACUUM SWITCH
20 watts max. 5amps. Used at antenna switch in Collins model. 400-1000 mc.

CHOK BARGAINS
WE, 4.3 by 0.22 65 ohm. $1.45
N.Y. 5 henry 20 m. 100 ohm. D.C. $1.35
RCA, 50 henry, 650 m. high voltage. 19.00

POWER PLANT (PE 197)
4-cylinder HerculesGas engine. Runs on 110 volts 60 cycle, voltage regulated, 50W-0.3KA. At 850. Par. Par. Single phase, complete with running spare parts, meter panel, battery, tools, remote cables, etc. Weight 1250 lbs. Expert Packed. Excellent for emergency power. Brand new...$725.00

Scope Transformer hermetically sealed 1800 volts, 4 ma, 6.3 volts, 9 amp. 21 volts, 2.5 amps, 5 x 3½ x 3½...$5.95

Precision 15 Mcg. 1% Accuracy Resistor. Marconi, 1500 ohm, 1% tolerance given in glass. 39¢ each. For 10 $3.50

OIL CONDENSERS
1 mfd 230 vac...$1.10
3 mfd 230 vac...$1.45
5 mfd 230 vac...$2.90
7 mfd 230 vac...$3.40
10 mfd 230 vac...$4.95
15 mfd 230 vac...$8.25
20 mfd 230 vac...$11.90
30 mfd 230 vac...$15.50
40 mfd 230 vac...$18.25
50 mfd 230 vac...$21.00
70 mfd 230 vac...$27.50
100 mfd 230 vac...$30.00

VERISCAN POWER
These transformers have many uses—filtering, isolation, etc. All have 2 separate primaries for 110/220 volt 25-60 cycle operation. Primaries can be used in series or in parallel. 3 Choices of Core sizes:
- Type R 115 volts 500 millas and 6.3 volts 5 mfd
- Type S 115 volts 500 millas and 6.3 volts 5 mfd
- Type T 115 volts 500 millas and 6.3 volts 5 mfd

MIDGET VARIABLE BARGAINS
Hammarl. MC-3205 250 mfd...$60
Hammarl. MC-3020 250 mfd...$60
Hammarl. APC-100 250 mfd...$60
Bud MC-913 35 mfd...$1.25
Hammarl. RF 15 15 mfd...$1.25
National TMS-150 mfd...$0.75


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NEW GUARANTEED SURPLUS

AIRCRAFT AMPLIDYNES

G.E.

5AM31NJ-18A. Input 27 V.D.C. @ 44 amp. Output 60 V.D.C. @ 8.3 amp. max 120 watts. Stock #SA-111. Price $14.50 ea.


Servo Motor

Pioneer Type CK-2. 2 phase 460 cycle. Fixed phase 24 V. var. phase. 49 V. max. 1.05 oz/in. stall torque. Stock #SA-97. Price $1.75 ea. net.

RATE GENERATORS

Elinco PM-2

2.0 v. DC per 100 rpm. Use to 1000 rpm. Stock #SA-63. Price $7.50 ea.

Elinco F-16. 2 Phase AC. 1.7 V AC per 100 rpm. 40 cycle output at 1800 rpm. Stock #SA-193. Price $12.50 ea.

SPERRY PHASE ADAPTOR — 601102

115 volts 400 cy. Used for operating 3 phase equipment from single phase source. Stock #SA-194. Price $.75 each.

Delco PM Motor — 5068571

Alnico field. 27 v. DC. 10,000 rpm. 1" x 1" x 2" dia. 0.125 diam. shaft. 21/32" lg. Stock #SA-151. Price $.75 each.

400 CYCLE WESTINGHOUSE FL BLOWER

115 v. 400 cy. 17 c.f.m. Includes capacitor. Stock #SA-144. Price $.75 each.

SWEEP GENERATOR CAPACITOR

Hi-speed bearings. Split stator. Silver plated coaxial type. 5-10 mm. Stock #SA-167. Price $.75 each.

TWX Pat-199.

Write for complete listing, or call ARMory 4-3366

4 Godwin Ave.

DYNAMOTORS

D-191. 27 v. DC In @ 1.5 amps. DC output 286 v. 869 amps. Stock #23-1. 115 v. DC In @ 3.4 amps. Stock #SA-188. Price $5.35 each.

MICROWAVE ANTENNA

AS-211A/APG 15k. 12 cm dipole and 12 in. Parabola housed in weatherproof 6s-cm 16" diam. 24 V. DC. D-c motor forennie scan. Stock #SA-95. Shipping wt. 70 lbs.

Remote Position Indicating System

Price $9.50 ea.

SELSYN SPECIAL

W.E. KS-5960-13

Size 5. 115 v. 400 cycles. Use for reduced 60 cycles. Stock #SA-182. Price $3.75 each.

Blower Assembly

MX-215/APG

John Oster C-2P-1L

28 V. DC. 7000 RPM 1/100 H.P. 22 L. H. Blower.

Stock #SA-202. Price $3.75 each.

G.E. 10 rpm dc Motor 5BA10F112

Output 40 lb. in at 10 rpm. 24 V. 1.15 A. Series-wound. 2 wire reversible.

Ideal for relay servo-systems. Stock #SA-114. Price $8.75 each.

Phase Shift Capacitor—4 stator single rotor 9-360° phase shift. (Use in complex wave synthesis.) Stock #SA-114.

Price $.75 ea.

400 Cycle Inverters

Pioneer—12116-2-A, 12123-3-A.

Holtzer Cabet—MG-169P, MG-149H.

General Electric—JS7211T, JS5131J-1A.

Leland—15943 and PE-218.

INVERTER—Wincheburg PUT/AF-Invert 28 v. DC at 100 amperes. Output 115 v. 600 cy. @ 2500 V.N. Voltage and frequency regulated. Cont. duty. Wt. 75 lbs. Stock #SA-164.

800 Cycle Inverter

Navy Type CBV-21AAR. GE. SAS121J1S. 27 v. DC Input @ 45 amps. 120 v. 600 cy. output at 1750 V.A. 1/2 hp. Wt. 25 lbs. Stock #SA-192. Price $20.50 each.

LP-21-LM Compass Loops

New

Original Cartons

Stock #SA-99.

Price $.95 each.

110 RPM MOTOR

G.E. SB10M18D. 27 V. @ 8.7 amps. 1 oz/in. tors. 17/64" diam. x 3/16" lg. Operates on AC or DC. Stock #SA-99.

Include 154 for F.P. and handling

Price $2.95 ea. net.

Open account shipments to rated concerns.

All prices F.O.B. Paterson, N.J.

Paterson, N. J.

SEROVETEK

PRODUCTS CO.

Incorporated

Surplus Division

www.americanradiohistory.com
### RELIANCE

**HAS WHAT YOU WANT TOO — IN ELECTRONIC SPECIALS**

**OIL FILLED CAPACITORS**

<table>
<thead>
<tr>
<th>Value</th>
<th>Stock No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 mfd 250,000 V, D.C.</td>
<td>$1.45</td>
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<tr>
<td>2 mfd 750 V, A.C.</td>
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<td>3 mfd 100,000 V, A.C.</td>
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<tr>
<td>4 mfd 6000 V, D.C.</td>
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<tr>
<td>4 mfd 3000 V, D.C.</td>
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<tr>
<td>4 mfd 1000 V, D.C.</td>
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<tr>
<td>4 mfd 600 V, D.C.</td>
<td>$0.45</td>
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<tr>
<td>4 mfd 200 V, D.C.</td>
<td>$0.45</td>
<td></td>
</tr>
</tbody>
</table>

**FILAMENT TRANSFORMER**

**WESTINGHOUSE #6D4298**

Tested at 40,000 volts
Prc. 115 V, 6.3 Amp. **Only $8.50**

**RELIANCE**

**Merchandising Company**

**Arch St. Cor. Croxey, Philadelphia 3, Pa.**

**MINIMUM $5 ORDER**

**Telephone** Rittenhouse 6-4927

---

**PORTAGE MICAS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Stock No.</th>
<th>Price</th>
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<td>5MFM</td>
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<td>300000</td>
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<tr>
<td>7MFM</td>
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<tr>
<td>9MFM</td>
<td>10000</td>
<td>$0.01</td>
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<td>11MFM</td>
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<td>12MFM</td>
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<td>15MFM</td>
<td>2000</td>
<td>$0.03</td>
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<tr>
<td>18MFM</td>
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<td>20MFM</td>
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<tr>
<td>25MFM</td>
<td>600</td>
<td>$0.05</td>
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</tbody>
</table>

**PULSE TRANSFORMERS**

Western Electric Formally core 1 3/8", 150 turns No. 33 AWG each pt. & sec. 20 to 1460 and 1/4" x 1/4" fully pressed, core, K59800-446. 1 1/4" 3/4 x 3/4" fully cased, 3 windings 1-1/2" x 1-1/2", 2-1/2" x 2-1/2", 3-1/2" x 3-1/2". The core, K59801-266. 1 1/4" 3/4 x 3/4" fully pressed, core, K59802-298. 1 1/2" 1-1/2" fully pressed, core, K59803-99. 1-1/2" 1-1/2" fully pressed, core, K59804-480. A number of the above types in pulleys on the K59805-947. Also available in pulleys as special orders. K59806-71747, 50 ohm pulse cable connection, 450 volt output, 5,900 volt input, 19.50. K59807-61708, 50 ohm pulse cable connection, 3,830 v, 17,300 v output (250 KVA @ 1/4 micro second) cos 225, our price only.

**GEARS**

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Teeth Pitch P.D. (in.) Face (in.) Hole (in.) Material</th>
<th>Price</th>
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<td>2511</td>
<td>48 1/8 7/32 1/8 7/32 1/8 3/16 Stainless</td>
<td>$0.29</td>
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<td>2518</td>
<td>48 1 1/16 1/16 1/16 1/16 1/16 Stainless</td>
<td>$0.29</td>
</tr>
<tr>
<td>2521</td>
<td>48 1 1/16 1/16 1/16 1/16 1/16 Stainless</td>
<td>$0.29</td>
</tr>
<tr>
<td>2523</td>
<td>48 1/8 7/32 1/8 7/32 1/8 3/16 Stainless</td>
<td>$0.29</td>
</tr>
</tbody>
</table>

**SELSYS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Stock No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>$7.25 pair</td>
<td>C78248</td>
<td>$9.25 ea.</td>
</tr>
</tbody>
</table>

**SELSYS SYNTHONIC DIFFERENTIAL**

C78248

115 V., 60 Cyc., 3/4" dia. x 4 1/4" body. Used in Pans for Radio Clock, TV, etc. Also 10 V., 50 Cyc. $7.75 pair.

**SELSYS**

**MINIMUM $5 ORDER**

**Telephone** Rittenhouse 6-4927

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**RELIEF**

**October, 1948 — ELECTRONICS**
G. E. Motor Starting Reactors
Type 11K2840G2
Rated at 410 Volts, 2 Phase, 60 Cyc,
15.8 Amps, 15-50 HP, Waterproof steel
case. 17" x 12" x 10". Brand New!
In original factory case.
Price $9.90

Inter-Communication Sets Manufactured by Dictograph
Designed to bring toampton and office the convenience of two
way conversation without the use of telephone. Sounds electric
wire, or telephone.
It can be set up in any two rooms you wish... being limited only by the
length of the wire you use. Inter-Communication Sets will
operate efficiently up to 800 feet using 16-gauge wire.
BRAND NEW, Pair
Price $9.95

Motor Generators
Input: 115 Volts, DC at 14 amperes, 5500
speed, ball bearings. Output: 1.25 KVA;
60% P.F.; 120 VAC, 60 cy, single ph. 164
Amperes. With resistive control of voltage
output and frequency built-in and with
Centralized automatic controller built-in, permitting line-start
operation. Fully enclosed. Splash-proof.
BRAND NEW! In original
Factory Cases
Same machine for 230
Volts, D.C. Operation
Price $120

Synchro's
Ferd Instrument Synchro Generator, Type 3K111
Mod. 2 115/60 Volts 60 Cycle... Price $11.95
Arma Corp. Synchro Differential Generator,
Type 3DG MB4 Mod. 1 90/60 Volts 60 Cycle... Price $7.95
Dialight Synchro Transmitter, Type C74141... Price $4.35
Central Instrument Synchro Motor, Type 3M1-
Mod. 2 115/60 Volts 60 Cycle... Price $8.95
Sparry Gyroscope Voltage Regulator, 76115, 115 Volts
60 Cycle... Price $4.95
Dielite Synchro Transmitter, C70351, Type 14, 115
Volts, 60 Cycle... Price $4.35

Motors and Generators
Western Electric Motor, XE8421, 29 VAC, 290
D.C., 5 hp, 2900 RPM... Price $4.19
Oster Short Motor, Type E-57, 275 Volts DC
1,750 HP, 56 RPM... Price $4.75
Oster Series Motor, Type C-256-1A, 27.5 Volts
1,150 HP, 56 RPM... Price $4.75
Univolt Elect. Motor, Type 2110-1A, 115 Volts
2,000 RPM... Price $2.95
Sparry 3 Phase Motor, Type 115/1960, 2,000
Volts, 230/460... Price $7.95
N.E. 115/460 Volt 7 hp Motor... Price $6.75
N.E. 1-Watt Motor, Type 549J8, 115 Volts 40
Watts, 115 Volts AC, 60 Cycle... Price $1.50

MAGNETRONs
2428 2920-3010 mw 171 kW... Price $11.00
2477 2560-2900 mw 315 kW... Price $14.00
2571 2560-2900 mw 315 kW... Price $10.00
700 A, B, C, D, 2150 kW... Price $25.00
700 A, B, C, D, 2150 kW... Price $25.00
700 A, B, C, D, 2150 kW... Price $25.00
700 A, B, C, D, 2150 kW... Price $25.00
700 A, B, C, D, 2150 kW... Price $25.00

Klystrons
Westinghouse, Type 417A... Price $9.00
Westinghouse, Type 732A/B... Price $5.00

All Items Listed Below are "Brand New" Unless Otherwise Specified

Transistors
"Transtats" American Voltage Regulator
PE-204A
Input Voltage: 12 Volts DC
Output Voltage: Two windings
4.5 VDC @ 56 MA
Two windings
45VDC @ 0.5 MA
Ports alone worth double the money.
BRAND NEW!
Price $75

Vibrator Power Supply
Built by Allis-Chalmers to U.S. Navy Specifications
Price $1

Inverters and Dynamos
PE103 Ballastron Dynamo, Input 6-12 Volts,
Output 200 Volts, 100 MA, without filter.
Price $9.90
PE206 Inverter, Input 5 VDC DC, output 80
VDC, 800 Cycle, 500 VA... Price $9.95
PE208 Inverter, Input 7 VDC DC, output 115
VDC, 600 Cycle, 1500 VA Rebuilt Like New.
Price $22.90
Dynamat for SCR-522, Input 24 Volts DC, output
25-30-300 Volts. Rebuilt Like New... Price $3.25
G. E. Dynamo, 3D83BA, Input 16 Volts DC,
Output 240 Volts AC, 1.75 Amps. Inside
with filter... Price $5.00
MGI-1/2A Inverter, Input 11.5 Volts DC,
Output 240 Volts AC, 1.25 Amps. Complete
with built-in filter... Price $10.95

Meters
Bristol Pymastrm Potentiometer Type 4100YM2,
but Guaranteed... Price $5.00

Hept Portable Ammeter, Mod. A16, 0-15 Amperes.
Input 220/380/440 VAC, 1500 MA, complete
with built-in filter... Price $5.00
G. E. Voltmeter, Mod. AB1, 4-15 Volts AC, 115
Volts, 0-800 Cycle, 60 RPM... Price $19.95

Transformers
Stepdown Transformer, 570/230/115, 60 cycle,
150 VA, air-cooled... Price $3.00
Westinghouse Transformer Primary 110 Volts
60 cycle, Secondary 220 Volts, 200 watts.$5.60

Batteries
8 Volt Dowar Wet Cell Battery, 15 amp-hours.
Complete with electrolyte and filler syringe.
May be used as four 2 volt batteries $5.60
2 Volt Willard Battery, replacement for G. E.
Portable radio model, 5L300... Price $3.95
4 Volt Searchlight Battery, 80 Ampere hours
(all batteries shipped dry)
Price $10.50

Amplydynes
G. E. Amplydynes, Mod. SAM452D90, Input 115
Volts, single phase, 40 Cycle 5.0 Amperes.
Output 250 Volts, 0.6 Amperes, 150 watts, 450 RPM.
Continuous duty... Price $35.00
G. E. Amplydynes, Mod. SAM341FL, Input 25 Volts
115/230 VAC, 1500 MA, complete with built-in
filter... Price $4.50

Voltage Regulators
Eclipse Voltage Regulator, Type 1001, set at 115
Volts AC, 60 cycle, 250 Volts, 0.5 Amperes.
Price $1.95
Eclipse Voltage Regulator, Type 1005, set at 77.5
Volts AC, 60 cycle, 250 Watts... Price $1.95

Leland Voltage Regulator, 11651, set at 220
Volts AC, 60 cycle, 250 Watts... Price $1.95


All prices F.O.B. Boston. Orders accepted from rated concerns on open accounts. Not 30 days.

Electro Sales Company
Dept. E-10, 111 Pearl Street, Boston 10, Mass.

Write for
112 Page Catalog
on company letterhead

Electronics — October, 1948

295
HEATHKIT SINE AND SQUARE WAVE AUDIO GENERATOR KIT

The ideal companion instrument to the Heathkit Oscilloscope. An Audio Generator with less than 0.01% distortion, high calibration accuracy, covering 0 to 20,000 cycles. Circuit is highly stable resistance capacity tuned circuit. Five tubes are used, a 6SN7 and 6AK5 in the oscillator circuit, a 6550 square wave clipper, a 6SN7 as a cathode follower output and 5Y3 as transformer power supply rectifier.

The square wave is of excellent shape between 100 and 5,000 cycles giving adequate range for all audio, FM and television amplifier testing. Either sine or square waves available instantly at a toggle switch. Approximately 25V of sine AC available at 50,000 ohms output impedance. Output = 1 db. from 70 to 20,000 cycles. Nothing else to buy. All metal parts are punched, formed and cadmium plated. Complete with tubes, all parts, detailed blueprints and instructions.

HEATHKIT SIGNAL TRACER KIT

Reduces service time and greatly increases profits of any service shop. Uses crystal diode to follow signal from antenna to speaker. Locates faults immediately. Internal amplifier available for speaker testing and internal speaker available for amplifier testing. Connection for VTVM on panel allows visual tracing and gain measurements. Also tests phonograph pickups, microphones, PA systems, etc. Frequency range to 200 Mc. Complete ready to assemble. 110V 60 cycle transformer operated. Supplied with 3 tubes, diode probe, 2 color panel, all other parts. Easy to assemble, detailed blueprints and instructions.

Small portable 9" x 6" x 4½". Wt. 6 pounds. Ideal for taking on service calls. Complete your service shop with this instrument.

HEATHKIT SIGNAL GENERATOR KIT

Every shop needs a good signal generator. The Heathkit fulfills every servicing need, fundamentals from 150 Kc. to 30 megacycles with strong harmonics over 100 megacycles covering the new television and FM bands. 110V 60 cycle transformer operated power supply.

400 cycle audio available for 30% modulation or audio testing. Uses 6SN7 as RF oscillator and audio amplifier. Complete kit has every part necessary and detailed blueprints and instructions enable the builder to assemble it in a few hours. Large easy to read calibration. Convenient size 9" x 6" x 4½". Weight 4½ pounds.

THE NEW HEATHKIT VACUUM TUBE VOLTOMETER KIT

The most essential tool a radio man can have, now within the reach of his pocketbook. The Heathkit VTVM is equal in quality to instruments selling for $75.00 or more. Features 500 microamper meter, transformer power supply, 1% glass enclosed diode resistors, ceramic selector switches, 11 megohm input resistance, linear AC and DC scale, electronic AC reading RMS. Circuit uses 6SN7 in balanced bridge circuit, a 6X6 as AC rectifier and 6X5 as transformer power supply rectifier. Included is means of calibrating without standards. Average assembly time less than four pleasant hours and you have the most useful test instrument you will ever own. Ranges 0-3, 30, 100, 300, 1000 volts AC and DC. Ohmmeter has ranges of scale times 1, 100, 1000, 10M and 1 megohm, giving range 1 ohm to 1000 megohms. Weight 8 lbs.

HEATHKIT CONDENSER CHECKER KIT

A condenser checker anyone can afford to own. Measures capacity and leakage from 0.0001 to 100 MFD on calibrated scales with test voltage up to 500 volts. No need for tables or multipliers. Reads resistance 500 ohms to 7 megohms, 110V 60 cycle transformer operated complete with rectifier and magic eye indicator tubes. Easy quick assembly with clear detailed blueprints and instructions. Small convenient size 9" x 6" x 4½". Weight 8 pounds. This is one of the handiest instruments in any service shop.

Build YOUR OWN TEST EQUIPMENT

- $39.50
- New 1948 Heathkit
- 5" OSCILLOSCOPE KIT
- A necessity for the newer servicing technique in FM and television. A price you can afford. The Heathkit is complete, beautiful two color panel, all metal parts punched, formed and plated and every part supplied. A pleasant evening's work and you have the most interesting piece of laboratory equipment available.

Check the features — large 5" 5RP1 tube, compensated vertical and horizontal amplifiers using 6527's, 15 cycle to 30 M cycle sweep generator using 884 gas triode, 110V 60 cycle power transformer gives 1100 volts negative and 350 volts positive.

Convenient size 8½" x 13" high, 17" deep, weight only 26 pounds. All controls on front panel with test voltage and ext. syn. post. Complete with all tubes and detailed instructions. Shipping weight 35 pounds.

Order today while surplus tubes make the price possible.

Nothing ELSE TO BUY

- $34.50
- Shipping Wt. 13 lbs.

- $19.50
- Nothing ELSE TO BUY

- $24.50
- Nothing ELSE TO BUY

- $19.50
- Nothing ELSE TO BUY

HEATH COMPANY

DEPT. E... BENTON HARBOR, MICHIGAN

October, 1948 — ELECTRONICS
Desirable Select Surplus Items of Electronic Equipment, New, Unused

BC-375E TRANSMITTERS
TYPE BC-375E AIRCRAFT RADIO TRANSMITTERS, 100 WATT FREQUENCY RANGE 200-500 KC AND 1,500-12,500 KC EACH. Complete as follows:

<table>
<thead>
<tr>
<th>Quan.</th>
<th>Type No.</th>
<th>Description</th>
</tr>
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<tr>
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<td>BC-375E</td>
<td>Transmitter</td>
</tr>
<tr>
<td>1</td>
<td>FT-115-B</td>
<td>Mount</td>
</tr>
<tr>
<td>1</td>
<td>TT-151-A or C</td>
<td>Mount</td>
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<td>TU-58</td>
<td>Tuning Unit (1500-3000 KC.)</td>
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<tr>
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<td>Tuning Unit (3000-4500 KC.)</td>
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<td>BC-306-A</td>
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<td>Mount</td>
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<tr>
<td>1</td>
<td>PL-64</td>
<td>Plug</td>
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</tbody>
</table>

war surplus units all new and packed in original crate.

NAVY TDE TRANSMITTER
Navy Model TDE Radio Transmitter is designed for medium and short wave telegraph and telephone operation. Frequency range 300 to 18,000 Kc. Output CW 125 watts, Phone 25 watts operates on 230 volts D.C. Transmitter motor generator filters and controls all located in one steel cabinet as shown in illustration.

GASOLINE AND DIESEL ENGINE GENERATORS
We have available gasoline and Diesel engine generators of all types. Contact us if interested in any of these remarkable new surplus units.

RADIO TELEGRAPH TRANSMITTER MODEL ET-8023 D1
This Radiomarine Transmitter has a power output of 200 watts and is either master oscillator or crystal control in operation. Emission CW or MCW. Frequency range 2,000 to 24,000 Kc. in nine overlapping bands. New in original export packing. Supplied complete with one set of operational tubes and typewriter table.

All material offered subject to prior sale

FRENCH-VAN BREEMS, Inc.
630 FIFTH AVENUE
NEW YORK 20, N. Y., U. S. A.

CABLE ADDRESS, FREXVAN, N. Y.
Electronic Engineering Experts

ELECTRONICS — October, 1948
Whether you require large quantities of relays for production runs or single units for laboratory or amateur work, Wells can make immediate delivery and save you a substantial part of the cost.

Our capable engineering staff is prepared to offer assistance in the selection of correct types to suit your exact requirements.

Each relay is brand new, standard make, inspected, individually boxed and fully guaranteed. The following list represents only a tiny portion of our relay stock. Write or wire us for information on types not shown.

### STANDARD DC TELEPHONE RELAYS

<table>
<thead>
<tr>
<th>No.</th>
<th>Stock</th>
<th>Operating Coil</th>
<th>Voltage</th>
<th>Resistance</th>
<th>Contacts</th>
<th>Manufacturer</th>
<th>Each</th>
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<tr>
<td>821</td>
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### SENSITIVE DC RELAYS

### ANTENNA CHANGEOVER RELAYS

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### HEAVY DUTY KEYRELAYS

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### ADJUSTABLE TIME RELAY

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### DC MECHANICAL ACTION RELAYS

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### TYPE C.M.S. RELAYS

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### DC-CURRENT REGULATOR

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### D-C ROTARY STEP RELAY

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### D-C RATCHET RELAY

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<td>2PO (SPST) (NO)</td>
<td>Cased</td>
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</tr>
</tbody>
</table>

### SPECIAL SAMPLE ENGINEERING OFFER

Any ten relays listed (one of each type) with the exception of Stock Nos. R-621 and R-246—only $10.00.

ORDER DIRECTLY FROM THIS AD OR THROUGH YOUR LOCAL PARTS JOBBER.


320 N. LA SALLE ST., DEPT.-SL, CHICAGO 10, ILL.

www.americanradiohistory.com
NEW DUAL SENSATIONAL SPECIAL

FM TUNER

Phono-Motor

For Recording or Playback!

Heavy Duty. Rim Drive Motor—built by a leading

mf. for RCA. Will Play or Record on either

58, 30, or 8 RPM. Ideal for playing new

strings, records, 78 R.P.M. Weighted 10" Turntable as-

sures good recording and play-back. Complete parts in-

cluding Motor, Turntable, switch, drive wheels etc. less

plate. Sensational value! Cat. No. $5.95

Model XFM-1

$49.50

Complete with 8 Tubes

This amazing new GE FM Tuner is a super

instrument, offered to the public by Newark as a sensa-
tional price! It’s easily connected to any AM receive-

er or stereo FM Tuner. Complete Power complete F.M.

from 88 to 108 Mc. Full view 12" slide rule
dial. Two controls: on/off, volume control, and

tuning. Handset cabinet 15 1/2" W 10 1/2" H.

11 3/4" D Universal 6 tap Power Transformer, for

total line 103-260 volts 50-60 cycles. AC. Shipped wt. 20 lbs. Cat. No. A-3022

Famous Make 3" SCOPE

Reduced to $84.50 Reg. $115.00

SAVE $30.50

We made a natural purchase from a famous manufacturer of test equipment! Now you can afford this

instrument—save $30.50. This oscilloscope has many outstanding features not found in run-of-the-mill

scopes such as Built-in ...
SURPLUS MATERIAL—Shipped Immediately

Thousands of Relays Available—Send for Complete Listings

TUBES! GUARANTEED!

<table>
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<th>TYPE</th>
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STANDARD BRAND PRECISION RESISTORS

Types WW3, WW4, and WW5

Following sizes are in 1% and 2% tolerance Price $0.35

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<tr>
<th>Size</th>
<th>Price</th>
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<tr>
<td>50.0</td>
<td>$5.50</td>
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RADIO NOISE FILTERS

These line noise filters are available in large quantities and priced at 7 cents apiece.

Mellor NF 12-000—Housed in a bakelite type case with a binding post and prongs. 75 cents apiece.

Mellor NF 12-15A—Housed in wooden type rectangular case 3 x 1/2 x 1 1/2. 15 cents each.

Mellor NF 12-25A—Housed in rectangular case 3 x 1 1/2 x 1 1/2. Internal screw terminals. Bound at 50 cents each. 5 cents extra for black box.

Bendix—model 3687—Generator filter. 45 cents apiece.

Price $0.15

TRANSTAT VOLTAGE REGULATORS

Model 229064

For fixed winding 115 Volt-60 cycles

Price $6.00

Type RH

Fixed Winding 115 Volt-60 cycles

Price $1.00

4000-6000 VOLT LOW CURRENT DC SUPPLY

Price $1.35

Write for Latest Catalog

EDLIE ELECTRONICS, INC.

TELEPHONE Digby-9-3143

NEW YORK 6, N. Y.

A LEEDS LEADER

- 50 microamps movement ±
- 250 ohms DC resistance
- 2% accuracy
- 4½ dia. Black Bakelite case
- 6½ dial with graduated divisions
- 1½ High. Shipping Weight 10 lbs. Per Piece, Special Each $9.75

SUPERIOR POWERSTATS

Variable Transformer for precise Voltage Control. Excellent mechanical construction, design, and durability.

VARIABLE TRANSFORMERS

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Input</th>
<th>Output</th>
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<td>TYPE 20</td>
<td>0-150 V.</td>
<td>0-35 V.</td>
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<td>TYPE 116</td>
<td>0-150 V.</td>
<td>0-35 V.</td>
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<td>TYPE 116U</td>
<td>0-150 V.</td>
<td>0-35 V.</td>
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<tr>
<td>TYPE 126</td>
<td>0-150 V.</td>
<td>0-35 V.</td>
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<tr>
<td>TYPE 116V</td>
<td>0-150 V.</td>
<td>0-35 V.</td>
</tr>
</tbody>
</table>

If not rated 25% with order, balance F.O.B. our warehouse New York. We ship to any part of the globe.

Write Dept. EL

"The Home of RADIO"

75 VESEY STREET
Cortlandt 7-5612

October, 1948 — ELECTRONICS
DIVERSITY RECEIVING EQUIPMENT

BRAND NEW!  EXPORT PACKED!

OVERCOMES FADING IN RADIO TELEGRAPH COMMUNICATION AT HI-FREQUENCIES

- Lots of extra parts, Meters, Condensers, Transformer, etc.
- 2 extra sets of spare tubes (Besides set in unit)
- Designed to operate from a 100-260 volt, 25-60 cycle single phase power source
- Power consumption approximately 70 to 80 watts
- Front panel finished in baked black wrinkle lacquer
- Tube line up: 3-6A6; 1-77; 1-IV; 1 neon; 1-80; 2-6SJ7; 1-VR150/30
- Overall dimensions: 19" wide x 14" deep x 21" high—Export packed 21" wide x 20" deep x 36" high

2 COMPLETE INSTRUCTION BOOKS SUPPLIED WITH EACH UNIT.

PRICE
Special $149.50

BRAND NEW BC 223AX

Latest model of the 223 series. Has built-in phantom antenna. Frequencies from 2 to 5.25 mc with three plug-in tuning units, complete as shown less xtal, tubes, and power supply. Tube line up consists of 2—801A and 3—46; output 25 watts CW, 10 watts phone. Shipping wt. 160 lbs.

SPECIAL $29.95
Complete set of tubes for above unit $4.95

TUBES!

<table>
<thead>
<tr>
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<th>TUBES!</th>
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<td>371A</td>
<td>2.25</td>
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TUBES!

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<td>9LP7</td>
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<td>SCP1A</td>
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<td>SCP1</td>
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<td>371A</td>
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</table>

MARINO RADIO CO.
203 GREENWICH STREET, NEW YORK, N. Y.

ELECTRONICS — October, 1948

301
**VACUUM TUBE VOLT-Ohm-CAPACITy METER**

Three new features engineered into this all purpose instrument make it unique in its price range. It designed not only to meet present conditions but to be realistic for the years ahead. A very exceptionally low price of $25.00 reveals the also the well known “low cost” in fixtures. No other unit in manufacturing this meter features the following: 1. **Economical construction**—made possible by the use of a high quality calculator without the extra features found in most other meters. 2. **High reliability**—the over-all efficiency of the new meter is greater than that of any other type of vacuum tube voltmeter, using the latest developments in vacuum tube technology. 3. **Low cost**—the meter is available at a price that makes it possible to use a high quality instrument in everyday work. 4. **Direct reading**—the meter will automatically range from 20 to 1000 megohms. 5. **4500 volts**—the meter can be used in applications requiring voltages in excess of 4500 volts. 6. **WIDE VOLTAGE RANGE**—the meter can be used in applications requiring voltages from 20 to 1000 volts.

**Special Values**

D. C. MICROAMMETERS
- 0-100 uA. ga. at 10 A.M. $1.00 ea.
- 0-250 uA. ga. at 50 A.M. $1.50 ea.
- 0-1000 uA. ga. at 500 A.M. $2.00 ea.
- 0-1000 b. ga. at 500 A.M. $2.50 ea.
- 0-2000 b. ga. at 500 A.M. $3.00 ea.

R. F. MILLIAMMETERS
- 0-100 ra. at 10 A.M. $2.00 ea.
- 0-250 ra. at 50 A.M. $2.50 ea.
- 0-500 ra. at 50 A.M. $3.00 ea.
- 0-1000 ra. at 50 A.M. $3.50 ea.

**SHUNTS**

50 or 240 Vdc. 50 Vdc. type $1.00 ea.

**PRECISION ELECTRICAL INSTRUMENT CO.**

146 Grand Street
New York 13, N. Y.

**BARGAIN BUYS**

COMPLETE RADAR SETS
- APR/1 with Tuning Unit—$150.00
- APR/2 with Tuning Unit—$175.00
- APR/3 with Tuning Unit—$200.00

**SPECIAL OFFER**

600V...$10.00

**SPEAKERS**

These FM speakers are the finest that are available. All have heavy overseas Atlantic X. magnetis.
- 3" 1 3/4...$6.00 each
- 3" 1 1/4...$7.50 each
- 4" 1 1/4...$10.00 each

**MICROPHONES**

Unbreakable dynamic adjustable impedance BOUND ENGINEERS BUY DIRECT 50% discount

**SPECTRA PRODUCTS**

355 Chambers St.
New York 7, N. Y.

**T526/8 U/CRAIL TEST SETS**

**MICROWAVE & RADAR USE**

New war surplus—overseas packed, original cost $125. Your cost only $17.50.

C. E. MAASS

86 Pennsylvania Ave.
Tuckahoe, N. Y.
GENERAL ELECTRIC 150 WATT TRANSMITTER

Cost the Government $1800.00 • Cost to You—BRAND NEW—$100.00

This is the famous transmitter used in U.S. Army Bomber and ground stations during the war. Its design and construction have been published everywhere in the form of Blue-Collar Units which are included. Each unit has its own oscillator and power amplifier, is permanently coupled to a motor and is designed for operation on a certain range of frequencies. The particular frequency range. Transmission and accessories are included in black-cable, and the microphone, volter- meter, key, etc., are all included. All parts are furnished. 500 kc and 5500 kc. Will operate on 10 and 10-meter band with slight modification for which dis- cussion is available. Natural class "C" stage, using 212 tubes and equipped with antenna-coupling circuits which are balanced, and a 123-Volt power supply. Seven tuning units, antenna-tuning unit, and essential plug.

1949 MODEL MUTUAL CONDUCTANCE TUBE TESTER

No possibility of good tubes reading "Bad" or bad tubes reading "Good" as on dynamic condensation testers or other ordinary emission testers. Attractive panel design. Also equal to any on the market in appearance. Large 4½" meter. Calibrated and marked in type of standard tubes. Used as a Bad-Good tester for both Class X and Class Y types. Has variable DC, 150 Volts. Calibration is adjustable for the voltages of the test tubes. Includes tubes of the same make and type as the test tubes. A new, leading type Tester. High accuracy. $10.95

SCR-274N COMMAND SET

The greatest radio equipment value in history

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. 9-E BUFFALO 3, N. Y.

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. 9-E BUFFALO 3, N. Y.

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. 9-E BUFFALO 3, N. Y.

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. 9-E BUFFALO 3, N. Y.

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. 9-E BUFFALO 3, N. Y.

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. 9-E BUFFALO 3, N. Y.

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BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. 9-E BUFFALO 3, N. Y.

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. 9-E BUFFALO 3, N. Y.
### Industrial Power Supply Equipment

#### TUBES

<table>
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<tr>
<th>TRANSMITTER</th>
<th>THERATRONS</th>
<th>RECTIFIERS</th>
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<tbody>
<tr>
<td>RK75/307A</td>
<td>4.50</td>
<td>2021</td>
</tr>
<tr>
<td>450TH/6C21</td>
<td>22.50</td>
<td>3C23</td>
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<tr>
<td>750TH</td>
<td>17.50</td>
<td>FG1A</td>
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<td>WLS33</td>
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<td>C6A</td>
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<td>Triode</td>
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<td>714AY Magneton</td>
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<td>3B22</td>
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<tr>
<td>710A Magneton</td>
<td>10.75</td>
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</table>

**RECTIFIERS — Dry Disc Type — Continuous Duty Ratings**
- 3.5V, A.C. 1.8V, D.C. 1.0 Amps Full Wave Bridge...
- 6.5V, A.C. — 2.2 V, D.C. @ 3.0 Amps Full Wave Center Tap...
- 36V, A.C. 200 Mill D.C. H.W...
- 36V, A.C. 2.2 Amps D.C. Full Wave Bridge...
- 54V, A.C. — 1.6 Amps D.C. G.E. Full Wave Bridge...
- 154V, A.C. — 600 Mill D.C. Full Wave Bridge...
- 200V, A.C. — 400 M.A. D.C. G.E. Full Wave Bridge...

**CONDENSERS**
- 500 Mfd 200V dry Electrolytic...
- 2 Mfd 660V Tubular Oil...
- 10 Mfd 600V Oil...
- 2 Mfd 250V Oil...
- 2 Mfd 120V Oil...
- 25/25 600V D.C. or 125 Mfd— 1200V D.C. Oil...
- 10 Mfd 25 KV...
- 20 Mfd 125 KV...
- 50 MFD 32 KV Tubular Vacuum...

**RELAY**
- RC-117 — Westinghouse Time Delay Current Relay, Type C 2 to 1 amp A.C. or D.C. .8 amp continuous rating Rating 20-40% drop out rate...
- Net Wt. 3 lbs. Dim. 3" W x 5" D x 53/4" H...

**NEW RA38 POWER SUPPLIES**
- 115V, 60 cycle input adjustable output 0-15,-...
- 000V.C. or D.C. @ 500 Mils. Complete with extra set of new tubes and remote control...
- Shipping weight 2100 lbs...
- $250.00

**METERS**
- Weston Model 476-3" A.C. Ammeter, 3 Amp...
- Weston model 7001 Millivoltmeter—3.5"...
- Multimeter, Supreme model 543-S $12.95
- R. F. ammeter weston 425-3 A $5.95

**TRANSFORMERS**
- T-103 — Voltage regulator transformer, American Transformer Co. Spec. 29145 Alias KVA output 11.5 50/60 cyc.
- 115 V, 1000 Amps...
- 230 V, 50 amp...
- $75.00

**TRANSISTORS**
- T-102 — Filament Transformer, American Transformer Co. Spec. 29106, Type WS 200 KVA...
- 50/60 cyc. Single phase, 35 KVA test...
- 12 KV D.C. operating...
- 115...50/60 cycle...
- 10 amp...
- $12.50

**MOTOR GENERATORS**
- G.E. Type CC-21991 Input 115 volts D.C. @...
- 5.7 Amps...
- Output 115 V. A.C. 60 cycle, single phase 350 V.A. @...
- $58.00
- G.E. Type CC-21990 Input 32 V. D.C. @...
- 22 Amps...
- Output 115 V. A.C. 60 cycle, single phase, 350 V.A. @...
- $63.00

**WESTINGHOUSE — Type "AB"**
- De-ion circuit breakers...
- Thermal trip without enclosure 3 pole...
- 50 amp frame size...
- Style 545-3B9 D 15 amp rating...
- 9.50 ea...
- Style 545-3B7 D 25 amp rating...
- 9.50 ea...
- Style 545-3B5 D 50 amp rating...
- 9.50 ea...

**HEATERS**
- H-149 — Chromelox strip heaters, 300 W., 115 V. (5x15x3/4"")...
- $1.00

---

**COAXIAL CABLES**

<table>
<thead>
<tr>
<th>RG 5/U</th>
<th>RG 8/U</th>
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<tr>
<td>RG5U</td>
<td>per 100 ft.</td>
</tr>
<tr>
<td>$4.50</td>
<td>100 ft.</td>
</tr>
</tbody>
</table>

---

**BIRCHER TUBE CLAMPS**

| 926 A... | 15¢ ea.  |
| 926 B... | 15¢ ea.  |
| 926 C... | 15¢ ea.  |
| 926 D... | 15¢ ea.  |
| 926 E... | 15¢ ea.  |

---

**TYPE F2L MICA CAPACITORS**

<table>
<thead>
<tr>
<th>CM 70 TYPE</th>
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<tr>
<td>.042 MFD 1500 Volts Wkg.</td>
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<tr>
<td>.033 MFD 1500 Volts Wkg.</td>
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<tr>
<td>.056 MFD 1500 Volts Wkg.</td>
</tr>
<tr>
<td>.056 MFD 5000 Volts Wkg.</td>
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**LIFE ELECTRONIC SALES**

91 GOLD STREET, N. Y., N. Y.
TELEPHONE DIGBY 9-4154-5

October, 1948 — ELECTRONICS
ELECTRONICS — October, 1948

SELENIUM RECTIFIERS AND SPECIALIZED ELECTRONIC COMPONENTS

<table>
<thead>
<tr>
<th>Full Wave Bridge Types</th>
<th>0-30 VAC</th>
<th>0-450 VDC</th>
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<tbody>
<tr>
<td>Type</td>
<td>Current</td>
<td>Price</td>
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<tr>
<td>B1-3</td>
<td>3 AMP.</td>
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<td>B1-5</td>
<td>5 AMP.</td>
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<tr>
<td>B1-10</td>
<td>10 AMP.</td>
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<tr>
<td>B1-25</td>
<td>25 AMP.</td>
<td>$32.95</td>
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<td>B1-50</td>
<td>50 AMP.</td>
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<td>B1-75</td>
<td>75 AMP.</td>
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<td>B1-100</td>
<td>100 AMP.</td>
<td>$175.95</td>
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Three Phase Bridge Types

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<tr>
<th>Type</th>
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<tbody>
<tr>
<td>B11-2</td>
<td>2 AMP.</td>
<td>$4.95</td>
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<td>B11-5</td>
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<td>$7.95</td>
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<tr>
<td>B11-10</td>
<td>10 AMP.</td>
<td>$14.95</td>
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</table>

Rectifier Mounting Brackets

For Type B1-1 to Type B1-5...$ .35 per set
For Types B13-1 to B13-5...$ .65 per set
For Types B17-1 to B17-11...$ .80 per set

Rectifier Capacitors

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
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<tbody>
<tr>
<td>CF1-10</td>
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<tr>
<td>CF1-20</td>
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<td>CF1-50</td>
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Electrolytic Capacitors

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<tr>
<td>0-1 MA D.C. Weston (4/4&quot;) Rd., Bakelite case...$ 3.98</td>
<td></td>
</tr>
<tr>
<td>0-15 A.D.C. Weston (4/4&quot;) Rd., Bakelite case...$ 9.98</td>
<td></td>
</tr>
<tr>
<td>0-30 A.D.C. Weston w/4 1/4 Rd., bakelite case...$ 12.98</td>
<td></td>
</tr>
<tr>
<td>0-45 A.D.C. Weston w/4 1/4 Rd., bakelite case...$ 20.98</td>
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Meters

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
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<tbody>
<tr>
<td>0-1 MA D.C. Weston 4&quot;/4&quot; Rd., Bakelite case...$ 3.98</td>
<td></td>
</tr>
<tr>
<td>0-15 A.D.C. Weston 4&quot;/4&quot; Rd., Bakelite case...$ 9.98</td>
<td></td>
</tr>
<tr>
<td>0-45 A.D.C. Weston 4&quot;/4&quot; Rd., Bakelite case...$ 20.98</td>
<td></td>
</tr>
<tr>
<td>0-1000VAC 3-1/2 Rd., dial type...$ 12.98</td>
<td></td>
</tr>
</tbody>
</table>

Opad-Green Company

71 Warren St. Phone: BEekman 3-7385 New York, 7, N. Y.

To avoid shipping errors, kindly order by type #.

All prices subject to change without notice.

Minimum order $2.00. Bills C.O.D.'d only under $25.00. 25% deposit on C.O.D. Add 10% for Parcel Post and handling. Terms: Net 10 days to effect checks. Orders Promptly Filled From Our Stock.
An amazing value for
RADAR RESEARCH and
EXPERIMENTAL LABORATORIES

Type TS-100/AP
TEST OSCILLOSCOPE
for pulse timing
and test applications

Original Govt. Cost $750.00
A rare value at only $240
F.O.B. Boston
Price includes tubes, spare fuses,
co-ax test cables, and circuit plan.

This versatile, accurate, precision built instrument is designed for precise measurement of short time intervals with circular sweep, and for test 'scope applications with linear sweep.

CIRCULAR SWEEP
Sweep rate: 1.5 microseconds per inch; 125 microseconds per revolution.
Sweep accuracy: ±0.03 microseconds; stable crystal oscillator holds sweep accuracy.
Range of measurement: time intervals from 0.5 to 600 microseconds can be measured by utilizing the selectable intensity gate and selecting any one of the first 100 revolutions after triggering.
Trigger voltages: 120 volts positive; 75 volts negative; 125 microseconds.
Trigger stability: 0.1 microseconds with respect to circular sweep; can be operated at recurrence frequencies from 300 to 1500 per second.
Synchronization: sweep whose time duration is to be measured must be triggered from the test oscilloscope.
Signal deflection: radial by center wire; sensitivity—225 volts per inch.

With circular sweep, the TS-100/AP is useful for calibrating pulser and coincidence circuits, for measuring radar ranges (to an accuracy of 5 yards), for measuring delay lines, pulse lengths, pulse separations, and for measuring time duration of any event not exceeding 600 microseconds.

Self-contained in louvered metal case 8" wide, 12 1/2" high and 16 1/2 inches deep; removable cover protects the control panel when the instrument is not in use; the cover contains spare fuses, test leads and power cord.

Linear sweep
Sweep rate: 12, 120, and 360 microseconds for 3-inch sweep.
Sweep accuracy: ±2%.
Sweep synchronization: sweep starts at trigger or after delay adjustable from 2 to 502 microseconds.
Internal triggering: from self-contained source of 120 volts positive or 75 volts negative providing 1/4 microseconds trigger at 500-1500 pulses per second.
External triggering: requires positive 15 volts or 10,000 ohms with 120 volt/microseconds rise, or negative 50 volts with 500 ohms with 200 volt/microseconds rise.
Deflection: 150 volts/3 inch thru condensers for either vertical plate, or to upper plate thru single-stage amplifier having gain of 12, upper frequency cut-off at 3 cycle, lower frequency cut-off at 100 cycle; maximum peak input 2 1/2 volts. 2 1/2 volts.

With linear sweep, the TS-100/AP is useful for testing synchronizers, testing radar sets, line-up receivers, and for measuring pulse lengths up to 1300 microseconds. Availability of the sweep voltage makes this instrument applicable to electronic modulation of FM oscillators for modulator measurements.

Quantity limited—ORDER NOW—
get your TS-100/AP while this offer lasts. Give complete shipping instructions with your order.
TELEMARINE'S SELECTED ELECTRONIC SURPLUS

**5-Meter Walkie-Talkie**

Model BC-282 Transmitter; simple, popular communciation unit. Quick tune, needs no sidemounts. Only two tubes; Type 57 and 25 inch. A 55-6 crystal in a crystal calibrator circuit. Range 5 to 50 miles, depending upon location and altitude. Operates from single battery, type A 75. Price $20.95. Complete, Each $29.95

**CR-536 HANDY-TALKIES**

We have just a few of these popular Handy-Talkies, and they won't last long. All are in very excellent condition, and complete with crystals (receiving and transmitting) and batteries. All are in top operating condition and priced at various operating frequencies ranging from 2.5 to 6 mc. None available for operation on 80 meter band. We will supply units with matched frequencies as long as quantity permits. First come, first served!

Price, Each $5.00

**32 VDC 110 AC CONVERTER**

MRI. By Kato Engineering, for marine or farm installation. Latest type, compact and ruggedly built for continuous duty. Rubber shock mounting on fiber base, with complete input and output filtering. Output: 110 volts, 60 cycles AC. 225 KVA, but will operate efficiently on loads up to 100 KVA. New units only.

Price, Each $34.95

**FREQUENCY METER**

**TS-69/AP**

Frequency range 400 mc to 10,000 mc, continuous. Long life for lab, school, or for hams experimenting with static for tuning phone based. Black-ceramic band and a metal case, dim 6" x 3 1/2", contains variable and accurate measuring, range from crystal rectifier to 3 100 microamperes. Meter, VOM, and calibration charts for extreme precision. Telescopic antenna and crystal for crystal calibrator circuit. Range 3.5 to 6.0 mc. Complete, Each $14.95

**AMPLIDYNE MG SET**

Motor 110 220, 60 C.A.C.

For Automatic or Remote Control of heavy equipment. Mfd. by General Electric. Generator is Type V-587557, motor 2AM58. Navy type CG-31ABO. Generator delivers 250 volts, DC, 375 watts. Motor—115 or 220 volts 1-phase, 60 cycles AC, rated at % HP B.M.P.I. 1750. Includes expander for starting, and instructions for 115 or 230 volt connections. Generator section can be removed, and entire assembly shortened to make variable % HP E. A. motor. Quantity sufficient to warrant this conversion.

Price, Each $60.00

**32 VDC 110 AC CONVERTER**

MRI. By Kato Engineering, for marine or farm installation. Latest type, compact and ruggedly built for continuous duty. Rubber shock mounting on fiber base, with complete input and output filtering. Output: 110 volts, 60 cycles AC. 225 KVA, but will operate efficiently on loads up to 100 KVA. New units only.

Price, Each $34.95

**32 VDC 110 AC CONVERTER**

MRI. By Kato Engineering, for marine or farm installation. Latest type, compact and ruggedly built for continuous duty. Rubber shock mounting on fiber base, with complete input and output filtering. Output: 110 volts, 60 cycles AC. 225 KVA, but will operate efficiently on loads up to 100 KVA. New units only.

Price, Each $34.95

**DECK ENTRANCE INSULATORS**

Type B and F. Bowl and Flange Type

Mfd. by OHIO BRAKE CO. for Army and Navy use. Heavy galvanized metal flange 8" diameter, produces 800 cycles AC power. Top flange diameter in 6 1/2" diameter. Brass fixed type rod 15" long. Flange diameter between top flange and base is 4 1/2". Individually packed in cartons. Quantities available.

New, price each $3.00

**CAPACITORS**

1000 mLDC and DVC electron ice condensers. Each $0.35

All Prices F.O.B. N.Y.C.

All Material Offered Subject to Prior Sale

TELEMARINE COMMUNICATIONS COMPANY

Phone—Longacre 4-4490-1
280-Ninth Ave., N.Y. 1, N.Y.
BOONTON 120A VHF CIRCUIT CHECKER

This instrument was developed by the Boonton Radio Corp. to permit checking at VHF. Capacitance, inductance and complete Resonant Circuits, ideal for Television and FM Tuners. Quality control, etc. Three Frequency ranges, Available for immediate delivery.

Catalog price is $235.00—Our price is $150.00 f.a.b. N.Y.C. Reconditioned, in good operating condition, subject to prior sale.

THE NATIONAL INSTRUMENT CO.
FAR ROCKAWAY, N. Y.

UNUSUAL BARGAINS

VIBRATOR
Hi-freq., extra-heavy duty, Roudland 22J-0014A, Input 6, 12 or 24 volts: output 200 cycles ±10%, 20 extra-heavy contacts, rated at 35 amps continuous duty, each brought to separate base pins. In case 2 1/2 x 2 1/2 x 5 1/2. BRAND NEW, in orig. boxes. $4.95

ANTENA SWITCH, 3PD T
Extra-heavy contacts porcelain stand-offs; on base 7" x 8" x 1/4"; insulators close worth more than price of switch. Per dozen $9.95 EACH... .99

ELECTRONIC SUPPLIES
317-E East 2nd St.
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TUBE DIVISION  •  HARRISON, N. J.
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Application of rigid rotor with two pairs of spring-button type contacts.* Supplied as shown with terminals wired.

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3 pole, 3 deck, 100 position, break-before-make. 200 contacts. 101 solder lugs per deck. This unit employs a newly designed switch rotor with spring-button type contacts.*

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PROTELGRAM has been chosen by leading TV manufacturers because it is the answer to the demand for bigger, better, more true-to-life television. PROTELGRAM is available to all interested manufacturers. Its profit potentials are unlimited. For further information, write today to North American Philips Company, Inc., Dept. PA-8, 100 East 42nd Street, New York 17, N. Y.

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All five types are currently being mass-produced at the famed RCA tube plant in Lancaster, Pennsylvania. In addition, a large new plant is under construction at Marion, Indiana, where the production will be centered on the RCA-16-inch metal-cone kinescope.

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