Three hundred hermetic items proved to MIL-T-27A... Filters, high Q coils, power, plate, filament, pulse, audio transformers. Eliminates costs and delays of initial MIL-T-27A testing. Seven hundred stock items for virtually every application in the electronic field... each with UTC Reliability, highest in the field.

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Electronics SEPTEMBER 1 • 1957

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SHOP

THIS MONTH’S COVER . . .
It shows a Pratt and Whitney J-57 jet engine and the trans
zized jet fuel translator that n
ures the rate of fuel flow. t
latter was designed at the ele
tronics section of the Pratt and Whitney Division of United Air
craft, E. Hartford, Conn.

Arnold Waterman, who heads up the section that designed the instru
ment, has been a reader of ELE
TRONICS since he graduated from
college in 1936.

He has back issues for twenty
years stored in his attic. This has
insured a certain modicum of pri
vacy for perusal and avoids copies
being mislaid in other parts of the
household.

Recently he noticed that the
weight is causing the ceiling be
low to sag. Faced with the choice
of getting rid of back issues or
reinforcing the ceiling, he decided
in favor of our magazine.

PRECIOUS COMPRESSION . . .
The October 1 issue will contain a
comprehensive 28-page Special
Technical Report on Miniaturiza
tion. In doing research for the
article, associate editor Findlay re
ceived manufacturers’ prices on
some of the smallest of the small in
components.

There seems to be an inverse
square relationship between price
and size.

After studying data, which in
cluded potentiometers of less than
0.25 cubic inch selling for $6.50 and
interstage transformers of 0.375 cubic inch for 15 dollars each, the "if decided to build (on paper) transistor portable using the smallest parts.

Our cost estimate ran to $474.00 including batteries and headphones; size estimate is on the order of a regular-size cigarette package. This figures out to a cost of $82 per cubic inch.

REMEMBER THE COHERER
... Not many electronic engineers are left who had first-hand experience with the coherer of the early days of radio. At least 60,000 coherers have been put into operation in the world during the past year, however.

We stumbled across the story last fall, but didn't recognize it immediately. While doing some Christmas shopping, associate editor Manoogian found a radio-controlled bus in a toy store. Containing no tubes or transistors, it seemed worth investigating. Best he could obtain from the store manager was an instruction booklet that contained the basic circuit.

The transmitter was readily identified as a spark transmitter, complete with spark gap and short antenna. The receiver circuit had a small rectangle drawn between antenna and ground, which we assumed to be a diode "detector". But that's all we had of data.

Quite by coincidence a Japanese engineer, Tatsuco Tauboi, stopped in a short time later and saw Haig about getting some technical information on tube characteristics. He didn't know about the bus circuitry but promised to get more data when he returned to Japan.

He did a good job and the technical story appears in Electrons At Work, in this issue. He tells us that the confusing symbol is that of the coherer. Like the old-time device, it consists of a glass envelope having electrodes at both ends, and containing nickel powder. It conducts when the radio signal is picked up, so that the batteries operate the relay and then the motor. The motor is arranged mechanically to tap the glass and disturb the line-up of metallic particles to break the circuit and set it for the next impulse. This provides the decohering action.

MENTIONS ABROAD ... From Copenhagen, one of our correspondents, Else Baisler, tells us about Danske Radio Industri, a quarterly review of the Danish Association of Radio Manufacturers. As part of its service to subscribers this review runs a column called "Transistor Literature" which calls attention to articles of interest in other magazines. In the June number, there are 36 articles from ELECTRONICS mentioned. These were published in issues from February to May of this year.

DUAL PURPOSE, to serve as a display for edification of visiting engineers to our editorial offices, and to prevent losing any of the tiniest components, supplied by manufacturers for our Special Technical Report on Miniaturization for the October 1 edition, the editors mounted the units in plastic boxes as shown above.
Get Your Own B-NOBATRON!

Multipurpose B-Power Source Available in Five Models, Ranging from 300 to 1000 VDC Tops; Low Ripple, Accurate Regulation; Provide Filament and Bias Current in Addition to High Voltage Output.

Here's the economical and lasting answer to B-Power supply needs for nearly every laboratory, and many industrial operations. Nobatrons are built to last, and serve without maintenance. Damage to the Nobatron and its load is prevented by input and output fuses. Five models offer ranges of: 0-300 VDC, 0-325 VDC, 0-500 VDC, 0-600 VDC, and 200-1000 VDC. All but the largest model deliver 6.3 volts for filament supply and all but the 300-B and 1000-BB offer 0.150 volt regulated bias.

Regulation accuracy is within a maximum tolerance of .5% *, and ripple is held to five millivolts RMS or below (except for 20 mv. maximum on the 200-1000 VDC model). Input range is 105 to 125 VAC, with frequency of 50, 60, or 400 cycles. B-Nobatrons may be used in either cabinet or rack mountings, and are a handsome contribution to their quarters. Your local Sorensen representative will be glad to tell you all about these B-Nobatrons. Write directly for technical data, to

SORENSEN & COMPANY, INC. Richards Avenue, South Norwalk, Connecticut

*Only .15% maximum variation on the 0-300, and .25% on the 0-600 models.

### SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model</th>
<th>300B*</th>
<th>325B</th>
<th>500B</th>
<th>600B</th>
<th>1000B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage VDC</td>
<td>0-300</td>
<td>0-325</td>
<td>0-500</td>
<td>0-600</td>
<td>200</td>
</tr>
<tr>
<td>Output Current Ma</td>
<td>0-150</td>
<td>0-125</td>
<td>0-300</td>
<td>0-500</td>
<td>0-500</td>
</tr>
<tr>
<td>Regulation Accuracy</td>
<td>±0.15% **</td>
<td>±0.5%</td>
<td>±0.5%</td>
<td>±0.25%</td>
<td>±0</td>
</tr>
<tr>
<td>Ripple (V(p-p))</td>
<td>5 max.</td>
<td>5 max.</td>
<td>5 max.</td>
<td>5 max.</td>
<td>20 mV</td>
</tr>
<tr>
<td>Bias Supply (VDC)</td>
<td>—</td>
<td>0-150</td>
<td>0-150</td>
<td>0-150</td>
<td>—</td>
</tr>
<tr>
<td>Max. Bias Circ. Imp. (Ohms)</td>
<td>—</td>
<td>25000</td>
<td>25000</td>
<td>50000</td>
<td>—</td>
</tr>
<tr>
<td>Max. Int. Imp. (Ohms)</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>AC Voltage (CT Unreg.)</td>
<td>6.3/10 amp</td>
<td>6.3/10 amp</td>
<td>6.3/15 amp</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Filament</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Voltages</td>
<td>5 amps, series or parallel (two outputs)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**or ±0.3 volts, whichever is greater
MARCONI
Standard Signal Generator
MODEL TF 867

**UNDISTORTED 100% MODULATION**

**AM WITHOUT FM**

A signal generator also ideal as a video oscillator for wide-band television systems.

Precise high-quality a.m. with truly negligible f.m. Rock-steady carrier frequency for narrow-band testing. Other features include:

**WIDE RANGE**
15 kc to 30 mc on 15 ft. high-discrimination full-vision scale.

**CRYSTAL ACCURACY**
0.01% with built-in 1 mc harmonic source.

**HIGH OUTPUT**
4 volts down to 0.4 microvolts.

**FLEXIBLE MODULATION**
Internal 400 and 1,000 cps; external 50-10,000 cps within a db.

Also incorporated: Automatic level control, overall negative feed-back from r.f. output to modulation input, modulation monitoring by dual rectification, and variable impedance termination with animated diagram.

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### Figures of the Month

#### Receiver Production

<table>
<thead>
<tr>
<th>Latest Month</th>
<th>Previous Month</th>
<th>Year Ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: RETMA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Television sets, total</td>
<td>543,778</td>
<td>342,366</td>
</tr>
<tr>
<td>With UHF</td>
<td>72,760</td>
<td>41,596</td>
</tr>
<tr>
<td>Color sets</td>
<td>nr</td>
<td>nr</td>
</tr>
<tr>
<td>Radio sets, total</td>
<td>1,088,343</td>
<td>1,023,771</td>
</tr>
<tr>
<td>Auto sets</td>
<td>416,058</td>
<td>396,151</td>
</tr>
</tbody>
</table>

#### Receiver Sales

<table>
<thead>
<tr>
<th>Latest Month</th>
<th>Previous Month</th>
<th>Year Ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: RETMA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Television sets, units</td>
<td>389,770</td>
<td>399,757</td>
</tr>
<tr>
<td>Radio sets (except auto)</td>
<td>729,421</td>
<td>547,480</td>
</tr>
</tbody>
</table>

#### Receiving Tube Sales

<table>
<thead>
<tr>
<th>Latest Month</th>
<th>Previous Month</th>
<th>Year Ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: RETMA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiv. tubes, total units</td>
<td>35,328,000</td>
<td>32,836,000</td>
</tr>
<tr>
<td>Receiv. tubes, value</td>
<td>$31,314,000</td>
<td>$28,955,000</td>
</tr>
<tr>
<td>Picture tubes, total units</td>
<td>1,104,013</td>
<td>758,328</td>
</tr>
<tr>
<td>Picture tubes, value</td>
<td>$19,981,319</td>
<td>$14,031,519</td>
</tr>
</tbody>
</table>

#### Industrial Tube Sales

<table>
<thead>
<tr>
<th>Latest Quarter</th>
<th>Previous Quarter</th>
<th>Year Ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: NEMA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vacuum</td>
<td>$11,224,707</td>
<td>$12,408,371</td>
</tr>
<tr>
<td>Gas or vapor</td>
<td>$3,332,537</td>
<td>$3,223,612</td>
</tr>
<tr>
<td>Magnetrons and velocity modulation tubes</td>
<td>$15,359,108</td>
<td>$15,890,681</td>
</tr>
<tr>
<td>Gaps and T/R boxes</td>
<td>$1,409,463</td>
<td>$1,242,745</td>
</tr>
</tbody>
</table>

#### Military Procurement

<table>
<thead>
<tr>
<th>Latest Year</th>
<th>Previous Year</th>
<th>Year Ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: Defense Dept.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Army</td>
<td>$69,381,000</td>
<td>$56,285,000</td>
</tr>
<tr>
<td>Navy</td>
<td>$21,426,000</td>
<td>$34,230,000</td>
</tr>
<tr>
<td>Air Force</td>
<td>$159,829,000</td>
<td>$149,962,000</td>
</tr>
<tr>
<td>Total—Electronics</td>
<td>$250,636,000</td>
<td>$236,357,000</td>
</tr>
</tbody>
</table>

#### Broadcast Stations

<table>
<thead>
<tr>
<th>Latest Month</th>
<th>Previous Month</th>
<th>Year Ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: FCC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TV stations on air</td>
<td>519</td>
<td>519</td>
</tr>
<tr>
<td>TV stations CPs—not on air</td>
<td>132</td>
<td>126</td>
</tr>
<tr>
<td>TV stations—new requests</td>
<td>77</td>
<td>77</td>
</tr>
<tr>
<td>A-M stations on air</td>
<td>3,079</td>
<td>3,040</td>
</tr>
<tr>
<td>A-M stations CPs—not on air</td>
<td>159</td>
<td>167</td>
</tr>
<tr>
<td>A-M stations—new requests</td>
<td>322</td>
<td>311</td>
</tr>
<tr>
<td>F-M stations on air</td>
<td>330</td>
<td>332</td>
</tr>
<tr>
<td>F-M stations CPs—not on air</td>
<td>31</td>
<td>27</td>
</tr>
<tr>
<td>F-M stations—new requests</td>
<td>24</td>
<td>21</td>
</tr>
</tbody>
</table>

#### Communication Authorizations

<table>
<thead>
<tr>
<th>Latest Month</th>
<th>Previous Month</th>
<th>Year Ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: FCC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aeronautical</td>
<td>49,699</td>
<td>53,413</td>
</tr>
<tr>
<td>Marine</td>
<td>63,844</td>
<td>63,025</td>
</tr>
<tr>
<td>Police, fire, etc.</td>
<td>23,270</td>
<td>23,103</td>
</tr>
<tr>
<td>Industrial</td>
<td>35,711</td>
<td>35,315</td>
</tr>
<tr>
<td>Land transportation</td>
<td>9,992</td>
<td>9,580</td>
</tr>
<tr>
<td>Amateur</td>
<td>160,000</td>
<td>162,533</td>
</tr>
<tr>
<td>Citizens radio</td>
<td>27,931</td>
<td>26,930</td>
</tr>
<tr>
<td>Disaster</td>
<td>347</td>
<td>392</td>
</tr>
<tr>
<td>Experimental</td>
<td>788</td>
<td>783</td>
</tr>
<tr>
<td>Common carrier</td>
<td>2,790</td>
<td>2,731</td>
</tr>
</tbody>
</table>

#### Employment and Payrolls

<table>
<thead>
<tr>
<th>Latest Month</th>
<th>Previous Month</th>
<th>Year Ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: Bur. Labor Statistics)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prod. workers, comm. equip.</td>
<td>364,500-p</td>
<td>391,900</td>
</tr>
<tr>
<td>Av. wkly. earnings, comm.</td>
<td>$78,60-p</td>
<td>$79,19</td>
</tr>
<tr>
<td>Av. wkly. earnings, radio</td>
<td>$76,21-p</td>
<td>$76,81</td>
</tr>
<tr>
<td>Av. wkly. hours, comm.</td>
<td>40.1-p</td>
<td>40.2</td>
</tr>
<tr>
<td>Av. wkly. hours, radio</td>
<td>39.9-p</td>
<td>39.9</td>
</tr>
</tbody>
</table>

#### Semiconductor Sales Estimates

<table>
<thead>
<tr>
<th>Latest Month</th>
<th>Previous Month</th>
<th>Year Ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>June '57</td>
<td>May '57</td>
<td>June '56</td>
</tr>
<tr>
<td>Transistors, Units</td>
<td>2,245,000</td>
<td>2,055,000</td>
</tr>
</tbody>
</table>

#### Stock Price Averages

<table>
<thead>
<tr>
<th>Latest Month</th>
<th>Previous Month</th>
<th>Year Ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source: Standard and Poor's)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radio-tv &amp; electronics</td>
<td>51.42</td>
<td>51.69</td>
</tr>
<tr>
<td>Radio broadcasters</td>
<td>66.56</td>
<td>69.18</td>
</tr>
</tbody>
</table>

#### Figures of the Year

<table>
<thead>
<tr>
<th>Electronic Output Index</th>
<th>1947=100</th>
</tr>
</thead>
<tbody>
<tr>
<td>325</td>
<td>100</td>
</tr>
</tbody>
</table>

#### Totals for the First Six Months

<table>
<thead>
<tr>
<th>1957</th>
<th>1956</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,722,139</td>
<td>3,415,202</td>
<td>-20.3</td>
</tr>
<tr>
<td>7,187,294</td>
<td>6,659,165</td>
<td>+ 7.9</td>
</tr>
<tr>
<td>2,810,403</td>
<td>2,868,250</td>
<td>-2.0</td>
</tr>
<tr>
<td>3,638,969</td>
<td>3,391,102</td>
<td>+ 7.3</td>
</tr>
<tr>
<td>221,175,000</td>
<td>227,656,000</td>
<td>-0.3</td>
</tr>
<tr>
<td>3,814,658</td>
<td>5,152,743</td>
<td>-26.0</td>
</tr>
</tbody>
</table>

September 1, 1957 — ELECTRONICS
Signal-Enhanced Radar Adds DX, Plies Outer Space

Technique makes feasible radar tracking of earth satellites and intercontinental missiles

RESULTS of a three-year research program on ORDIR at Columbia University, sponsored by Rome Air Development Center, USAF, have been partially disclosed. Most encouraging and noteworthy fact is that the scientists engaged in this work were able to successfully dodge around the basic radar receiver sensitivity limit—noise. Exactly how done is still classified information.

► System Characteristics — The new technique may best be explained by resorting to a lock and key analogy given by John Bose, former assistant to Major Armstrong. The radar transmitter contains a specially designed modulator that places a certain identifying characteristic (key) on the f-m/c-w carrier. The received echo is operated on by special circuits (tumblers) in the receiver (lock) which enable the signal to be recognized even though its signal strength is many times less than that usable by present systems.

► Facts—Owing to the classified nature of the project, little detail on operating characteristics could be gleaned. However, this much can be told.

The transmitter uses special modulation, does not use a magnetron but can use a klystron or platinotron. Wideband operation is used.

The receiver has a wideband front end. New circuits use a combination of the following techniques to detect the signal, transient filtering, coherent integration and spectrum analysis. How these techniques are employed was not disclosed, except that the result is called signal-enhancing.

► Applications—It is not too difficult to envision the use to which this hypersensitive radar system could be put. The line-of-sight distance for a target about 600 miles high is approximately 2,500 miles. This range would allow detection of the earth satellite as it swings through its orbit (300 to 700 miles high) as well as a reentering ICM. In the latter case, detection at 2,500 miles would provide only a few minutes advance warning—minutes we now lack.

(Continued on page 8)
Radio Astronomy Maps The Universe

Largest computer-controlled radio telescope is now ready to increase astral knowledge

Claimed to be the most sensitive short-wave radio receiver and the most far-reaching radio transmitter ever constructed, this $2.5-million radio system, used by England's University of Manchester, features a computer-controlled servo system that makes it possible to track the course of a star in the sky, to scan any three coordinates of an arc in space, or to traverse rapidly from one preset position to another.

- **Geometrics**—The 2,000-ton structure consists of a bowl which pivots between two 180-ft towers and the bowl can be rotated around a fixed axis parallel to the earth. The towers themselves ride on railway cars, which travel on the ground on a 352-ft diameter circular railway track, so that complete spherical coverage of the sky is obtained.

- **Tasks**—A team of 36 men, headed by Professor A. C. E. Lowell, will work in the one to two-meter band where an antenna with a beam width of one degree and a power gain of 16,000 will be used to locate sources of radio emission 200-million light-years back. Future work is planned to operate in the 21-cm band with a beam width of 25 minutes, to detect emission from hydrogen clouds of a density of one atom per cc at a distance of 10,000 light-years away. This emission results from a reversal of electron spin in a neutral hydrogen atom and is computed to occur only once in 11-million years.

- **Controls**—One man, sitting at a control desk located in a building about 200 yards away from the center of the huge radio telescope, can control the entire mechanism. Azimuth speed—or ground-track travel ranges between 8 minutes of arc per minute up to 20 degrees per minute. Elevation speeds range from 9.6 minutes of arc per minute up to 24 degrees per minute.

The computer, designed by Dunford and Elliott of Sheffield, is accurate to within four minutes of arc and the drive system is accurate to within 5 minutes of arc.

- **Computer**—The electromechanical analog computer solves 14 trigonometric equations from the inputs of sidereal time and astronomical coordinators, to give azimuth and elevation-command signals to the main-drive system. Computer design was solved for scanning requirements in any one of three sets of coordinates: the rate of scan is variable and the elevation rate is either time controlled or position controlled. In addition, controls indicate the actual position of the system in terrestial, galactic and celestial coordinates.

Training Device Fakes Fallout

Transmitter simulates gamma radiation, receivers are calibrated in roentgens

Electronic equipment for faking fallouts may mushroom into a substantial business by winter.

Requested by the Army for training personnel how to operate in contaminated areas, a Radiation Survey Training Set was created by the Naval Training Device Center, Port Washington, N. Y. to stimulate radioactive contamination and the radiometers (1M 108) troops will use to detect it. Admiral Radio was awarded the contract for development and production and will deliver a development model to the Center this month. First 225 complete units will go to Army.

- **Potential market**—Navy and Marine Corps have also expressed interest in the equipment for their own personnel. Air Force and Civil Defense will probably request such equipment later. Civil Defense now has radiometers with no safe way to train personnel to use them.

Equipment and training procedures devised by the Center are both simple and effective. Following a loud but harmless explosion with accompanying white flash and mushrooming cloud, a radio transmitter located beneath the trick atomic explosion starts beaming (Continued on page 10)

September 1, 1957—ELECTRONICS
variable "L" by BURNELL

ADJUSTOROIDS®

The Adjustoroid, a low cost adjustable toroid, exclusively developed by Burnell & Company, Inc., contains an actual complete toroid which relays all the excellent characteristics of the non-adjustable types. Adjustment is obtained by a completely stepless function with magnetic biasing.

The nominal inductance value for an Adjustoroid is the maximum value, and the inductance range is the nominal value minus approximately 10%.

Hermetically sealed to meet Government MIL specifications. Many types of networks in tuned circuits are being produced which employ the Adjustoroid in completely hermetically sealed packages.

Intermediate inductance values as well as special taps and extra windings available on special order with minimum delay.

For additional technical data on Adjustoroids, refer to equivalent toroid in catalog.

and now ...

NEW SUBMINIATURE VARIABLE INDUCTORS

AF-87

(30-500 cycles)
maximum Q at 400 cycles

AF-88

(50-1000 cycles)
maximum Q at 800 cycles

Burnell subminiature variable inductors are especially designed for low frequency applications or where proportionately high inductance values are required. Except for low frequency, high inductance values, subminiature inductors are similar to Adjustoroids and measure 1/4" in height and 45/64" in width and depth. Variable inductors are available in all inductance values up to 80 Hys.

BURNELL & CO., INC.

Dept. 897, 10 Pelham Parkway, Pelham Manor, New York
Pacific Division: 720 Mission St., S. Pasadena, Calif.
out harmless radio propagation in elliptical patterns similar to those created by wind spreading fallout material.

Field strength of this radio transmission varies in relation to distance from receiver to source just as radioactive propagation. Terrain irregularities, first thought to be a problem, actually distort radio propagation just as they do movement of radioactive material.

Ten trainees, scattered within the ten-mile range of the transmitter, will check their portable transistorized receivers for field strength of the radio transmission. Receiver meters (device 48E1A) will look and operate like real radicameters (LM 108) with field strength calibrated in roentgens. Special hot spots will be simulated by oscillators, miniature transmitters that emit signals on the same frequency.

TELLUROMETER with radiotelephone is latest boon to surveyor as . . .

**Microwaves Map Rough Terrain**

Light-weight instruments cut surveying tasks two to ten times

Two suitcase-sized tellurometers, microwave mapping instruments, are in operation in Canada. They replace conventional transverse and triangulation distance surveying methods.

- **Light-weight**—Developed by the South African Council for Scientific and Industrial Research, the tellurometers weigh 24 pounds.

Light-weight equipment is necessary in the rough country where most Canadian mapping is done today.

Purchasers are Photographic Survey Corp. of Toronto, commercial surveyors, and the surveys and mapping branch of the Canadian Department of Mines. PSC says tellurometry can increase mapping productivity two to 10 times.

- **Microwaves**—Working with a master station, the instruments measure the time it takes microwaves to travel from the master to remote and return. Range is 50 miles. Voice contact between stations is maintained by a built-in duplex radiotelephone. PSC is a member of Hunting Associates, a group of 50-odd engineering, geophysical, oil, transport and manufacturing firms. The latest associate is Photronix, a Columbus, Ohio, highway engineering firm.

- **Highways**—Photronix was formed recently to exploit a computer method of photogrammetry. Information gathered from aerial photos and ground surveys is transferred to computer punch cards. The computer accounts for shoulders, ditches, side slopes and super-elevations and tabulates earthwork volumes, seeding areas, slopes and mass diagrams. Savings of up to 60 percent in planning time and 40 percent in costs are claimed.

(Continued on page 12)
surface barrier transistors from SPRAGUE

2N344/SB101
for Medium Gain Amplifiers

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2N345/SB102
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2N346/SB103
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2N240/SB5122
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<tr>
<td>Ts</td>
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</table>

IN VOLUME PRODUCTION Now!

For general high frequency applications, and for high speed computer switching circuits, design around Sprague surface barrier transistors. They are available now in production quantities from a completely new, scrupulously clean plant, built from the ground up especially to make high quality semi-conductor products.

The four transistor types shown are the most popular. Orders for these units are shipped promptly. What's more, surface barrier transistors are reasonably priced. High quality and excellent electrical characteristics make them an economical solution to many difficult circuit requirements.

Sprague surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type number are manufactured to the same specifications and are fully interchangeable. You have two sources of supply when you use surface barrier transistors!

WRITE FOR COMPLETE ENGINEERING DATA SHEETS ON THE TYPES IN WHICH YOU ARE INTERESTED. ADDRESS REQUEST TO THE TECHNICAL LITERATURE SECTION, SPRAGUE ELECTRIC CO., 35 MARSHALL ST., NORTH ADAMS, MASS.
Microwave Cooking Warms Up

Estimate for 1962 sees 100,000 sold, 1965 climb to 250,000

MICROWAVE cooking ranges for the home, according to General Electric estimates, will reach an annual market figure of 100,000 in 1962. Ratheon sees it booming along at a 250,000 annual rate in 1965.

The first serious attempt to crack the home market with electronic ovens came at the beginning of 1956. That year saw 2,500 of them move into homes. This year, those in the electronic range business see the total modestly lifted to a 3,000 rate. At least one company thinks it will be higher, though not much.

Producers — Companies producing electronic ranges for homes include Tappan, Westinghouse, Hotpoint, Whirlpool, Kelvinator. General Electric plans to produce an oven early in 1958.

Raytheon is a supplier of the generating equipment, also makes complete microwave ovens of greater size for restaurants.

Microwave ovens have been reduced to home size just since 1950. In 1950 a unit stood 5 feet high, was water-cooled and weighed 750 pounds. Today, an electronic oven can be tucked into a wall space 24 in. x 21 in. x 22 in. It is air-cooled.

One of the safest features which is aiding sales appeal is that the oven is turned off immediately when the oven door is opened.

Bandwidth — Microwave cooking is being done in the 2,400-2,500-mc bandwidth. Raytheon feels that it can produce the microwave equipment for less if the frequency were extended. In the FCC hearings on the part of the spectrum above 890 mc, Raytheon has asked that the bandwidth be widened, making it 2,370-2,500 mc.

The present price of the ranges runs about $1,200. Raytheon estimates that mass production and improvements will eventually bring it down in the neighborhood of $600.

Tappan, Mansfield, Ohio, feels that there is no question of the electronic oven's acceptability among housewives if the price can be brought down to $800.

Meat and Potatoes — The basic appeal that microwave cooking has for the housewife is time saving. The afternoon bridge party doesn't have to break up at four-thirty. It can go on until almost six.

The working wife doesn't have to tug a reluctant working husband to the restaurant because there isn't time to make dinner. A steak in a microwave cooker takes one and a half minutes. A baked po-
tato is done in four minutes, a saving of 56 minutes over a gas oven.

The economics of using high frequency radio energy to cook food for large groups such as in hospitals and restaurants has recently been documented by the Kaiser Foundation Hospital, Walnut Creek, Calif. It estimated that annual savings by hospitals in the U.S. would be more than $100,000,000.

Tube Savers Extend Life Of I-O Tubes

Market Potential: 500 TV stations using 1,600 cameras

Three companies are offering TV broadcasters for delivery this year devices designed to extend the life of TV camera-orthicon tubes.

Principle of each is to wobble the image on the orthicon tube to prevent burn-in and sticking. Besides extending the life of the i-o tubes by wobbling the image, all three devices are expected to allow transmission of clearer pictures, without carryover from previous scenes.

(Continued on page 14)
Arnold Magnetic Materials

... the most complete line in the industry

PERMANENT MAGNET MATERIALS
- Cast Alnico Magnets
- Sintered Alnico Magnets
- Vicalloy
- Cunife
- Arnox III

HIGH PERMEABILITY MATERIALS
- Tape Wound Cores of Deltamax, Supermalloy, Permalloy
- "C" and "E" Cores of Silectron
- Bobbin Wound Cores
- Molybdenum Permalloy Powder Cores
- Iron Powder Cores
- Sendust Powder Cores
- Special Magnetic Materials

PRECISION-TESTED TO YOUR SPECS...

Arnold magnetic materials can answer all your requirements. It is the most complete line in the industry; and in addition, Arnold maintains complete control over every production step from raw materials to finished products.

Typical testing of Molybdenum Permalloy Powder Cores is illustrated above. Precision equipment and methods such as these accurately measure the properties of all magnetic materials before shipment, insuring ultimate performance in accordance with your specifications.

Such a source can bring you advantages in long experience and undivided responsibility, and in unequalled facilities for quality control and production.

* Let us supply your needs!

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Main Office & Plant: Marengo, Illinois
Repatri Pacific Division Plants: 541 East 61st Street, Los Angeles, Calif.
District Sales Offices:
- Boston: 200 Berkeley St.
- Los Angeles: 3450 Wilshire Blvd.

ELECTRONICS — September 1, 1957

Circle 5 Readers Service Card
scanning beam inside the tube follows and automatically compensates the wobble, causing the transmitted picture to appear as a normal stationary image on home tv receivers.

Complete unit comprises about 50 small parts, including six capacitors, a synchronous resolver and a drive motor. With cover closed, it is similar in appearance to a cigar box. The unit mounts easily on the exterior of seven out of eight tv cameras now in use and provides maximum prevention without burn-in.

► Other types — RCAs unit for monochrome cameras, called an orbiter, operates on an electromagnetic principle. Two coils are added in quadrature around the image section of the tube yoke assembly. For color cameras, RCA uses a rotating prism, called an orbital wedge, which is located between the lens and the image orthicon tube.

Visual Electronics’ equipment consists of a motor-driven mechanism that causes the lens of a tv camera to move in a small circular orbit. The image on the orthicon photocathode moves in turn in the same circular orbit.

The problem of holding the transmitted picture stationary is achieved by introducing suitable correcting signals to the centering circuits of the tv camera. The correcting signals are sine and cosine functions obtained from a sine-cosine potentiometer. Each function is amplified by a small transistor amplifier and applied to the correct deflection circuit.

Under average station use, life of i-o tubes without tube savers ranges from 200 to 1,000 hours. Tubes cost about $1,200 each and must be replaced two to ten times a year. One company believes its new device will double the life of i-o tubes.

Costs of tube savers, depending on the system, range from $750 to $2,400 each.

Market potential is big. There are about 1,600 cameras now in service in the nation’s more than 500 tv stations.

Military Electronics

► New Falcon GAR-2A, air-to-air infrared guided aircraft rocket, will travel with radar-guided Falcon GAR-1D. Mixed loads are said to give the interceptor greater attack versatility

► Hard glass electron tube, capable of prolonged operation at 300 degrees C and reduced in price from $300 to $5, has been produced by Bendix under AMC contract

► Hawk, low-altitude ground-to-air defense missile, is being integrated into Missile Master, electronic system for controlling and coordinating fire of Nike anti-aircraft batteries

► Improved d-c data transmission system which utilizes ordinary telephone lines has been developed by Burroughs. Known as Cordat (Coordinate Data Set), the system is used both at transmission and reception points. At transmission, radar-furnished d-c analog voltages are converted to digital data transmission over telephone lines. At reception, digital data is reconverted into d-c analog voltages where it is used by a computer system for use in aircraft detection and target interception

Computer Applications Increase

Wage reports and automatic mail sorting expand jobs computers can do for business

MAGNETIC tape is slicing into the time and money spent by industry in filling out government forms. The Federal Social Security Administration’s accounting division in Baltimore has started the ball rolling.

► Savings—Previously, a 600-page binder prepared for 26,000 employees meant that the government agency had to prepare 26,000 key punch cards manually
Kahle Machinery

FOR EVERY STEP OF SEMICONDUCTOR MANUFACTURING:

- TRANSISTORS
- GLASS DIODES
- RECTIFIERS

Kahle, the pioneer manufacturer of Automatic Semiconductor machinery, continues to set the pace in the design and development of newer, more efficient semiconductor production machinery. Typical of Kahle design advances is a new Semi-Automatic Glass Diode Sealing Machine #2948 now producing 700 glass diodes per hour for leading semiconductor manufacturers throughout the world. Modified versions of this machine are available for smaller and larger production quantities — a high speed, Fully Automatic model produces up to 2000 units per hour.

If you want to efficiently automate your semiconductor production — it will pay you to consult Kahle first. Kahle will design a semiconductor production machine to solve any requirement. There's no risk involved — every machine is tested to customer satisfaction before shipment.

Learn why Kahle machinery is used by more and more semiconductor manufacturers. Write today.

KAHLE ENGINEERING COMPANY

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PLANTS: SEVENTH STREET, NORTH BERGEN, N. J.
HUDSON AVE., UNION CITY, N. J.

DESIGNERS AND BUILDERS OF SPECIAL AUTOMATIC AND SEMI-AUTOMATIC EQUIPMENT FOR ALL INDUSTRIAL APPLICATIONS

Circle 6 Readers Service Card
to use the data. Now, it feeds the tape into its own computing system, makes a reproduction and sends back the master tape.

A Social Security spokesman said several other large employers are expected to join the program and that the agency wants as many participants as it can get.

Who — General Electric, IBM and Consolidated Edison Company of New York are sending their employee payroll records to Baltimore on reels of tape rather than on piles of paper forms. The New York Power Company already had an IBM 705 handling its payroll and other financial records. It was only one more step to have the computer record employees' names, social security number, amount of taxable ages and other pertinent data on tape for this quarter.

Postman — Envisioning a five-to-ten-year transition to electronics, the Post Office Department, in conjunction with the National Bureau of Standards, has been experimenting in various cities with electronic sorting machines. One such sorter, called trans-orma, under test at Silver Spring, Md., can sort 15,000 letters an hour into 200 chutes.

At Chicago, a five-year, $40-million modernization and automation program is under way. Sixty-six miles of electronically controlled conveyors are being installed.

Billion billion — A mechanical blackboard that erases itself automatically to find the best of 2-billion-billion possible answers to a problem has been developed at the University of Michigan.

Called MITAB, for Michigan Transportation and Assignment Blackboard, the $5,000 device provides short cuts in 20 minutes to answers that would take a big electronic computer years to work out the long way.

Properly, it cannot be called a computer because it cannot remember instructions. It can be directed, however, to add, subtract and perform other functions.

Use — The device has potential as a research and instructional tool. Its face is made up of 400 indicators arranged in 20 by 20 matrix, 800 lights and 400 switches. Each indicator registers from zero to ten.

Example — If the rows represent the machines available for jobs in a factory and the columns the various jobs to be done, the indicators can be set to show the cost of each job on each machine.

With 20 jobs and 20 machines there are 2,432,902,008,176,640,000 possible ways to assign the jobs. The problem is to find the best arrangement — the least total cost, the fastest operating time or some other criterion. It is possible to add and subtract from rows and columns and perform other mathematical tricks to arrive at the solution in minutes. Thus, shown the way, a computer could then solve the original problem.

Magnetic Tape Comes To Life

Originally audio medium, it now advances on many fronts beyond the sound sphere

With volume of audio tape recorder sales now exceeding $100 million annually and raw tape sales for all uses approaching $12 million per year, informed sources in the tape industry look for their largest sales increases in the industrial field.

While recording equipment for instrumentation, automation, tele-metering, computers and other types of data processing represents only about ten percent of the market, the tape consumed by such devices accounts for about one third of the total sales of the magnetic ribbons.

Although there has been some resistance in business to data-processing equipment using magnetic materials (If somebody accidentally erases a roll of tape we're ruined!), tape is nonetheless steadily supplanting punched-card information carriers. With the cost for a square foot of office or factory space showing no signs of going down, the fact that a 7-inch reel of tape can store as much information as a cubed stack of punched cards measuring a yard in each direction becomes a potent sales argument.

Video — While industrial appli-
...the Standard of the Industry

...for Capacitance and Dissipation-Factor Measurements is the G-R Type 716-C Capacitance Bridge. This instrument is used the world over for the accurate measurement of these characteristics and their change with frequency, temperature, and humidity. In addition to the measurement of all types of capacitors and dielectric properties of insulating materials, the Bridge is capable of measuring resistance and parallel capacitance of high-valued resistors, up to several thousand megohms; inductance and storage factor of inductors, up to several thousand henrys; characteristics of electrolytes, and many other impedances by substitution measurements.

Type 716-CM Capacitance Bridge in Walnut Cabinet, $600
716-CR Relay Rack Model, $565

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<th>Substitution Measurements</th>
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<td>Accuracy Dissipation Factor Readings</td>
<td>±0.1% or ±2% whichever is larger; lower than ±0.05% or ±0.2% of change in dissipation factor observed</td>
</tr>
</tbody>
</table>

for use between 0.5 Mc and 3 Mc

Type 716-CMS1, $580 Type 716-CRS1, $545
Also available are oscillators, null detectors, filters, and a dielectric sample holder for measurement of solid materials.

Write For Complete Information

DISCAPS, manufactured by Radio Materials Corporation, meet the highest standards for ceramic capacitors. Every unit is tested for acceptable power factor, capacity, and leakage resistance with the aid of measuring instriments of instant kind. The G-R Type 716-C Capacitance Bridge for high dielectric materials. Type 172 Precision Capacitor with warm-correction for low dielectric materials. Capacitance measurements by substitution methods give accuracies of the order of 0.1%. The G-R Type 716-C Test Fixture eliminates the effects of "lead" capacitance.

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass., U.S.A.

All G-R Products are now covered by a 2-Year Warranty
Now, in the JETEC 30 package
both Silicon and Germanium, including NEW AUDIO

FUSION ALLOY
TRANSISTORS

Raytheon presents the well rounded range of Transistors charted on the opposite page. This covers not only the full complement of JETEC 30 Transistors but others including several in an extremely small package.

All of these Transistors are made by the Raytheon-perfected fusion-alloy process that assures superior electrical performance and supreme reliability; life tests aggregating over 20,000,000 transistor hours show less than one open per 800,000 hours, and no shorts!

RAYTHEON TRANSISTORS
for superior reliability . . . superior performance
<table>
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<th>Type</th>
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<th>$I_{eh}$ max.</th>
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Available to Signal Corps specification

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<th>$I_{cc}$ max.</th>
<th>$I_{eh}$ max.</th>
<th>$I_{el}$ max.</th>
<th>Power Gain</th>
<th>Conv. Gain</th>
<th>Diss. Coeff.</th>
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<tr>
<td>2N138B</td>
<td>B</td>
<td>2N138A</td>
<td>Amplifier</td>
<td>12</td>
<td>50</td>
<td>15</td>
<td>37</td>
<td>26-31</td>
<td>50</td>
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<tr>
<td>2N359</td>
<td>C</td>
<td>2N138A</td>
<td>22.5</td>
<td>100</td>
<td>25</td>
<td>50*</td>
<td>37</td>
<td>33</td>
<td>50</td>
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<td>25</td>
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<td>25</td>
<td>50</td>
<td>31</td>
<td>30</td>
<td>50</td>
<td>500</td>
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For above eight types $I_c = -200$ ma max.

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<th>Supersedes</th>
<th>Circuit Usage</th>
<th>$V_{cc}$ max.</th>
<th>$I_{cc}$ max.</th>
<th>$I_{eh}$ max.</th>
<th>$I_{el}$ max.</th>
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<th>Conv. Gain</th>
<th>Diss. Coeff.</th>
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<td>3</td>
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<td>-</td>
<td>-</td>
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<tr>
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<td>Amplifier</td>
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<td>3</td>
<td>12±2</td>
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<td>-</td>
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<tr>
<td>2N414</td>
<td>C</td>
<td>2N112/CK760</td>
<td>Converter</td>
<td>-15</td>
<td>5</td>
<td>12±2</td>
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<td>2N112A/CK760A</td>
<td>Amplifier</td>
<td>-15</td>
<td>5</td>
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<td>C</td>
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<td>10</td>
<td>12±2</td>
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<td>2N113</td>
<td>Gen. Purp.</td>
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<td>12±2</td>
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<td>Gen. Purp.</td>
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<td>12±2</td>
<td>-</td>
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For above eight types $I_c = -400$ ma max.; $Z_{oa} = 1.5$ ohms for $I_c$ of 100 ma

<table>
<thead>
<tr>
<th>Type</th>
<th>Case</th>
<th>Supersedes</th>
<th>Beta</th>
<th>$L_m$</th>
<th>$H_{f''''}$</th>
<th>$H_{f'''}$</th>
<th>$H_{f'''''}$</th>
<th>$H_{f'''''}$</th>
<th>$C_e$</th>
<th>$f_{com}$</th>
<th>Diss. Coeff.</th>
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<td>2N427</td>
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<td>2N428</td>
<td>C</td>
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<td>17</td>
<td>80</td>
<td>40</td>
<td>1.7</td>
<td>0.1</td>
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<td>0.3</td>
<td>0.4</td>
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</table>

For above four types $I_c = -400$ ma max.; $Z_{oa} = 1.5$ ohms for $I_c$ of 100 ma

Write for Data Sheets on individual types for complete ratings and test conditions.

All ratings on this page taken at 25°C. Dissipation coefficients shown are for free air. All are hermetically sealed.

SEMI CONDUCTOR DIVISION
Silicon and Germanium Diodes and Transistors • Silicon Rectifiers
NEWTON, MASS.: 55 Chapel St., Bigelow 4-7500 • NEW YORK: 589 Fifth Ave., Plaza 9-3900
CHICAGO: 9501 Grand Ave., Franklin Park, TUxedo 9-5400
LOS ANGELES: 5236 Santa Monica Blvd., NORmandy 5-4221
cations are expected to show the greatest growth spurt in the next few years, expansion in other areas continues apace. Video tape is now a commercial reality with Ampex in production and at least two other prototypes, by RCA and Bing Crosby Enterprises, have been demonstrated. RCA is reported to be aiming at the home-instrument market, while the Bing Crosby efforts have been taken over by tape-makers Minnesota Mining & Manufacturing. Further consolidation in this direction has seen the purchase by Ampex of a minority interest in Orradio, another tape producer.

► Stereo—Major breakthrough in the home field is expected this year, with most or all of the important phonograph record companies due to plunge into the stereo recorded tape field. Although stereo tapes have been available for several years, all of the producers have been small operators with the exception of RCA Victor.

Now Mercury, followed closely by Capitol and Columbia, has introduced a stereo tape line. This leaves Decca as the major holdout, at the present time.

The stereo disk is also definitely contemplated in the record industry, but it is unlikely that its introduction to the consumer market will be seen this year.

► Photo, too—Although most magnetic recording business activity is centered around electronics manufacturers, it is interesting to note the movement into the field by names better known for photographic products. These include Bell and Howell, Berndt-Bach, Federal Mfg. and Eng., Stencil-Hoffman, Wollensak and Revere Camera.

Eastman Kodak, which has been supplying plastic stock for tape base material for several years, is now reported to be on the verge of coating it as well and marketing the finished product.

Devices Advance British Electronics

Mail is sorted; hearts are sounded; and life is sustained

NEWS FROM BRITAIN indicates that electronic aids are keeping pace on several fronts. Recent developments in diverse fields point up the widespread use of the electronic art for practical applications.

► Sorting Mail—Twenty electronic letter sorters, developed by the British Post Office, will soon ease mail-sorting tasks in England. Letters of various mixed sizes pass across a window and an operator, sitting in front of one of the machines, presses one of twenty-four keys according to a memorized combination.

The letter is conveyed on roller tracks by an electronically-controlled memory to be correctly pigeon-holed for its destination.

► Bulk—Another machine segregates letters and packages. Mail is tipped into a loading hopper and carried by a conveyor band to a segregator drum. Thin letters slip through the hinged flaps which make up the outside of the drum, on to a conveyor below. Bulk cannot pass through the flaps and emerge ready for hand stamping.

► Postal Orders—An electrically-driven machine for counting postal orders, now in an experimental stage, can handle up to 300,000 postal orders a day. It occupies little more space than a typewriter.

► Sounding Hearts—Three British medical men have collaborated in designing a stethoscope which amplifies sounds and shuts out unwanted noise. Based on the principle that all sounds have a certain frequency, a doctor manipulates two controls so that only sounds of a particular frequency are carried to ear pieces. With this stethoscope, a doctor can, for example, listen to the heart of a poliomyelitis patient in an iron lung while the

(Continued on page 22)

Controls Speed Defense Work

ELECTRONIC machine-tool controls are finding more applications in the atomic energy and air defense programs. A numerically controlled milling machine designed by Bendix for Martin Aviation (ELECTRONICS, Feb. 1956, p 122) is now being installed for production work on the Matador missile and P6M jet seaplane.

► Tape Control—Use of tape-recorded machining instructions permits quick change-over in production and faster production on new operations since templates and hand-made models are not required before production can start.

► Lathe Control—A control system developed by Lear, Inc. for use in a General Electric plant for machining radioactive materials employs three servo systems to control a hand lathe from a distance. The system is sensitive to one-quarter degree change in position and can hold normal machining tolerances with remote operator behind shielding.

TUBES make missiles (left) and radioactive parts as . . .
Barry's New "LO" Mount Meets MIL-C-172B at low cost

With this extra vibration isolation that adds reliability to your design.

We designed for lower cost — and developed a better mount for MIL-C-172B. Even at 10° inclination, the new Model L44 Mount performs effectively. And its other characteristics, too, far exceed requirements of MIL-C-172B.

The basically simple and versatile construction of this new isolator let us match characteristics to your specification. Your design now gains reliability with a mount that more than satisfies MIL-C-172B — and at low cost.

**Extra-low transmissibility and low natural frequency**

This low transmissibility — below 2 at resonance in all load ranges — is a major advantage of the Model L44 isolator. It accommodates high-amplitude inputs, even at resonance, without snubbing. Typical isolation at 10° inclination is also shown above.

**Very low rocking modes**

In base-mounted systems, transmissibility of rocking modes under horizontal vibration is reduced to the point where they are indiscernible. This is due to the combination of inherently low ratio of horizontal-to-vertical stiffness plus horizontal self-centering friction damping.

**For center-of-gravity designs**

Independent horizontal damping makes the "LO" mount especially suited for installation in the plane of center-of-gravity of the equipment. The natural frequency of the system shown above is below 5 cps.

**Controllable characteristics**

These exceptional characteristics result from the unique Barry spring and friction-damping design pictured above. And these characteristics can be controlled to give high performance with a wide variety of equipment. Horizontal and vertical damping can be controlled independently. Special versions of the "LO" mount will control transmissibility at resonance for a given input or handle very high-amplitude inputs at resonance without snubbing.

**Physical characteristics**

The L44 Mount is dimensionally interchangeable with MIL size isolators. It is available in 7 load ranges from 0.25 to 10 pounds per mount in long- and short-core models. It meets all environmental as well as vibration requirements of Procedure I, MIL-E-5272A. Temperature range is -85°F to 250°F. Weight is 1½ ounces per mount.

Write today for data sheet 57-05 Barry's new Western Division, in Burbank, California, offers fast, on-the-spot design and prototype service, and production of special systems.
The brain of the instrument, contained in a compact box weighing only 18 ounces, is suspended from the neck. Two sets of ear pieces can be used simultaneously, and a tape recorder and a loud-speaker can also be connected. This last feature has an obvious value for teaching purposes. A special microphone conveys only wanted sounds. The instrument is produced by Air-sonic Ltd., London.

Sustaining Life—An apparatus for coaxing new-born babies to breathe is in regular use at the Royal Maternity and Women’s Hospital in Glasgow, Scotland. The electronic respirator is actually controlled by the infant. When the baby makes an effort to breathe, a small pressure change in his face mask operates a sensitive trigger valve and brings an electronic controller into operation.

The original impulse supplied by the baby is amplified and used to open a valve connected to an air or oxygen cylinder.

FCC Actions

Cracks down on vessels under the jurisdiction of the Communications Act without radiotelephone installations. FCC will fine such vessels $500. Each day of navigation without radiotelephone constitutes a separate offense. In addition, the master of the vessel is fined $100 for failure to enforce or comply with the Communications Act.

Permits West Coast Telephone Company to file comments in Commission’s study of the portion of the spectrum at and above 890 mc, even though filing date has passed.

Studies a switch in class B f-m allocations. It may give channel 231 to Cincinnati, Ohio, after removing channel 278 from Cincinnati and assigning it to Middletown, Ohio.

Grants RCA Communications permission to set up rates and regulations for 45-wpm printer subchannels between the United States and Switzerland.


Utilities Eye Microwave Channels

Statistical microwave survey establishes reasonable basis for power utilities usage.

Answers to a questionnaire sent to 310 electric, gas, steam and water utilities operations indicate the extent and usage of microwave systems by such companies. The survey was conducted by L. E. Ludekens, National Committee for Utilities Radio representative on the Operational Fixed Microwave Council.

Extent—The report shows that as of April 1, 1957, there are 86 licensees in the Power Radio Service, having 1,028 microwave transmitters authorized in the three as-
Here is Raytheon's radically new and improved version of the popular 6AH6 for military and severe environmental use in radar, communications, computers and instruments. It embodies manufacturing and quality control techniques above and beyond military requirements.

**features**

- **LOW INTERFACE RESISTANCE**  
  with strict controls on interface formation during life

- **LONG LIFE**  
  duplicating that of the well-known 6AN5WA

- **NO PULSE OVERSHEEPT**

- **9000µmhos TRANSCONDUCTANCE**
  
  \[
  g_t = 6.3 \text{v} \quad E_p = 300\text{v} \quad E_c = 150\text{v} \n  I_t = 0.45\text{A} \quad I_p = 10\text{mA} \quad I_c = 2.5\text{mA} \n  \]

- **ALL MILITARY RELIABLE TUBE SPECIFICATIONS**
  
  including:  
  - Shock
  - Fatigue
  - Interface Life
  - High Temperature Life
  
  Stability Life
  Survival Rate Life
  Heater Cycling Life
  Noise and Microphonics

---

**SPECIAL TUBE DIVISION**

**RELIABLE MINIATURE AND SUBMINIATURE TUBES**  
**VOLTAGE REFERENCE TUBES**  
**VOLTAGE REGULATOR TUBES**  
**PENCIL TUBES**  
**NUCLEONIC TUBES**

---

NEWTON, MASS.: 56 Chapel St.  
NEW YORK: 589 Fifth Ave.  
CHICAGO: 9501 Grand Ave., Franklin Park  
LOS ANGELES: 5236 Santa Monica Blvd.
signable frequency bands. In all, there are 13,700 radio-frequency route miles with transmitters located at 513 stations.

There are now in use over 41,000 voice circuit miles and approximately 69,000 circuit miles of combined voice, telemetering, supervisory control, relaying and other forms of transferred intelligence. The utilities now have constructed what might be called their main route microwave system, and are presently installing numerous specialized and wayside channels.

Response to the NCUR questionnaires indicates 72 equivalent voice circuits, as a present maximum for any one radio frequency path, and a statistical average of 10 equivalent voice channels for an average microwave path. On the subject of Mobile Radio Service repeat-control microwave stations; in the 960-mc band there are a total of 162 transmitters, with 24, or 19 percent, used for repeat-control. In the 2,000-mc band, there are 434 transmitters, with 8, or 2 percent, used for repeat-control. In the 6,700-mc band, there are 948 transmitters, with 11, 1 percent, used for repeat-control operations.

Trends — Analysis of existing microwave systems indicates that the major portion of the multiplex channelizing is represented in conventional voice circuits. However, recent trends indicate there will be a greater increase in installations involving high-speed protective relaying, area load frequency control, and various forms of computer and high speed business machine operations. There is also an indication that there will be a limited need for specialized television applications using both wide band and narrow band video circuits.

Comments on future applications definitely indicate a practical need for incidental control and alarm indication operations in the Mobile Service vhf frequency spectrum.

Council—The Operational Fixed Microwave Council is primarily a microwave system recording and fact-finding agency for applicants in the Safety and Special Services. It keeps books on current and proposed microwave communication systems and advises prospective microwave users of interference potentials. As of May 1, 1957, there were 3,012 operational fixed microwave beams being used or proposed in the United States.

Japanese Firms May Make U.S. Radios

A JAPANESE government source says the Ministry of International Trade and Industry expects to receive a formal proposal from a major U.S. manufacturer for the production of American radios in Japan. The radios would be for export to Southeast Asia and Latin America.

Plan—Under the plan, leading Japanese manufacturers now receiving technical assistance from the U.S. company will produce the radios, which would be bought and trademarked by the firm before shipment. At least ten Japanese firms are believed to be involved.

If the Japanese government approves the plan, subcontracts will probably be made with each firm according to production capacity. It is believed that the U.S. company involved may also seek contracts for production of television sets, phonographs and other products. Japan’s decision, if a formal proposal is submitted, is said to hinge on whether the proposed exports will interfere with the exports of Japanese items of a similar type.

Financial Roundup

SIXTEEN out of 18 firms whose earnings were compared in this month’s Financial Roundup showed improved earnings in 1957 over comparable 1956 periods.

Only one of the 18 lost money in its latest reporting period. Five companies reported losses in comparable periods, last year.

A more detailed analysis of 32 companies that recently reported six months earnings, printed in the August 20 Business Edition, also showed improved earnings.

<table>
<thead>
<tr>
<th>Company</th>
<th>Net Profit 1957</th>
<th>Net Profit 1956</th>
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<tr>
<td>ACE Industries</td>
<td>$9,818,000</td>
<td>$5,892,000</td>
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<tr>
<td>Advance Industries 5m</td>
<td>113,328</td>
<td>567,758*</td>
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<td>Barry Controls 6m</td>
<td>150,148</td>
<td>168,486</td>
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<tr>
<td>Allen B. Du Mont 6m</td>
<td>997,900*</td>
<td>484,000*</td>
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<td>Hoffman Electronics 6m</td>
<td>864,299</td>
<td>783,972</td>
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<td>102,362</td>
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<td>Tipp Industries 12m</td>
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<td>30,615,000</td>
<td>11,713,000*</td>
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<tr>
<td>* Losses</td>
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</tr>
</tbody>
</table>

(Continued on page 26)

September 1, 1957 — ELECTRONICS
Perkin has developed Magnetic Amplifier Regulated DC Power Supplies for missile launching and check-out, with ratings of 30, 50, 100, 200, 300, 400, 500 amperes and above. The unit shown here is a 24-32V, DC @ 100 amp. unit, 19" rack panel mount, with a regulation of ±1% over the range of 24-32 volts. There are provisions for remote operation and sensing. Perkin ground power supplies are now being used in the Thor, Atlas, Bomarc, Vanguard and other missile programs.

Perkin airborne power supplies more than meet both military specifications MIL-E-5272A and MIL-C-7115. The use of silicon rectifiers provide a much more compact package with higher efficiency ratings and longer life expectancy. The unit illustrated provides 27.5 volts DC (26 to 30 volt range), 20 amperes continuous duty. The input is 115/200V AC, 3 phase; frequency range 400 CPS ±6 CPS. The regulation is less than ±0.5 volts.

Perkin has designed and manufactured over 6,000 units operating in Military and Commercial Radar Systems. 6, 7, 8, 9, 10 KV and other ratings can be designed for your specific mechanical and space configurations. Typical 6KV specifications are: AC Input -100-120V, 380-420 CPS, single phase; DC Output -6KV, ±5% 0 100 microamperes; Temperature Range - -55°C to +125°C @ 50,000 feet altitudes and above. Weight -2 1/4 lbs.; no tubes or moving parts.

Hundreds of Perkin Ground Radar Systems are in operation throughout the country. Built to specifications MIL-E-4158, this unit was conservatively designed and will operate at 150% load continuously without damage to the unit. Specifications are: AC Input -120/208V ±10%, 3 phase, 60 cycle ±2 CPS, 4 wire system; DC Output -24-32V @ 100 amps.; Regulation -±5% (for any combination of line and load changes); Ripple -1% RMS or less.

Other Standard Perkin Products Include:

- Laboratory DC Power Supplies and AG Line Regulators
- DC-DC and DC-AC Static Inverters
- Transistorized B+ and Heavy Duty Power Supplies
- Pulse Generators
- Servo Controls

PERKIN ENGINEERING CORPORATION
345 Kansas Street, El Segundo, California
Immediate delivery on standard models available from factory and:

New York Area Office: Sales and Warehousing: 1060 Broad Street Newark 2, New Jersey • Market 3-1454
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For a prompt reply on your application, write or wire FACTORY on your letterhead... or check (✓) coupon below, specifying information desired.

PERKIN ENGINEERING CORPORATION
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Please send further data on power supplies for:

MISSILE - GROUND ☐ RADAR - GROUND ☐
MISSILE - AIRBORNE ☐ RADAR - AIRBORNE ☐

Other Power Supplies rated at ___Volts, ___Amps.

Name ____________________________
Title ____________________________
Company _________________________
Address __________________________
City __________________ State ______
Phone __________________ Ext. ____

For further data return above coupon.
Models Mean Business

Market looks good for firms that make training-aid devices

Two scaled ship-models, now plowing through the waters of a 20-foot-square tank at Northwestern University, may be the forerunners of a substantial business in electronic equipment sales.

Devised by engineers at Naval Training Device Center, where development contracts amounting to $25 to $30 million a year are let, the precisely-scaled models react sufficiently like full-scale ships to be a valuable and inexpensive training aid. Technical details and circuits are described on p. 172, this issue.

Operation—Characteristics such as response to the helm, response to the engine telegraph, acceleration and deceleration have time lags similar to those of the full-scale ship.

Business—Prototype was built by Teletronic Lab. Gardner Displays was prime contractor for four AK's and four DE's. Electronic equipment transmitter, amplifiers and receivers was subcontracted from Fenske, Fedrick and Miller. Cost of electronic equipment for one complete set: about $5,000.

Link has made one 7-ft. submarine now in use at New London, Conn.

Market potential for ships looks good: ROTC units at all universities, Officers' Candidate Schools, the several hundred Reserve Training Centers, Fleet Training Centers, Coast Guard, Army, Merchant Marine, NATO countries and private training centers for yacht owners.

Industry Shorts

British radio equipment exports of $63.6 million in the first six months of 1957 show a 10-percent increase over the same period last year. Biggest jump has been made by sound reproducing equipment, with hi-fi exports at $14.4 million for the first six months, up 30 percent over last year.

Ionosphere begins 50 miles above the earth and may extend 6,000 to 20,000 miles up instead of 200 as previously believed, says R. A. Helliwell, professor at Stanford University.

Scotland tv will extend to more than three million people in August when the new Independent Television Authority station opens at Black Hill, Lanarkshire.

British Government tv license now costs $11.20 per year, radio license remains at $2.50 per year. BBC gets $7.19 of tv tab, $2.18 of radio tab; Post Office and Treasury divide remainder.

AEC's Hanford Operations will install a 17-mile two-terminal multi-channel microwave communications system at Richland, Wash.

Total U.S. electronics exports for the first five months of 1957 were about $665,000 above the figure for the comparable period last year. This year's January-May exports amounted to $125,415,574 compared to $124,751,521 in the same period last year.
KAY

Noise Figure Measurement
10-3,000 mc

KAY Mega-Node Sr.

- Absolutely no modulation on noise output
- Built-in stability
- Longer life on noise diode
- Ease of operation due to front panel design
- All power supplies regulated

A calibrated random noise source providing an output from 10-3,000 mc, the Mega-Node Sr. may be used to measure noise figure and receiver gain and for the indirect calibration of standard signal sources.

At the lower end of the frequency, range noise figure may be obtained directly from the meter. For greater accuracy at higher frequencies, corrections for diode transit time and termination mismatch are available from charts supplied with each instrument.

SPECIFICATIONS

Frequency Range: 10 mc to 3,000 mc
Output Impedance: 50 ohms unbalanced into Type N Connector
Noise Figure Range: 0 to 20 db
Filament Voltage Supply: From regulated supply
Meter Calibration: Linear in db noise figure; logarithmic in D.C.M.A.
Fuse Protection: One Type 3AG, 2 amps
Tubes: 1 Eclipse Pioneer TT1 Diode
Power Supply Source: 117 Watts ±10% 60 cps a.c. Available for 50 cps
Power Consumption: 200 Watts
Price: $790.00 FOB Plant

KAY ELECTRIC COMPANY
Dept. E-9 14 Maple Avenue Pine Brook, N. J.
Caldwell 6-4000

KAY Microwave Mega-Nodes

Calibrated random noise sources in the microwave range, used to measure noise figure, and receiver gain and calibrate standard signal sources in radar and other microwave systems. Available in following waveguide sizes to cover range of 960-26,500 mc.

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG-69/U</td>
<td>$400</td>
<td></td>
</tr>
<tr>
<td>TRG-51/U</td>
<td>$195</td>
<td></td>
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<tr>
<td>TRG-48/U</td>
<td>$195</td>
<td></td>
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<td>TRG-49/U</td>
<td>$195</td>
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<tr>
<td>TRG-50/U</td>
<td>$195</td>
<td></td>
</tr>
</tbody>
</table>

Available with fluorescent or inert gas (argon or neon) tubes. Noise output fluorescent tubes 15.8 db ± 2.5 db; argon gas tubes, 15.2 db ± 1 db*; neon tubes, 18.0 db ± 3 db*.

*Noise output of inert gas tubes independent of operating temperature. Universal power supply for both fluorescent or gas and all waveguide sizes: $100.

† $167. per Guide when 3 or more are purchased with $100. power supply.

NEW! WR-770, WR-650—$595.00 each; WR-510, WR-430, WR-340—$365.00 each. All WR numbers fluorescent only.

KAY Mega-Node

Calibrated random noise source reading direct in db, for measurement of noise figure, receiver gain and for indirect calibration of standard signal sources. Frequency Range, 5 to 1200 mc; Output Impedances, unbalanced—50, 75, 150, 300; Infinity; balanced—100, 150, 300, 600, Infinity; Noise Figure Range, 0-16 db at 50 ohms, 0-23.8 db at 300 ohms. Price: $295.00 FOB Plant.

KAY Rada-Node

Complete radar noise figure measuring set for I-F and R-F, including attenuators, detector and noise sources. Complete with power supplies. Frequency range: 5 to 26,500 mc; noise figure range, up to 21 db, in lower part of spectrum. Prices on request.

Kay Electric Now Manufactures Improved Versions of New London Noise Figure Measurement Instruments. See Future Advertisements and Write for Detailed Specifications and Prices.

ELECTRONICS — September 1, 1957

Circle 13 Readers Service Card
Acetic Acid
Acetone
Aluminum Nitrate
Aluminum Sulfate
Ammonium Carbonate
Ammonium Chloride
Ammonium Hydroxide
Ammonium Phosphate
Antimony Trioxide
Barium Acetate
Barium Carbonate
Barium Fluoride
Barium Nitrate
Benzene
Boric Acid
Cadmium Chloride
Cadmium Nitrate
Cadmium Sulfate
Calcium Carbonate
Calcium Chloride
Calcium Fluoride
Calcium Nitrate
Calcium Phosphate
Carbon Tetrachloride
Cobalt Carbonate
Ether, Anhydrous
Ether, Petroleum
Hydrochloric Acid
Hydrofluoric Acid
Hydrogen Peroxide
Lithium Carbonate
Lithium Chloride
Lithium Nitrate
Lithium Sulfate
Magnesium Carbonate
Magnesium Chloride
Magnesium Oxide
Manganese Dioxide
Manganous Carbonate
Methanol
Nickelous Chloride
Nickelous Nitrate
Nickelous Sulfate
Nitric Acid
Potassium Dichromate
Potassium Hydroxide
Isopropyl Alcohol
Radio Mixtures
Silicic Acid
Sodium Carbonate
Sodium Chloride
Sodium Hydroxide
Sodium Phosphate Dibasic
Strontium Nitrate
Sulfuric Acid
Toluene
Triple Carbonate
Xylene
Zinc Chloride
Zinc Nitrate
Zinc Oxide

STRONTIUM NITRATE, C. P. ANHYDROUS for Electronics

One of many controlled purity Baker production chemicals for the electronic industry. You may use Strontium Nitrate as a screen settling compound, or for emission coatings. Baker Strontium Nitrate, C.P. Anhydrous Powder for Electronics, is produced to the controlled purity standards that make it ideal for either of these important applications.

In the specifications shown below, note the low level of total alkali as an impurity. There is close control of the iron and heavy metals, because these are known to be critical impurities in electronic applications. This material is offered in the anhydrous form as a fine powder to facilitate the manufacture of emission suspensions.

Today, the increasing demands of the electronic industry for closer tolerances present ever-new challenges for higher chemical purity. Baker works closely with chemists and electronic engineers to aid in meeting these challenges. Look over the list of Baker electronic chemicals on this page—write for prices and samples of those which interest you in your production.

<table>
<thead>
<tr>
<th>STRONTIUM NITRATE, C. P. Anhydrous Powder, for Electronics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sr(NO₃)₂</td>
</tr>
<tr>
<td>Calcium (as CaO)</td>
</tr>
<tr>
<td>Barium (as BaO)</td>
</tr>
<tr>
<td>Chloride (CI)</td>
</tr>
<tr>
<td>Water Insoluble</td>
</tr>
<tr>
<td>Total Alkali (as SO₃)</td>
</tr>
<tr>
<td>Iron (Fe)</td>
</tr>
<tr>
<td>Heavy Metals (as Pb)</td>
</tr>
</tbody>
</table>

Maximum Limits of Impurities

J. T. BAKER CHEMICAL CO.
Phillipsburg, New Jersey

BRANCH OFFICES

NEW YORK 122 E. 42nd St. CHICAGO 435 N. Michigan Ave.
PHILADELPHIA 6008 Market St., Upper Darby, Pa.
LOS ANGELES 170 E. California St., Pasadena 5, Cal.

Circle 14 Readers Service Card Circle 15 Readers Service Card
PYRAMID CQM


Computer circuits require electrolytic capacitors of the highest reliability. Pyramid type CQM capacitors fill this requirement. They are made with electrodes of the highest purity aluminum obtainable (99.99%) and specially formulated electrolytes. Carefully inspected materials, coupled with controlled manufacturing methods, produce a capacitor capable of meeting the most exacting computer specification.

The capacitors are made in high purity aluminum containers hermetically sealed with molded tops held in place by rolling the can rim securely over a buna rubber gasket. The terminals are molded into the top. These terminals and the buna rubber gasketing insure a tight, permanent seal.

Two types of terminals are available: (1) a screw type terminal with tapped inserts, (CQM); (2) a lug type terminal, with anti-rotational locks, swaged to solid aluminum inserts, (CQML).

Internal connections to the aluminum inserts are made with straps of the same high purity aluminum as the electrodes. This feature contributes to low leakage and long shelf life.

Pyramid type CQM capacitors may be ordered in various capacitance and voltage combinations ranging from 45,000 mfd at 5 WVDC to 850 mfd at 400 WVDC. Container diameters are 13/4", 2", 2 1/2" and 3". The height for all units is 4 1/2". Other sizes, or units for special applications may be obtained by inquiring of Pyramid's Engineering Department.

NEW FROM PYRAMID

PYRAMID TQ


Present day electronic equipment, telephone network systems, and industrial control systems, where a high degree of reliability is essential, require capacitors having a long life.

Pyramid Electric Company introduces type TQ, a high quality electrolytic capacitor which will meet the requirements of design engineers today and for some time to come.

From raw material to finished product, the Pyramid type TQ is manufactured under controlled conditions and constant supervision.

Type TQ Capacitors are available in single, dual and triple capacitances. They vary in voltage range from 6 to 450 working volts DC. Can sizes are available in 1" diameter x 2 1/2" length, 1" x 3", 1" x 3 1/2", 1" x 4", 1 1/4" x 2 1/2", 1 1/4" x 3 1/2" and 1 1/4" x 4".

For complete specifications write for technical bulletin.
MINIATURE SELENIUM RECTIFIERS BY WESTINGHOUSE

longest expected
From 60,000 to 100,000 operating hours ... that's the rated life you can expect from highly-reliable miniature selenium rectifiers by Westinghouse.

Made by superior vacuum evaporation deposit process, Westinghouse selenium rectifiers are ideally suited for high gain magnetic amplifier circuits, sensing devices, computers, high voltage, low-current power supplies ... and many other applications requiring rectifiers with exceptionally low reverse current, minimum unforming and long life.

No matter what your needs ... 6 to 100,000 volts ... from a few micro-amps to 50 milliamps ... stacks, cans, or cartridges in a variety of configurations ... Westinghouse has the miniature rectifier to meet your specific requirements.

Just call your Westinghouse sales engineer.

YOU CAN BE SURE...IF IT'S

Westinghouse
VINYL-GLASS SLEEVING
DELIVERS LONGER FLEX-LIFE

Progressive stiffening under heat signifies deterioration of vinyl-glass sleevings — so retention of flexibility is important as a guide to ultimate life expectancy. Here are the figures on BH Vinyl-Sil:

- 2800 hours at 130°C.
- 320 hours at 150°C.
- 115 hours at 180°C.
- 4 hours at 232°C.

BH Vinyl-Sil is available in two types. Both are rated for 8,000-volt minimum dielectric breakdown and meet all requirements of ASTM, NEMA* and MIL-I-3190B* Class B-A-1 specifications. Moisture problems call for BH Vinyl-Sil 105, which offers no capillary attraction to water. It is the only vinyl-glass sleevings to be recognized by the Underwriters' Laboratories for 600-volt, continuous wet or dry operation at 105°C. For standard applications, use BH Vinyl-Sil 8000.

The outstanding dependability of BH Vinyl-Sil comes from over seven years' pioneering research, development and production testing. Prove it yourself — send us the facts on your electrical insulation problems — we'll make recommendations and send you appropriate samples.

BENTLEY, HARRIS MANUFACTURING CO.
1309 Barclay Street
Telephone: TAYlor 8-0634
CONSHOHOCKEN, PA.

BENTLEY, HARRIS
Flexible SLEEVINGS

*New Revised Standards Available On Request From Bentley, Harris.
Centralab

Proof of Reliability and Versatility...

85,000,000 PEC's* (Packaged Electronic Circuits) used in these and other applications

Packaged circuits mark
decade of electronic progress

Centralab PEC's — combining capacitors, resistors, inductors, and wiring in one compact sub-assembly — were originally designed for military applications. And due to their reliability and versatility, more than 85,000,000 have been used during the past ten years to guarantee circuit performance in countless electronic products. New developments promise even greater design flexibility for future applications.

HEARING AIDS — PEC provided compact design, making attractive eye-glass hearing aid possible.

TV SETS — 17 PEC's replaced over 100 parts, simplifying assembly and improving performance.

HEARING AIDS — PEC provided compact design, making attractive eye-glass hearing aid possible.

TV SETS — 17 PEC's replaced over 100 parts, simplifying assembly and improving performance.

TRAFFIC — PEC helps control flow of traffic for safe passage of emergency vehicles.

AUTOMOTIVE — PEC provides photo-multiplier tube socket and 20 resistors in one space-saving, packaged unit.

PORTABLE RECORDER — PEC amplifier provides large recorder quality to miniature tape recorder.

GUIDED MISSILES — Rugged, compact PEC's save space, are shock proof and resist extreme heat.

ELECTRONIC ORGAN — PEC filter reduces sharp transient of keying to give natural touch response.

JET AIRCRAFT — PEC's simplify assembly of instrument panels, guarantee circuit performance.

APPLIANCES — PEC in surface burner control enables finer selectivity of temperature.

*Trademark

Continued on next page...
Centralab offers you **TWO TYPES** of PEC’s*

**STANDARD COUPLATES**
- YD-200
- YD-300
- YD-700
- YD-400
- YD-500

An infinite number of PEC combinations available from these five basic designs

Centralab can adapt the basic shapes shown above to meet a broad variety of design requirements. These five basic Couplates can be furnished with any of five types of terminals . . . narrow tab as illustrated, or your choice of wide tab, long wire, stub wire, and crimped wire to meet your specifications.

All resistors are produced to nominal resistor values

<table>
<thead>
<tr>
<th>VALUE</th>
<th>TOLERANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>±10%</td>
</tr>
<tr>
<td>600</td>
<td>±10%</td>
</tr>
</tbody>
</table>

Circuitry performance is more stable because the tolerance is a distribution over the nominal and not fringe values.

**NOW! Extended Capacity Ranges**

Maximum capacities:
- 150 to 600 volts up to .5mf
- 6 volts up to 2.0mf

This increases the scope of P.E.C.’s for your applications.

---

**SPECIAL DESIGNS**

Any shape and contour available for miniaturization and simplification

Centralab can produce special packaged electronic circuits to your requirements and to any applicable MIL specifications. The PEC’s shown below illustrate a few recent solutions to customer problems.

- **POTTED AND MOLDED CIRCUITS**
  - Provide long life and reliability under extreme operating conditions.

- **THE ULTIMATE IN MINIATURIZATION**
  - Micro-miniature PEC for printed-board insertion contains four ± 10% resistors and four 0.055 mf. ± 20% capacitors.

- **TRIMMER RESISTORS**
  - These CRL units save money by using bank of trimmers in applications not requiring frequent or continuous adjustments.

- **INTEGRATE DIODES, COILS, AND SOCKETS**
  - Cut assembly errors and costly procedure of purchasing, inventorying, and testing of individual components.

Centralab - originator and undisputed leader in P.E.C. development - offers you a responsible source for your Packaged Electronic Circuits. You can rely on our expert engineering assistance and modern production facilities to meet your quality and quantity requirements. Most important, Centralab offers you 35 years of experience in design, manufacture, and application of electronic components. Write for complete information on products and services.
It's easy to obtain Precise Measurements with a D-B Standing Wave Detector

Super-flexible miniature coaxial probe cable eliminates 95% of noise due to conventional cable.

D-B broadband probe requires no tuning across its allocated band. Exceptionally convenient operation.

Each broadband probe contains a second harmonic trap which eliminates measurement errors.

Stainless steel ball bearings, precision ground and spring loaded for perfect alignment.

5-point kinematic carriage suspension assures maximum linearity of probe motion.

Vernier scale permits reading of probe travel to .01mm without mounting costly accessories.

Lever control for continuously variable speed drive. Changes knob speeds from "vernier" to "fast," saving time during quick measurements.

Non-rocking instrument support on 3 leveling screws. Enables quick alignment with other test equipment in use.

Large, convenient tuning knob is stationary, leaving eyes free to watch indicator.

Interchangeable waveguide blocks. Each realigns perfectly to probe travel in a few seconds.

— easy because D-B units are built without the usual sources of error. You get perfect parallelism between slot and waveguide axis...between probe travel and waveguide axis. The waveguide is precision-formed in one piece to provide a uniform path for measured waves, thus minimizing residual VSWR. You can use any D-B slotted line to measure adjacent frequency bands. Merely substitute different-size waveguide blocks and probes — the alignment accuracy is guaranteed to remain unimpaired.

Check the unique features below for further proof of D-B convenience and exceptional accuracy. Literature on request.

DE MORNAY - BONARDI
760 SOUTH ARROYO PARKWAY - PASADENA, CALIFORNIA

Circle 20 Readers Service Card Circle 21 Readers Service Card
Where do you stand on your missile or aircraft program? Do you have a new contract for radar, computers or guidance control mechanisms? Then let Atlas help you from pilot stage to production efficiency.

Atlas design, production and methods engineers, toolmakers and skilled mechanics are ready to work on your project on a job basis...as many men, machines and hours of work it requires and no more. Every modern, cost cutting tool, technique and quality control method is utilized. Atlas mechanical and electronic technicians thoroughly test your product.

Let Atlas help you in your program. We've been "precision-engineering" on a contract basis for more than a quarter of a century. May we work for you? Write to us with your production and design problems...get your copy of the booklet "Precision-engineering Electro-Mechanical Equipment." Atlas Precision Products Co., Philadelphia 24, Pa. (Division of Prudential Industries).

"From Drawing Board...to Production Line."

ATLAS Precision Products
BOST CHI DET LA NY PHILA OFC KLG NEW RAYTHEON RECORDING STORAGE TUBE. CAN STORE A PICTURE OR DATA IN LESS THAN 1/60 SECOND. READ OUT 30,000 TIMES. NOW WITH OVER 600 LINES RESOLUTION AT HALF-AMPLITUDE MODULATION. CAN BE USED FOR FREQUENCY OR SCAN CONVERSION.

A SUPERIOR TUBE IN WRITING-ERASING, STEEDXXX SPEED, DYNAMIC RANGE AND CAPACITY.

AMONG ITS USES ARE 1. DATA STORAGE FOR ANALOGUE COMPUTERS.
2. STOP MOTION OF TV SIGNALS.
3. STORAGE OF SIGNALS TO BAND COMPRESS.
4. EXPANSION OF TV SIGNALS FOR NARROW BAND TRANSMISSION.
5. STORAGE OF REPETITIVE SIGNALS TO IMPROVE SIGNAL-TO-NOISE RATIO. MANY NEW PRODUCT USES BEING DEVELOPED.

DATA SHEETS ON THE RK-6835/QK-464 ARE JUST OFF THE PRESS. WRITE FOR YOURS NOW. NO OBLIGATION. TUBES ARE AVAILABLE FOR IMMEDIATE DELIVERY ON SMALL QUANTITY ORDERS.

Excellence in Electronics RAYTHEON MANUFACTURING COMPANY

Microwave and Power Tube Operations, Section PT-06, Waltham 54, Mass.

Regional Sales Offices: 9501 W. Grand Avenue, Franklin Park, Illinois; 5236 Santa Monica Blvd., Los Angeles 29, California

Raytheon makes: Magnetrons and Klystrons, Backward Wave Oscillators, Traveling Wave Tubes, Storage Tubes, Power Tubes, Receiving Tubes, Picture Tubes, Transistors, Ceramics and Ceramic Assemblies
Anaconda announces Analac an improved film-insulated, solderable magnet wire can be used similarly to Formvar or Plain Enamel—except that it is solderable without stripping.

Soldering by dipping, iron or gun produces a perfect joint—in just one second in finer sizes—without prior removal of the insulation. Analac reduces labor, saves time and money wherever many soldered connections are made, or where small diameter wire makes other means of insulation removal hazardous to the insulation or wire.

Not only this, Analac has the excellent abrasion resistance and other good mechanical properties of the enamel wire you're now using. It handles readily, performs well in high-speed winding.

Analac is colored a bright red with stable dye used many years for identical applications—making it highly visible even in finest sizes. This helps operators feel more secure, results in higher quality work. Distinctive color simplifies its identification, too, from nonsolderable wires.

Analac is available in an exceptionally large range of sizes. The Man from Anaconda will be glad to give you more information and help with a production run in your plant. See "Anaconda" in your phone book—in most principal cities—or write: Anaconda Wire & Cable Company, Magnet Wire Headquarters, Muskegon, Michigan.
JOINT IS COMPLETED WITHOUT STRIPPING WIRE with Analac wire dipped in a 50-50 tin-lead solder at 360°C (680°F). The insulation is removed at the temperature of molten solder.

1. STRONG JOINTS—as strong as the same joints made in bare copper wire—are produced. Here in laboratory test, joint holds under high stress.

2. EXCELLENT ABRASION RESISTANCE of Analac is shown in this test. It has the same high windability normally associated with Formvar, Plain Enamel.

3. MOLOED-PLASTIC CASES—designed and developed by Anaconda—protect spools of Analac from damage during shipping. Result: no breaks due to bent spools.

solderable magnet wire

See the Man from Anaconda for ready-to-solder Analac magnet wire

NEW CATALOG ON ANALAC
Yours for the asking. Mail coupon for your copy.

ANAConDA WIRe & CAble CoMMpAnY
Magnet Wire Headquarters, Muskegon, Michigan.

Please send me catalog C-95A on Analac ready-to-solder magnet wire.

NAME & TITLE...........................................
COMPANY...........................................
ADDRESS...........................................
CITY, ZONE, STATE.................................
A Transformer becomes a precision device with Allegheny Magnetic Materials in the core

The operation of a transformer is no better than the magnetic core around which it is built. With Allegheny magnetic materials in the core, you get the best—uniformly and consistently.

Sure there are reasons why! For one thing, there's the long experience of a pioneer in development and quality control of electrical alloys. But most important, the A-L line offers complete coverage of any requirement you may have, any service specification. It includes all grades of silicon steel sheets or coil strip, as well as Allegheny Silectron (grain-oriented silicon steel), and a wide selection of special high-permeability alloys such as Allegheny 4750, Mumetal, etc.

In addition, our service on magnetic materials includes complete lamination fabrication and heat treatment facilities. What's more, this extensive experience in our own lamination stamping department is a bonus value for all users of A-L electrical sheets or strip. • Let us supply your needs. Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.

STEELEMAKERS to the Electrical Industry
Allegheny Ludlum

ADDRESS DEPT. E-93
TOWARD THE LIMITS OF THE MICROWAVE SPECTRUM

Amperex® DX151
4 MM KLYSTRON

high power output
wide tuning range
low heater power
unique 'dispenser' cathode
waveguide output
electrostatic focusing
rugged construction

ask Amperex

about new millimeter tube developments

Amperex ELECTRONIC CORPORATION
230 Duffy Avenue, Hicksville, L. I., N. Y.
the first really new paper tubular capacitor... 
AEROVOX "WHITECAP" "WAX-FREE"

TYPE V84 TUBULAR CAPACITOR!

Aerovox announces the development of a WAX-FREE paper tubular capacitor with electrical characteristics surpassing all others... even the best molded units.

Aerovox "WHITECAP" capacitors offer a distinctive white case, completely free of wax. The absence of any wax facilitates handling and assembly procedures. No dripping and no gummed-up machines. Light in weight and clearly marked, these units will enhance the appearance of any assembly.

Aerovox "WHITECAP" capacitors are superior electrically over ALL other conventional paper tubulars including molded units. Outstanding humidity resistance... far greater than ever known before in units designed for radio-TV applications. Highest Insulation Resistance ever offered before in a paper tubular. Wide temperature range... low-power-factor. New standards of reliability backed by millions of hours of life and service tests.

Operating Temperatures — -40°C to 85°C at full voltage rating and to 100°C with voltage rating of 75%

Power-Factor — at room temperature will not exceed 1%

Humidity — will withstand 95% relative humidity at 40°C in accordance with RETMA Specification RS164 except that exposure will be increased to 500 hours instead of 100.

Immediate delivery on all production quantities. For full details contact your local Aerovox Sales Representative or write immediately to...

AEROVOX CORPORATION
NEW BEDFORD, MASSACHUSETTS

September 1, 1957 — ELECTRONICS
IYILAC Custom Air Conditioning

+130°F.

Ambient Temperature (outside)

-65°F.

Inside Temperature ±½°

Condition: MIL-E-5272*

Today, electronic systems can function under the most difficult environmental conditions (MIL-E-5272*), by using highly specialized air conditioning equipment.

Custom air conditioning is our business at Ellis and Watts. For example, we recently designed and built MIL-AC Units for Radome installations operating in ambient temperatures from −65°F. to +130°F. These air conditioning units maintain temperatures within ±½°F., with continuous dehumidification under varying internal load conditions. Because of operational limitations height of unit was restricted to 36".

MIL-AC Units are self-contained, compact, lightweight, readily air-transportable. They can be designed to cool, heat, humidify, dehumidify, filter, and can incorporate air-cooled or water-cooled condensers. Units are manually or automatically controlled. We are staffed with specialists who will analyze your requirements, submit a proposal, complete your installation promptly and to your complete satisfaction.

Write for helpful load calculating Nomograph and other technical data for use in making time-saving preliminary calculations.

*Military specification dealing with the following climatic and environmental conditions: Temperature, humidity, altitude, salt spray, vibration, fungus, sunshine, rain, sand and dust, explosive atmosphere, acceleration and shock.

Typical MIL-AC Unit. MIL-AC configurations, features and functions to suit your specific requirements.

ELLIS AND WATTS PRODUCTS, INC.

P.O. Box 33, Cincinnati 25, Ohio.

Ellis and Watts also design and build custom air conditioners, liquid coolers and heaters, dehumidifiers, waveguide dehumidifiers, laboratory temperature and humidity control units.
MEASURE High VOLTAGES

0 to 100 KV at Frequencies of 20 Cycles to 50 Megacycles

JENNINGS Model J1003 High Voltage Vacuum Tube Voltmeter is truly a versatile instrument with six direct reading linear voltage ranges to cover voltages of 0 to 100 kilovolts. It can accurately measure these voltages at frequencies from just above dc levels to 50 megacycles. There are two separate high voltage input circuits so that positive or negative peaks may either be read separately or added together vectorially.

Thus it can be used for single ended measurements of rf, audio and dc ripple voltages in radio or television transmitters, for measurements of high voltage pulses in radar and test equipment, and for measurements of magneto and ignition coil output. In these measurements one input circuit can be used to view a wave shape on an oscilloscope while the other indicates its peak value on the meter.

The instrument can also be used for the vector addition of multiphase line-to-line voltages in either balanced or unbalanced circuits, as well as for voltage readings on center-tapped transformers and push-pull tank circuits.

Send for Catalog Literature

Type JP325 HV Probe for use with an oscilloscope where the meter indication is not required.

Type JCDS Vacuum Capacitor to double the voltage range of the meter.

Remote Indication Kit to enable both dividers to be removed and installed close to the circuit being measured.

Panel Mounting Plates to mount the meter section on a 19" relay rack.

JENNINGS RADIO MANUFACTURING CORPORATION - 970 MCLAUGHLIN AVE. P.O. BOX 1278 - SAN JOSE 8, CALIFORNIA
to guarantee quality... speed production of MOTOROLA TRANSISTORS

Exclusive Motorola high-speed testing equipment permits positive control at key check points and at final testing on Motorola's fast moving transistor assembly lines. These simplified instruments, developed by Motorola, incorporating Motorola transistors and silicon rectifiers, check seven electrical characteristics... enabling a single operator to test 500 transistors per hour with the highest degree of accuracy.

The ability to create specialized equipment allows Motorola to "productioneer" semiconductor devices... accomplishing high-volume production while maintaining exacting standards of quality. At Motorola, semiconductor knowledge and production skill combine to assure you a dependable supply of finest quality units... at the most competitive prices.

Unique testing methods are only one example of Motorola's excellence in semiconductor technology. For complete data concerning Motorola semiconductors... or for applications information, write, wire or phone Motorola, Inc., 5005 E. McDowell Road, Phoenix, Arizona. Bridge 5-4411
Now available...

Du Pont Hyperpure Silicon in new grades!

Whether you make or use silicon devices, investigate how new grades and broader commercialization of silicon can benefit you.

Du Pont silicon used in rectifiers, transistors and photocells can now be closely matched to device needs, because of newly established, clear-cut differences in grades. Each grade has a rated maximum content of boron, the most critical impurity. Because of this new grading, more efficient use of Du Pont Hyperpure Silicon is now possible.

GRADE 1—This grade, with a maximum of 3 atoms of boron to every billion atoms of silicon, has the highest quality. It is a new grade developed for such devices as power rectifiers and power transistors, permitting lower reverse currents and hence higher-rated voltages.

GRADE 2—meets the needs of intermediate-voltage devices, such as those used in the field of radio and television. This grade contains no more than 6 parts of boron per billion. It is useful, too, for such applications as rectifiers for variable speed motors.

GRADE 3—is useful in making high-current, low-voltage devices such as diodes and low-voltage transistors. It has excellent potential for use in rectifiers for alternating-current generators in automobiles. This grade contains a maximum of 11 parts per billion of boron.

SOLAR-CELL GRADE—is the basic material used in solar batteries for powering telephone lines, radios and toys. Solar-grade silicon is a high-quality photoconductive material.

Quantities to meet today's needs

If you are a manufacturer of silicon devices or are planning to manufacture semiconductors, there is sufficient production capacity for Du Pont Hyperpure Silicon to meet anticipated requirements and assure you of an uninterrupted supply. Technical information on the growing of single crystals and the measurement of their properties is available to you. Get in touch with us about your silicon problems. We will be pleased to help you.

DU PONT HYPERPURE SILICON is available in three polycrystalline forms—needles, dense lumps and cut rods. At the Du Pont laboratories, single-crystal ingot, such as those shown at left, is grown from each lot of polycrystalline Hyperpure Silicon.

The specifications are based on the values determined in our laboratory from resistivity measurements of such crystals and resistivity measurements of floating zone refined bars cut from those crystals. Boron concentrations refer to those in the melt from which the characterization crystals are grown.

Part of this characterization crystal is included with each shipment of a full lot of silicon. It may be used by the manufacturer as a seed to initiate the growth of single crystals and also as a resistivity reference to check the purity of single crystals grown from the lot.

Provision of these seed crystals is part of the service rendered to crystal growers by Du Pont, the pioneer producer of semiconductor-grade silicon in commercial quantities.

NEW BOOKLET ON DU PONT HYPERPURE SILICON

If you manufacture or use silicon devices, you'll want this new booklet which provides property data on Du Pont Hyperpure Silicon. It contains basic information on silicon and some of its many uses.

E. I. du Pont de Nemours & Co. (Inc.), Pigments Department Silicon Development Group, Wilmington 98, Delaware.

Circle 32 Readers Service Card

PIGMENTS DEPARTMENT

DU PONT

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BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

September 1, 1957 — ELECTRONICS
having your ups and downs?

...if they involve Deposited Carbon Resistors

DALOHM has the answer!

All Dalohm products are carefully designed and skillfully made to assure you of supreme quality and dependability, plus the widest versatility of application.

Outstanding examples of the Dalohm line are these deposited carbon resistors, made for accurate performance where carbon composition resistors are not suited or wire wound resistors too expensive.

**TYPE DC**

- Pure crystalline carbon film bonded on ceramic rods of special material; provide precision resistance values, low voltage coefficient, low capacitive and inductive characteristics in high frequency applications, extremely high stability and economy.
- Resistance ranges from 10 ohms to 50 megohms
- Tolerance 1% or higher as specified
- Five wattages—1/8, 1/4, 1/2, 1 and 2; eight physical sizes

Write for Bulletin R-24A

**TYPE DCH**

Essentially the same as type DC except hermetically sealed in a non-hydroscopic ceramic envelope to provide absolute protection against thermal shock, salt water immersion and humidity.

Write for Bulletin R-27A

**TYPE DC-5**

For extremely high resistance where maximum stability is a prime factor in high voltage applications. Powered at 5 watts; high voltage up to 20,000 VDC; resistance range 1 megohm to 200 megohms; tolerance 1% or up to 10% on request.

Write for Bulletin R-28

You are invited to write for the complete catalog of Dalohm precision resistors, potentiometers and collet-fitting knobs.

If none of our standard line fills your need, our staff of able engineers and skilled craftsmen, equipped with the most modern equipment, is ready to help solve your problem in the realm of development, engineering, design and production. Just outline your specific situation.

DALE PRODUCTS, Inc.

1300 28th Avenue Columbus, Nebraska, U.S.A.

* Export Dept: Pan-Mar Corp. 1270 Broadway New York 1, N. Y.

ELECTRONICS — September 1, 1957

Circle 33 Readers Service Card
BALANCED ARMATURE CHOPPER withstands SHOCK and VIBRATION

Unique Structure Operates During High G Vibration

By supporting the moving contact at its center of gyration, Airpax engineers have produced a mechanical modulator that continues operating in the presence of vibration yet preserves the advantages of conventional choppers:

100% modulation,
zero output with zero input,
passive signal circuit, and
wide dynamic signal range.

Contacts of any chopper are deranged from normal operation by shock and vibration. In Airpax Series 350 choppers, this derangement is below 10 electrical degrees for vibrations up to 15 G. The choppers are undamaged by vibrations up to 100 G.

For full technical details on how this new chopper can fit into your equipment plans, write to

RATINGS OF SERIES 350 CHOPPERS

Drive
Frequency ........ 400 ± 20 CPS
Voltage ......... 6.3 ± 0.6 RMS volts

Contacts
Dwell Time ... 130 electrical deg. min.
Balance .... within 15 electrical deg.
Phase Angle ... 65 elect. deg. nominal
Voltage ......... up to 100 DC volts
Current ......... up to 2 milliamperes
Noise .......... 200 microvolts average

Environment
Vibration .... 10 to 2500 CPS at 15 G
Shock .......... 50 G in any direction
Temperature .... -65 C to +125 C
C.M.C. Model 400B

DIGITAL PRINTER

four 12-DIGIT print lines per second!

$850. for standard 6-digit model  Additional digits - $50. each

Operates with most existing counting equipment
WITHOUT MODIFICATION! A reliable, accurate, compact instrument that fills an industry need for a truly high-speed, low cost digital printer. It may be connected directly to digital counting instruments and will print, on standard adding machine tape, the count measured during each counting sequence. Important features include: Parallel Entry, No Stepping Switches, Relays or Moving Contacts.

Furnished standard with 6 digit print-out but up to 12 digits is optional. Write today for complete specifications

Computer-Measurements
5528 Vineland Ave., No Hollywood, Calif.

Subsidiary of Hancock Manufacturing Corp.
For greater miniaturization, higher performance...

new TRANSISTORIZED servo amplifiers

Transicoil introduces four new, completely transistorized Servo Amplifiers for use in applications requiring the highest order of precision, miniaturization, and dependability. Measuring a mere 3'' or less in length, these servo amplifiers help you keep assemblies within the severe space limitations of many types of military and industrial applications.

The new amplifiers produce voltage gains of 100:1, 200:1, 2000:1, and 4000:1. They are specifically engineered for use with Transicoil Motors and Motor Driven Induction Generators in sizes 8, 9, 11, 15, and 18. To insure maximum accuracy and dependability, Transicoil supplies these servo amplifiers only as part of its own miniaturized servo assemblies. All amplifier units are hermetically sealed and are made with the same care, materials, and precision that have made Transicoil a recognized leader in the manufacture of custom built servo components and assemblies.

For more complete information on Transicoil’s new Transistorized Servo Amplifiers, write for Bulletin 101. And when you have control problems involving miniaturization or control complexity, be sure to get in touch with Transicoil. You profit most when you let Transicoil design and supply your complete servo package. You will be under no obligation—you pay only for results, on a fixed fee basis, for equipment delivered and operating properly.

DAYSTROM TRANSICOIL CORP.
A Subsidiary of Daystrom, Inc.
Worcester • Montgomery County •
LINDE Sapphire is...
Hard - Moh 9
Transparent, single crystal, pure aluminum oxide
Nonporous - 0% porosity
Easily sealed to metals and ceramics
Priced competitively with sintered materials

LINDE Sapphire has...
Strength at elevated temperatures
High melting point - 2040°C.
Excellent IR transmission at high temperatures (above 500°C.)

LINDE Sapphire is available as...
Windows
Domes
Rods and tubes
Special shapes – to order

For more information about LINDE Sapphire... Write "Crystals Dept. BD-9," LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. In Canada: Linde Company, Division of Union Carbide Canada Limited

The terms "Linde" and "Union Carbide" are registered trade marks of Union Carbide Corporation.
everything you need!

specifications

130a

input amplifiers: (similar vert. and horiz. amps.), sensitivity 0.5 mv/cm to 50 v/cm, 14 calibrated ranges, 1-2-5-10 sequence plus continuous vernier. pass band dc to 300 kc, ac or dc coupling. balanced input on 1, 2, 5, 10 and 20 mv/cm ranges.

sweep range: 1 µsec/cm to 12 sec/cm. 21 sweeps: 1-2-5-10 sequence, 5% accuracy.

trigging: internal, line voltage or external 0.5 v or more. pos. or neg. slope, -20 to -30 v trigger range.

preset trigger: optimum setting for automatic stable trigging.

amplitude calibration: 1 kc square wave, 5% accuracy.

price: $650.00.

specifications

150a, 150ar

sweep range: 0.02 µsec/cm to 15 sec/cm.

calibration: 24 sweeps: 1-2-5-10 sequence, 0.3 µsec/cm to 5 sec/cm. 3% accuracy.

trigging: internal, line voltage or external 0.5 v or more. pos. or neg. slope, -20 to -30 v trigger range.

preset trigger: optimum setting for automatic stable trigging.

horizontal amplifier: sweep magnification 5, 10, 50, 100 times. vernier position control selects any 10 cm part of sweep. external input pass band dc to over 500 kc. sensitivity 200 mv/cm to 15 v/cm.

vertical amplifier: pass band dc to 10 kc. optimum transient response and rise time less than 0.035 µsec. signal delay of 0.25 µsec permits leading edge of triggering signal to be viewed.

amplitude calibration: 18 calib. voltages, 1-2-3-10 sequence, 0.2 mv to 100 v peak-to-peak. accuracy 3%. approx. 1 kc square wave, rise and decay approx. 1.0 µsec.

prices: hp-150a high frequency oscilloscope, $1,100.00.

hp-150ar rack mount oscilloscope, $1,200.00.

hp-151a high gain amplifier, $200.00.

hp-152a dual channel amplifier, $250.00.

hewlett-packard company

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cable "newpack" • davenport 5-4451
field engineers in all principal areas

data subject to change without notice.

prices f.o.b. factory.

low frequency cabinet oscilloscope, model 130a. covers dc to 300 kc. similar horizontal and vertical amplifiers. input circuits balanced on 5 most sensitive ranges. single ended input may be dc or ac coupled. direct reading, linear sweep times. with most transducers, needs no preamplification to produce brilliant, high resolution trace. universal automatic triggering; one preset condition provides optimum triggering for almost all inputs. $650.00.

low frequency rack mount oscilloscope, model 130br. similar to -hp- 130a except for rack mount and includes x5 magnifier usable on all ranges and expanding fastest sweep to 0.2 µsec/cm. parallel input terminals front and rear. $650.00.
High Frequency Cabinet Oscilloscope, Model 150A. Covers dc to 10 MC with new reliability and convenience. Two plug-in preamplifiers for high gain or dual channel measurement (see below). 24 direct-reading sweep times; sweeps 0.02 μsec/cm to 15 sec/cm. Universal automatic triggering; one preset condition insures optimum triggering. $1,100.00.

High Frequency Rack Mount Oscilloscope, Model 150AR. Same as -hp- 150A except for mounting in standard relay rack. Fitted with “pull-out” slides for maximum servicing accessibility. $1,200.00.

High Gain Amplifier, Model 151A. Designed for plug-in use with -hp- 150A or 150AR Oscilloscopes. High gain unit with 5.0 mv per cm sensitivity and frequency response dc to 10 MC. 12 calibrated ranges in 0.5, 1, 2, 5 sequence. 1 megohm input impedance with 25 μuf shunt. Pass band rise time 0.035 μsec. Equipped with two BNC input terminals. $200.00.

Dual Channel Amplifier, Model 152A. Designed for plug-in use with -hp- 150A or 150AR Oscilloscopes. Permits two phenomena to be presented on CRT simultaneously. Either amplifier usable separately. For dual presentation, electronic switch applies outputs to alternate traces, or switches outputs at a 100 KC rate. 50 mv/cm sensitivity, 9 ranges, 1, 2, 5, 10 sequence. $250.00.
For the “killing” demands of accessory power...

**AMF has experience you can use**

- No part of a missile is more important than the power supply that directs it to the “kill”. And AMF has produced more gas turbine power units for guided missiles than any other source.
- Typical AMF systems produce up to 50 hp.—with modifications, up to 200 hp.—at durations from 20 seconds to many hours. They are completely independent of the main power plant, insensitive to missile attitude or altitude, and to environment, acceleration, shock, or vibration. Units offer multiple start-stop flexibility, precise frequency and voltage control, and can be packaged to fit practically any space arrangement, with little size and low weight. See for yourself why, in accessory missile power as in a variety of other highly specialized fields, AMF has experience you can use.
For high-speed switching

CBS
HIGH-FREQUENCY TRANSISTORS
2N438
2N439
2N440

These transistors are designed for high-speed switching, control, analog and digital computer applications. All three are available in symmetrical versions, and they feature:

1. JETEC Case . . . employs a standard metal case (with .200 inch pin spacing) welded to achieve reliability never before approached with NPN transistors.

2. Alloy-Junction . . . for greater uniformity, higher voltage and current, flatter gain, and lower saturation resistance.

Note the many desirable features. Write for Bulletin E-268 giving complete data and helpful application notes.

CHECK THESE FEATURES
1. High frequency response:
   2N438 . . . . . . . . . . . . . . . . . . . . . . 2.5 to 5 mc.
   2N439 . . . . . . . . . . . . . . . . . . . . . . 5 to 10 mc.
   2N440 . . . . . . . . . . . . . . . . . . . . . . 10 to 20 mc.

2. High operating voltage ... up to 30 volts.

3. High switching speed ... below 0.2 µsec.

4. High current amp. factor ... up to 100.

5. High dissipation rating ... up to 100 mw.

6. Low leakage current ... 3 µamps av.

7. Low base resistance ... 150 ohms av.

8. Low collector capacitance ... 10 µf.

Reliable products through Advanced-Engineering.

CBS semiconductors

CBS-HYTRON
A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

ELECTRONICS — September 1, 1957
NOW—from a single stock Sola voltage regulator—
±1% regulation of all these 6.3v tube filaments*

Now, you can supply banks of 6.3v electron tubes with ±1% regulated filament voltage from a single Sola Constant Voltage Filament Transformer. This static-magnetic stabilizer, designed for compact mounting as a manufacturer’s component, is available in five stock ratings ranging from 5 to 25 amperes.

The Sola Constant Voltage Filament Transformer assures superior performance, reliability, and long life for the tubes it operates. The capacitor, an integral part of the Sola Constant Voltage principle, is supplied separately for external mounting, allowing greater flexibility in physical layout.

For further information on regulated 6.3v filament supply, contact your area representative or write for Circular CVF-269.

*S filament current drawn by 160 electron tubes with filament ratings of .15a each equals 24a—within the capacity of Sola’s 25a Constant Voltage Filament Transformer.
in radar load isolators, too
CRUCIBLE PERMANENT MAGNETS

give maximum energy... minimum size

Special applications, such as radar load isolators, demand compact but powerful magnet assemblies. And this is but one of the many places where the consistently higher energy product provided in Crucible Alnico magnets pays off.

These Crucible Alnico permanent magnets can be sand cast, shell molded, or investment cast to exact size, shape or tolerance requirements... and in any size from a mere fraction of an ounce to hundreds of pounds.

The design and production of permanent magnets has been a Crucible specialty ever since Alnico alloys were discovered. It's one of the good reasons why so many people bring their magnet applications to Crucible. Why don't you? Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America
Tip and Shank of New G-E Soldering Iron No Bigger Than a Paper Match: Gives Quick Heat Recovery for Production Use

General Electric's new Miniature soldering iron is designed especially for continuous production-line work on sub-miniature components. It can help increase your production by delivering fast, more dependable heat recovery from joint-to-joint. This is made possible by an efficient tubular heater built into its 3/16" diameter, long-life tip. As a result, heat is concentrated right at the work, minimizing heat loss.

What's more, the maneuverable Miniature iron gives you tip-touch control for rapid soldering of critical joints. Its tiny 3/16" shank reaches into almost inaccessible areas, with reduced risk of damage to adjacent parts.

Here are just a few of the other big reasons why the new Miniature is the answer to your needs for a small, efficient, production soldering iron:

EASY TO MAINTAIN—Tip and heater assembly can be replaced quickly and easily.

IMPROVES OPERATOR EFFICIENCY—Weighs less than 1 1/4 ounces, reduces fatigue.

TIP LASTS LONGER—Vacuum processed iron tip resists harmful effects of tin and high temperatures.

PORTABLE—Transformer plugs into any standard 115-volt outlet.

For more information contact your local G-E Apparatus Distributor, or write for Publication GEC-1318, Section 724-8, General Electric Company, Schenectady, N. Y.
**AMP's custom-designed and versatile line**

**FOR RADAR AND ELECTRONIC EQUIPMENT APPLICATIONS**

**Ampli-Film®**

- The all-purpose high voltage dielectric
- Is not affected by acids or organic solvents
- Undergoes no distortion under high temperatures and pressures
- Is readily bonded by adhesives
- Is easy to handle and fabricate

**CAPITRON® WAFER CAPACITOR**

Ampli-Film® dielectric sheets and high conductivity copper electrodes are bonded together under high heat in hydraulic presses using a special non-polar thermo-plastic bonding resin to obtain a solid, void-free sealed capacitor for rugged requirements in high voltage circuits. Having indefinite shelf life, these capacitors are designed for use in oil filled assembly, but also they are well suited for many applications in potted or encapsulated assemblies. They can be supplied in various form factors including curved shapes.

**CAPITRON® POWER SUPPLIES**

Use of Capitron® Wafer Capacitors enables AMP to provide a wide variety of high voltage power supplies for radar indicators and radar modulators. The small size and light weight of these units dictates their use in many airborne applications. They are supplied either as oil filled metal cased units or as epoxy encapsulated units. AMP's LGH terminals solve high altitude application problems.

**CAPITRON® ARMORED WAFER CAPACITOR**

Factors of this Capacitor are as follows
- Armor type encapsulation to resist extreme thermal and mechanical shock.
- Eliminates high altitude flash-over, as metal terminals are not exposed ... they are enclosed within the armor encapsulation.
- Multiple connections to capacitor leads can be made with little or no increase in over-all size of the capacitor.
- Versatility of design eliminates revamping assembly to accommodate the capacitor.

**CAPITRON® PULSE SYSTEM PACKAGE**

Charging choke, pulse forming network and pulse transformers are combined in a unit of minimum size and weight to work with a specific magnetron. All components are designed by and manufactured under the direct control of AMP's pulse specialists.

**CAPITRON® PULSE FORMING NETWORKS**

AMP pulse forming networks can be supplied to meet rigorous specifications with special emphasis on high reliability, small size and light weight for airborne radar applications.
L&N's new Guarded Wheatstone Bridge

If you are checking resistors, making routine resistance measurements, or performing laboratory experiments, this new 4735 Guarded Wheatstone Bridge gives you faster, more accurate resistance measurements.

The most advanced general purpose bridge available today, this new 4735 has a host of new features including: high accuracy with a wide operating range . . . guarding of galvanometer circuit to prevent voltage errors due to humidity effects . . . three galvanometer keys interlocked with a battery key . . . therms minimized by special features of construction . . . and bench-type or relay-rack mounting.

Complete information on this versatile bridge is presented in Data Sheet E-53(1). Write today for a copy from your nearest L&N Office or from Leeds & Northrup Company, 4979 Stenton Ave., Philadelphia 44, Pa.

Guarding against effects of humidity
High accuracy with wide operating range
Fast reading of resistance values

Partial Specifications

List Number—4735 Guarded Wheatstone Bridge.
Range—0.01 ohm to 1,111 megohms.
Limit of Error—±(0.05% + 0.001 ohm) up to 100 megohms; ±0.5% above 100 megohms.
Rheostat Switches—Five decades of enclosed switches in steps of 10 x (1000 + 100 + 10 + 1 + 0.1).
Multiplier Dial—Eleven-position enclosed switch; from 10^-5 to 10^+5.
Galvanometer Sensitivity Keys—Three tap keys provide sensitivities of approximately 1, 1/100 and 1/1000.
Battery reversal key is provided.
Case—Metal, gray enamel finish; 19" x 9" x 7", for relay-rack or bench use.
MILITARY type silicon diodes

TRANSITRON'S Military type silicon diodes are designed to meet the requirements of MIL-E-1, and are characterized by reliability under the most severe operating conditions. Their subminiature size and rigid specifications make them ideal for a wide range of applications. Types 1N457, 1N458, and 1N459 are intended for low and medium frequency uses, requiring voltage ratings up to 175 V. Type 1N251 is a high frequency diode especially designed for detector and high speed pulse units.

In addition to these four military types, silicon diodes meeting many other application requirements are also available. These include high conductance types, as well as fast switching-high voltage diodes.

<table>
<thead>
<tr>
<th>Type</th>
<th>Minimum Forward Current at -1 V (mA)</th>
<th>Inverse Current at Specified Voltage (µA)</th>
<th>Maximum Operating Inverse Voltage (volts)</th>
<th>MIL-E-1 155 z</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N457</td>
<td>20</td>
<td>.025 @ -60 V</td>
<td>60</td>
<td>1026</td>
</tr>
<tr>
<td>1N458</td>
<td>7</td>
<td>.025 @ -125 V</td>
<td>125</td>
<td>1027</td>
</tr>
<tr>
<td>1N459</td>
<td>3</td>
<td>.025 @ -175 V</td>
<td>175</td>
<td>1028</td>
</tr>
<tr>
<td>1N251</td>
<td>2</td>
<td>.2 @ -10 V</td>
<td>30</td>
<td>1023</td>
</tr>
</tbody>
</table>

*Inverse recovery time under .15 microseconds

SEND FOR BULLETIN TE 1350
From one source...

SELENIUM • GERMANIUM
for all dc needs from microwatts to megawatts

SUB-MINIATURE SELENIUM DIODES
Developed for use in limited space at ambient temperatures ranging from -50°C to +150°C. Encapsulated to resist adverse environmental conditions. Output voltages from 20 to 160 volts; output currents of 100 microamperes to 11 MA. Bulletin SD-1B

SELENIUM CONTACT PROTECTORS
Designed to eliminate arcing and erosion across the contacts of relays and switches. A complete series in each of three basic types: Diode type, Cartridge type and Hermetically sealed type for industrial application. For complete data: Bulletin SR-150

STYLE S SILICON POWER DIODES
A complete series of hermetically sealed diodes for operating in temperatures from -55°C to +130°C. Power supply and magnetic amplifier types. PIV range: 50 to 600 v. For 100ma DC output request Bulletin SR-136B For 300ma DC output request Bulletin SR-132E

SELENIUM TV AND RADIO RECTIFIERS
The widest range in the industry! Designed for Radio, Television, TV booster, UHF converter and experimental applications. Input ratings from 25 to 150 volts AC and up. DC output current 50 to 1,200 MA. Write for application information. Bulletin ER-178-A

SELENIUM HIGH VOLTAGE CARTRIDGE RECTIFIERS
Designed for long life and reliability in Half-Wave, Voltage Doubler, Bridge, Center-Tap Circuits, and 3-Phase Circuit Types. Phenolic Cartridge and Hermetically Sealed types available. Operating temperature range: -83°C to +100°C. Specify Bulletin H-2

STYLE T SILICON POWER DIODES
Stud mounted—hermetically sealed types for power supply and magnetic amplifier applications. PIV ratings from 50 to 600 volts at 800 ma rectified DC output current. All welded construction. For operation at -55°C to +150°C. Ask for Bulletin SR-135C

SILICON MEDIUM POWER RECTIFIERS
Specifically engineered for industrial applications—the most conservatively rated silicon rectifiers in the industry! Rugged all-welded construction and hermetic sealing mean greater reliability—longer life. Types available in 3 series. Request Bulletin SR-142B.

10 AMP SILICON POWER DIODES
Conservatively rated to provide a substantial safety factor in industrial applications. Hermetically sealed, all-welded case construction provides reliability over a long life. Types available in a wide voltage range. Write for Bulletin SR-151

150 AMP GERMANIUM JUNCTIONS
Designed for high velocity, forced air cooling, the finned copper heat exchanger of these junctions feature 56 sq. inches of cooling area in 5.7 cubic inches of volume. Voltage input ratings from 20 to 85 volts rms. Lug or stud terminals. Bulletin GPR-2

For complete data on the products listed write on your letterhead to International Rectifier

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REPRESENTATIVES THROUGHOUT THE WORLD

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September 1, 1957 — ELECTRONICS
...the complete line of **SILICON RECTIFIERS**
...the widest range in the industry!

**Selenium Industrial Power Rectifiers**
For all DC power needs from microwatts to kilowatts. Features: long life; compact, light weight and low initial cost. Ratings: to 250 KW, 50 ma to 2,300 amperes and up, 6 volts to 30,000 volts and up. Efficiency to 87%. Power factor to 95%. Bulletin C-349

**High Current Density Selenium Rectifiers**
A complete line for natural convection cooling in industrial applications. Inverse voltage ratings up to 56 volts per cell. Rectified DC output approximately twice that of standard selenium stacks in approximately 50% less volume. Write for Bulletin SR-152

**Selenium Photocell—Sun Batteries**
Self-generating photocells available in standard or custom sizes, mounted or unmounted. Optimum load resistance range: 10 to 10,000 ohms. Output from .2 MA to 60 MA in ave. sunlight. Ambient temperature range: -65°C to +100°C. Bulletin PC649

**High Voltage Silicon Power Diodes**
Two styles available. Hermetically sealed, pigtail construction. Style K: PIV from 600 to 1200 volts at 100 ma DC output current. Ask for Bulletin SR-138E. Style J: PIV ratings from 600 to 1000 volts at 125 ma DC output current. Bulletin SR-144A

**Silicon Rectifier Stacks**
These units consist of hermetically sealed junction diodes mounted on copper cooling fins, stacked to include the interconnections required for specific circuits. Junction ratings: 1.25 amps. DC output, 70 to 350 AC input volts rms. Request Bulletin SR-137A.

**330 Amp Germanium Junctions**
Low current density germanium junctions of high capacity for heavy duty applications. Corrosion resistant, cast aluminum cooling fins dissipate heat at high rate. Efficiency: 98.5. Six types. Input voltage ratings from 20 to 66 volts rms. Request Bulletin GPR-2

**500 Amp Germanium Junctions**
Six high capacity junction types especially suited for extra-heavy duty such as electrochemical installations where air cooling is desirable. Cast aluminum anodized housing. Input voltage ratings from 20 to 66 volts rms. Efficiency 98.5. Bulletin GPR-2

**Liquid Cooled Germanium Junctions**
Liquid cooled for maximum power in minimum space. Junction rating: 670 amps at 28 to 66 volts rms. Housed in high-conductivity copper cast around special steel coils. Water, oil or other accepted coolants may be used. For complete data. Bulletin GPR-2

**Silicon Cartridge Rectifiers**
The answer to tough miniaturization problems! Ratings for high temperature applications: from 1000 volts PIV at 100ma half-wave DC output to 16,000 volts PIV at 45ma. Hermetically sealed, metallized ceramic housing. Request Bulletin SR-139B

**Corporation or contact the International Rectifier branch office or representative nearest you.**

**RECTIFIER CORP.**
**INDUSTRIAL METALLIC RECTIFIERS**
General Electric M-2 Leak Detector Offers You

UNSURPASSED LEAK SENSITIVITY

Expensive rejects of sealed electronic products can be reduced by leak testing housings before assembly with the new General Electric mass spectrometer leak detector. It offers:

EXTREME SENSITIVITY—detects leaks of $1 \times 10^{-10}$ standard cubic centimeters of air per second ($9 \times 10^{-6}$ micron cubic feet per hour).

FAST RESPONSE—as low as 2 seconds for small, hermetically sealed electronic components.

HIGH RESOLUTION which helps eliminate the possibility of response to elements other than the tracer gas.

THESE EASY MAINTENANCE FEATURES HELP REDUCE DOWN-TIME

Simplified design of the vacuum system and use of plug-in components gives excellent accessibility and saves maintenance time. The easily removed spectrometer tube greatly reduces down-time when the tube needs cleaning or filament replacement.

No special training is needed to operate the General Electric M-2 leak detector. After starting, the M-2 is operated simply by opening and closing one valve. The leak will show up on the leak rate indicator of the operator's panel. An audible alarm is also available.

For further information, contact your nearest General Electric Apparatus Sales Office or write for descriptive bulletin, GEC-336, to Section 585-63, General Electric Co., Schenectady 5, N. Y.

Down-time is reduced through easy access and removal of the spectrometer tube (right) and by a simplified vacuum system design.
At last!  
Mycon Plastic Capacitors  
up to 150° C!

- Reliability proved
  - Rated for infinite long life
- Insulation resistance 1 x 10^{11} OHMS

Derated at 125°C as follows:
- 100 volts - 56%
- 200 volts - 56%
- 300 volts - 33.3%
- 400 volts - 33.3%
- 500 volts - 20%
- 600 volts - 16%

Tested and proved! Only Southern Electronics Corporation has developed a test procedure which insures built-in reliability! For your most exacting requirements - be sure - always specify S.E.C.

SUPER MYCON CAPACITORS
Tolerance to 1% - lowest temperature coefficient. Superior insulation resistance at high ambient temp. Good stability compatible with material.

Wire, write or phone for complete catalog today!

SOUTHERN ELECTRONICS Corporation
150 West Cypress Avenue, Burbank, California
PIONEERS IN CUSTOM CAPACITOR ENGINEERING
Faster Wiring with
NEW
Klein Shear Cutting Plier

Two-step wiring of resistors:
1. Cut wire and bend in hook.
2. Close for soldering.

Here is a new Klein Plier based on an original principle which assures cleaner, faster cutting. The shear action makes it possible to cut hard wire or dead soft wire easily, quickly.

The reverse side of the plier has a milled section behind the knife so designed that when the wire is cut, it is held in position and a turn of the hand forms a 3/16-inch hook at the proper angle. Without changing pliers this hook may then be closed on the terminal for soldering.

Shear blade is held in place with a countersunk setscrew and may be quickly replaced when knife becomes dull.

Also available as a straight side cutting plier with shear.

Furnished standard with self-opening coil spring and 1/16-inch point.

ASK YOUR SUPPLIER
Foreign Distributor
International Standard Electric Corp.
New York

208-6NC. Similar in design to 208-6C but reverse side designed to put a positive 3/16-inch hook on the end of a resistor wire. Smooth one-motion operation saves production time on every television or radio set.


Mathias KLEIN & Sons
Established 1857
7200 McCormick Road • CHICAGO 45, ILLINOIS
Now the famous Allen-Bradley Type J (2 watt) and the smaller Type G (½ watt) variable resistors are available encapsulated in epoxy resin... completely sealed. The operating shaft is provided with an "O" ring—to prevent moisture and detrimental vapors getting into the control. This new construction provides your critical circuits with the reliability and unequalled performance of Allen-Bradley's solid hot molded type resistor elements... plus the extra protection of epoxy encapsulation.

These famous Allen-Bradley variable resistors give you smooth control—without abrupt resistance changes. "Noise" characteristics are extremely low, and improve with long use. These controls can be supplied in single, dual, and triple units, with shaft variations and standard or special resistance tapers—as you may require. Please write today for complete information.
You can obtain greater precision with Allen-Bradley temperature compensating capacitors... much more accurate than conventional units... more accurate than the requirements of MIL or RETMA specifications.

Allen-Bradley is able to assure this accuracy by producing its own ceramic bodies. Years of experimentation, thousands of tests, and meticulous compounding enables Allen-Bradley to provide the exact characteristics you require. The accompanying temperature coefficient curve—typical of all Allen-Bradley temperature compensating capacitors—illustrates how precisely these characteristics are maintained.

Allen-Bradley temperature compensating capacitors are available from 2.0 to 510 mmf with eleven different temperature characteristics from P-100 to N-1500 in tolerances of ±5%, 10%, and 20%. Use these quality ceramic capacitors—they cost no more—and they will give you a more stable product.

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.
Whenever You Want Dependable Electrical Protection

... BUSS FUSES ARE YOUR ANSWER!

Here's why... With BUSS fuses, dependable electrical protection isn't left to chance. Every BUSS fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

The result — when an electrical fault occurs, BUSS fuses quickly clear the circuit and the danger of damage to equipment is held to a minimum. Yet, BUSS fuses won't cause needless shutdowns by blowing when trouble does not exist.

By specifying BUSS fuses, you make sure your product received maximum electrical protection. And you are helping to safeguard the good name of your product for service and reliability.

If you have a troublesome fusing problem... you can save engineering time by letting our research staff of fuse engineers work with you. If possible, a fuse will be selected that is available in local wholesalers' stocks, so that your device can easily be serviced.

For more information on BUSS and FUSETRON Small Dimension fuses and fuseholders... Write for bulletin SFB. Bussmann Mfg. Division (McGraw-Edison Co.) University at Jefferson, St. Louis 7, Mo.

"BUSS fuses are made to protect—not to blow, needlessly"

65
HOW TO TEST CORES

You can get your core program off the ground now with the Burroughs BCT-301. This complete and flexible system for accurately measuring the operating characteristics of tape wound cores is the result of six years of core research at Burroughs. And with it, you get the benefit of advanced techniques and procedures which are now in everyday use at Burroughs, and are accepted practice among major core manufacturers.

Designed expressly for the individual testing of square loop cores, the BCT-301 allows precise control over frequency, pattern, amplitude, and rise time of the core driving signal. Thus, you can get extremely accurate measurements of the switching time of the core as well as the amplitude of the output pulse. And the unitized sections of the BCT-301 can be expanded and modified to meet new testing requirements as they arise.

Write for additional details on the BCT-301, or request a demonstration of how this new tool can get your core program off the ground now.

specifications

- **core mounting jig**: Applies light single turn loops around core for input and output windings. Special electrical and mechanical design minimizes pickup by the secondary as well as other disturbances caused by air flux. Adjustable pins accommodate wide range of bobbin sizes with equal precision.
- **pattern generator**: Provides extreme flexibility in generating pulse patterns applied to core, controlling pulse spacing, repetition rate of cycle, and number of pulses in pattern.
- **current drivers**: Two drivers convert voltages from pattern generator into positive and negative constant current pulses used for driving core. Front panel controls vary current amplitude from 0 to 1.0 ampere; rise time from 0.2 µsec. to 1.0 µsec.; pulse duration from 1.0 µsec. to 10.0 µsec.
- **calibrator**: Accurately measures currents and voltages. Permits measurement of driving current and amplitude of output voltage with an error of less than 1%. Used with calibrated oscilloscope, permits highly accurate readings of switching time.
- **power supply**: Provides seven regulated d-c voltages.

---

Burroughs Corporation • ELECTRONIC INSTRUMENTS DIVISION, DEPT. C, 1209 VINE STREET, PHILADELPHIA 7, PA.
INDUSTRY
APPROVED

AlSiMag® 196
PRECISION CERAMICS
High Strength - Low Loss

Your best buy for uses requiring rugged strength, low dielectric loss, precision tolerances. Dependable performance. Produced by the source offering widest choice of specialized ceramic compositions in the field. Withstand high temperatures. Hard. Minimize chipping, breaking. Chemically inert. Permanently rigid. Cannot rust, corrode or deteriorate with time. Wide latitude of shapes and sizes. Pressed ... extruded ... machined. The right equipment for every operation, every size order ... to improve quality, decrease cost. Rapid delivery of uniform parts. Prototypes available ... small lots for test purposes without special tooling.

VERSATILE AlSiMag 196 STARS
IN SUCH APPLICATIONS AS THESE:

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<td>Insulators</td>
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<td></td>
<td>Tube Parts</td>
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Why not investigate the many advantages of AlSiMag 196 for your application? Sketch or blueprint, together with details of operation, will bring you complete information.
Using the diffused-meltback process

G.E. gets the most from silicon...

Curves illustrating impurity distribution after diffusion. P-type impurities in the high concentration side of the meltback junction diffuse, within solid semiconductor, into "plateau" region of low impurity concentration. High resistivity "plateau" contributes to elimination of punch-thru effects.

Before going through the diffused-meltback operation, a crystal of silicon is sawed into wafer-form: wafers are then diced to produce 4000 to 5000 individual silicon bars. Photomicrograph at left shows size-comparison of a silicon NPN bar, or pellet, with human hair (Arrow 2). "Tear drop" at end of bar is formed during meltback process. Micro-thin base, or "P", region (Arrow 1) is created through G-E diffusion technique. Base regions of 2-micron size are made with relative ease.
to put the most into transistors

High degree of uniformity and control in junction formation. General Electric's diffused-meltback process was developed by Dr. I. A. Lesk of the G-E Advanced Semiconductor Laboratory. The development came about as the result of Dr. Lesk's efforts to create a transistor manufacturing process that would yield high-quality results at reasonable cost.

Not only does the G-E diffused-meltback process result in a maximum number of transistors from a single crystal (4000 to 5000 NPN transistors), but it offers an extremely high degree of uniformity and control in transistor junction formation.

Opens the door to high frequency performance. Diffusion of a melted-back silicon bar, or pellet, is the final step in the diffused-meltback process. It's the stage in which the micro-thin base, or "P" region is formed, establishing the final NPN transistor structure. Because the actual diffusion is accomplished over a high temperature heating cycle lasting several hours, the need for split-second accuracy is eliminated. The result is a high degree of process control.

By proper choice of the initial impurity concentrations and the time and temperature of the diffusion cycle, heavily-doped base regions as thin as 2 microns are easily obtained. These micro-thin, uniform base regions are the "open-sesame" to extremely reliable high frequency transistor performance.

High current gain. Silicon NPN transistors feature inherent high current gains and high frequency cut-offs. The diffused meltback process permits mass production, since it combines the principles of impurity segregation and solid-state diffusion.

G-E silicon NPN transistors are nominally rated for 25 megacycles, but with useful gain to 50 megacycles—the highest frequencies offered by any mass-produced silicon NPN triode on the market today. All production units are aged at extremely high temperatures for over 150 hours. This is to provide maximum stability of $I_{CEO}$ and current gain ($\beta$).

The header assemblies of G-E silicon NPN transistors are constructed of high-purity materials. A gold-silicon alloy is used for end connections; the base lead is pure aluminum. There are no solders or fluxes, eliminating any danger of transistor "sleeping sickness" caused by corrosion at soldered junction points.

Outstanding For Switching Applications and Linear Amplifier Use. The gold-alloy mountings, with a melting temperature of over 350°C represent the lowest melting point of the entire transistor assembly structure. The G-E Series 4JD4A silicon transistors provide reliable operation to 150°C, with storage temperatures to 200°C.

With well-controlled high frequency characteristics and a low saturation resistance of 20 ohms, G-E silicon NPN transistors are "nationals" for switching applications and linear amplifier use.

Would you like complete specification information? Please contact your nearest G-E Semiconductor Products district office, or write to General Electric Company, Semiconductor Products, Section S2597, Electronics Park, Syracuse, N. Y.

Progress Is Our Most Important Product

General Electric

Ordering Data—G-E Silicon NPN Transistors

High Frequency Amplifier Type
ask for: 2N439 (formerly 4JD4A2)

Computer DCTL Type
ask for: 2N430 (formerly 4JD4A3)

General-Purpose Amplifier Types
ask for: 2N431 (formerly 4JD4A4) 9 to 30
2N432 (formerly 4JD4A5) 20 to 55
2N433 (formerly 4JD4A6) 45 to 100

View of unopened G-E silicon NPN diffused-meltback transistor, showing mounted silicon bar with aluminum base lead connected. Bar ends attached using a gold-alloy mounting technique. No solders or fluxes are used.

Diffusion furnace. Operator places quartz vials, with large quantity of silicon bars, in furnace. Diffusion occurs through high-temperature heating cycle lasting several hours.

An aging oven in which G-E silicon NPN transistors are aged at extremely high temperatures for over 150 hours. Provides maximum stability of $I_{CEO}$ and current gain ($\beta$).
Reliable, Efficient DC Conversion

Industry’s Highest Power Transistors


The excellent electrical characteristics of Delco High Power transistors permit the conversion of low DC voltage to higher DC voltage—with a high degree of efficiency—in a wide range of applications. This proved performance offers greater reliability than will be found in corresponding vibrator circuits.

The low saturation voltage of Delco 2N173 and 2N174 transistors also reduces their internal power dissipation in conversion applications to an insignificant degree so that little self-heating is apparent. The result is an overall economy which permits converters of smaller size... important in many applications.

<table>
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<tr>
<th>TYPICAL CHARACTERISTICS</th>
<th>2N173</th>
<th>2N174</th>
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<tr>
<td>Properties (25°C)</td>
<td>12</td>
<td>28</td>
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<tr>
<td>Maximum current</td>
<td>12</td>
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<tr>
<td>Maximum collector voltage</td>
<td>60</td>
<td>80</td>
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<tr>
<td>Saturation voltage (12 amp.)</td>
<td>0.7</td>
<td>0.7</td>
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<tr>
<td>Power gain (Class A, 10 watts)</td>
<td>38</td>
<td>38</td>
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<tr>
<td>Alpha cutoff frequency</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>Thermal gradient from junction to mounting base</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Distortion (Class A, 10 watts)</td>
<td>5%</td>
<td>5%</td>
</tr>
</tbody>
</table>
The development and production of the finest quality solderless terminals for your electrical circuitry requirements is AMP's primary objective. We also constantly search for allied products and application techniques that will speed, simplify, and obsolete present time-consuming sub-assembly operations. AMP-SPIRAP and its application technique stems from such constant searching activity.

AMP-SPIRAP is a unique, spirally-cut plastic wrapping that...

- eliminates tedious cable lacing, insulation damage, and pulling of wires through spaghetti tubing
- is quickly applied to wire bundles of any size up to 3 1/2 inches diameter
- permits individual wires to be entered or led out at any point
- is quickly unwound to allow wires to be added, removed, or relocated—thereby eliminating the necessity for cutting into the cable bundle after assembly
- holds wires together tightly, but permits flexibility for forming cable
- provides mechanical protection over entire length of cable

When required for your maintenance and repair needs, AMP-SPIRAP is available in the U.S.A. through American Pamcor Inc.

Additional information about AMP-SPIRAP and its application versatility is available on request. SEND FOR YOUR FREE SAMPLE TODAY.
Even in the most remote areas, wings aloft are guided on their way by Aerocom's new medium range Aerophare Transmitter. This transmitter was designed and built to provide long, trouble-free service with no attendants...even where the total population is Zero.

**AEROCOM'S**

**Dual Automatic Package-Type Radio Beacon**

for completely unattended service. This aerophare (illustrated) consists of two 100 watt (or 50 watt) transmitters with keyer, automatic transfer and antenna tuner. (Power needed 110 or 220 volts 50/60 cycles, 520 V.A. for 50 watt, 630 V.A. for 100 watt.)

Frequency range 200-415 kcs.: available with either crystal or self excited oscillator coil. High level plate modulation of final amplifier is used, giving 40% tone modulation in 100 watt transmitter and 60% in 50 watt model. Microphone P.T switch interrupts tone, permitting voice operation.

The "stand-by" transmitter is selected when main transmitter suffers loss (or low level) of carrier power or modulation. Audible indication in monitoring receiver tells which transmitter is in operation.

Unit is ruggedly constructed and conservatively rated, providing low operating and maintenance costs.

Also available in 1 K.W. and 4 K.W. Models
Two new switch-controls
Volume setting unaltered by ON-OFF operation

Just switch on and walk away. No coming back or waiting for further adjustment after warm-up.

Volume can be changed instantly as desired by rotating shaft . . . or can remain indefinitely at any selected setting regardless of on-off switch operations.

Push-push switch available with either 3 amp 125V rating (Type J) or 6 amp 125V rating (Type TJ).

Pull-push switch available with 3 amp 125V rating (Type K). Both switches available in many special terminal and control combinations.

Write today for Data Sheets containing dimensional drawings and complete technical details.

The most complete line of variable resistors and associated switches available is manufactured by CTS. Consult CTS Specialists on all your control problems.

WEST COAST MANUFACTURERS:
Many types of variable resistors now in production at our South Pasadena plant. Your coil, transformer and compression molding business also invited. Prompt delivery. Modern versatile equipment. L. A. phone CLinton 5-7186.

The Exclusive Specialists in Precision Mass Production of Variable Resistors
JUNIOR VoltOhmyst® WV-77C — Biggest value in vacuum-tube volt-ohmmeters! Factory tested and calibrated to lab standards. Measures dc from 100 millivolts to 1200 volts; ac from 100 millivolts to 1200 volts rms; resistance from 0.5 ohm to 1,000 megohms. User Price $59.50*

SENIOR VoltOhmyst® WV-80A — Improved circuit provides greater accuracy. 99% on BOTH ac and dc measurements. Measures directly the peak-to-peak values of complex waveforms and rms values of sine waves. LARGE full-vision meter, with less than 1% tracking error, provides one of the easiest reading VTVM scales. User Price $79.50*

MASTER VoltOhmyst® WV-82B — Ideal for TV, radar and other types of pulse work. Has accuracy and stability necessary for laboratory applications. Postures ±1% multiplier and shunt resistors; ±1% meter movement; DC polarity reversing switch; zero-center scale adjustment for discriminator alignment; ±1% accuracy on AC and DC voltages, many other features. User Price $137.50*

FOR YOUR LAB OR LINE

ELECTRON-TUBE MicroMhoMeter WT-30A — Accuracy suited for electronic equipment manufacturers, research and development, maintenance groups. Precision tube testing under actual circuit conditions. Built-in "short" test; burnout protected meter; regulated power supplies for dc voltages; measures gm up to 100,000 micromhos in 6 ranges. User Price $785.00 *

ULTRA-SENSITIVE DC MICROAMMETER WV-84B — Popular choice in industrial, chemical, general lab applications. Designed to measure extremely "feeble" currents, extremely high resistances. Self-contained batteries permit use almost anywhere. Low-drain tubes extend battery life, meter protected from accidental overloads. User Price $110.00* (less batteries)

5" OSCILLOSCOPE WO-88A — An all-purpose scope for general lab use, production-line alignment and testing. Built-in voltage-calibrating facilities permit simultaneous waveform display and peak-to-peak voltage measurements. Sync polarity instantly reversible with front panel switch. Directly coupled, push-pull amplifiers in vertical circuit provide flat response down to dc. User Price $179.50*

5" OSCILLOSCOPE WO-81A — Dual Band 4.5 Mc scope, for waveform observation and measurement, signal tracing and alignment of chrominance circuits and wide-band amplifiers — voltage-calibrated input step-attenuators and calibrated graph screen make possible direct voltage readings as easily as with a VTVM. User Price $239.50*

7" OSCILLOSCOPE WO-56A — For phase measurements or vector display — 7-inch screen plus trace expansion of 3 times screen diameter provide unusually large waveform display for distant or close examination of minute portions of waveforms. Frequency-compensated voltage-calibrated attenuators in both "V" and "H" amplifiers. User Price $289.50*

5" OSCILLOSCOPE WO-68B — Famous "engineer's choice" dual-band scope for use when extra sensitivity and extended frequency response are required. Uses flat-faced cathode-ray tube with post-ulator potential of 3000 volts; automatic sync limiting; push-button for calibration checking; excellent phase characteristics; full screen deflection over entire rated frequency range. User Price $475.00*

For fast delivery of the best in test instruments for lab, line or shop... call your RCA Distributor!

RADIO CORPORATION OF AMERICA
CAMDEN, N. J.

COMPONENTS DIVISION

Circle 64 Readers Service Card

September 1, 1957 — ELECTRONICS
Sustained operating temperatures up to 400° F, as in guided missiles, are death to inferior electrical insulations and laminates. CDF glass-base laminates of Teflon®—the only laminates of their kind approved by the military—can take this punishment steadily.

LATEST HIGH-HEAT INSULATION SYSTEMS
NEED CDF GLASS-BASE LAMINATES AND TAPES

Widest available range offers Teflon, epoxy, silicone, mica products for dimensional stability under continuous heat

As components and equipment grow smaller, and heat becomes more difficult to dissipate, CDF high-heat electrical insulations become increasingly important to electronic design. For nowhere else can such a wide range of quality insulations be found under one roof as at CDF.

FOR HIGH-HEAT PRINTED CIRCUITRY, CDF glass-base metal-clad laminates of Teflon® and epoxy exhibit best dimensional stability and current-carrying capacity. Constant operating temperatures of 300°F — soldering temperatures to 500°F — are readily met by these specialized CDF Dilecto® laminates.

HIGH-HEAT FLEXIBLE INSULATIONS. CDF offers a wide choice of insulating tapes made of Teflon, silicone varnish, silicone rubber, and Micabond®, with glass-cloth support. CDF tapes may be used either by hand wrapping or on automatic winding machines. Unsupported Teflon in colors available to meet MIL-STD 104.

TEFLON SPAGHETTI TUBING AND OTHER SPECIALTIES.
Part of CDF's vast fabrication facilities is devoted to the production of custom parts from Teflon — spaghetti tubing, rods, sheets, and machined parts to rigid specifications.

NEW — cementable Teflon, bondable to itself and to other materials with commercial adhesives.

SEE SWEET'S Product Design File, Electronics Buyers' Guide, and other directories for the name and phone number of your CDF sales engineer. Then send your print or your problem, and we'll return specific technical data and test samples.

*trademark of DuPont tetrafluoroethylene resin

CONTINENTAL-DIAMOND FIBRE
A SUBSIDIARY OF THE_BUTT COMPANY • NEWARK 16, DEL.
Here are 6 NEW Precision Switches by MICRO SWITCH...

Designed to meet modern electrical control requirements

MICRO SWITCH pioneered the development of precision switches...It has been first in precision switching for two decades...These new switches are typical of MICRO SWITCH's continuing leadership.

MICRO SWITCH alternate action pushbutton switch gives on-off control of up to four circuits

Shown here is the MICRO SWITCH 8PBR1-T2 (unlighted) which allows on-off control of up to four circuits. When the switch button is pushed, the contacts of the switches are alternately reversed. They complete a cycle of action every two operations of the button.

This alternate action is achieved by the extremely compact design of a long-life assembly of ratchets. Variations are possible which will permit almost any sequence of switch operation. For instance, on a switch with a four-push sequence, a great many sequences of switch operation can be provided.

This switch requires but 1 1/4 in. below its mounting panel and mounts in a 3/4 in. hole. Button is of off-white plastic. Operating force is 36 oz. max. (Send for Data Sheet 124)

SWITCH CHARACTERISTICS
Two SPDT switches; break distance .010 in. min. Electrical data: U/L listed at 5 amps. 125 or 250 vac; 30 vdc rating; inductive, 3 amps. at sea level and 2.5 amps. at 50,000 feet; resistive, 4 amps. at sea level and 50,000 feet. Maximum inrush is 15 amps.

MICRO SWITCH magnetic hold-in toggle switch—permits remote release of toggle lever to its unoperated position

This MICRO SWITCH 2ET1 magnetic hold-in toggle switch is a momentary-action toggle switch which also functions as a maintained-contact switch by means of a solenoid incorporated into the design of the switch. When the toggle lever is operated and the solenoid is energized, the magnetic force of the solenoid holds the switch in the operated position. This magnetic hold-in feature permits remote electrical release of the lever.

The precision SPDT switch and a 28 vdc solenoid are contained in one compact unit. The small size makes it an ideal component for applications where space is a critical factor. (Send for Data Sheet 137)

SWITCH CHARACTERISTICS
Total travel 30°; Electrical data: 28 vdc rating: inductive 3 amps. at sea level and 2.5 amps. at 50,000 feet; motor, 4 amps. at sea level and 50,000 feet; resistive, 4 amps. at sea level and 50,000 feet; inrush, 24 amps. at sea level and 50,000 feet; Hold-in rating of solenoid is 18-30 vdc.
ELECTRONICS

Switches have uses unlimited

NEW!

MICRO SWITCH
"Rocket Switch"—
a rugged, sealed small switch for indicating and lockout devices

Developed for use on rocket launchers, this MICRO SWITCH Type-EN switch is attached to a rugged cam-type actuator. The assembly fits the needs of many industrial designs.

Type-EN switch consists of one SPDT toggle switch. This switch is provided with a hold-in feature, when the toggle lever is operated and a solenoid is energized, the magnetic force holds the lever operated. This hold-in feature permits remote electrical release of the lever. Both switch and solenoid are sealed within the cylindrical shaped enclosure. This insures constant operating characteristics. An elastomer seal at the base of the toggle lever prevents entrance of dust or moisture. (Send for Data Sheet 132)

SWITCH CHARACTERISTICS

Operating force—4 to 12 lbs.; Full overtravel force—10 lbs. min.; Release force—5 lbs. min.

Electrical Data: 250 vac; inductive: 2 amps; resistive: 10 amps; at sea level and 50,000 feet; 6 amps; at sea level and 50,000 feet; 12 amp; at sea level and 50,000 feet. Motor, 10 amps; at sea level and 50,000 feet; 20 amp; at sea level and 50,000 feet. (Altitude ratings established with a rugged cam-type actuator.)

NEW!

MICRO SWITCH
completely sealed magnetic hold-in toggle switch

The MICRO SWITCH SET Series is a completely sealed momentary action toggle switch which also functions as a maintained contact switch. When the toggle lever is operated and a solenoid is energized, the magnetic force holds the lever operated. This hold-in feature permits remote electrical release of the lever. Both switch and solenoid are sealed within the cylindrical shaped enclosure. This insures constant operating characteristics. An elastomer seal at the base of the toggle lever prevents entrance of dust or moisture. (Send for Data Sheet 131)

SWITCH CHARACTERISTICS

Total travel 30°; Contact arrangement SPDT, may be wired either N.O. or N.C. Electrical rating at 250 vac; inductive: 300 vac; resistive: 100 vac; at sea level and 50,000 feet; inrush, 40 amp; at sea level and 50,000 feet; motor, 40 amp; at sea level and 50,000 feet; 20 amp; at sea level and 50,000 feet. Hold-in rating of solenoid is 19-30 volts dc.

NEW!

MICRO SWITCH
three-position toggle switch—4 SPDT circuits with a single lever

MICRO SWITCH Series of toggle switches uses four SPDT switching units. Two units are actuated in each extreme toggle lever position. None are actuated when lever is in center position. Many different combinations, however, may be obtained, including the make and break of circuits in all three lever positions. Outstanding features of this series include the compact design, positively-driven switch actuators and sturdy construction. A safety catch guards against accidental movement of toggle lever. (Send for Data Sheet 120)

SWITCH CHARACTERISTICS

Electrical rating at 250 vac; inductive: 10 amp; at sea level, 6 amp; at 50,000 ft.; resistive: 10 amp.; motor: 6 amp. Basic units listed by Underwriters Laboratories for: 10 amp. 125 or 250 vac; 1/4 amp. 125 vac; 1/4 amp. 250 vac.

NEW!

MICRO SWITCH
"typewriter" pushbutton switch for manual keyboard control

MICRO SWITCH 1PB8-T2 switch is ideal for one-finger rapid-repeat operation such as is required for the type of keyboard control found in electric typewriters, adding machines, etc. The repeat action is as rapid as the fastest operator can push the button. This switch uses a SPDT MICRO SWITCH subminiature switch for snap-action reliability. The contoured button and unique overtravel spring combine to reduce operator fatigue. Operating "feel," however, is sufficient to avoid mistakes and false actuations. Removable 1/2 in. dia. plastic button is available in red, green, off-white or black. It is keyed to prevent rotation. (Send for Data Sheet 123)

SWITCH CHARACTERISTICS

Electrical rating at 30 vac; inductive: 3 amp; at sea level and 50,000 ft.; maximum inrush: 15 amp. Basic subminiature switch is listed by Underwriters Laboratories at 5 amp. 125 or 250 vac.
UNIVERSITY ANNOUNCES THE VERSATILE MODEL

CLH WIDE-ANGLE PROJECTOR

EXCLUSIVE OMNI-DIRECTIONAL MOUNTING

Horn bell rotates full 360° on its axis, while the "U" ring bracket provides better than 180° vertical and 360° horizontal adjustment of projector positioning. Thus, sound can be distributed in any direction regardless of projector location.

USE SINGLY OR STACKED

The "U" mounting bracket of the Model CLH is specially designed to link two or more projectors into any configuration, achieving exactly the sound distribution pattern required. Even diagonal or alternating projections are just as easy to achieve as "standard" patterns.

VERSATILITY & ADAPTABILITY UNLIMITED

Meets every soundcasting requirement. Use the CLH wide-angle projector with any University driver to get exactly the frequency response, efficiency and power handling capacity you need. Here is dependable performance and real economy—actual dollar savings you can count on year after year.

SPECIFICATIONS: Air Column, 4 1/2 ft; Horn Cut-off, 150 cps; Dispersion, 120° x 60°; Bell Mouth, 21 1/2" x 11 1/2"; Depth (less driver), 20"; $44.50 List.

LISTEN

University sounds better

UNIVERSITY LOUDSPEAKERS, INC., 80 SOUTH KENSICO AVENUE, WHITE PLAINS, N. Y.

Patents Pending

THE MOST COMPLETE SELECTION OF DRIVERS IN THE INDUSTRY NOW AVAILABLE FOR USE WITH THE CLH

Model CLH $44.50 List

Model PA-50. Features extended high and low frequency range, highest continuous duty power capacity, greatest conversion efficiency, husky built-in multi-match transformer with terminals conveniently located at base of unit. The answer to the toughest sound problem. Nothing like it!

Response: 70 to 10,000 cps; Power Capacity: Full Range 50 watts; Adjusted Range* 200 watts; List Price: $57.50.

Model PA-50D. For applications requiring the greatest power handling capacity, maximum sensitivity, widest range frequency response, plus rugged lifetime construction. Completely die-cast aluminum housing. Increased sound output cuts amplifier requirements in half!

Response: 70 to 10,000 cps; Power Capacity: Full Range 50 watts; Adjusted Range* 200 watts; List Price: $47.50.

Model SA-30. "Battleship" construction for maximum durability against abuse or in hazardous environments. Completely die-cast aluminum housing and built-in matching transformer for connection to high impedance lines or "constant voltage" systems.

Response: 80 to 10,000 cps; Power Capacity: Full Range 50 watts; Adjusted Range* 60 watts; List Price: $47.50.

Model SA-50. Will deliver that extra punch needed to cut through heavy noise. Use for speech or high quality music. For applications requiring the greatest power handling capacity, maximum sensitivity, widest range frequency response, plus rugged lifetime construction. Completely die-cast aluminum housing. Increased sound output cuts amplifier requirements in half!

Response: 80 to 10,000 cps; Power Capacity: Full Range 50 watts; Adjusted Range* 60 watts; List Price: $36.50.

Model MA-25. Low in cost, high in quality, featuring high efficiency magnet, tropicalized 2" voice coil, "rim-centered" breakdown-proof bakelite diaphragm. Increased sound output cuts amplifier requirements in half!

Response: 85 to 6500 cps; Power Capacity: Full Range 25 watts; Adjusted Range* 50 watts; List Price: $27.50.

ACCESSORIES

2YC Connector enables two driver units to be used with one CLH trumpet for up to 200 watts output. Now you can get the Super-Power you want...when you want it, using standard stock drivers.

PMA Adapter fits standard 1/2" dia. threaded pipe to the CLH "U" mounting bracket. Takes the headache out of mounting on pipe.

September 1, 1957 - ELECTRONICS
The shaped winding pictured here produces the empirical function in the graph. It is an example of Fairchild's leadership in non-linear potentiometer design which started with their very first potentiometer over fifteen years ago—a functional unit designated Type 736.

**NON-LINEAR FUNCTIONS**

featuring advanced techniques for winding precision potentiometers

The superiority of Fairchild functional components can be traced, in part, to the advanced winding techniques developed by Fairchild engineers. The shaped card shown above is one of these; others include wire size changes (butt welded instead of soldered), variable space winding, and the use of welded taps. After thorough inspection, the completed windings are curved and fitted into the potentiometer cases.

**Over 2500 Functions**

These advanced techniques, in many cases, avoid the need for tapping and shunting, and eliminate external resistors. Advances like these are the natural outgrowth of Fairchild's broad experience attained in manufacturing precision potentiometers to produce more than 2,500 different non-linear functions.

Some of the more common of these include:

\[
\begin{align*}
R &= K\sqrt{0} \\
R &= \sin 2\theta \\
R &= K \sin^2\theta \\
\frac{\% R}{\% \theta^2} &= 1.875 \log 2 \\
R &= 1 - \cos(90^\circ - \theta) \\
R &= 1 - \cos \theta \\
\text{Sec} &\theta \\
\text{Sin-Cos} \\
\text{1.875 log 2 cycle log}
\end{align*}
\]

These functions can be provided in many standard types ranging from \(\frac{7}{8}\)" to 3", as well as an infinite variety of specials. Call on this vast experience the next time you have a problem involving non-linear functions—or any precision potentiometer problem. Write to Dept. 140-89A, Fairchild Controls Corporation, Components Division:

**FAIRCHILD**

**PRECISION POTENTIO METERS**

and COMPONENTS

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WEST COAST
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Los Angeles, Calif.
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QUICKLY INTERCHANGEABLE . . . EASILY SERVICED
- Miniaturized
- Lightweight
- Simple, fast installation
- Meets MIL-E-5272
- Can be hermetically sealed with dimensional changes

<table>
<thead>
<tr>
<th>OSTER TYPE</th>
<th>SB-9805-01</th>
<th>SB-9805-02</th>
<th>SB-9805-03</th>
<th>SB-9805-11</th>
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<tbody>
<tr>
<td>Motor</td>
<td></td>
<td></td>
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<tr>
<td>Fixed Phase Voltage</td>
<td>26v</td>
<td>115v</td>
<td>115v</td>
<td>26v</td>
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<tr>
<td>Control Phase Voltage</td>
<td>26v</td>
<td>115v</td>
<td>115v</td>
<td>26v</td>
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<td>Frequency</td>
<td>400</td>
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<td>Max. Power @ Stall</td>
<td>6</td>
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<tr>
<td>No Load Speed</td>
<td>10,500</td>
<td>10,000</td>
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<td>Generator</td>
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<tr>
<td>Excitation Voltage Phase 1</td>
<td>26v</td>
<td>0.3v/1000 RPM</td>
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<td></td>
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<tr>
<td>Output Phase 2</td>
<td>0.3v/1000 RPM load</td>
<td>0.012v</td>
<td>0.012v</td>
<td>3.5 watts Max.</td>
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<tr>
<td>Null</td>
<td>.012v</td>
<td>.012v</td>
<td>.012v</td>
<td>.012v</td>
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<tr>
<td>Wobble Voltage</td>
<td>.007v</td>
<td>.007v</td>
<td>.007v</td>
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<td>(Power Excitation)</td>
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<td>3.5 watts Max.</td>
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<tr>
<td>Linearity</td>
<td>.5% to 4000 RPM</td>
<td>.5% to 4000 RPM</td>
<td>.5% to 4000 RPM</td>
<td>.5% to 4000 RPM</td>
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<tr>
<td>Potentiometer</td>
<td>360°</td>
<td>360°</td>
<td>360°</td>
<td>360°</td>
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<tr>
<td>Mechanical Rotation</td>
<td>1000 ohms</td>
<td>50,000 ohms</td>
<td>50,000 ohms</td>
<td>1000 ohms</td>
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<tr>
<td>Resistance</td>
<td>±5%</td>
<td>±5%</td>
<td>±5%</td>
<td>±5%</td>
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<tr>
<td>Accuracy of Total Resistance</td>
<td>350°</td>
<td>350°</td>
<td>350°</td>
<td>350°</td>
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<tr>
<td>Electrical Angle</td>
<td>1000 ohms</td>
<td>50,000 ohms</td>
<td>50,000 ohms</td>
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<tr>
<td>Servo Block Unit</td>
<td>3000 hours excluding pot.</td>
<td>3000 hours excluding pot.</td>
<td>3000 hours excluding pot.</td>
<td>3000 hours excluding pot.</td>
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<tr>
<td>Ambient Temperature</td>
<td>-55°C to 72°C</td>
<td>-55°C to 72°C</td>
<td>-55°C to 72°C</td>
<td>-55°C to 72°C</td>
</tr>
<tr>
<td>Altitude</td>
<td>-1000 feet to 55,000 feet</td>
<td>-1000 feet to 55,000 feet</td>
<td>-1000 feet to 55,000 feet</td>
<td>-1000 feet to 55,000 feet</td>
</tr>
<tr>
<td>Life</td>
<td>3000 hours excluding pot.</td>
<td>3000 hours excluding pot.</td>
<td>3000 hours excluding pot.</td>
<td>3000 hours excluding pot.</td>
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<tr>
<td>Gear Train</td>
<td>1000 : 1</td>
<td>336 : 1</td>
<td>167 : 1</td>
<td>10,000 : 1</td>
</tr>
<tr>
<td>Ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Dust Enclosed per</td>
<td>Section 4.11 MIL-E-5272A</td>
<td>Section 4.11 MIL-E-5272A</td>
<td>Section 4.11 MIL-E-5272A</td>
<td>Section 4.11 MIL-E-5272A</td>
</tr>
<tr>
<td>Backlash</td>
<td>Anti-Backlash gear on pot.</td>
<td>1°</td>
<td>1°</td>
<td>Anti-Backlash gear on pot.</td>
</tr>
<tr>
<td>Synchro</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Input Voltage—Stator</td>
<td>11.8v</td>
<td>11.8v</td>
<td>11.8v</td>
<td>11.8v</td>
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<tr>
<td>Output Voltage—Rotor</td>
<td>10.5v</td>
<td>10.5v</td>
<td>10.5v</td>
<td>10.5v</td>
</tr>
<tr>
<td>Clutch Brake</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Voltage</td>
<td>100v dc</td>
<td>100v dc</td>
<td>100v dc</td>
<td>100v dc</td>
</tr>
<tr>
<td>Input Power</td>
<td>2.0 watts Max.</td>
<td>2.0 watts Max.</td>
<td>2.0 watts Max.</td>
<td>2.0 watts Max.</td>
</tr>
<tr>
<td>Operate Time—Energize</td>
<td>5 milliseconds</td>
<td>5 milliseconds</td>
<td>5 milliseconds</td>
<td>5 milliseconds</td>
</tr>
<tr>
<td>Operate Time—De-energize</td>
<td>20 milliseconds</td>
<td>20 milliseconds</td>
<td>20 milliseconds</td>
<td>20 milliseconds</td>
</tr>
</tbody>
</table>

Other products include motor-gear-trains, synchros, AC drive motors, DC motors, servo mechanism assemblies, motor tachs, servo torque units, reference and tachometer generators, actuators, motor driven blower and fan assemblies and fast response resolvers.

Write for further information TODAY, enclosing details of your requirement.

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Avionic Division
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Interesting, varied work on designing transistor circuits and servo mechanisms.
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80 Circle 70 Readers Service Card September 1, 1957 — ELECTRONICS
If you have this problem, investigate

**GRIP-EZE**

—an example of Phelps Dodge's realistic approach to Magnet Wire research

**THE PROBLEM:** To develop a solderable film-coated wire without fabric for winding universal lattice-wound coils without adhesive application.

**THE SOLUTION:** Phelps Dodge Grip-eze—a solderable film wire with controlled surface friction for lattice-wound coils that provides mechanical gripping between turns and keeps wire in place.

**EXAMPLE:** Coils wound with (a) conventional film wire; (b) Grip-eze. Note clean pattern of Grip-eze as compared to fall-down of conventional film wire.

*Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!*
"Designed for Application"

Delay Lines and Networks

The James Millen Mfg. Co., Inc. has been producing continuous delay lines and lump constant delay networks since the origination of the demand for these components in pulse formation and other circuits requiring time delay. The most modern of these is the distributed constant delay line designed to comply with the most stringent electrical and mechanical requirements for military, commercial and laboratory equipment. Millen distributed constant line is available as bulk line for laboratory use and in either flexible or metallic hermetically sealed units adjusted to exact time delay for use in production equipment. Lump constant delay networks may be preferred for some specialized applications and can be furnished in open or hermetically sealed construction. The above illustrates several typical lines of both types. Our engineers are available to assist you in your delay line problems.
OS-45 Coolant/Dielectric keeps black-boxed equipment functioning from -65°F to 400°F

You know the problems all too well: How to keep black-boxed electronic equipment operating in sub-zero arctic temperatures; how to dissipate the heat black boxes generate at extremely high altitudes when air-cooling is impractical.

Monsanto’s OS-45 coolant/dielectric is the answer. It is usable from -65°F to 400°F. In addition, OS-45 is an excellent heat-transfer medium, with surprisingly good dielectric properties for today’s air-borne electronic equipment.

NO HANDLING PROBLEMS . . . A silicate ester, Monsanto’s OS-45 is safe to use and does not affect most materials used in electronic construction.

OS-45 may well be the coolant/dielectric you need in miniaturizing air-borne electronic equipment. You can make a realistic appraisal by reading Technical Bulletin O-123. We’ll be glad to send it to you. Just wire, write or send the coupon below.

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Over 200 years experience
by 14 leading companies
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16 YEARS

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Kovar alloy is available as rod, wire, tube, sheet, strip, and foil...in fabricated shapes such as cups, eyelets, leads...and, it can be welded, soldered and brazed to other metals readily. What's more, technical service available from Stupakoff Engineers insures the most suitable design to achieve best application results.

Write us about your specific requirements.

STUPAKOFF DIVISION OF
The CARBORUNDUM Company

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LATROBE, PENNSYLVANIA
Stupakoff KOVAR glass-sealing alloy

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perfect matching
permanent bonding
long-term reliability
The Transformers, Inc. Ratiometer is a precision instrument to measure any voltage ratio from 0.000001 to 1.111111. Transformer ratios can be accurately measured at "no load" and under full load. Two models are available:

**MODEL 204** is designed for use between 200 cps and 2,000 cps. It is supplied with plug-in units for 400 cps operation.

**MODEL 206** is designed for use between 40 cps and 1,000 cps. It is supplied with plug-in units for 60 cps operation.

Plug-in units for any other frequency are supplied to order.

**ACCURACY**

Five parts per million referenced to unity ratio.

**MAXIMUM VOLTAGE**

| Model 204 | 120 V | 200 cps |
| 180 V | 300 cps |
| 240 V | 400 cps and over |

| Model 206 | 120 V | 40 cps |
| 160 V | 60 cps |
| 240 V | 100 cps and over |

**PRICE**

$865

Model 204 Ratiometer, complete with 400 cps plug-in filter and quadrature units

$1235

Model 206 Ratiometer, complete with 60 cps plug-in filter and quadrature units

The Ratiometer consists of two precision variable transformers, a calibrated quadrature injector, a filter, and a pre-amplifier. Block diagram indicates connections of the various components within the instrument.

For additional information, ask for Bulletin #204

**TRANSFORMERS, INCORPORATED**

200 Stage Road, Vestal, N.Y.
Assure long-lasting protection of vital connections under a wide range of extreme environmental conditions

Currently establishing itself as a performance leader in the missile systems field, Pyle-Star-Line connectors offer engineers an entirely new line of electrical connectors for universal military and industrial use.

With characteristics of construction and performance never before combined in compact, rugged, lightweight standardized connectors, they exceed NEC requirements and classes A, B, C and E of military specifications MIL-C-5015C.

FEATURES

- Tough, lightweight shell: Strength comparable to mild steel, yet weight only 1/3 as much.
- Anodic coating: Gives shell toughness of case-hardened steel. Takes up to 1800 volts to penetrate coating.
- "Sandwich" insulation: Silicone laminate floats between two rigid discs. Silicone disc absorbs shock, lets contacts align themselves freely; rigid disc impart just the right amount of restraint. Gives all advantages of both flexible and rigid mountings.
- Chamber sealings: Silicone insulation disc positively and completely prevents water, gas, moisture or dust from passing into shell.
- Wide range of pin and socket configurations: Configurations from 2 to 100 poles available. Within each form size all inserts are interchangeable and reversible.

<table>
<thead>
<tr>
<th>Environmental Limits of Pyle-Star-Line Connectors</th>
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<tr>
<td>Temperature</td>
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<tr>
<td>Pressure</td>
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<tr>
<td>Chemical Resistance</td>
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<td>Corrosion Resistance</td>
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<td>Dust Resistance</td>
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<td>Shock Resistance</td>
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<td>Vibration</td>
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<tr>
<td>Humidity &amp; Moisture Resistance</td>
</tr>
<tr>
<td>Air Leakage</td>
</tr>
</tbody>
</table>

Write today for complete specifications.

the PYLE-NATIONAL company

Where Quality is Traditional

1330 North Kostner Avenue, Chicago 51, Illinois

District Offices and Representatives in Principal Cities of the United States

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ELECTRONICS — September 1, 1957

Circle 77 Readers Service Card
You can’t count on shooting down a guided missile. The only effective defense against it is some form of Electronic Counter Measures…devices that deceive or destroy enemy missiles short of their targets.

Admiral has taken the lead in furthering the high priority program to develop ECM. Advanced ECM developments now in progress at Admiral will serve many defense purposes. Resulting equipments will be carried by aircraft for protection in hostile territory. At ground installations, ECM will confuse enemy missiles.

Inquiries are invited regarding Admiral’s capabilities in ECM and other forms of military electronics.
available in stock and custom-built units!
The clean, graceful lines of "Wide-Vue" panel instruments add
two plus values to your equipment designs. First, style—ultra-
modern beauty that blends with today's streamlined panels. Sec-
ond, functionalism—longer scales with wide-angle readability.
The 2½" size, for example, has the same scale length as a con-
ventional 3½" meter. Wide-Vue's durable cover is formed in one
piece from clear plastic, and can be supplied with black or color
(custom-built units only) finishes. DC, AC, and AC rectifier
types in 2½", 3½", and 4½" sizes.

SELF SHIELDED MOVEMENT
ELIMINATES CALIBRATION
PROBLEMS...
All stock DC Wide-Vue meters use the
Simpson self shielded
Core Magnet Meter
Movement, except the
0-25 and 0-50 DC
Microameters and
V. U. meters.

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Phone: ES1eetbrook 9-1121
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**ESSEX EXTRA TEST MAGNET WIRE**

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**Dependable insulation qualities**

**Superior windability**

High speed winding subjects magnet wire to a most severe test—demands tough, pliable insulating film... spool-to-spool uniformity... copper with proper degree of anneal. These are qualities you find in every spool of Essex Extra Test Magnet Wire. Essex engineers maintain close control from raw material through finished product to assure you consistent, trouble-free performance. Essex delivers one quality of Magnet Wire to all customers—"Extra Test"—and this wire is produced to the industry's most severe specifications. You pay no more for these "extra tests" so be sure to specify SX.

**TESTING...**

Essex Extra Test Magnet Wire has earned its reputation for excellence through continuous testing of every important quality. Here the Dielectric test is being made. Results in each case must exceed accepted standards.

**PACKAGING...**

Essex Extra Test Magnet Wire is available in Metal or Fiber container (MAGNA-PAK®). Distinctive labeling assures fast, accurate identification. MAGNA-PAK® containers are palletized for shipment; simplifying storage.

**ESSEX\(^\text{®}\) MAGNET WIRE**

**DIVISION ESSEX WIRE CORPORATION, Fort Wayne 6, Indiana**

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- Hartford, Conn.
- Indianapolis, Ind.
- Kansas City, Mo.
- Los Angeles, Calif.
- Milwaukee, Wisc.
- Newark, N. J.
- Portland, Oregon
- Rochester, New York
- Saint Louis, Mo.
- San Francisco, Calif.
- Upper Darby (Philadelphia), Pa.

**Distributed nationally to the repair and maintenance industry through Insulation and Wires, Incorporated**
Famous Ward Leonard Vitrohm® vitreous-enameled resistors are now available in every style to meet all requirements of Military Specification MIL-R-26C including the severe bogeys on moisture resistance, thermal shock, insulation resistance and many other properties.

What's more, this line offers you all characteristics—G, V, and the exacting Y—and all specification sizes and resistance values—even the highest values using the finest wire (0.00175” dia.) permitted by the spec.

Tab-terminal, axial-lead and stack-mounting types are available in styles and characteristics shown in table.

For complete data on these MIL-R-26C resistors, write us for Bulletin 12. (And incidentally, for Vitrohm resistors to highest commercial and industrial standards, get W/L Catalog 15.) Ward Leonard Electric Co., 30 South Street, Mount Vernon, N.Y. In Canada: Ward Leonard of Canada Ltd., Toronto.

**ENGINEERING DATA**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>STYLE</th>
<th>AVAILABLE IN CHARACTERISTICS</th>
<th>RESISTANCE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stack Mtg.–Tab</td>
<td>RW20</td>
<td>V and G</td>
<td>All values in Spec.</td>
</tr>
<tr>
<td>Tab terminal</td>
<td>RW29</td>
<td>V, Y† and G</td>
<td>All values in Spec.</td>
</tr>
<tr>
<td>Axial lead</td>
<td>RW55</td>
<td>V and G</td>
<td>All values in Spec.</td>
</tr>
</tbody>
</table>

†Maximum values for single-layer-wound resistors with 0.00175” diameter wire.

WARD LEONARD
ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

ELECTRONICS—September 1, 1957
ASHLAND, MASS. — If you want to control temperatures in tight spots, you should see Fenwal. Fenwal has cut the size of thermostats way down.

You can fit one of their Midget THERMOSWITCH units anywhere a cigarette will fit. And, if you’re working with even less space, one of their Miniature THERMOSWITCH units is what you’re looking for. The Miniatures are little bigger than a lump of sugar, and some are even smaller.

The Midgets and Miniatures use the same unique principle used in Fenwal’s bigger THERMOSWITCH controls. They use it with the same high degree of success.

The principle of all Differential Expansion THERMOSWITCH units, large or small, is this: a single metal shell expands or contracts with temperature changes, making or breaking totally enclosed electrical contacts.

The smallness of the Midget and Miniature units does not deprive them of any of the performance characteristics that have made larger THERMOSWITCH units famous. They have THERMOSWITCH ruggedness, THERMOSWITCH accuracy, and reasonable THERMOSWITCH prices.

Temperature range of the Midget series: $-50^\circ F$ to $500^\circ F$. Range of the still smaller Miniature series: $-20^\circ F$ to $275^\circ F$.

Midgets and Miniatures, all in stainless steel, come in a variety of mountings. Hermetic sealing is also available.

These Fenwal THERMOSWITCH units are precision-engineered to give optimum temperature control with minimum-sized devices. They remain accurate under the most severe operating conditions.

You should have details on this advance in temperature control at your fingertips. Write for information to Fenwal Incorporated, 209 Pleasant Street, Ashland, Massachusetts.
Fast, convenient, dependable
precision wave analyzers
frequency-selective voltmeters

Sierra now offers exactly the instruments you need for wave analysis, wire carrier and microwave subcarrier applications.

**Sierra 121A Wave Analyzer** is a highly selective, double superheterodyne receiver covering frequencies from 15 KC to 500 KC and providing wave analysis data directly in voltage and dbm at 600 ohms. The instrument offers the selectivity required for use with new single sideband carrier systems.

**Sierra 158A Wave Analyzer** is similar but covers frequencies from 500 KC to 10 MC.

Both analyzers have high selectivity, accuracy of ±2 db, spurious response at least 50 db down, and a signal measurement range of 77.5 µv to 97.5 volts. The instruments are supplied in cabinet mountings which are readily adaptable to relay rack mounting.

### SPECIFICATIONS — SIERRA VOLTMETERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency Range—kc</th>
<th>Selectivity</th>
<th>Accuracy</th>
<th>Direct Reading in dbm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Down 3db</td>
<td>Down 45db</td>
<td>Frequency</td>
<td>Measuring</td>
</tr>
<tr>
<td>101C</td>
<td>20-500</td>
<td>±500 cps</td>
<td>±500 cps</td>
<td>Note A</td>
</tr>
<tr>
<td>103B</td>
<td>30</td>
<td>±400 cps</td>
<td>±3000 cps</td>
<td>±0.5 kc</td>
</tr>
<tr>
<td>104A</td>
<td>5-150</td>
<td>±300 cps</td>
<td>±1500 cps</td>
<td>±5 kc</td>
</tr>
<tr>
<td>108B</td>
<td>15-500</td>
<td>±550 cps</td>
<td>±2900 cps</td>
<td>Note B</td>
</tr>
<tr>
<td>114A</td>
<td>100-800</td>
<td>±550 cps</td>
<td>±2900 cps</td>
<td>Note A</td>
</tr>
</tbody>
</table>

All Sierra Carrier Frequency Voltmeters feature built-in calibration oscillators and circuits for level calibration, have dial monitoring jacks, and (except 103B) are furnished with Sierra Model 149A Precision Spiral Scale Dials.

1 Contains carrier re-insertion oscillator for monitoring suppressed carrier systems. Furnished with planetary drive dial. Note A. Ranges from ±2 KC at low end of dial to ±3 KC at upper end. Note B. ±1 KC in the 48 KC to 256 KC region. Note C. ±1 db for 10 dB steps on 125 ohm balanced measurements. Note D. All models may be converted for 135 and 600 ohm balanced line measurements by convenient plug-in bridging transformer, Model 130D.

### Impedance Meter, Line Fault Analyzer

**Sierra 166 Impedance Meter** (at left) measures impedance on high noise circuits, 30 kc to 300 kc, measures on "hot" lines through coupling capacitor. **Sierra 124 Line Fault Analyzer** pinpoints shorts, opens or grounds on open wire lines. Direct reading, range ½ to 200 miles, accuracy ½ mile.

Data subject to change without notice.

Sierra Electronic Corporation
A Subsidiary of Philco Corporation
3885 Bohannon Drive Davenport 6-2060 Menlo Park, California, U.S.A.

Sales Representatives in Major Cities
Canada: Atlas Radio Corporation, Ltd., Toronto, Montreal, Vancouver, Winnipeg
Export: Frazer & Hansen, Ltd., San Francisco, New York, Los Angeles

Circle 83 Readers Service Card

ELECTRONICS — September 1, 1957
Three Genisco Accelerometers help the Super Sabre close in

If enemy air infiltration happens, you can be sure that modern knights of the sky powering the swift Super Sabre at speeds faster than sound will spearhead America’s defense.

Typical of today’s supersonic aeronautics, the USAF’s Super Sabre reflects the finest contemporary engineering skill and scientific creative imagination. But this swept-wing assassin is more than just another jet-powered plane. It is a proven, integrated electro-mechanical system, combining a multitude of precision sub-systems, assemblies, and individual parts.

The automatic flight control system, for example, consists of numerous components, each one vital to the performance of the system. Naturally, component reliability is imperative if the plane is to carry out its mission. The flight control system of the F100D incorporates three Genisco Model DDL Accelerometers.

The Model DDL is only one of many Genisco Accelerometers now in use on America’s air guardians, including our most important operational guided missiles. Like other models, the DDL was designed for a particular application—to function perfectly in the severe vibrational and shock environment of supersonic flight.

Genisco’s ability to design for the most stringent applications and to produce precision instruments in large quantities has made the company an important link in our nation’s defense chain.

Descriptive technical data on the Model DDL and other Genisco accelerometers will be sent upon request.

2233 Federal Avenue, Los Angeles 64, California

Circle B4 Readers Service Card

Circle B5 Readers Service Card
Impedance-matching weather protection of Du Pont TEFLON®

Du Pont TEFLON tetrafluoroethylene resins are uniquely qualified as materials for making the matching devices and radome used in the feed system of the new Diamond K-band antenna. The 16,000 mc radar signal passes through an impedance-matching and weatherizing system based on components of a TEFLON resin, and is reflected from the accurate parabolic dish. The .027" wall of the radome matches the horn to space.

No other material could compare with TEFLON resins for this highly critical electronic application. They are unaffected by outdoor weathering and have so little moisture absorption that their dielectric constant remains unchanged under all humidity conditions. The very low dielectric constant of TEFLON resins gives the material its excellent matching characteristics. They are rated at 2.1 from 60 cycles through the super-high frequency range and have a power factor of under 0.0003 from 60 cycles to over 10,000 mc, so that the loss figure in transmission is very low. Dirt has no tendency to stick to the naturally "slick" surface. TEFLON is unaffected by heat up to 260° C.

With this system, the plane of polarization can be varied a full 360° by Faraday rotation. Use of a TEFLON resin overcomes the impedance-matching problem. Moreover, no orienting effects are produced by radomes of this resin. VSWR of the antenna is less than 1.2:1 over the required ±1% frequency band.

For your own designs, you are invited to take a closer look at the many outstanding advantages of Du Pont TEFLON tetrafluoroethylene resins in electronic applications. The coupon will bring you details.

TEFLON®
is a registered trademark...

TEFLON is the registered trademark of the Du Pont Company. It should not be used as an adjective to describe a product of another concern, nor may this registered trademark be used in whole, or in part, as a trademark for any product.

SEND FOR INFORMATION

For additional property and application data on Du Pont TEFLON tetrafluoroethylene resins, mail this coupon.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept.
Room 179, Du Pont Building, Wilmington 98, Delaware
Please send me more information on Du Pont TEFLON tetrafluoroethylene resin. I am interested in evaluating this material for...
Name_________________________Position_________________________
Company_________________________State_________________________
Street__________________________City___________________________
Type of Business__________________

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec.
Lots of good reports on Bendix Transistors

"Extra performance at no extra cost is the answer!"

If you're after extra quality at no extra cost . . .

TRY BENDIX HIGH GAIN POWER TRANSISTORS

More impressive than anything we can say about Bendix High Gain Power Transistors is the enthusiastic endorsement they are receiving from engineers who have tried them. These design, project, and research and development people report they like Bendix transistors because of their high power and current gain - low leakage - life stability - high breakdown voltage - low thermal resistance - linear temperature variation.

Why this universal acceptance? Because our transistor program is based on the following:

1. Simplified design that keeps initial cost down and operating dependability up.
2. Extra performance capability through use of component parts and materials that exceed specification requirements by a sizeable margin.
3. Improved manufacturing techniques that help contribute to better transistors at low cost.
4. Uniformly dependable quality . . . through close quality control that includes comprehensive inspection procedure utilizing Bendix-developed test methods and instruments.

We believe that our many years' experience in designing and producing precision, special-purpose electron tubes has a great deal to do with this extra-high quality and dependability.

We make a wide variety of power transistors. And, because we are in volume production, we can offer immediate delivery on most models. We'll be glad to help you in working out troublesome circuitry problems, too, if you wish.

It will pay you to get complete details about Bendix transistors. Write SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.

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Power Amplifiers  High-CURRENT Switches
Inverters  Power Oscillators
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Roebling
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Subsidiary of The Colorado Fuel and Iron Corporation
Tips for designers

Terminal board for a complex circuit in an electronic spectrophotometer is made of Taylor Grade LE laminate . . . selected for its insulating and mechanical properties.

Gas pump impeller unit is fabricated of Taylor Grade LE-6 phenolic laminate . . . economical, light-weight, wear-resistant . . . chosen because of strength, stability.

Guides for sliding doors, made from Taylor vulcanized fibre, last longer because of high strength and resistance to abrasion.

Metal plating barrels of Taylor Grade C-5 melamine withstand corrosion and erosion successfully in alkaline solutions. Downtime and maintenance costs are substantially reduced.

Precise electrical insulation parts? Taylor can produce them.

This coil form for radio frequency transformers is fabricated by Taylor of Grade XX laminate plastic tubing for Collins Radio Co. The O.D. of the center section is held to a tolerance of .230" ± .0005". Material was chosen for its good electrical properties, dimensional stability and machineability.

This coil form for radio frequency transformers was produced by Taylor's Fabricating Division, holding the tolerance of the outside diameter of the center section to ± .0005".

Taylor has special techniques and facilities capable of providing parts—such as this coil form—to your own specifications, promptly and economically. You can shorten your production steps by putting Taylor to work for you ... simplifying production . . . safeguarding schedules . . . reducing overall costs.

Precise fabrication of laminates and vulcanized fibre is difficult . . . but Taylor can and is doing it, in a great variety of Taylor grades, and to extremely close tolerances. In your present products or in those that are now on your drafting boards are opportunities for you to take advantage of Taylor's equipment and experience. Design to closer tolerances—Taylor can handle the job. Taylor is equipped to handle any type of fabrication—punching, drilling, grinding, forming, milling or turning—simple or complex.

Chances are that Taylor's staff of specialists can help you with design, material selection and fabrication. Call or write your nearest Taylor sales office for a talk about your needs.

TAYLOR SUPERIOR COPPER-CLAD LAMINATES
Taylor GEC (glass epoxy) Copper-Clad and Taylor XXXP-242 cold punching (paper-phenolic) Copper-Clad. Taylor uses high purity rolled copper on base materials with outstanding electrical properties.
NEW General Electric Time Meters cost less, read easier, give wider range of measurement

ALL DIGITS 2½ TIMES LARGER—NEW, EXTRA DIGIT GIVES WIDER RANGE FROM 0 TO 99999.9 HOURS OR MINUTES

At a new, low cost, General Electric now offers you a complete line of time meters for measuring operating time of every type of electrical equipment.

Available in 2¼ and 3¼ inch sizes these new General Electric Time Meters offer you these important benefits:

- **DUST-PROOF PROTECTION** . . . due to totally enclosed construction. Sealed models also available to military specifications.
- **RESET MODEL** . . . conveniently located reset knob available (optional) on all General Electric Time Meters except sealed models.
- **INCREASED OPERATING TEMPERATURE RANGE FROM — 67°F TO 150°F** . . . means more flexible application and longer meter life.

**3 WAYS YOU BENEFIT WITH GENERAL ELECTRIC TIME METERS:**

**LOWER COST, BETTER PLANNED MAINTENANCE** . . . because you can measure the operating time of your equipment, thus allowing you to apply pre-planned productive maintenance.

**LESS DOWNTIME, FEWER PRODUCTION LOSSES** . . . because you can measure the total operating life of your equipment, and thus replace it on a scheduled basis before it breaks down unexpectedly.

**BETTER UTILIZATION OF MANPOWER AND MACHINES** . . . because General Electric Time Meters measure the shutdown time of your equipment, allowing efficient scheduling of employee and machine work assignments.

**FOR AN ACTUAL DEMONSTRATION** of how these new General Electric Time Meters can help you save money and improve operating performance, call your nearest General Electric Apparatus Sales Office. And write today for descriptive bulletin GEA-6710, General Electric Company, Section 584-12, Schenectady, N. Y.

**Progress Is Our Most Important Product**

Circle 89 Readers Service Card
For amplification of thermocouple, strain gage, and similar low level signals the Type 190 Data Amplifier provides a combination of features available in no other amplifier:

- Infinite rejection of common-mode d-c signals
- One microvolt input resolution
- Gain stability of 0.01%
- Rapid step input response
- Linearity of 0.05%

The true differential response of the Type 190 provides increased accuracy and simplified installation for data reduction, control, and similar applications. With infinite rejection of common d-c signals, and a rejection ratio at 60 cps of the order of a half million, errors due to ground currents are completely eliminated, and pickup problems greatly diminished.

The Type 190 is designed for fixed-gain operation from low impedance sources, into high impedance load. Gain may be set at values ranging from 160 to 1200. Amplifier characteristics are unchanged at ambients from -67°F to +170°F.
INSTANTLY...  
measure and supply DC voltages to 0.02%  
with the new KIN TEL DC voltage standard and null voltmeter

LABORATORY ACCURACY. The Model 301 is an extremely compact and accurate variable DC power supply and calibrated null voltmeter. It employs KIN TEL's proved chopper circuit to constantly compare the output voltage against an internal standard cell. As a DC voltage standard, it combines the stability and accuracy of the standard cell with the current capabilities and excellent dynamic characteristics of the finest electronically regulated power supplies. The self-contained null voltmeter indicates the voltage difference between the supply in the 301 and the DC source being measured, affording simple and rapid measurement of DC voltages to an accuracy of 0.02%.

PRODUCTION LINE SPEED. DC voltage measurements can be made as fast as changing ranges on a VTVM. Merely set the direct reading calibrated dials on the 301 to exactly null out the unknown DC input voltage. The reading on the dials then indicates the value of the unknown input voltage to within 0.02%. As a variable DC standard or power supply, the calibrated dials provide instant voltage selection to an accuracy normally attained only with standard cells.

VERSATILITY. The KIN TEL Model 301 is ideal for rapid and accurate production calibration of precision measuring instruments and DC power supplies... design of DC amplifiers and complex electronic circuitry... computer reference... versatile precision reference for calibration and measurement laboratories.

IMPORTANT SPECIFICATIONS

Output Voltage & Current 1 to 50 volts at up to 20 ma
Full Scale Meter Ranges (Zero Center)
DC Output Range ......... ± 500, 50 volts
DC Input Range ............. ± 500, 50 volts
DC Null Meter Range .. ± 50, 5, 0.5, 0.05 volts
Long Time Stability ............. ± 100 parts per million
Output Voltage Calibration ............. ± 0.02% or 2 mv
Output Hum and Noise ........... Less than 100 µv RMS
Line and Load Regulation ............. 0.002%
DC Output Impedance ............. Less than 0.01 ohm
Response Time ............. 0.2 milliseconds

Model 301 Price $625.

Representatives in all major cities. Write today for demonstration or descriptive literature.
5725 Kearny Villa Road, San Diego 11, Calif., Browning 7-6700
how G.E. data center analyzes dynamic jet engine operation

G.E. wants to know a lot of things about an aircraft gas turbine before it leaves the ground. Not just thrust, pressure, temperature ... but vibration and stress characteristics too. While suitable equipment has long been available for recording and measuring the "static" operating characteristics, only the last five years have seen reliable techniques introduced for measuring, recording, and reducing significant information from dynamic signal sources.

A pioneer in the application of these techniques, General Electric's own dynamic data handling installation at the Flight Propulsion Laboratory Department, Aircraft Gas Turbine Division, Evendale, stands as one of the most complete in the country. Originally conceived by the Laboratory, the facility has contributed substantially to the outstanding progress of aircraft gas turbine design at G.E. Data recorded at the test site can be played back through two tape systems at the Laboratory into electronic data analysis equipment and analog and digital displays for a fast, detailed picture of gas turbine performance.

The substantial part played by magnetic tape in the system reflects its growing importance as the common denominator of dynamic data handling. Dynamic range and frequency range are several times greater than characterize other recording media, and the data is stored "live". The original electrical transducer signal can be accurately re-created whenever desired for observation and processing.

Five portable magnetic tape data recording systems are used by G.E. to collect data at the engine test cells. Signals ranging in frequency from DC to 30 kc, are recorded by Direct or FM carrier techniques. Wide 1½" tape carries 28 tracks of data, plus reference frequencies, timing signals, and voice, as desired. Monitoring oscilloscopes permit visual observation of the recorded signals. It is interesting to note that the five portable recording systems were originally designed by the Davies Laboratories Division for the limited space and severe environments of aircraft flight testing. The strength built into them has proved invaluable to G.E. despite the fact that they have never been operated in the air.

With the completion of a test, the reel of tape is transferred to the data reduction center. Two complete Davies Division laboratory record-reproduce systems permit utmost flexibility in feeding tracks of data serially or simultaneously into reduction and display equipment. Oscilloscopes permit a quick look at results through rapid visual inspection; wave analyzers provide a record of frequency components; level recorders measure amplitude; direct-writing recorders and oscilloscope cameras permit a complete record of wave shapes and phase relationships.

Davies Division magnetic tape data recording installations as large and complex as this one at General Electric Company can rarely be outfitted with standard package equipment. But for the smaller installations, recently announced Davies Universal Magnetic Tape Systems are an ideal choice. You can get a good background in magnetic tape data recording techniques in general by requesting our Bulletin 1001. Universal Systems are covered in Bulletin 2701. Minneapolis-Honeywell Regulator Company, Davies Laboratories Division, 10721 Hanna Street, Beltsville, Maryland. Or call Webster 5-2700.
"WE'VE CUT OUR COSTS 50% with the WALES FABRICATOR-DUPLICATOR"

Mr. Richard H. Aufderheide, President and Production Manager of Rex Metal-Craft Inc., Indianapolis, Indiana reports: "We have been able to cut our costs 50% by using the Wales Fabricator and Duplicator for the manufacture of the Breathalyzer. This punching equipment has proven highly efficient for fast set-up, close tolerance, short to medium production work."

The WALES Fabricator combined with WALES positive Duplicator is the modern, low cost answer to hole punching. You get holes with sharp definition, clean walls and minimum bell mouth. This equipment is perfect for short to medium runs, from one piece to thousands. Change dies for hole sizes in seconds with a range up to 3½” dia. Accuracy is automatic and positive. Make your own templates, too, on the Fabricator. Eliminate layout, drilling machines or jig-borers. The WALES Fabricator-Duplicator is a complete punching shop in itself.

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Time studies, specifications, illustrations etc., are all yours for the asking.

WALES MOBILE FIELD UNITS
We'll bring the Fabricator Duplicator right to your door for a demonstration. Ask for details.

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Ucinite manufactures a variety of special connectors for the heater and heater-cathode terminals of magnetrons. Many of these have been adapted for special applications as to size and function to meet the sealing and mounting requirements of high temperature and high altitude operation and other special conditions.

Connectors are coaxial in construction and can be supplied with built-in capacitors for added protection. Connecting leads of any length can be furnished to customer's specifications.

With an experienced staff of design engineers, plus complete facilities for volume production, Ucinite is capable of supplying practically any need for metal or metal-plastics assemblies. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.
Hughes
Quick Recovery
Silicon
Junction
Diodes

FASTER THAN GERMANIUM COMPUTER DEVICES

...and able to withstand high voltages at high temperatures, these quick recovery silicons are particularly useful in circuits where germanium once provided the only possibility. Unlike germanium, breakdown voltages for the silicons increase with temperature, thereby removing the danger of failure should temperatures rise to unexpected levels. This kind of ruggedness together with increased speed identify the diodes as ideal when the demand for reliability is greatest.

Perhaps one of the IN620 series will be just right for your particular application; if not, there will undoubtedly be a Hughes germanium or silicon diode that is. For a call from one of our field sales engineers or for additional information about our quick recovery silicon diodes, please write:

PHYSICAL CONFIGURATION. All types are packaged in the famous glass body, created at Hughes to provide absolute protection from moisture penetration and contamination. Body length: 0.265 inch maximum. Body diameter: 0.105 inch maximum.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIV @ 0.1mA</td>
<td>up to 200V</td>
</tr>
<tr>
<td>Forward Voltage @ 4mA</td>
<td>less than 1.5V</td>
</tr>
<tr>
<td>Recovery (modified IBM “Y” test)</td>
<td>400K ohms (min.) in one µsec, when switched from 50mA forward to 28V reverse.</td>
</tr>
<tr>
<td>Reverse Current @ 25°C</td>
<td>as low as 1µA @ -175V</td>
</tr>
<tr>
<td>Reverse Current @ 100°C</td>
<td>as low as 100µA @ -175V</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>-60°C to +125°C</td>
</tr>
</tbody>
</table>

Types now available
IN625 through IN629

SEMICONDUCTOR DIVISION • HUGHES PRODUCTS

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ELECTRONICS — September 1, 1957

Circle 95 Readers Service Cord 103
RCA Traveling-Wave Tubes for Improved Microwave Designs

Lightweight, Compact Power Types—Need No Solenoid Power

Featuring integral periodic-permanent-magnet focusing systems, RCA’s new power traveling-wave tubes eliminate the need for external solenoid power—make possible dramatic advances in physical compactness and weight reduction.

RCA Dev. No. A-1101 . . . only 2½ inches in diameter and short enough to mount in a standard aircraft ATR-box, this remarkable tube weighs only 12 pounds including the permanent-magnet focusing system! Designed to operate at altitudes up to 70,000 feet, the A-1101 delivers about 100 watts at 10% duty factor over the range from 2000 to 4000 Mc.

RCA Dev. No. A-1063 . . . approaching the ultimate in compactness, the A-1063 complete with permanent-magnet focusing system weighs only 3½ pounds—is less than 1½ inches in diameter! “Plug-in” construction simplifies field maintenance. Minimum power output is 10 watts from 2250 to 3750 Mc.

Low-Noise Types Increase Receiver Sensitivity—Eliminate Crystal “Burnout”

RCA low-noise traveling-wave tubes enable the practical design of rf-amplifier and if-amplifier stages for microwave receivers featuring high signal-to-noise ratio and increased sensitivity. Crystal “burnouts” caused by TR-tube leakage are eliminated by the isolation afforded by the rf stage. RCA low-noise traveling-wave tubes can be made in a variety of designs to meet specific requirements.

Here are some typical types:

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Noise Figure</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1215 to 1365 Mc</td>
<td>7.0 db</td>
<td>25 db</td>
</tr>
<tr>
<td>2000 to 2500 Mc</td>
<td>7.0 db</td>
<td>25 db</td>
</tr>
<tr>
<td>2700 to 3500 Mc</td>
<td>6.5 db</td>
<td>25 db</td>
</tr>
<tr>
<td>2500 to 4000 Mc</td>
<td>7.0 db</td>
<td>20 db</td>
</tr>
<tr>
<td>3500 to 4300 Mc</td>
<td>6.5 db</td>
<td>20 db</td>
</tr>
<tr>
<td>5900 to 7400 Mc</td>
<td>7.0 db</td>
<td>25 db</td>
</tr>
</tbody>
</table>

For details on RCA Traveling-Wave Tubes, call your RCA Field Representative.
ELECTRONICS — September 1, 1957

New Beam Power

9-Pin Miniature Adds a New Measure of Performance to Compact High-Fidelity Amplifier Designs

RCA-6973...delivers up to 20 watts in push-pull class AB; operation in audio amplifier service. Distortion at maximum rated power output is 1.5%. The compact construction, relatively low heater-power requirement of 6.3 volts at 450 ma and linear operation over a wide range of power make RCA-6973 an excellent designers' choice for compact Hi-Fi amplifiers.

New Front-End Tubes for Medium-Priced FM Sets

RCA-6DT8, RCA-12DT8...designed for rf amplifier and oscillator-mixer service—inter-unit shielding of RCA-6DT8 and -12DT8 permits FM-tuner designs with high voltage-gain capability and substantial reduction in antenna radiation.

New Photoconductive Cell Permits Direct Relay Operation — without the use of an amplifier

RCA-6957...is intended for use in street-lighting control and industrial light-operated relay applications. Sensitivity and current-handling capabilities permit relays to be directly operated in many applications — simplify circuitry—minimize power-supply requirements. Spectral response covers the approximate range from 3300 to 7400 angstroms. Maximum response occurs at about 5800 angstroms.

3 New RCA "Drift" Transistors Make Practical the Mass-Production of All-Transistor Short-Wave Receivers

RCA-2N370 for f-amplifier; RCA-2N371 for oscillator; RCA-2N372 for mixer service...first transistors specifically designed and controlled for operation in short-wave receivers at frequencies up to 23 Mc. These three new "drift" transistors are controlled for input and output values and for power gain characteristics to give good unit-to-unit interchangeability. The new units offer advantages of high frequency stability and economies in space, weight, and battery life.

750 Kilowatts—Peak Power Output — with power gain of at least 100 offered by new RCA Super-Power Tube in plate-pulsed modulator service at 225 MC

RCA-6952...beam power tube, featuring ceramic-metal construction—intended for use at frequencies up to at least 600 Mc as plate-pulsed amplifier in applications involving Government end use, such as long-range search radar and pulsed communications service. For details on this and other RCA Super-Power Tubes, contact your RCA Field Representative.

For sales or applications information on the products shown, please contact your RCA Field Representative at the RCA Field Office nearest you.

Equipment Sales:

- 744 Broad Street, Newark 2, N. J., Humboldt 5-3900
- Suite 1181, Merchandise Mart Plaza, Chicago 54, Ill., Whitehall 4-2900
- 6355 E. Washington Boulevard, Los Angeles 22, Calif., Raymond 3-8361

Government Sales:

- 415 South Fifth St., Harrison, N. J., Humboldt 5-3900
- 224 N. Wilkinson Street, Dayton, Ohio, Hemlock 5585
- 1625 "K" St., N.W., Washington, D.C., District 7-1260

Technical bulletins on the following types are available from RCA, Commercial Engineering, Section I-19-A, Harrison, N. J. Please use this coupon.

□ 6961 □ 6957 □ 6973 □ 6DT8, 12DT8

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Company ................................ Address ..........................
For details on this PACE Analog Computer Group 131R and on time rental at EAI's Computation Centers—serving eastern industry in Princeton, New Jersey—serving Western industry in Los Angeles, California—serving European industry at Brussels, Belgium, write Electronic Associates, Inc., Dept. EL-9, Long Branch, New Jersey.
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R.F. interference suppressed

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PAPER AND FOIL WITH SOLID IMPREGNANT

SOLDER

COLOR CODE

CUTAWAY VIEW OF PVZ CAPACITOR ENLARGED 13 TIMES

GRAPH ABOVE shows outstanding temperature and voltage characteristics for 95% reliability.

VOLTAGE RATING VS LIFE AT ELEVATED TEMPERATURE FOR 95% RELIABILITY

Dotted portion indicates region of unreliable operation.
Solve critical space and temperature problems with subminiature PVZ* capacitors

Low-cost molded units operate from —55 C to +125 C

Now immediately available for exacting applications in commercial and military electronic equipment, these molded paper capacitors meet performance requirements of Characteristic “E” for MIL-C-91A. General Electric’s PVZ capacitors are priced substantially lower than comparable metal-clad tubulars. They are designed to operate for a minimum of one year at +125 C with no voltage derating.

Completely solid after molding, PVZ capacitors feature the following advantages:

- small size
- excellent humidity resistance
- high lead-strength
- insulated body—solid impregnant
- high shock and vibration resistance
- color code for easy identification

General Electric PVZ capacitors are available at 100, 200, 300, and 400 volts. Microfarad ratings range from .00047 to .15.

If you need a capacitor with the characteristics described above, ask your General Electric Apparatus Sales Engineer about PVZ tubulars. He can give you expert application information. He can also arrange for immediate delivery of PVZ capacitors from factory stock in most ratings. For descriptive data write for bulletin GEC-1452 to General Electric, Section 447-2, Schenectady 5, N. Y.  *Trademark of the General Electric Co.

PVZ CAPACITORS range in size from .175" diameter by .625" length to .375" diameter by 1.0625" length. Capacitance ratings are available with ±20%, ±10%, and ±5% tolerances. The color code indicates microfarads, volts, and capacitance tolerance.

Progress Is Our Most Important Product

GENERAL ELECTRIC
Doubtless you've learned to depend on the Bendix Synchro "Supermarket" for fast delivery and tremendous selection of precision synchros, servo motors and other vital electronics systems components. But did you know that Bendix is also a prolific producer of radar antenna devices?

Over the years Bendix airborne and ground-based antenna devices have been successfully designed by our highly specialized staff of radar and servo-mechanisms engineers to meet a wide variety of exacting requirements. And, of course, world-famous Eclipse-Pioneer precision rotating components are standard in all Bendix radar antenna devices.

When you order from Eclipse-Pioneer, you'll enjoy the advantages of experienced engineering coupled with favorable delivery and prices that result from mass production techniques.

District Offices: Burbank and San Francisco, Calif., Dayton, Ohio, and Seattle, Wash.—Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

TYPICAL EXAMPLES OF BENDIX RADAR ANTENNA DEVICES

Lightweight, ground-based, air-transportable tracking antenna pedestal for mounting 8-ft. diameter, S-band segmented parabolic reflector and rotating scanner; highly accurate 2-speed data systems in elevation and azimuth.

Lightweight, ground-based, air-transportable, dual reflector, multi-band, high gain search antenna and control system; 2-speed data systems and magnetic clutch drives in azimuth and elevation.

Airborne weather radar antenna with line of sight stabilization for x- or c-band; switchable wide fan (cosecant squared) beam pattern for mapping or pencil beam for storm detection.

Eclipse-Pioneer Division
TETERBORO, N. J.
THREE STANDARD PACKAGES AVAILABLE IN THREE CORE TYPES

MOLDED and CASED TOROIDS

<table>
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</table>

IN ORDERING: Please designate type, core, dash number, and inductance value. For example: "MPF 050 -10 24 MH."

SUBMINIATURE TOROIDS

unlimited!

HSD-HSB and MPF SERIES NOW STOCKED FOR SAME DAY SHIPMENT

The country's largest facilities for the production of toroidal components now makes possible the maintaining of warehouse stocks and immediate delivery of CAC's popular subminiature toroids—in a wide range of inductances.

This is CAC's answer to heavy industry-wide demand. Elaborate testing and inspection procedures assure both quality and required performance.

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Continental Connector
TAPER PIN TERMINAL BLOCKS

for computer applications

MACHINE TAPERED FOR PRECISION
... MOLDED IN FOR RUGGEDNESS

Here is an improved terminal block design with permanently molded-in and precision reamed taper pin receptacles for maximum durability. These receptacles maintain secure electrical and physical contact with AMP Series "53" solderless taper pin. The body is molded of high impact, glass reinforced Alkyd 446 (MIL-P-14E, Type MA160). Other molding materials on request. Taper receptacles are brass, gold plated over silver for low contact resistance.

Continental Connector can supply all types of taper pin blocks and connectors for conventional wiring and printed circuitry in any combination of feed-through shorting or non-shorting terminals. Our engineering department is prepared to cooperate in solving your connector application problems. Write today for technical information.

DUAL TERMINAL CONNECTOR FOR SOLDERLESS WIRING
15 contact ... series 600-65

Developed primarily for COMPUTER APPLICATIONS requiring dual solderless wiring leads for each single contact. The right angle plug is dip soldered to the printed circuit board and mated with the dual terminal socket. Socket terminals are precision machine tapered for AMP "53" solderless wiring. Contact rating 20 millivolt drop maximum at 7.5 amps. Connector rating 500 volts RMS.

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Electronic Sales Division
DeJUR-Amesco Corporation
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Circle 107 Readers Service Card
High Resolution Double Pulse Generators

from Beckman® Berkeley

For multi-purpose laboratory use

For seven years Beckman/Berkeley double pulse generators have played an important part in the designing and testing of pulse circuitry wherever pulse techniques are studied. Basically, these are general purpose laboratory instruments that provide a source of "clean" paired or single pulses. Both instruments feature independent adjustment of pulse width, pulse amplitude, pulse to pulse spacing, pulse polarity and repetition rate. Unusually low interaction between control functions is achieved by careful design and by operating all circuitry from precision-regulated supply voltages.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>MODEL 903</th>
<th>MODEL 4904</th>
</tr>
</thead>
<tbody>
<tr>
<td>PULSE WIDTH</td>
<td>0.15 to 1.8 µ sec.</td>
</tr>
<tr>
<td>MAXIMUM PULSE AMPLITUDE</td>
<td>200 volts negative, 50 volts positive across 1000 ohm load, 10 volts negative and 2.5 volts positive across a 50 ohm load</td>
</tr>
<tr>
<td>RISE TIME</td>
<td>0.035 µ sec.</td>
</tr>
<tr>
<td>DECAY TIME</td>
<td>0.15 µ sec.</td>
</tr>
<tr>
<td>PULSE POLARITY</td>
<td>positive or negative</td>
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<tr>
<td>PULSE SPACING</td>
<td>0 to 10 µ sec. Single control</td>
</tr>
<tr>
<td>INTERNAL DRIVE</td>
<td>1 to 10000 cps.</td>
</tr>
<tr>
<td>EXTERNAL DRIVE</td>
<td>1 to 1000 cps by negative 100 volt pulse with 0.5 µ sec rise time and 2 µ sec. duration</td>
</tr>
<tr>
<td>OSCILLOSCOPE SYNC.</td>
<td>30 volt positive pulse 1 µ sec. before first pulse</td>
</tr>
<tr>
<td>PRICE (f.o.b. factory)</td>
<td>$498.00</td>
</tr>
</tbody>
</table>


Write for complete specifications on the Models 903 and 4904 Double Pulse Generators. Please Address Dept. G-9

Beckman®

Berkeley Division
2200 Wright Avenue, Richmond 3, California
a division of Beckman Instruments, Inc.

September 1, 1957 — ELECTRONICS
**New Low Prices Make the Use of Silicon Possible NOW**

Right now, you can utilize the superior design characteristics of Automatic Silicon Rectifiers at attractive quantity prices comparable to germanium, because of Automatic’s mass production techniques. Advanced engineering skills have made possible such design characteristics as:

- Higher Operating Temperatures
- No Derating with Temperatures
- Minimal Difference Between Operating Voltage and Peak Inverse Voltage
- Higher Storage Temperature

Complete specifications are available on Automatic “S” Line Rectifiers. Write for your copy today.

---

### Automatic “S” Line Silicon Rectifiers

#### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type 1N91</th>
<th>Type 1N92</th>
<th>Type 1N93</th>
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<tr>
<td>Absolute Maximum Ratings (For 85° C. Ambients)</td>
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<td>S91H</td>
<td>S92</td>
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<td>Peak Inverse Voltage Volts</td>
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<td>200</td>
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<td>Continuous D.C. Reverse Working Voltage Volts</td>
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<td>100</td>
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<td>D.C. Output Current MA</td>
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<td>Half-Cycle Surge Current 60 c.p.s. Amps</td>
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<td>Full Load Voltage Drop Volts</td>
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<tr>
<td>Leakage Current MA</td>
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<td>@ Rated P.I.V.</td>
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<td>100</td>
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<tr>
<td>Maximum Operating Frequency KC</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Storage Temperature °C.</td>
<td>100</td>
<td>150</td>
<td>100</td>
</tr>
</tbody>
</table>
Now, an invisible electromagnetic shield will protect our United States Air Force's first supersonic bomber against electronically guided weapons.

The heart of this silent protector is a lightweight electronic countermeasure system, developed and produced by Sylvania's Electronic Systems Division. This system stands ready to baffle enemy radar seeking to guide missiles against the new aircraft.

In designing and developing the B-58's passive defense system, Sylvania made important advances in special components, including new cooling, packaging and miniaturization techniques.

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The Convair B-58 Hustler, first U. S. Air Force supersonic bomber, will be protected by Sylvania's electronic countermeasure equipment.
CLEVITE POWER TRANSISTORS

NEW 4 WATT CTP 1117

EXPANDED LINE OF POWER TRANSISTORS
FOR AUDIO OUTPUT, POWER SUPPLY
AND SWITCHING APPLICATIONS

Clevite Power Transistors, available in production quantities, offer:
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- LOW THERMAL RESISTANCE
- HIGH POWER GAIN
- LOW DISTORTION
- RUGGED WELDED PACKAGE
- HERMETIC SEAL

Check the outline specifications for the type of performance you get from Clevite Power Transistors.

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Data sheets B-211, B-214 and B-216 provide all the facts on Clevite Power Transistors. Write for your copies.

CLEVITE
TRANSISTOR PRODUCTS
241 Crescent St., Waltham 54, Mass. Twinbrook 4-9330
A Division of Clevite Corporation

MILITARY TYPE 2N297 SIGNAL CORPS
Spec.
MIL-T-12679A/32
(Sig. C.)

<table>
<thead>
<tr>
<th>Type</th>
<th>Instantaneous Collector-to-base Voltage (absolute Maximum)</th>
<th>Junction Temperature (absolute Max.)</th>
<th>Average Total Power Dissipation (with inf. heat sink @ 25°C)</th>
<th>Average Total Power Dissipation (with 36 sq. in. heat sink @ 25°C)</th>
<th>Typical Power Gain</th>
<th>Frequency Cutoff</th>
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<tr>
<td>Military</td>
<td>-60 -40 -40 -80 -20 -80 Volts</td>
<td>85 85 85 85 85 85 °C</td>
<td>25 30 25 25 25 25 Watts</td>
<td>15 18 15 15 15 15 Watts</td>
<td>3 33b 33c 31c 30d 30c 26c 60c 60</td>
<td>5 6 7 6 4 Rs/s</td>
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<tr>
<td>CTP 1117</td>
<td>CTP 2N297</td>
<td>CTP 1109</td>
<td>CTP 1111</td>
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</table>

| a Large Signal D.C. Current Gain | 12 to 40 at Ic 2.0 amps |
| b Vcc = 14V, Ic = 750ma, R = 17Ω (choke coupled), R1 10Ω |
| c Vcc = 14V, Ic = 420ma, R1 = 30Ω (choke coupled), R1 10Ω |
| d Vcc = 7V, Ic = 420ma, R1 = 15Ω (choke coupled), R1 10Ω |

ELECTRONICS — September 1, 1957
Circle 111 Readers Service Cord

117
MARCONI
MILITARY AND CIVIL
airborne
DOPPLER NAVIGATORS

CONTINUOUS AUTOMATIC POSITION INDICATION WITHOUT GROUND-BASED AIDS, ALL OVER THE WORLD

POSITION IN LATITUDE AND LONGITUDE
DISTANCE RUN AND DISTANCE TO GO • WIND VELOCITY
ESTIMATED TIME OF ARRIVAL • TRACK GUIDANCE

Write for details to
AERONAUTICAL DIVISION
J. S. V. WALTON, MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED
23-25 BEAVER STREET, NEW YORK CITY 4.

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Many important openings exist in both basic and development phases of computer and data processing componentry. NCR uses the team approach to solving problems in physical chemistry, ceramics, and solid state physics involving magnetics, ferroelectrics, phosphors, photoconductors, electroluminescence, crystal structure, memory devices, and non-mechanical printing.

Challenging projects in electronics also need men with new ideas and superior know-how for systems analysis, switching circuits, logical design, indication media, random access, input and read-out devices.

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We have other interesting openings.
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Sperry's Microwave Electronics Division provides a unique service: Developing and producing special radar subsystems and components for the electronic industry.

- Microline® equipment ranges from single miniaturized components to complete microwave systems—together with complex antennas, precision test equipment, and automatic checkout instrumentation.
- Whether your immediate need is for one component or for the complete line, we will be happy to discuss your problem with you.
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1 Antenna
2 Multi-feed rotating joint
3 Waveguide switch
4 Dummy load
5 Directional coupler
6 Mixer-duplexer
7 Local oscillator
8 Ferrite isolator
9 Transmitter klystrons
10 Traveling wave tube drivers

MISSILE
11 Antenna
12 Receiver
13 Transponder

FIELD TEST EQUIPMENT
14 Combination test set
15 Range calibrator
16 VSWR meter

SUPPORT EQUIPMENT
17 RACE (Rapid Automatic Checkout Equipment)
18 System evaluators
19 System performance monitors

DEPOT SUPPORT EQUIPMENT
20 Peak power meter
21 Multi-pulse generator
22 Directional couplers
23 Ferrite isolators
24 Ferrite attenuators
25 Barretter mounts

ELECTRONICS - September 1, 1957
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The 700-C Series Recording Oscillographs can put up to 60 traces on 12" wide recording paper at speeds from .03 to 144 in. per sec., with frequency response from DC to 3,000 cycles per second. Power supply is 28 volts DC or 115 volts AC. Both the oscillograph and the amplifier system (either carrier or linear/integrate) may be bench, shock, or vibration mounted, or installed in a standard relay rack without modification.

Whether your measuring and recording needs are for dynamic testing of guided missiles or aircraft; structural tests of buildings, bridges or ships; performance tests of heavy machinery or electrical equipment; riding quality evaluation of automobiles, trucks, or railroad coaches; physiological or medical research; or similar applications in all fields of industry, science and engineering—it will pay you to let a Honeywell Industrial Engineer show you why the Heiland System is unmatched for sensitivity, stability, and dependable performance. Call your nearest Minneapolis-Honeywell Industrial Sales Office today...and write for Bulletins 101K and 701K.
now! a low cost gasoline/oil resistant insulated wire . . . the NEW Nylon-jacketed CONTINENTAL PETROL WIRE

Looking for a low-cost gasoline and oil resistant insulated wire? An insulated wire approved for use in wiring gasoline pumps and in refineries BUT at lower cost than lead jacketed rubber insulation? Then you've been looking for this NEW Continental PETROL wire.

Nylon-jacket over thermoplastic insulation, PETROL wire is not affected by most oils, acids and alkalies. It is approved by Underwriters' Laboratories for 30°C in gasoline . . . 60°C in oil or air.

Available in sizes from 14 to 6 AWG . . . in a rainbow-range of colors.

For more information on the new Continental PETROL wire, outline your requirements in a letter and mail to us immediately. A Continental field engineer will be glad to help with any insulated wire problem in your area.

FREE 72-page catalog of the complete line of Continental Insulated Wire and Cable available on request. Send for your copy today.
The Auto-Lite engineers shown here are checking the thermal characteristics of dozens of different kinds of insulation materials. You can be sure that, no matter what the results, they won’t be satisfied. They’ll go right on looking for other materials that can resist even more heat.

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No matter what you need—whether it be high temperature aircraft wire or cable, magnet wire or wire for electronic and electrical applications—why not tell us your insulation problem and let us help you in reaching a solution.
General Plate Stainless Clad Copper Enables Griscom-Russell K-Fins

To Meet 2600°F Operating Conditions

Two metals are often better than one, and here's a case in point... In Griscom-Russell's K-Fin tubing for high temperature gas to liquid heat exchangers, General Plate Stainless Clad Copper reduces fin tip temperatures 29% (2090°F to 1475°F) with nearly twice the heat transfer rate of unclad stainless.

Benefits? Fin tip temperatures in G. R. K-Fin run well below the oxidation point — fin life is greatly extended — heat exchanger performance is improved substantially — with worthwhile economies in design.

G. P. Stainless Clad Copper is available in widths up to 13" and thicknesses up to ½", single or double clad, in long lengths. It can be blanked, drawn, spun, formed, brazed, and spot or seam welded.

Let us send complete information on G. P. Stainless Clad Copper — it may be just what you have been looking for. Write today for Catalog Sheet 727C.

You can profit by using General Plate Clad Metals.
Waldes Truarc Rings speed assembly, facilitate maintenance, improve performance of new automatic calculator

THE NEW MARCHANT DECIMAGIC
automatic-decimals calculator made by Marchant Calculators, Inc., Oakland, California.

E-RING SECURES PARTS AGAINST SPRING THRUST: Slip clutch assembly uses Truarc series 5133 E-ring to hold parts on shaft. Functioning of the assembly is dependent upon the ring's ability to withstand thrust exerted by the heavy barrel spring.

LOCKING PRONG RINGS PERMIT SIMPLE DESIGN: Shift slide assembly uses two Truarc series 5139 bowed locking prong rings to lock the parts together in a sliding fit. Precise amount of spring tension prevents objectionable wobble and noise, permits the key to slide smoothly in operation. Easy radial assembly and disassembly of rings facilitates field maintenance and repair. Alternative construction would have required cut washer, spring washer and hairpin-type spring clip on each stud.

CREScent RING SPEEDS ASSEMBLY, DISASSEMBLY: Main clutch utilizes radially-installed series 5103 crescent ring for rapid assembly and disassembly. Ring's low protruding shoulder provides necessary clearance between ring and the two studs. The main clutch operates each time a Deci-Magic control key is depressed.

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In Truarc, you get

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U.S. and Canada.

Controlled Quality from engineering and raw materials through to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

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WALDES KOHINOOR, INC.
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ELECTRONICS — September 1, 1957

Circle 121 Readers Service Card 127
These portable self-powered units can be moved instantly to any location. Light-weight, completely transistorized, with power supply self-contained, these precision instruments...carefully developed and use-tested...provide a reliable, trouble-free answer to your field testing problems.

*Does one of these Cubic transistorized test instruments meet YOUR needs?*

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- Amplifier phasing control — phase balance can be obtained at any one frequency to above 25 mc, provided amplifiers are not overdriven by the input signals.

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September 1, 1957 — ELECTRONICS
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<thead>
<tr>
<th>DC Plate Voltage</th>
<th>3000 Volts Max.</th>
<th>Plate Dissipation</th>
<th>1000 Watts Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Screen Voltage</td>
<td>350 Volts Max.</td>
<td>Screen Dissipation</td>
<td>12 Watts Max.</td>
</tr>
<tr>
<td>DC Plate Current</td>
<td>1.0 Amps Max.</td>
<td>Grid Dissipation</td>
<td>0 Watts Max.</td>
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September 1, 1957—ELECTRONICS

Circle 130 Readers Service Card
WHO MINDS STORE? . . . Vacations are wonderful and we certainly have enjoyed the time so far squeezed in between routine publishing emergencies. And it may be that we are prejudiced by the fact that several of our favorite restaurants were closed for weeks following our return to the office. But it does seem to us that this business of shutting down a plant for long stretches works a certain amount of hardship on the customer and must result in some shift of trade.

NEW BREED . . . Evidence is beginning to build up around our best educational institutions that there will soon be a numerically important group of men out in industry programming computers. A cross between a mathematician and a technician and perhaps other things too, such men need a name. "Computer programmer" leaves much to be desired. Who's got the answer?

MANPOWER EASING? . . . Can't measure it, certainly have no statistical proof, don't think it will develop very fast, but we do feel there may be some slight easing of the engineering manpower shortage. If this is so it could be caused by a combination of factors, such as cutback of some military projects, tightening of government allowances for recruiting and research and even some long overdue steadying down on the part of manufacturers in their employment practices.

OPPORTUNITY . . . Fact that manufacturing plants are still loaded with machine tools purchased during the war, and economic considerations that slow modernization, are having two effects. It is becoming increasingly difficult to effect man-hour productivity increases, and the military services are becoming concerned about our standby production capacity.

As this logjam slowly breaks under the impact of competitive pressures there will be increased opportunity for the sale of automatic controls in general and electronic controls in particular; tool programming devices appear to be a particularly good bet.

WHISTLE IN DARK . . . Far be it from us to guess what the general public will or will not go for. But it does seem to us that while shorter television picture tubes are indeed a worthwhile technological advance this and this alone is unlikely to give the fall sales season the sales fillip it needs. We think the boys in the back room, if not those in the front, know it.

LOOKING AHEAD . . .

Sale of prerecorded magnetic tape is moving steadily though inconspicuously upward. Much of it is stereophonic, which may give hi-fi business a needed impetus.

Competitive struggle between tubes and transistors on basis of size alone is by no means over; ceramic envelopes are one of the keys to smaller tube size.

Microwave communications equipment is probably in for a new spurt but time required for studies of spectrum utilization in Washington could delay it until late next year.

Watch Japanese technological as well as commercial progress in our field. Both are coming up fast.
SUNIARY — Completely automatic shift to emergency broadcast transmitter is achieved in less than 24 seconds after loss of regular transmitter carrier, making lost air time much less than is possible with ordinary remote manual control. Complete remote monitoring and remote control facilities are also provided at studio, with fail-safe provisions for both automatic and manual-remote modes of operation.

By JAMES H. GREENWOOD
Chief Engineer

Automatic Changeover

ONE APPROACH to the conversion of existing transmitter plant facilities for unattended operation involves performing manually, at some remote control point, all operations previously performed by an operator on duty at the transmitter location. The other approach involves making the transmitter plant completely self-operating. With an automatized plant, the lost air time in the event of trouble is much less than would be possible with simple remote operation. Usually it is also less than would occur with an operator on duty using normal manual controls. An automatized plant requires no human attention other than for starting and stopping. The legal requirement of log-keeping must still be performed by an operator, however.

Remote manual control requires less complex equipment and is therefore cheaper to purchase and install. However, more capable human supervision is required continuously at the remote control point.

The WCAE conversion provides both manual-remote and automatic operation, chosen by a selector switch. For normal operation, the automatic mode is used. In case of trouble the manual-remote mode is activated. It then becomes possible to override the automatic operations where desired.

**Basic Control System**

Commercially available remote control equipment was modified as in Fig. 1 for performing the manual-remote and remote metering operations at WCAE. The manual-remote metering and control positions (12 through 25) are made inaccessible until required, to avoid unintentional operations which would interfere with the automatic operation.

The most important automatic operation needed is the shift from the regular to the auxiliary upon failure of the regular transmitter. The basic circuit for accomplishing this is shown in Fig. 2. A sample of the current going to the antenna is fed through current transformer $T_1$ and a rectifier-filter system to the relay, holding its contacts open. Loss of power to the antenna permits the contacts to close, feeding power to one of the solenoids operating antenna switch $SW_1$. This connects the antenna to the auxiliary transmitter and at the same time feeds power to the auxiliary.

---

**FIG. 1**—Modification of step-switch control circuit at remote control point. With switch in locked position as shown, dialing above 11 makes switch return to home position

**FIG. 2**—Simplified automatic antenna shift circuit. Loss of antenna current makes relay drop out, thereby energizing switch solenoid for transferring antenna and power to auxiliary transmitter
of Radio Transmitters

and removes power from the regular transmitter.

A common power switch, connected at X, is used for both transmitters and for the automatic switching equipment to prevent a shift to the auxiliary when the equipment is shutdown at the end of the broadcast day. When the transmitter is turned on, there is a delay of nearly 2 minutes before the regular transmitter will supply power to the antenna. To avoid a shift to the auxiliary during this period, a time-delay relay is used, energized by the same common power switch X, with its contacts connected at Y. This disables the automatic transfer function for the first 5 minutes after application of power. If the regular transmitter has not come on during this time, the antenna shift circuit operates and turns on the auxiliary.

The complete automatic shift circuit is given in Fig. 3. When 5-minute time-delay relay \( K_3 \) is closed, current is fed through contacts on relays \( K_6, K_7 \) and \( K_8 \) to 8-second time-delay relay \( K_4 \). This relay prevents operation of the antenna transfer switch by momentary interruptions such as occur during lightning storms. The 8 seconds covers both the momentary carrier interruption and the following 5 seconds of reduced-power operation provided by the regular control circuit of the transmitter.

Contacts on relay \( K_4 \) are normally closed since this relay is in the fail-safe control circuit for the transmitters, shown in Fig. 4. Relay \( K_4 \) is provided to permit intentional carrier interruptions for transmission of Conelrad alerts. It is operated manually from the remote control position and when operated disables the automatic transmitter shift equipment. Another relay, with its coil connected in parallel with \( K_6 \), simultaneously cuts the plate voltage and thus stops the carrier.

**Auxiliary Operations**

The auxiliary transmitter is adjusted to start in 12 seconds. This is made possible by operating continuously the few tubes having indirectly heated cathodes and by having motor-generator plate supply. The total time from loss of the regular transmitter to operation on the auxiliary is thus approximately 20 seconds.

Automatic operation of the antenna transfer switch is provided in one direction only—from the
regular to the auxiliary transmitter. After each such operation the regular must be checked, repaired if necessary and manually returned to the air. Switch SW₃ permits manual operation of the antenna transfer switch in either direction by an operator at the transmitter. This switch is paralleled by circuits to the remote control position, as are all the circuits necessary for checking the operation of either transmitter on the dummy antenna. These circuits are accessible at the remote control position only after unlocking the manual-remote mode of operation.

Relays K₄ and K₅ are necessary only to handle the high currents required by solenoid-operated antenna transfer switch SW₂. These relays are interlocked with the limit switches on SW₂, so they and the SW₂ solenoids are deenergized when the switch has reached the end of its travel even though the activating switch may remain closed. They are also electrically interlocked to avoid the possibility of energizing both simultaneously during maintenance or testing.

Remote Monitoring

Facilities are provided for monitoring the demodulated output of each transmitter at the remote control point and at the transmitter station, whether on the air or on the dummy antenna, as a check on noise, distortion or possible failure of only the audio portion. For simplification, these circuits are omitted from the diagrams.

An indicating lamp is lighted at the transmitter when the antenna is connected to the auxiliary transmitter. At the remote control point, when the control position for operating SW₁ is dialed, the associated metering circuit indicates the position of SW₁. A high meter reading indicates that the regular transmitter is connected to the antenna, and a midscale reading that the auxiliary is connected. If the switch sticks in an intermediate position, a low meter reading is obtained. A zero reading indicates failure of the indicating circuit.

Going on the Air

Figure 4 shows the circuits for turning the transmitters on, in both the automatic and the manual-remote modes of operation. Each mode includes the fail-safe features required by the FCC as well as by logical considerations of safety. Relay K₅ is operated by the master power circuit on the remote control equipment. Failure of the remote lines opens this circuit. A local switch is connected in parallel with the remote master power circuit so an operator on duty can take advantage of the automatic features. An indicator lamp across the coil of K₅ shows when the transmitter control circuits have been energized, either locally or by remote control.

Relay K₆ is normally not operated, but is energized by contacts on SW₃ of Fig. 3 whenever the antenna is switched to the auxiliary transmitter. Normally open contacts on relay K₆ in series with normally closed contacts on relay K₅, connect to the regular transmitter start switch. When relay K₅ is operated, the regular transmitter comes on and stays on until relay K₆ operates. Loss of r-f to the antenna shifts the antenna to the auxiliary transmitter and operates relay K₆, thus removing power from the regular transmitter. In a similar manner, power is supplied to the auxiliary transmitter by normally open contacts on relay K₅ in series with normally open contacts on relay K₆.

Power may be reapplied to the regular transmitter for checking its operation on the dummy antenna by operating latching relay K₅. This relay may be operated both from the remote control position and at the transmitter plant. When operated, an additional pair of contacts disables the automatic antenna shift equipment. This permits manual return of the antenna to the regular transmitter, which deenergizes relay K₅. Power is then supplied to the regular transmitter.

![FIG. 3—Complete automatic antenna shift circuit. Audio is fed simultaneously to both transmitters through bridging pad and additional line amplifier.](image)

![FIG. 4—Fail-safe controls for regular and auxiliary transmitters, with provisions for overriding automatic control when required.](image)
by relays $K_r$ and $K_p$. Relay $K_n$ is manually released, reactivating the automatic antenna transfer facilities.

Latching relay $K_n$ performs similar functions for the auxiliary transmitter, except that in this case there is no need to disable the automatic antenna transfer equipment. After any such check of either the regular or the auxiliary transmitter latching relays $K_n$ and $K_n$ must be returned to their normal positions. Since these relays can be operated from the remote control position only with the equipment in the manual-remote mode, all return-to-normal controls are operated as the last step in any use of the manual-remote mode.

Means are provided at the remote control point for manually raising and lowering the power outputs from each transmitter. The increase and decrease operations associated with metering of antenna current control the output power of whichever transmitter is feeding the antenna. This is accomplished by relay $K_n$ in Fig. 4. Its coil is connected in parallel with relay $K_n$ which is operated when the auxiliary transmitter is connected to the antenna. Thus, in the operated position of relay $K_n$ the antenna current increase and decrease control circuits are connected to control the power output of the regular transmitter. Likewise, when relay $K_n$ is unoperated and the regular transmitter is feeding the antenna, the antenna current increase and decrease control circuits are connected to control power output of the regular transmitter. Remote control circuits for raising and lowering dummy antenna current are similarly routed to the correct transmitter by relay $K_n$.

**Metering and Controls**

Antenna current metering and the associated increase and decrease controls are available in the automatic mode of operation, since antenna current is required to be logged. Metering and controls for dummy antenna current are accessible only in the manual-remote mode. A servo loop for maintaining antenna current within tolerance was not found necessary. The regular transmitter is already equipped with an automatic line-voltage regulator which effectively accomplishes this after initial warmup. Since it is necessary in any case for the remote operator to read and log antenna current, the additional burden of adjusting it during the first half hour of operation is negligible.

Upon shutting down the transmitter, the power output is automatically reduced to a preset value. The value is chosen to give an antenna current slightly below normal when the transmitter is cold. This avoids overloading the transmitter at sign-on the next morning.

**Alarm Circuits**

With automatic equipment for placing the auxiliary transmitter in operation, the remote operator must know that this has been performed. Circuits for providing this alarm are shown in Fig. 5, together with the power output controls for the auxiliary transmitter. When it is not operating, relay $K_n$ is deenergized. It remains so when the transmitter is first turned on, whether automatically or manually. In this condition, a-c is fed through the 0.25-$\mu$F capacitor to one side of the audio monitor circuit in the transmitter, producing a hum in the monitored signal at both local and remote monitors. Upon hearing this alarm signal, the operator checks all his circuits and thus confirms that the auxiliary is in use. One of the circuits which he checks is the antenna current, which will be slightly low. Operating the increase antenna current control operates increase relay $K_n$ in Fig. 5 and also operates relay $K_n$. Once operated, a second coil holds it closed, removing the hum from the audio monitor circuit. When the transmitter is shut down, relay $K_n$ is deenergized, operating decrease relay $K_n$. This runs the power output control motor until the low-limit switch is opened.

Since the two coils of relay $K_n$ are fed from separate a-c sources, it is necessary that they be in phase at the relay to secure stable operation. It is likewise necessary to maintain the same phase for the a-c power to all portions of the control equipment. In the various circuits shown, the a-c polarity is indicated by $C$ for common and $H$ for hot.

Both transmitters are equipped with overload protection. After the first operation of the overload re-

---

**FIG. 5—Power output control and in-use alarm for auxiliary transmitter. Controls for regular transmitter are same except for omission of alarm**

**FIG. 6—Audio monitor is fed from transmitter to studio continuously over line used also for metering and dialing in remote control equipment. Varistors suppress dialing clicks from audio line, half of normal plate voltage is immediately reapplied, and after 5 seconds is raised to full value. After a second overload, the same sequence occurs. However, if not manually reset in the meantime, a third overload will permanently remove all plate voltage. An indicator lamp lights upon the first overload and remains lighted until the relay has been reset. The remote operator is provided...
with an overload alarm, a manual reset and an automatic reset. The alarm is a hum superimposed on the audio monitor which is fed from the transmitter output by a phone line to the control point and continuously monitored there. This hum is obtained from the overload indicator lamp and is fed by a transformer and pad of suitable value to the control circuit.

**Overload Reset**

The automatic overload reset waits 15 seconds after the first overload, then resets the overload relay. However, it is so connected with the transmitter control circuits that it functions only after one or two overloads. If the overload relay is tripped three times within 15 seconds, the plate voltage stays off until manually reapplied. The hum which indicates an overload does not differ appreciably from that which indicates use of the auxiliary transmitter, though it does differ in other respects. With the automatic overload reset functioning, this sum is removed in 15 seconds. Should the operator prefer to reset the overload relay manually before the 15 seconds has elapsed, this operation will remove the hum. If the hum remains after manual reset or continues for more than 15 seconds, he reads the metering circuits provided and thus determines the exact status of the equipment.

Failure of the regular transmitter is normally accompanied by an overload and its indicating hum. In this case, after 8 seconds the auxiliary transmitter is substituted for the regular, and at the same time the overload-indicating hum is replaced by the auxiliary-indicating hum, which then remains until appropriately acknowledged by the operator.

**Power Failure**

Protection against power line failure is important at any transmitter plant. Two separate feeders bring in the a-c power, with automatic power-distribution type switchgear for selecting between them. This switchgear incorporates a 7-second delay so that momentary power dropouts do not actuate it. Except in very unusual situations any power interruptions will thus be 7 seconds or less. However, even a momentary interruption could result in a much longer period of lost air time, since all the time-delay relays in the transmitter would drop out. When power is restored again the normal transmitter start cycle takes about 2 minutes. The auxiliary does not come on in this case, despite loss of carrier, since the 5-minute time-delay relay disables the automatic shift just as it does at sign-on.

The time-delay relays in the regular transmitter prevent application of plate voltage until the mercury-vapor rectifiers and other tubes are up to operating temperature. When there is a momentary interruption of power, a different type of time delay is advisable. The tubes being protected cool off at approximately the same rate at which they warm up. Thus if power is removed for only 7 seconds, an additional 7-second delay before reapplying plate voltage is all that is required. Special relays of this type were unobtainable, and therefore available pneumatic time-delay relays were altered to provide this type of operation.

The automatic power-line-selecting switchgear also required modification. The two power lines are each three-phase. Occasionally only two phases fail. The sensing element for initiating the power-line shift, as originally installed, was single-phase. Thus the auxiliary power line would be placed in service only if the particular phase of the regular line to which the sensing equipment was connected should fail. This unacceptable characteristic was corrected by adding a relay across the second phase. In some 4-wire systems it may be necessary to provide two relays with contacta in series, with the coil of the second relay connected across the third phase.

Conventional compression and limiting amplifiers automatically maintain correct modulation level. Frequency stability is achieved by crystal control, where the performance has been so satisfactory that no servo loop is justified.

The manual-remote mode of operation employs a modified commercial remote control unit. Two metallic pairs are used between the control point and the transmitter. One pair is used for metering, operation of the step switches and (by capacitance coupling) audio monitoring of the transmitter output. The second line operates the controls selected by the step switches, and (by capacitance coupling) feeds a phone circuit. Figure 6 shows how the equipment was modified to permit a single line to be used for audio monitoring and for dialing and metering without mutual interference.

**Achieving Reliability**

Automatized operation can be successful only if all equipment is highly reliable. In a broadcast plant there is one unpredictable element—lightning—which complicates any evaluation of reliability. The specific points at which lightning has in the past caused trouble should all be studied and changes made to minimize a recurrence of the trouble. A good starting point is at the antenna. The lightning gap across the base insulator should be just large enough to prevent a sustained arc by the transmitter. With a point electrode this distance can be much smaller than with ball electrodes.

In Fig. 3, a neon lamp is shown connected across the diode in the antenna current metering circuit. This provides over-voltage protection for the diode during lightning surges.

All indicating lamps in 117-volt a-c circuits are neon since they have an almost unlimited lifetime. The absence of an indication can be as misleading as a false indication.

Any points of repeated trouble should be studied and the cause of the trouble eliminated if possible. All rectifier tubes in low-voltage power supplies were replaced with selenium or silicon units. Tests are now being conducted with the object of replacing the high-voltage rectifiers also with silicon units.

Automatization of the WCAE transmitter plant has been highly successful. This could not have been the case except for the extensive and whole-hearted assistance of the complete operating staff during the planning, installation and subsequent operation.
Magnetic Tape Controls
Projector Synchronism

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SUMMARY — Power-frequency control signal and movie sound share dual-track tape to synchronize picture to audio. Sync signal from projector supply line modulates tape through filament transformer and auxiliary record head without erase or bias. During projection, amplified control signal is fed to synchronous motor coupled to projector power train. Auxiliary motor acts as synchronous brake on projector which is adjusted slightly above frame rate which controls the projector speed during recording is simultaneously recorded on tape for subsequent control during playback. The reproduced sound and the image projected on the screen will therefore remain coincident during playback to the same degree that they were during recording.

EXAMINATION of the many systems devised for synchronizing sound to narrow-gage motion-picture film indicates that most of them are complicated for amateur use, expensive, low in audio quality or not fully automatic. These shortcomings are avoided by a system of coincident sound comprising a tape recorder modified by adding a head to record and reproduce a synchronizing tone, an amplifier producing 10 watts of power from the output of the auxiliary head, and a projector arranged for speed control from the synchronizing amplifier. The modifications to both the tape recorder and the projector are relatively simple.

Tape Control Signal

Figure 1 shows the recording system with signals from a microphone and a phono pickup mixed and half-track recorded on magnetic tape, while a 60-cps tone from the projector power line is recorded on the adjacent track.

Figure 2 shows the reproducing system with the audio track going to the sound channel, and the 60-cps signal fed through the synchronizing amplifier to control the speed of the synchronous motor on the projector.

Hence the power line frequency threading and cueing

To assure the starting of the tape at the proper time with respect to the film, cue points are

Simplicity of operation assures successful results in hands of novice. Auxiliary head is integral part of tape recorder shown.
established on both media. A convenient method is to affix narrow strips of pressure-sensitive tape to the film leader and to the back of the recording tape. When the tape machine is threaded up, the cue marker is positioned at some definite point. The projector is then started, and as the cue marker on the film leader passes a pre-determined point, the recorder is started and the tape assumes control of the projector speed.

The system can also produce “lip sync” by recording the sound simultaneously with photography, with the camera driven or controlled by a synchronous motor. The tape is later edited into the final sound track just as the filmed sequences are cut into the completed picture. System details will depend upon the equipment used, but most standard tape recorders and motion-picture projectors may be modified to a coincident sound system.

**Mechanical Assembly**

Projectors are usually equipped with a hand knob for checking film threading, which is connected directly to the shutter shaft. It then operates at one revolution per frame, or 16 rps when the projector speed is 16 fps. This knob may be removed and replaced with a gear, providing a convenient coupling to the synchronous motor.

The motor shaft usually rotates at 30 rps and the gear ratio between motor and projector should therefore be 30:16. A 48-pitch 32-tooth gear with a 1/8-in. face on the motor and a mating 60-tooth gear on the projector are an ideal standard combination. Although gear noise is not serious, the use of a fiber or nylon gear with one of metal will result in noise reduction. The loss of the testing knob presents no problem, as the projector motor switch can be snapped on and off quickly for a threading test.

When mounting the synchronous motor to the projector it is supported on studs attached to the gear housing. These studs have one end tapped in the center and the other end tapped off center. The resulting eccentricity permits a slight adjustment of the motor position for optimum meshing of the gears. The motor may also be mounted on a separate metal plate which in turn is secured by the gear cover plate mounting screws. This is recommended for projectors where the hand knob is in front and the gear cover plate is too small for the synchronous motor.

The motor found most satisfactory for this application is Bodine type KYC26. This is an instrument chart drive motor, requiring only 10 watts of power at 1,800 rpm.

**Speed Indication**

Since this system provides for speed control rather than for positive drive, a projector speed indicator is desirable. A small neon lamp operated from the synchronous motor power line will provide a stroboscopic light source. This illuminates the end of the lower film sprocket around the periphery of which 30 equally-spaced holes have been drilled and filled with white paint.

The sprocket contains eight teeth, and rotates twice per second when the projector speed is 16 fps. When the sprocket is illuminated by a 60-eps light source, the circle of white dots appears stationary. If the control fails, the dots will appear to rotate forward or backward, depending upon whether the projector is running fast or slow. For any other sprocket speed, frame rate, or number of sprocket teeth $T$, the number of strobe seg-
ments may be calculated from $(2 \times \text{cps} \times T)/(\text{fps} \times \text{fps})$.

The recorder modification involves mounting an auxiliary record-reproduce head at a convenient point where the signal track on the tape will pass over the head gap. Recorders equipped for binaural recording and playback require no modification. The 60-cps signal is applied to the second channel for recording through a bridging circuit, and its output is fed to the synchronizing amplifier on playback. On other recorders the Brush BK1090 head works well and is easy to install, since it requires only a single mounting hole.

**Recording Sync Signal**

Where an auxiliary head is installed on a standard half-track machine, the synchronizing tone is recorded without bias. Six volts from the cathode heater supply is applied directly to the winding of the head. This produces complete saturation of the tape and results in a series of "blocks" of oxide which are of alternating polarity. It also automatically erases any previous recording. The waveform is shown in Fig. 3A. When the head is resonated at 60 cps a reasonably good waveform may be reproduced from the pulses as shown in Fig. 3B.

The synchronizing amplifier may be any one capable of delivering 10 watts at 60 cps from the output of the auxiliary head, and having an output impedance of 500 ohms. Although this does not exactly match the impedance of the motor, it is quite satisfactory.

**Voltage Regulation**

Stray magnetic fields are often present in the vicinity of the motors and transformers of popular-priced recorders. These fields may induce a low-level 60-cps voltage in the auxiliary head, resulting in a slow beat with the signal from the tape. If this causes the output of the synchronizing amplifier to vary more than 10 volts, it will be desirable to arrange for some limiting action.

Any standard limiter circuit may be used, or it may be introduced into the power amplifier stage itself. A resistor of moderately high value inserted in series with the grid of each tube will provide all of the limiting necessary.

Limiting will introduce distortion, but it is of little consequence in this application since the synchronous motor is insensitive to it. Since the motor represents an inductive load, a power factor correction capacitor will improve the overall performance and output waveform.

A suitable synchronizing amplifier is shown schematically in Fig. 4. A switching arrangement either feeds 6.3 v to the head or applies the output of the head to the amplifier. The circuit is conventional except that the input includes a 10μf capacitor for resonating the recommended head at 60 cps, the output stage includes limiting resistors, and a power factor correcting capacitor is shunted across the output transformer.

The amplifier should be adjusted to produce an output of 110-130 v when connected to the motor load.

Some adjustment is obtainable by changing taps on the output transformer or by varying the screen grid voltage on the output stage. Since limiting is involved, the adjustment must be accomplished in the final stage.

**Signal Waveforms**

The limited output waveform is shown in C of Fig. 3 and the waveform as modified by the inductive load is shown at D. While this departs appreciably from a sine wave it is quite satisfactory for driving the synchronous motor.

The control motor is operated as a synchronous brake rather than as a motor. The best performance results from overdriving the projector with its own motor while using the synchronous motor to hold the mechanism down to speed.
SUMMARY — Airborne unit, designed around conventional ppi radar indicator, records video output of the operating radar directly on 35-mm film. Intensity-modulated crt with stationary sweep is continuously photographed by moving film, synchronized with rotation of radar antenna. Ground-based playback consoles, with range and azimuth-mark generators, permit trainees to measure or interpret target situation.

REALISTIC and reliable presentations of airborne radar observations can be obtained if the video output of an operating radar is stored permanently for later reproduction. Storage of the video information eliminates the need for complex scale models, or more complex electronic generators and provides as much latitude in the reproduced picture as with the original radar. In addition, the video recording can be replayed indefinitely for either training or operational briefing or meteorological use.

Conventional 35 mm movie film was favored as a recording medium because of ease of synchronization, high storage capability and very low rate of travel. In addition, reproductions of the master recordings are made easily and are not subject to accidental erasure as may be the case with magnetic recordings.

Recorder and Playback

The complete trainer consists of two basic pieces of equipment, an airborne recorder and a playback system.

The airborne recording unit stores video and synchronization information on 35-mm film directly from radar output signals. The playback unit recovers the recorded information and supplies it, together with all the necessary synchronizing and operating voltages to one or more ground based radar indicators.

Figures 1 and 2 show simplified block diagrams of the recording and playback systems, respectively.

For recording, a cathode-ray tube trace is intensity-modulated with the radar video signal and is swept in synchronism with the range sweep of the radar. The trace is maintained in a fixed position with respect to an optical system which produces a reduced image of the trace on continuously moving 35-mm photographic film. The image appears at right angles to the direction of film travel. Image magnification of the full trace occupies approximately eighty percent of the available film width.

Synchronizing

Film travel is determined by rotation of the radar antenna. A servo link, similar to that used to rotate the deflection yoke of a radar indicator, is coupled to the drive sprocket of the recording camera. As the antenna rotates, positional information is continuously fed to the recording camera and the film is driven accordingly. Consequently, a given length of film will always correspond to a specific angular displacement of the antenna.

Since commercial film maintains

FIG. 1—Block diagram of the recording system. A cathode-ray tube trace is intensity-modulated with the radar video signal and is swept in synchronism with the range sweep of the radar.
extremely close tolerances on sprocket hole size and position, this drive system provides a highly accurate method of assuring azimuth synchronization. In effect the synchronizing signal is locked into the sprocket holes.

Because of the large amount of redundant information in successive radar sweeps it is possible to permit some overlap of the exposure from adjacent sweeps. Instead of recording a series of discrete lines, with each line containing a larger amount of information in common with its immediate neighbors, the system records an integrated picture which has the appearance of a distorted view of the radar scope.

A flying-spot scanner and camera arrangement, similar to that used in the recording process, recovers the recorded information. A constant-intensity cathode-ray spot is swept linearly across the face of the scanner tube and an image of the trace is focused on the exposed area of the film. The magnified image covers the full width of the exposed area. A phototube, located behind the focal plane, receives the light transmitted through the film and converts the light-intensity levels into video voltages. Phosphor persistence on the scanner tube is very short compared with the sweep rate and the total light reaching the phototube at any instant may be considered as illumination entirely from the spot, the residual light from phosphorescence being negligible.

Video output of the phototube is amplified and applied to a radar indicator whose sweep is synchronized with that of the flying-spot scanner. Thus, target information appears at the proper radial distance on the indicator. Range relationships from the original radar presentation are preserved in the reproduction.

Film travel in the playback system is controlled by a synchronous motor driving a servo generator, which supplies signals to operate the film drive unit shown in Fig. 1, and the yoke rotation systems of one or more radar indicators. A synchronous drive motor provides an accurate time base for repeating runs simulating the same air speed.

The airborne recording unit is

![Block diagram of the playback system. A phototube, located behind the focal plane, receives the light transmitted through the film and converts the light intensities into video voltage variations.](image)
designed around a conventional ppi radar indicator. Two major changes in the indicator were required to adapt it to video recording. The long persistence, P-14, crt was replaced with a short persistence P-5 tube having the same electrical and mechanical characteristics; the deflection yoke gearcase was removed completely and the yoke was clamped in a position to produce only a horizontal trace. The complete gearcase was then built into a Fairchild Oscilloscope-records camera in place of the normal drive system.

Camera and indicator are mounted on a rigid base at the proper focal distance since fixed focus operation is used at all times. A light-tight housing including a bellows in the breadboard model couples the face of the indicator to the camera lens. Within the housing, but out of the camera field, a phototube monitors the light output from the crt for photometric purposes. Video output from the phototube, corresponding to the video information being recorded, is presented as a type A display on a small calibrated oscilloscope. Proper video and brightness levels, set at the beginning of each run, are checked periodically during the run.

Since the actual exposure depends on integrated light reaching the film while the monitoring oscilloscope displays only instantaneous values, it is necessary to compensate for changes in pulse repetition frequency and radar range, that is, sweep speed of the cathode ray spot. A modified agc circuit samples the duty cycle of the sweep voltage and adjusts the gain of the monitor scope amplifier accordingly.

The recording unit receives all necessary signals and most of the required operating power from the radar with which it is used. Exceptions include power supplied to the monitoring and agc circuits. Power for these circuits is obtained from regulated supplies operating from the aircraft 400-cycle lines. Conventional 60-cycle supplies were used in the breadboard model shown. For exclusive airborne use, an integrated 400-cycle supply would cut the size and weight by about 60 per cent.

The playback unit, a completely self-contained console requiring only 115-volt 60-cycle primary power, is designed primarily as a master station from which a number of remote indicators can be controlled. However, since it has a complete operating indicator, it may also be used as a training station.

Special optical and mechanical requirements for the scanning and film transport equipment made it more practical to design and build a special unit rather than use a commercially available camera. A photomultiplier and condensing system was mounted behind the focal plane. A servo drive for normal playback operation was designed with rapid traverse—approximately 250-times normal speed, in either direction for quick film positioning or rewind. In addition, the use of a 25-kv crt requires special precautions to prevent operating personnel from exposure hazards.

Range and Azimuth

Although the playback unit reproduces the original radar picture with fairly high fidelity, its usefulness as a training aid is enhanced by the addition of electronic range and azimuth-mark generators which permit each trainee to measure or indicate target location independently. Signals from the generators are mixed with the video output from the scanner to
produce a composite picture on the indicator.

Range indication on the scope is a bright spot which describes a circle about the origin as the ppi trace rotates. Azimuth indication is given by a bright radial line occurring when the ppi trace coincides with the predetermined direction. The intersection of the azimuth line with the range circle describes the coordinates of the selected point. Azimuth and range marks may be positioned either by the instructor to point out a particular target, or by a student, at a remote station, to indicate his interpretation of the target situation. In either case the marks appear identically on both indicators.

**Playback Controls**

The number of operating controls on the playback console has been kept to a minimum. Two controls deal with the mechanics of recovering the information. The centering control positions the scanner trace so that its image coincides with the recorded area of the film, while the orientation control adjusts the phasing in the servo system to provide the proper (north or ship's heading) orientation of the reproduced picture on the indicator.

The video gain and brightness controls, respectively, adjust photomultiplier gain and cathode-ray tube bias. These two quantities jointly determine the amplitude of the video signal applied to the indicators. The two parameters are made variable because they can be used to alter the picture quality while maintaining constant video output level. With high video gain and low brightness level, the photomultiplier noise becomes an appreciable influence in the total video output and the resulting picture simulates low gain output of the radar. Conversely, high gain operation may be simulated by increasing the scanner trace brightness and reducing the video gain accordingly. A monitor scope providing a type-A presentation of the video signal permits accurate maintenance of the proper video output level.

Other controls involve positioning of the electronic cursors, advancing or rewinding the film, and calibrating the monitor scope. A system of limiting and protective circuits prevents damage to the equipment due to a faulty adjustment of the main panel controls.

The video recording unit employs conventional 35-mm film developed to a gamma of approximately 0.7. The factor limiting resolution in the recorded image is the size of the cathode-ray spot rather than the resolving capability of the film; therefore, the fastest film available minimizes the recording spot intensity and size. Because of its general availability, Tri-X film has been adopted as the recording standard.

Film travel is set at approximately one inch per revolution of the antenna, which, for the AN/APS-23 radar in normal operation, corresponds to about 0.4 inch per second. At this rate the standard 100 foot roll of film gives approximately 50 minutes of continuous recording.

The film is effectively pre-fogged during recording by establishing a minimum-brightness level corresponding to the zero-signal level of video input. The minimum brightness is set to a level which, with no video superimposed, will expose the film sufficiently to bring all subsequent exposure above the toe of the film characteristic. Thus even weak video signals are recorded. Overexposure on large signals can be avoided by proper adjustment of the video gain.

The original recording is not used directly for playback, but is printed on standard positive stock. There are several advantages to the use of positive prints in addition to the fact that they provide for unlimited duplication with a minimum of extra photographic processes. In trying to recover the video signal from the original negative, the areas in which photomultiplier noise is highest are those in which the video signals are very weak and masking of these signals by noise can occur. With a positive, however, the reverse is true. Areas in which the photomultiplier noise is high have correspondingly high signal levels, while the low signal areas are relatively noise-free. In addition, the use of clear-base positive stock removes the attenuation effects of the gray base film and pre-fogging. It also permits use of a lower intensity on the flying-spot scanner with a resulting decrease in spot size and improvement in playback resolution.

The work described in this article was conducted by Stanford Research Institute under Air Force Contract AF 18-(600)-500. A complete technical report of the development of the video recorder has been published by the Air Force Personnel and Training Research Center, Air Research and Development Command.
SUMMARY — Up to four channels of telegraph signals are combined by time-division multiplex for transmission over a single radio communication circuit. Use of 572 transistors and 739 germanium diodes cuts weight of complete set to 275 lb, compared to 1,450 lb for older model using 357 vacuum tubes. Simplified ring counter and digital synchronizer contribute to high operating speed of 100 words per minute.

A small, lightweight multiplex telegraph set is under development for the Navy Bureau of Ships, to provide additional radio-telegraph channels for mobile and shipboard service. Use of transistor circuitry will allow an 80-percent reduction in volume and weight and a 95-percent reduction in power consumption over its electron-tube equivalent, which was developed earlier for fixed-station installations. Time-division multiplex equipment is used to combine two, three or four channels of telegraph information for transmission over a single radio communication circuit.

Although some of the circuits used in the transistorized version were derived from the rapidly growing field of transistor pulse techniques, several unique circuits were developed. This article describes two of these, a simplified ring counter and a digital synchronizer.

Simplified Ring Counter

A ring counter circuit was needed to perform the basic function of distribution (conversion between serial and parallel forms of information). Since the complete multiplex set requires twelve of these ring counter distributors, it is important for the counter to be of simple design, requiring a minimum of components.

The new ring counter achieves its simplicity through use of the inherent negative resistance characteristic of the point contact transistor. Only three components per stage, in addition to the transistors, are required.

The circuit of the simplified ring counter is given in Fig. 1. While only four stages are shown, the ring may be constructed of any number ranging from two upward. Rings of this type have been reliably operated with as many as 26 stages.

When power is applied, transistor Q, will conduct into saturation because of the negative bias supplied to its base through R,. As a result, the collector of Q, will be essentially at ground potential. Simultaneously, the counter element with the highest combination of reverse collector to base leakage current (I..) and emitter current amplification (alpha) will conduct into saturation. Current flowing through the common emitter resistor R, develops a bias voltage which, when applied to the emitters of the remaining off elements, holds them sufficiently in the reverse direction to prevent their conduction.

Figure 2 shows the input negative resistance characteristic curve of emitter voltage and emitter current for a typical ring stage. With the element nonconducting, the voltage at point B is mainly the re-
result of \( I_c \), flowing through base resistor \( R_b \). When conducting, the element will be stable at point \( A \). Because the common emitter resistor produces a voltage which is common to both on and off elements, the emitters of the off elements must be located at point \( C \). The off counter elements are held at this point, which corresponds to a slightly negative emitter current, by a bias voltage equal to \( BC \).

**Stepping Action**

The counter is stepped from one conducting element to the next by means of negative stepping pulses. Each pulse applied to the common emitter connection causes the conducting element to switch to the nonconducting state.

When the collector voltage of the on element switches from slightly negative to highly negative, a differentiated negative waveform is passed through coupling capacitor \( C \), and impressed on the base resistor of the following element, thus priming that element. When the stepping or triggering pulse is removed, the primed element conducts into saturation.

Referring to Fig. 3, the switching of the on element to the nonconducting state is shown as the displacement of load line \( XY \) to \( X'Y' \), with the resulting change in operating point from \( A \) to \( A' \). As described, when the collector voltage of the on element switches from slightly negative to highly negative, a differentiated negative waveform is generated and applied to the base of the following element. This priming effect is shown as a displacement of the characteristic curve for the primed element to the position indicated by the dotted curve. The emitter of the primed element is now more positive with respect to its base by a voltage equal to \( BD \) than any of the other elements in the distributor ring.

The time constant of the distributor coupling circuit has been designed to hold the element in this primed condition for a period longer than the duration of the trigger pulse. Therefore, when the trigger pulse is removed, indicated by a shift in the load line from \( X'Y' \) back to \( XY \), the primed element will be the one that is switched into conduction.

Each ring counter requires a drive amplifier (\( Q \), in Fig. 1) to produce negative triggering pulses of the required width and magnitude to step the counter. To control \( Q \), a square-wave input signal is applied to series-resonant ringing circuit \( C_r-L_r \). The ringing circuit has a resonant frequency of approximately 50 kc. The positive-going leading edge of the square wave shock-excites the resonant circuit into damped oscillation. Clamp diode \( D \) prevents the oscillation from continuing past the first half-cycle by dissipating the energy in the resonant circuit when the voltage swings negative. The result is a single positive output pulse of approximately 10 microseconds in width. This positive pulse is coupled by \( C_1 \) to the base of normally conducting transistor \( Q \), driving the transistor out of saturation and into cutoff for the duration of the pulse. The collector output of \( Q \) is thus a 10-microsecond trigger pulse swinging from ground potential to approximately —20 volts.

**Ring Counter Waveforms**

A group of typical waveforms of the ring counter and its drive am-
amplifier is shown in Fig. 4. Waveform B shows the positive output pulse that is obtained from the ringing circuit and applied to the trigger pulse is shown in waveform C.

At the instant the trigger pulse is received, the base is driven to -6 volts by the differentiated negative pulse resulting from the preceding element turning off, as shown in base waveform H. The base voltage then begins to decay exponentially, reaching approximately -4 volts when the trigger pulse is removed. At this instant the voltage of the primed base is approximately 3 volts more negative than the base voltage of any of the other ring elements, and therefore the primed element conducts, as shown in waveforms G and I.

Satisfactory operating margins are achieved in the simplified ring counter without adjustment of the circuit constants. The basic ring counter element is biased to be stable only in the on condition and therefore is not dependent upon interception of the emitter load line (R, in Fig. 2) more than once with the emitter input characteristic curve. No stabilization circuits are required.

This circuit was designed to operate with transistors which have emitter to collector current gains as low as 1.8 and which allow reverse current flow at 20 volts and 60 C to be as high as 3 ma.

Use of Ring Counter

A block diagram of the complete multiplex system is shown in Fig. 5. It consists of the transmitting and receiving terminal groups and the associated telegraph and radio equipment. On the sending side, independent transmitters deliver randomly timed start-stop telegraph signals to the individual transmitting group code converters.

A ring counter distributor in each converter assists in transforming the information from serial to parallel form. The converter outputs are scanned, channel by channel, by another ring counter distributor within the multiplexer, picking up a complete character in turn from each. The signal elements within these characters are then transmitted in sequence, under the control of a third ring counter, to the external equipment at the multiplex frequency rate.

On the receiving side, the operation is exactly reversed, with distributors performing the complementary functions. The information contained in the incoming multiplex signal is separated, channel by channel, and delivered to the proper code converters. The start-stop signals are then reconstructed and delivered to the telegraph receivers. Initial framing of the receiving channel ring distributors is necessary to insure that the information will be delivered to the proper channels.

The operating speed of each terminal is controlled by a frequency standard using a transistorized crystal oscillator. To obtain high stability, the oscillators operate at the relatively high frequency of 63 kc. Ring counters are used, because of their simplicity, to divide this down to the required scanning frequency. At the receiving terminal, a synchronizer operates in conjunction with the frequency dividers to maintain exact synchronism between the incoming signal and the demultiplexer.

Figure 6 shows a block diagram of the oscillator, frequency-dividing and multiplexing distributing circuits used in the transmitting terminal group. The oscillator output is applied directly to the drive amplifier transistor for the first ring counter. The square-wave output from the first element is used to drive the second ring counter. This
procedure is continued throughout the remainder of the dividing and distributing circuits. In this way, counter rings 1 through 4 divide the 63 kc exactly 420 times to generate the multiplexer signal ring driving frequency of 150 cps.

The signal ring, channel ring and signal matrix comprise the multiplexer portion of the transmitting terminal. Here the six-wire parallel input from each of the code converters is transformed into a sequential channel-by-channel multiplexer output signal.

The signal ring contains six elements, corresponding to the six pulses contained in the signal code. The channel ring contains four elements, corresponding to the four channels of information handled. The signal matrix is composed of 24 diode AND gates. Each AND gate has three inputs: signal ring, channel ring and code converter output, all of which must be present simultaneously to produce an output signal. The output signals of the 24 AND gates are then combined, by means of a diode OR gate, into the sequential multiplexer signal output.

**Digital Synchronizer**

To maintain the receiving terminal in exact synchronism with the incoming multiplex signals, it is necessary to compensate for the effects of oscillator drift and long-term signal distortion resulting from radio circuit multipath. This is accomplished by a unique digital synchronizer circuit designed to operate in conjunction with the receiving terminal frequency dividers. By noting the time location of on-off transitions in the incoming multiplex signal, the exact phase relationship between the incoming signal and the multiplexer signal ring driving frequency is established.

**Common Oscillator**

Synchronizer action is accomplished by adding or subtracting drive pulses to the second frequency divider stage until the proper time relationship is achieved. This system of synchronizing permits the use of a single crystal oscillator to drive both the transmitting and receiving groups in a given location, since the frequency of the crystal oscillator remains fixed.

Figure 7 shows a block diagram of the oscillator and frequency-dividing circuits used in the receiving terminal group. These circuits, and the demultiplexer not shown, are essentially the same as those of the transmitting group. The synchronizing circuits (Fig. 8) have been added to the block diagram of Fig. 7.

A normally open SUBTRACT gate has been placed in series with the normal drive input to dividing ring 2 in Fig. 7. This provides a means of subtracting drive pulses from the normal synchronous drive to ring 2. In addition, an output from the third element of ring 1 has been connected through a normally closed ADD gate to the normal drive input to ring 2. This arrangement provides a means of adding extra drive pulses to the normal drive.

The synchronizer circuits also include a group of phase-detecting gates. Any deviation of the incoming multiplex signal from the demultiplexer sweep frequency will be detected and the appropriate ADD or SUBTRACT gate action initiated.

When the receiving terminal is in exact synchronism with the incoming multiplex signal, the leading edge of the on time of element 1 of ring 4 will coincide with the trailing edges of the incoming multiplex signal code pulses. The incoming multiplex signal is inverted and applied to a signal pulse univibrator whose function is to generate a pulse for each negative-going transition in the multiplex signal. This pulse, adjusted to have a width slightly less than the on time of one element of ring 4, is applied to the six phase-detection AND gates. The second input to each phase-detection gate is obtained from ring 4.

No connection to a phase detection gate is made from element 1 of ring 4. Therefore, when the receiving terminal is in synchronism with the incoming multiplex signal, the output of the signal pulse univibrator will fall within the boundaries of the output of element 1, and there will be no output derived from any of the phase-detection gates.

If the incoming multiplex signal should be lagging, the output pulse from the signal pulse univibrator overlaps with elements 2, 3 or 4 of ring 4. This coincidence will be

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**FIG. 6—Transmitting terminal frequency dividers and multiplexer**

**FIG. 7—Receiving terminal frequency dividers and synchronizer**

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detected by the lagging phase detectors, resulting in the RETARD flip-flop being turned on. The need for retard action is thus stored. In like manner, if the incoming multiplex signal is leading, detection will be made by one of the leading phase detectors, and the need for advance action will be stored in the ADVANCE flip-flop.

**Amount of Correction**

The ADD and SUBTRACT gates are each controlled by a univibrator. Thus when the RETARD univibrator is triggered, the SUBTRACT gate is closed for a period of time equal to the univibrator relaxation cycle. When the ADVANCE univibrator is triggered, the ADD gate will be opened for a length of time as determined by the univibrator.

The amount of correction provided per correction rate cycle is controlled by adjusting the operating time of the ADVANCE and RETARD univibrators. By varying the univibrator operating period, one or more drive pulses can be added or subtracted per cycle. Each pulse added or subtracted will advance or retard the succeeding rings approximately 65 microseconds, or 1 percent of the on time of a signal ring element.

**Rate of Correction**

The correction rate cycle is established through the action of the RETARD and ADVANCE flip-flops. An externally generated sync rate clock pulse is applied at periodic intervals to the RETARD and ADVANCE flip-flops. If one of the flip-flops has been previously turned on, due to the detection of an out-of-phase condition, the arrival of the next sync rate clock pulse will reset the flip-flop and cause the associated univibrator to be triggered. Thus, the rate of correction can be controlled by adjusting the frequency of the sync rate clock input. The rate of correction can be varied from 6.25 pulses per second to one pulse per 20 seconds.

A slow correction rate is generally used to slow down the action of the synchronizer circuits during poor signal periods. Since the phase detectors will respond to every change in the phase relationship between the incoming multiplex signal and the receiving demultiplexer signal ring driving frequency, the synchronizer circuits will attempt to establish an in-phase relationship, not only with normal signals, but with all extraneous bursts of noise and distortion which may be received.

The multiplex equipment described was developed under the direction of T. A. Hansen, project engineer, with circuit design assistance from F. D. Biggam, R. J. Reek, R. A. Slusser and the author.

**REFERENCES**


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**FIG. 8—Synchronizer circuit compensates for effects of oscillator drift and long-term signal distortion resulting from multipath radio transmission**

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Demodulator-Limiter for Control System Signals

SUMMARY — Transistor circuit for carrier-based control systems limits while modulating or demodulating. Circuit operates at high signal-conversion efficiency, produces hard limit and has excellent linearity.

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Any control systems require hard limiting of control signals to predetermined levels. It is sometimes also desirable to have independent control of the plus and minus, or phased, signal limit levels, such that either or both can be fixed or varied according to some desired function.

In systems which employ medium-level phase-sensitive modulators or demodulators, this flexibility of limit control can be achieved without additional components by using the modulator or demodulator circuit shown in Fig. 1. Where the signal source is isolated from the load, this circuit provides full-wave operation at high-signal conversion efficiency without requiring a center-tapped signal transformer.

Circuit

Assuming a demodulator application for the circuit of Fig. 1A, operation in the linear range is as follows: during one-half cycle of the carrier frequency the bases of \( Q_1 \) and \( Q_3 \) are negative with respect to their collectors, offering a low impedance to signal current flow through their emitter-collector paths. During this same half-cycle, the bases of \( Q_2 \) and \( Q_4 \) are positive with respect to their collectors, offering a high impedance to signal current flow through their emitter-collector paths.

During the next half cycle, \( Q_1 \) and \( Q_3 \) act as open switches and \( Q_2 \) and \( Q_4 \) as closed switches, resulting in full-wave rectification of the signal input.

As the signal level is increased the mode of operation changes at a predetermined level, causing the output to limit. During one-half cycle \( Q_1 \) presents a high impedance to current flow through its collector-emitter path only as long as its base is positive with respect to both its emitter and collector.

When output voltage \( e_1 \) exceeds switching voltage \( e_2 \), current flows through the base-emitter path of \( Q_1 \), creating a low impedance path for signal current through its collector and emitter. This shunt across the load automatically regulates the voltage at the input terminals of the circuit by virtue of its decreasing impedance as a function of increasing signal. During the next half cycle switching voltage \( e_3 \) determines the output limit level.

If the signal phase is reversed, switching voltages \( e_1 \) and \( e_2 \) replace \( e_2 \) and \( e_3 \) in determining the limit level on alternate half-cycles of signal voltage. Thus, nonsymmetrical, symmetrical, fixed or variable limits can be attained by the proper choice or variation of the two center-tapped switching voltages. To obtain a hard limit the signal voltage and the switching voltage must have the same wave-form.

Application

Figure 1B shows the limiting characteristics for the circuit of Fig. 1A which was designed for an autopilot system. This application required nonsymmetrical and variable limit levels for the acceleration commands to an elevator servo. Since the two limit levels were to be varied by the same function, the circuit requires only one carrier transformer. In this case, the transformer primary voltage is varied by a servo-driven potentiometer.

Acknowledgement is due Kenneth D. Johanson for assistance in preparing this article and Earling Johnson for constructing and testing the unit.
Magnetic Field Pickup

By ROGER R. WEBSTER and JAMES M. CARROLL

SUMMARY — Enhanced sensitivity and reduced size of portable, watertight, detector make this unit ideal for tracing underground or underwater cable systems used for airport and harbor lights. Instrument locates open circuits by sudden drop or loss of 250-cps signal generated by vibrator. Ferrite core is used in the detecting element pickup coil. Signal is amplified by a three-stage, transistorized, tuned amplifier.

A 250-cps a-c signal, from the signal-generator is applied, through an impedance matching transformer which accommodates various cable conditions, to the end of the cable to be tested. Signal current in the cable produces a magnetic field which induces voltage in the pickup coil of the magnetic-field detecting element. The induced signal is amplified and applied to an indicating meter and headset. Cable faults are located by a sudden change in the intensity of the received signal, usually by a sudden drop, or by complete loss of the 250-cps signal.

Signal Generator

The signal-generator circuit is shown in Fig. 2. The signal is generated by a 250-cps vibrator, coupled to the output terminals through a tapped transformer. The output impedance of the signal generator can be approximately matched to the cable under test to provide maximum-signal current. Open-circuit voltages are approximately 250, 64, and 16 v in the high, medium and low output positions respectively, corresponding to output impedances of approximately 2,750, 170, and 10 ohms. Relay K interrupts the 250-cps signal at about two cps. This distinctive modulation permits fault identification in regions where harmonics of 60-cycle fields cause high background noise.

A push-pull connection on the
primary of the output transformer avoids d-c saturation of the transformer core and allows the use of a small transformer. Input current requirements are minimized and vibrator life increased because of the decreased contact current.

In the input and output circuits, r-f filtering gives a better wave shape and minimizes high-frequency noise generated by the vibrator.

**Amplifier-Indicator**

The signal from the magnetic-field surrounding the cable is amplified and rectified. Signal strength is indicated on an output meter and the headset is used for monitoring the amplifier output.

**Ferrite Core**

Sensitivity was greatly increased by using a ferrite core in the pick-up coil. Coil and core are mounted on a telescoping boom connected to the amplifier.

The three-stage amplifier is mounted on an etched circuit board. It is tuned to 250 cps by the series L-C circuit in the emitter circuit of the second stage. The output is down 5 db from maximum at 215 cps and 285 cps. Three type 201-A triode n-p-n grown-junction germanium transistors in the amplifier give minimum overall gain of 85 db.

The input impedance of the unit is approx. 10 ohms, designed to match trailing leads in seawater when following submerged cables. Output impedance of approx. 600 ohms matches the headset.

Amplifier output, rectified by a diode, is indicated on a d-c meter. Resistor, \( R_c \) in Fig. 1, terminates the output when headset is out.

**Watertight Case**

The amplifier case is watertight to a submerged depth of 3 feet, except for the phone jack which may be plunged when the headset is not in use.

The complete unit is carried easily in two watertight portable cases, which house the major units.

The cable-fault detector can localize practically all types of cable faults so that the cable may be exposed and repaired.
Telemetering System

By EDWARD K. NOVAK

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SUMMARY — Modification of standard Weather Bureau type radiosonde
permits use of 1,680-mc carrier with three simultaneous channels of informa-
tion, one of which is time-multiplexed into 12 additional channels with
sampling rate of one sample per minute. Equipment utilizes f-m/a-m tele-
metering principles and has probable max range of 360 miles

ALTHOUGH highly efficient and
completely adequate for its inten-
tended purpose the weather bu-
reau’s AN/AMT4 balloon-carried
telemetering system is restricted,
in its commercially available form,
to measurements of only those pa-
rameters that can be represented by a
variable resistance. Also, it is re-
stricted by its inability to obtain
simultaneous measurements of two
or more parameters because of its
single-channel nature. Furthermore,
measurements are referred to altitude rather than time so that
data usually is obtained only during
the ascending period of the
balloon.

In an effort to utilize the desir-
able features of this system while
also increasing its utility, to in-
clude time sequencing, simultane-
ous channels and other features,
the equipment to be described was
developed.

The telemetering methods util-
ized in this equipment are basically
f-m/a-m. The r-f transmitter is
frequency modulated and the sub-
carriers are amplitude modulated.
However, since two channels con-
tain frequency information and the
third conveys amplitude information
in terms of frequency, a-m is
used to indicate a change in the
signal, not the degree of change,
thereby avoiding the disadvantages
in amplitude modulation while re-
taining its advantage of simplicity.

System Description

A simplified block diagram of the
system is shown in Fig. 1. The
main system consists of a 5794
pencil-triode uhf oscillator trans-
mitter, frequency modulated by the
multiplexed signal obtained from
simultaneously summing three am-
plitude-modulated subcarriers. Two
of the subcarriers convey pulse in-
formation and the third carries
d-c voltages representing various
measured parameters.

Rectangular waves from astable
and bistable multivibrators in the
test package are fed to the anti-
coincidence circuit, which compares
these signals and amplitude modu-
lates the 3-ka subcarrier channel
when anticoincidence occurs.

Short random pulses, originating
at a test amplifier in the test pack-
age, are applied to the pulse
counter. The counter selects only
positive or negative pulses of a
predetermined level and triggers a
bistable multivibrator, which in
turn amplitude modulates the 7.35-
kc subcarrier channel.

Eight signal input wires, origi-
nating in the test package and the
power pack, apply to the sequencing
switch voltages representing meas-
urements of test circuit electrical
parameters, test package tempera-
ture, battery pack temperature,
voltage standards and power sup-
ply voltages.

The output of the sequencing
switch is applied to a cathode fol-
lower and then to a blocking oscil-
lator whose output frequency is a
linear function of the voltage ap-
plied to its grid. The output pulses
of the blocking oscillator are
stretched and used to amplitude
modulate the 10.5-ka subcarrier
oscillator. A second pole on the

FIG. 1—Block representation of main telemetering system and auxiliary equipment
sequencing switch is utilized to measure the frequency of the astable and bistable multivibrators by time sequencing them along with the voltage measurements on the 10.5-kc channel.

Emergency System

The output of the sequencing switch is also applied through an isolating cathode follower to a second blocking oscillator which, with its associated transmitter, constitutes the auxiliary or emergency telemetering system. This system, carrying its own water-activated batteries, is a time-sequenced channel completely independent of the main telemetering system and provides partial data, in case of failure of the main system.

The ground station receiving equipment consists of a GMD receiver and tracking antenna or other suitable receiving equipment and a single channel 15-ips magnetic tape recorder. Under normal operating conditions, the main telemetering system only is tracked and recorded by the ground station. In the event of failure of the main system the receiver is switched to a-m and locked to the auxiliary transmitter.

When two receiving equipments are available, both telemetering systems are tracked and recorded, affording a cross-check on the data being measured by the time-sequenced channel.

Data Reduction

The data reduction system is shown in Fig. 2. The multiplexed or pulse-modulated tape recorded data is played back and fed into the reduction unit.

When pulse-modulated data only is recorded, such as is obtained from the auxiliary telemetering system, the playback signal is fed into an amplifier to make the signal level suitable for application to a slicer circuit. The slicer eliminates noise and shapes and limits the signal before it is applied to the discriminator. The output of the discriminator, consisting of the recovered test package parameter measurements, is applied to a paper-pen recorder.

To minimize errors due to striking of the mechanical pen stops on the paper recorder by the pen in the event of loss of signal or extraneous signals, electronic pen stops or pen travel limiters are used. The limiters prevent voltages larger or smaller than those normally applied to the pens from being applied to the pen driving amplifiers.

When multiplexed data is present on the tape, such as is obtained
from the main telemetering system, the playback signal is applied through an impedance matching amplifier to three band-separation filters tuned to the subcarrier frequencies. The frequency-separated outputs of the band-pass filters are amplitude demodulated and the recovered data appears at the output of the unit. The 3-kc and the 7.35-kc channel output signals are applied directly to the paper-pen recorder; the 10.35-kc time-sequenced channel output is first fed to the f-m discriminator in a manner identical to that used for pulse-modulated data.

The output of the paper-pen recorder is a strip-paper record containing each of the three channels. Since the output of the 3-kc channel may contain pulses recurring at 100 to 200 cps, which cannot be conveniently recorded by a pen recorder, an electronic counter is also connected to the 3-kc channel output. When pulses occur they are totaled by the counter and manually recorded on the paper record.

The output of the 10.5-kc channel consists of d-c levels at a 1/12-cycle per minute rate, corresponding to the sequencing switch speed and is recorded directly on the paper record. The data is transferred to a graph by manually reading off the number of pulses per time interval in the 3-kc and 7.35-kc channels and by converting the data in the 10.5-kc channel into voltage, current, frequency and temperature with a calibration curve.

**Circuit Description**

The transmitter, shown in Fig. 3, consists of a pencil triode, cavity resonators and a dipole antenna. The nominal frequency of operation as determined by the cavity resonators is 1,680 mc and can be adjusted to any frequency from 1,668 mc to 1,692 mc. Nominal carrier output of the transmitter is 0.5 w with a plate input of 120 v at 25 ma.

Due to the inability of the 5794 to maintain oscillations at plate voltages lower than 60 to 70 v, plate modulation results in a maximum attainable modulation of only about 25 percent. The frequency-modulation effects observed with plate amplitude-modulation led to the adaptation of this method for plate-frequency-modulation. Identical to a conventional choke-coupled plate modulator, the circuit utilizes the inherent dependence of frequency upon plate voltage in an oscillator to effect frequency modulation.

Although the effect is normally small enough to be neglected, it is adequate in this application since
the required deviation is only a very small percentage of the center frequency.

A first approximation for the frequency dependence of an oscillator upon plate voltage is given by

\[ f = \frac{1}{(LC)^{1/2}} \left( 1 + \frac{R}{2r_p} \right) \]

where \( R \) is a series resistance in the plate tank circuit representing the entire load; \( r_p \) is the plate resistance, a variable dependent upon plate voltage such that for a low-\( \mu \) triode the \( r_p \) changes by 2 to 3 percent per volt change in the plate voltage. The value of \( R \) in this circuit is in the order of 18 ohms; thus a 1-v change in the plate voltage results in a carrier frequency shift of 0.004 percent or about 60 kc. The incidental amplitude modulation under these conditions is 1 percent.

**Modulation**

Typical operation with the circuit illustrated in Fig. 3 shows that a 1 v p-p swing at the 5676 modulator output produces a frequency deviation of \( \pm 50 \) to \( \pm 60 \) kc. The modulation characteristic is linear up to 3.5 to 4 v p-p, producing a frequency deviation of \( \pm 200 \) to \( \pm 250 \) kc and resulting in a modulation index of about 20 for the highest modulating frequency. Power requirements for the modulator are comparatively negligible as is the small amount of amplitude modulation present under these conditions.

The modulator is preceded by an 5678 amplifying stage whose function is to linearly sum, or mix, the three modulated subcarrier oscillator outputs. The summing resistors are selected consistent with adequate signal to the modulator and a linear preemphasis response curve. Under these conditions the subcarriers appearing at the modulator plate have the amplitude ratios 0.5, 0.75 and 1, relative to the 10.5-kc subcarrier, for the 3-kc, 7.35-kc and 10.5-kc channels, respectively.

The subcarrier units each utilize one 5678 subminiature pentode in a modified Colpitts oscillator circuit and one 1N54A diode a-m modulator. Input voltages to the modulator of 4 to 5 p-p result in an output of 3 to 4 v p-p, modulated 94 to 98 percent. The oscillator-modulator is operated at relatively low levels to hold operation within the range of the diode so a linear modulation characteristic is obtained to maintain high Q in the subminiature toroids utilized for the oscillator tuning elements.

Relatively high input impedance to the modulator, about 100,000 ohms, is maintained to minimize loading of the test package circuitry. No inductor is required in the plate feed to the oscillator in this type of operation thus freeing that inductor for use in a tuned circuit at the output of the channel. The resulting band-pass filter produces a distortionless sinusoidal output at the subcarrier frequency to prevent cross modulation between channels. Since the modulation consists of rectangular waves, damping of the output tank circuit is necessary.

A circuit Q of 12 to 15 is adequate to obtain a satisfactory compromise between purity of carrier frequency wave shape and modulation distortion under these conditions of operation. Modulating frequencies in the range 80 to 400 cps are used in the 10.5-kc channel, 100 to 200 cps in the 3-kc channel and 0 to 200 cps in the 7.35-kc channel. The modulated output is linear for a modulation voltage range from \(-2\) to \(+2\) v peak or d-c as shown in Fig. 4.

**10.5-KC Channel**

The 10.5-kc subcarrier channel is modulated through the output of the time-sequenced switch by the 5875 blocking oscillator, which converts voltage into frequency, and a pulse stretcher. Since the output of the blocking oscillator consists of pulses only 30 to 100-\( \mu \)sec in width the 5678 pulse stretcher widens the pulse to a width such that several cycles of the subcarrier frequency are encompassed.

To include a minimum of 10 cycles of the subcarrier within one half cycle of the modulating signal at a maximum modulation pulse rate of 500 cps, a pulse width of 1,000 \( \mu \)sec is used in the univibrator-type pulse stretcher. The 1-megohm resistor in series with the output of the univibrator reduces the 40-v output pulse to the 4 v required for full modulation of the subcarrier and isolates the univibrator. The resistor also serves in conjunction with the output impedance of the cathode follower to reduce the output of the pulse stretcher to a negligible value when the sequencing switch applies the test package multivibrator output to the modulation terminal of the 10.5-kc subcarrier channel.

**Conversion**

The voltage to frequency conversion is accomplished by the use of a modified quenching-type blocking oscillator such as is used in the standard radiosonde for resistance to frequency conversion. In operation, a bias voltage \( E_b \) exists at the grid of the blocking oscillator at which high-frequency oscillations (10 to 12 mc) can build up. The resulting grid current charges the grid capacitor rapidly to a more negative grid voltage \( E_g \), at which oscillations are cut off. When oscillations cease, no further charge is contributed to the capacitor and it begins to discharge exponentially through the resistors in the grid circuit. When the voltage on the capacitor has dropped to \( E_b \), oscillations are resumed and the cycle repeats.

Within the limits of calculation accuracy, the voltage to frequency conversion over the required range is linear.

Because it is highly desirable in any system of telemetering to avoid absolute calibrations which depend upon tube characteristics, battery voltages, magnetic tape recorder speed and similar factors, no absolute calibration is used in this equipment. Rather, a standard unit of measure, a standard cell, is
used and applied such that it is handled by the equipment exactly as the data to be measured.

Reconversion

Since the voltage-versus-frequency characteristic of the blocking oscillator may be assumed linear, any unknown voltage \( E_u \) telemetered as a frequency \( f_u \) can be converted to voltage upon reduction of the data by the relation

\[
\frac{E_u}{E_m} = \frac{f_u}{f_m}
\]

where \( E_u \) is unknown voltage to be measured, \( E_m \) is standard voltage where \( E_m > E_u \), \( f_u \) is frequency corresponding to \( E_u \), \( f_m \) is frequency corresponding to \( E_m \), and \( f_u \leq f_m \).

If \( E_u \) is chosen equal to zero \( E_u/E_m = (f_u/f_m) \) and the unknown may be obtained by simple calculation or graphing.

The parameters to be telemetered on the 10.5-kc subcarrier are applied to the channel through a motor-driven rotating switch. The two-pole 12-position switch is driven at 1 rpm by a miniature 6-v d-c motor developing a torque of 10 in.-oz. at a drain of 10 to 12 ma.

Contact dwell time is about 4 sec and open time is 1 sec, resulting in one measurement for 4 sec per minute per parameter.

The voltage parameters are applied through nine positions of one of the switch sections to the 6021 isolating cathode follower in Fig. 3. The output of the cathode follower is applied to the blocking oscillator. The 5787 voltage stabilizer reduces blocking-oscillator drift due to shifts in both the plate voltage of the oscillator and the cathode follower cathode voltage with changing battery voltages. In addition, the reduced plate voltages on both the cathode follower and the oscillator are utilized to obtain a larger voltage-frequency conversion factor.

Frequency Parameters

The frequency parameters telemetered by the 10.5-kc channel are applied through two positions of

FIG. 6—Anticoincidence circuit amplitude modulates 3-kc subcarrier channel when anticoincidence occurs between rectangular waves generated in test package

Rectangular waves for anticoincidence circuit are generated in test package simulator by astable and bistable transistor mvbr
the second section of the rotating switch such that when each of the two frequencies, the astable multivibrator and the binary, appears at the output of the switch and thereby also at the input to the 10.5 kc channel modulator, the blocking oscillator is effectively disconnected from that input. When the switch is on the frequency-transmitting contact the low output impedance of the cathode follower forms a voltage divider in conjunction with the 1-megohm resistor in the blocking-oscillator output circuit, thereby reducing the blocking-oscillator output to a negligible value while at the same time passing the multivibrator frequency through to the subcarrier modulator.

Since the blocking oscillator never ceases to function because its grid is connected to a cathode follower and thereby never open, this method effectively turns it off without requiring additional switch contacts. In addition to this use for the cathode followers, their other function is to clip the multivibrator signals to equal levels and to couple them into the anticoincidence circuit.

Grounding position 1 of the sequencing switch results in a momentary removal, by the shorting-type wiper switch, of the bistable multivibrator from the input to the anticoincidence circuit. This is used to test the operation and to establish an operating level for the anticoincidence circuit.

Measuring Circuits

The anticoincidence circuit, shown in Fig. 6, produces an output pulse whenever pulses are gained or lost by the test package bistable multivibrator with respect to pulses produced by the astable multivibrator which is driving it.

After clipping in the cathode followers to establish relatively constant amplitudes, the astable and bistable multivibrator outputs are applied to R-C differentiators at the input of the circuit. After differentiation, the resulting pulses are summed, amplified and clipped by the following two amplifier sections and applied to the input of the univibrator such that triggering pulses appear only when either there are no miscounts or when there are pulses being lost by the binary. This effect is obtained by proportioning the amplitudes of the differentiated pulses so that a pulse is produced only when a negative pulse produced by the binary adds with a negative pulse produced by the astable multivibrator.

Thus, output pulses are produced only when the two waves are in coincidence because a negative pulse from the binary and a negative pulse from astable mvbr occur at the same time only once per cycle. Also, by proper proportioning, pulses are produced at the output when the binary misses a pulse, since subtraction of pulses is also utilized to prevent output of astable mvbr pulses.

When the binary gains pulses no signal results at the input to the univibrator since extra binary pulses do not add with other pulses to produce an output of sufficient amplitude to be passed by the circuit.

The output of the univibrator, if

![FIG. 7—Pulse counter uses biased limiters and bistable multivibrator to count randomly occurring pulses of either polarity and of 0.3 to several µsec width](image)

![FIG. 8—Data-reduction system employs pen-travel limiters to prevent loss of calibration in the event of violent striking of the pen stops during periods of signal interference](image)
there is one, is passed to one section of the anticoincidence tube.
Two actions take place here.

If a signal is present at both inputs an output results. However, this output is smaller than would result if either of the two inputs were missing because of the cancelling action in the common load resistor, the 10,000-ohm resistor at the cathode-plate terminal. Thus, when pulses are missed by the binary a signal appears at the upper grid of the anticoincidence circuit, but the corresponding signal does not appear at the lower grid, thereby an output results. When pulses are gained a signal appears at the lower grid, but no corresponding signal appears at the upper grid and again an output results.

Clamping

The second circuit action is the result of the clamping action by each of the two grids of the anticoincidence tube. When a pulse is missed, the momentary loss of clamping action on the upper grid reduces its bias, increasing current flow through the common load resistor. Since the output of the anticoincidence circuit is applied to a biased clipper set to produce no output unless the input exceeds a preset level, but which is exceeded by the above increase, an output results. When a pulse is gained an equivalent action takes place at the lower grid.

The biased clipper amplifier at the output of this circuit is effective in both of the actions just described. In addition, it clips the positive portions of the waves at the plate to maintain equal and predetermined amplitudes so these signals can be used directly to fully modulate the 3-ke channel.

The anticoincidence-circuit-test contact on the sequencing switch causes the binary signal to be momentarily removed from the circuit input once per revolution of the switch. The effect on the circuit is that of several missing binary pulses and an output is produced, thereby resulting in a test of the circuit and a reference signal once per minute.

During the data reduction process this test signal indicates proper circuit operation and serves as an amplitude reference to set the electronic counter used to tally miscounts.

To exclude tallying of noise and other extraneous pulses the counter is set to tally only pulses as great or greater than the test reference signal.

The pulse counter counts randomly occurring pulses of 2 to 15 v peak, of positive or negative polarity and 0.5 to several μsec in width. The circuit shown in Fig. 7 uses conventional biased limiters and a bistable multivibrator to perform this function. The limiters remove the high circuit noise originating in the test unit preceding the counter and pass only the positive and negative pulse information.

Following the limiters, an inverter, resistive summer, amplifier and a bistable multivibrator are used to produce a binary type output corresponding to input pulses. The output, consisting of a change in d-c level between the two stable states of the binary, is used to directly modulate the 7.35-ke subcarrier.

Data Reduction

To convert the multiplexed data recorded on single channel, 1-in. magnetic tape at 15 ips to a pen-paper strip recording, the output of the playback unit is applied to the subcarrier demodulator, shown in the schematic diagram in Fig. 8.

After passing through the multiplexed pulse modulated switch, the multiplexed signal passes through a signal preamplifier having a maximum voltage gain of 100. The amplified signal is then applied through matching amplifiers to the inputs of the three band-pass filters. The filters are standard RDB 15-percent bandwidth units and are connected for high-impedance input and output.

After separation by the filters the signals are amplified and demodulated by IN91's in conventional detector circuits. Simple low-pass filters with cut-off frequencies of about 700 cps remove the subcarriers and couple the demodulated signals to the output terminals of the unit. Since the 7.35-ke and 3-ke channels contain slow pulse information, they are coupled directly to a pen-paper strip recorder where they may be later read off visually.

The output of the 10.5-ke channel is in the form of a low-frequency recurrent wave which is switched from one frequency to another frequency every several seconds.

The signal is now in a form suitable to apply to a frequency to voltage converter or discriminator, after which it may be applied to the pen-paper recorder. In this system, however, the above signal is first passed through an amplifier-clipper so that some control over wave shape and amplitude is available should interference be present with the signals. In addition, the discriminator signal is passed through a pen-travel limiter before application to the paper-pen recorder.

The limiters are used for the purpose of preventing loss of calibration in the event of violent striking of the mechanical pen stops during periods of signal interference. This expedient is necessary since the pens operate in an expanded-scale manner for greater reading accuracy; thus both zero and the higher voltages are off the scale limits such that loss of signal, corresponding to zero volts, would cause striking of the negative pen stop, interference or noise, corresponding to a large voltage would cause striking of the positive pen stop.

Performance

The maximum recorded range of the system, as determined by balloon cut-down rather than by minimum usable signal strength, was 180 miles. The signal level at this range, however, indicated a probable maximum range approaching the calculated vhf radio horizon at 360 miles.

Overall system accuracy based on records of several flights indicated frequency measurements were accurate to ±1 cycle; other parameters referred to voltages having a full scale value of 10 v were accurate to ±0.1 v.

The laboratory assistance of M. Ishihara and J. B. Hoover in the development of this system is acknowledged.
SUMMARY — Two-to-one economy in circuit components over conventional transistor multivibrators is afforded by multivibrator consisting of three resistors, one capacitor, one diode and one unijunction transistor. Circuit can be astable or monostable in operation and has particular application in digital computers and counters where component cost and network complexity can be restrictive.

Most fundamental of digital-type circuits is the multivibrator. The semiconductor multivibrator to be described may be considered as a diode flip-flop. Its active element is a unijunction transistor, which is a three-terminal, single-junction, negative-resistance device. An almost two-to-one reduction in circuit components required by the unijunction transistor multivibrator, compared to conventional transistor configurations, affords a higher degree of circuit simplicity, miniaturization and economy.

Operation

The basic circuit configuration of the unijunction transistor multivibrator is illustrated in Fig. 1. During astable operation, C is charged from the battery supply through R, and diode D. During the charging cycle of the capacitor, D is conducting but the unijunction transistor is in the cut-off state. When the potential across the capacitor becomes equal to or greater than the peak-point potential of the unijunction transistor, the latter becomes unstable and switches into the conducting state. The junction potential at point B is then clamped almost to ground potential, causing D to become cut off. When D is in its nonconducting state, point A is virtually isolated from point B. The capacitor then discharges through R, until the potential at A is approximately equal to the junction potential of the unijunction transistor. At this instant, the diode becomes conducting again.

When the diode reverts to its conduction state, the current through the junction of the unijunction transistor decreases and the latter is driven into its cut-off state. Capacitor C will then recharge and the cycle will be repetitive.

Waveforms

Since capacitor C alternately charges and discharges through R, and R, respectively, the waveform at A consists of a periodic ex-
through $R_s$ is either high or low, depending upon the operating state of the unijunction transistor and the waveform across $R_s$ at point $C$ is a square wave. Frequency and symmetry of this square wave are dependent upon the time constants associated with resistors $R_o$, $R_i$, and capacitor $C$.

**Graphical Analysis**

A better understanding of the operation of the multivibrator may be obtained by considering its equivalent circuit. Figure 2A illustrates the d-c equivalent circuit of the unijunction transistor when $D$ is conducting. The capacitor is omitted and the diode is assumed to have negligible forward resistance.

The loop equations for this circuit are

$$E = (R_1 + R_2)I_1 - R_1V_d \quad (1A)$$

$$0 = -R_2I_1 + R_3 + V_\text{a} \quad (1B)$$

In Eq. 1B, $V_\text{a} = f(I_\text{a}, E, R_2)$, which represents the input characteristics of the unijunction transistor for a battery supply $E$ and load resistance $R_2$.

Solving for $V_\text{a}$ as a function of $I_\text{a}$,

$$V_\text{a} = \frac{R_1}{R_1 + R_2}E - \frac{R_1R_2}{R_1 + R_2}I_\text{a} \quad (2)$$

When $D$ in Fig. 1 is nonconducting, the steady-state equivalent circuit of Fig. 2B is obtained. It is assumed that $R_i$ is effectively isolated from the unijunction transistor by the high back resistance of the diode. For this circuit

$$V_\text{a} = E - R_3I_\text{a} \quad (3)$$

The application of Eq. 2 and 3 to the operating characteristics of the unijunction transistor permits the graphical load-line analysis of Fig. 3.

For the condition that the diode conducts, the steady-state input load line is determined by Eq. 2 and is represented by the dashed line. The intersection of the load line with the ordinate axis is at a point $V_\text{a} = (E) [R_o/(R_o + R_2)]$ and the slope of the load line is the parallel combination of $R_o$ and $R_i$.

For the condition that the diode is nonconducting, the load-line characteristic is determined by Eq. 3 and is represented by the solid load line (slope $= R_o$) in Fig. 3.

**Astable Operation**

For the diode multivibrator to be astable, or free running, the input load line should not intersect the unijunction transistor characteristic in the cut-off region when the diode is conducting.

When the diode is nonconducting, the input load line must intersect the unijunction transistor operating characteristic in the transition, or negative-resistance, region. Circuit conditions are

$$R_iE/(R_1 + R_2) > V_\text{a} \quad (4A)$$

$$E/R_2 \leq I_\text{a} \quad (4B)$$

In Eq. 4A and 4B, $V_\text{a}$ is the peak-point potential of the double-base diode and $I_\text{a}$ is the input current corresponding to its valley point. The operating path of the multivibrator, in relation to the input characteristics of the unijunction transistor, may be approximately determined from the graphical analysis, as indicated in Fig. 3.

**10-KC Generator**

Figure 4 shows the characteristics of an experimental unijunc-
tion transistor, similar to the 4JD5A1, that was used in the circuit of Fig. 1 to obtain a 10-kc symmetrical waveform multivibrator with a maximum output of 3.7 v.

The period of oscillation can be determined from

\[ t_T = \frac{R_1 C}{3 \left( \frac{1}{R_1 + R_2} + \frac{1}{R_1 + R_3} \right) + \ln \left( \frac{V_T}{V_p} \right)} \]  

where all parameters are determined from Fig. 1 and 3.

By changing the value of C to approximately 300 \( \mu \)F and 2,000 \( \mu \)F, operating frequencies of 55 kc and 7 kc, respectively, were obtained.

**Monostable MVBR**

Referring again to the basic circuit of Fig. 1, the multivibrator may be made monostable if

\[ R_1 E/(R_1 + R_2) < V_p \text{ and } E/R_2 < I_r \]  

Equation 6 fixes the stable operating point of the unijunction transistor in the cut-off region and Eq. 7 insures that this is the only stable operating point. If Eq. 6 and 7 are satisfied, a positive pulse will trigger the unijunction transistor from the off to the on state. The unijunction transistor will then remain conductive until the capacitor discharges through resistor \( R_2 \).

When the diode reverses at the end of the capacitor discharge cycle, the transistor becomes non-conductive. Since it is stable in cut-off state, the multivibrator circuit remains stable until the next positive trigger pulse is applied. Thus, the regenerated output waveform duration is

\[ t_D = -R_1 C \ln \left( \frac{V_T}{V_p} \right) \]  

Figure 5 shows the waveform generated by a monostable multivibrator. Minimum spacing of the trigger pulses is limited by the circuit's time constants.

On the other hand, if

\[ R_1 E/(R_1 + R_2) > V_p \quad E/R_2 > I_r \]  

a monostable circuit, having a stable operating point associated with the conductive state of the unijunction transistor is obtained.

Negative pulses may then be used to trigger the circuit into its regenerative cycle.

**Delayed-Pulse Generator**

Use of the monostable multivibrator as a delayed-pulse generator is illustrated in Fig. 6. Here \( R_2 \) and \( C_2 \) are used as a differentiating network while \( D_2 \) filters out the pulses of unwanted polarity. The output waveform consists of pulses which are generated by differentiating the trailing edge of the multivibrator output.

Diode \( D_2 \) filters out the pulses which are generated by the leading edge of the multivibrator waveform. Hence, the output of the delayed-pulse generator consists of a train of pulses which have the same polarity and repetition rate as the input pulses but which are delayed in time by an interval \( t_a \) determined by the time constants of the monostable circuit.

Figure 7 illustrates the relationship between the pulse delay \( t_a \) and the magnitude of the multivibrator capacitor \( C \) for the experimental delayed-pulse generator circuit shown. In this circuit the conditions defined by Eq. 6 and 7 are required for operation. Time delays from 50 \( \mu \)sec to 2 millisecond have been obtained for pulse repetition rates from 0 to 5 kc. The time delay is related to the magnitude of \( C \) in a linear manner. This relationship is convenient in design and facilitates constructing simple variable-delay pulse generators.

The advantages of this new circuit should be particularly significant in complex systems such as digital computers and counters where component cost and network complexity can be restrictive.

**REFERENCES**

SUMMARY — Integrating receiver digitalizes noise output from superheterodyne second detector. Result is integrated over any of several measured time intervals. Input to integrator switches at 500 cps to compare radiated noise with that from dummy antenna. Presence of signal is indicated by increase in average count difference from two inputs in the integrator. Error probability is about 20 percent for missed signals and two percent for false alarms at levels as much as 26 db below ambient noise.

DETECTION of electromagnetic radiations is difficult when they are obscured by noise, generated either within or outside the receiver. Such a signal may sometimes be detected by a narrow-bandwidth receiver, but this is tedious since only a small portion of the r-f spectrum can be examined at one time. The integrating receiver technique used in radio astronomy determines the presence or absence of a signal well below the noise level in a wide-band receiver. The receiver integrates over extended intervals by digitalizing the noise output from the second detector of a superheterodyne and accumulating the total on conventional pulse counters.

Figure 1 shows an actual antenna and a terminating-resistor dummy antenna providing two inputs to the system. A crystal r-f switch driven by the cycle controller changes the superheterodyne input between the signal antenna and the reference 500 times a second. The cycle controller also operates the gates in synchronism with the crystal switch; with gate 1 open when the receiver is on the reference antenna, and gate 2 open when the signal antenna is connected.

Operating Principles
The resistance of the reference antenna equals the impedance of the signal antenna. When there is no signal at the receiving antenna, the difference between the average noise levels from the two inputs is constant, but even a feeble signal raises the output slightly. The sampler produces at the gate input a quantity of pulses proportional to the average noise voltage from the receiver.

The cycle controller automatically measures integrating time intervals of 0.1, 1.0 and 10 sec, or manually for any desired interval. After a sample, count 1 is proportional to the reference antenna noise and count 2 proportional to the noise from the signal antenna, both integrated over the predetermined period.

Rapid switching between inputs insures that any low-frequency changes in receiver gain or line voltage affect both channels equally and therefore do not cause false...
Below Noise Level

increases in count difference. After a reference difference is measured with no signal at the receiving antenna, the arrival of a signal is noted by an increase in the difference between the counters.

**Circuit Techniques**

The detailed block diagram of Fig. 2 will help to visualize the techniques used to obtain these functions. The circuit schematic in Fig. 3 has each stage or group labeled in accordance with the blocks in Fig. 2.

An electron-coupled 100-kc crystal oscillator V1 and monostable multivibrator V2 comprise Z-1. Their output is a positive pulse of about 4 µsec. This provides the medium for sampling the second detector output level as well as a reference for all timing intervals.

The crystal diode at the input to Z-2 clamps the base line of the pulses to ground potential. The triode section of the amplitude modulator V3A is diode-connected and the pentode section V3B is an amplifier whose plate voltage sets...
the bias level on the diode. The pulse amplitude is about 100 v and the average bias is 90 v. Diode V8A therefore acts as a clipper limiting the pulse amplitude to that of the bias. Since this bias level is fluctuating randomly with the input signal, the pulses are effectively amplitude modulated.

V4 is a Schmitt multivibrator triggered by any pulse above a critical amplitude. This level is adjustable by coarse control R1 and by the fine count level control R2. The optimum setting of this discriminator permits the multivibrator to be triggered by about 20 percent of the pulses, but this percentage is not critical.

**Gates and Counters**

Gates 1 and 2 in Z-3 each consist of three triode sections connected with a common cathode resistor. Two of the sections are cathode followers while the third is an amplifier. There is d-c coupling between flip-flops 1 and 2 and the grids of the cathode followers.

Considering gate 1, with V8B of flip-flop 1 and V15B of flip-flop 2 both cut off, there are large positive potentials on the grids of V19A and V19B. The resulting heavy conduction through these tubes develops a high voltage across R3 and biases V20B far below cutoff. If V8B is changed to the conducting state V20B remains cut off, but if V15B is also triggered to conduction the voltage across R3 reduces to place V20B just at cutoff. Then the positive pulses from the amplitude discriminator are amplified by V20B. There must therefore be a coincidence of all these inputs to each gate before there is any output. Flip-flop 1 switches continuously back and forth between gates 1 and 2, but flip-flop 2 switches on only for a precise interval of 0.1 sec, 1 sec, 10 sec, or the interval determined manually depending upon the selection at S-1. Four binary scale-of-16 counter stages

![FIG. 3—Schematic diagram of integrating receiver. Output of each channel feeds counters shown in Fig. 4.](image)

![FIG. 4—Schematic of counters following integrator. Channels 1 and 2 are identical.](image)
Z-10, 11, 12 and 13, shown in Fig. 4 preceding channels 1 and 2, lower the speed requirements on the counters.

**Frequency Dividers**

Frequency division from the 100-ke reference oscillator occurs in Z-4, 5, 6 and 7. The first five dividers are monostable multivibrators each having a period approximately ten times its predecessor. Each multivibrator is triggered to its semi-stable state by one pulse, remaining there insensitive to the next nine pulses, returning just in time to be re-triggered by every tenth pulse. The output pulses are then 0.1 of the input frequency. The 10-sec period required of the last divider is impractical using a multivibrator of this type, so decade counter Z-7 is used instead.

The three stages of the cycle controller are in Z-8. Flip-flops 2 and 3 are bistable multivibrators and gate 3 is similar to gates 1 and 2 except that only two triode sections are required.

Initially V16B is cut off and high plate voltage causes V17A to conduct heavily, biasing V17B well beyond cutoff. No pulses from S-1 are passed, V16B is cut off and its high plate voltage closes gates 1 and 2. With S-1 in the 1-sec position, pressing the sample button S-4 supplies a momentary trigger which changes the state of flip-flop 3 and opens gate 3. The next pulse coming from S-1 is passed and triggers flip-flop 2, thus initiating the sample time by opening gates 1 and 2. The pulse from flip-flop 2 to flip-flop 3 is not of correct polarity to trigger and gate 3 remains open. One second later the next pulse from S-1 triggers flip-flop 2 again, terminating the sample time by closing gates 1 and 2 and pulsing flip-flop 3 with the proper polarity for triggering. Gate 3 is then closed to subsequent pulses from S-1. Start and stop pushbuttons S-2 and S-3 change the conducting state of flip-flop 2 so as to open and close respectively, gates 1 and 2 during manual operation of the cycle controller.

The antenna switch driver stages are in Z-9, but switch J-5 is a separate unit connected in the antenna of the receiver. The driving current for this switch is a square wave. The circuit is equivalent to an arrangement of four spot switches with V22A, 22B, 23A and 23B each acting as one of these switches. V21 is a phase inverter controlling the other tube. The initial driving voltage from flip-flop 1 is thus synchronized with the operation of gates 1 and 2.

**Application**

The fundamental application for this development involves the searching or monitoring of a wide band of frequencies for the presence of a signal. The integrator in conjunction with a "wide-open" receiver will improve the characteristic low sensitivity of a wide-band system. Once the presence of a signal is indicated, more precise information can be obtained by a narrow-band receiver. This application is common to radio astronomy and ionosphere research.

The improvement over conventional receivers through the addition of the integrating receiver is constant down to 1-percent duty cycles, slowly decreasing below this point. Even at 0.1-percent duty cycle, however, a considerable improvement in sensitivity is still realizable.

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NAVIGATION TRAINER

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SUMMARY —— Two self-powered radio-controlled ship models, a control center and a water tank, scaled 75 to 1, train naval personnel in the art of ship handling. Ship characteristics such as response to helm, engine telegraph, acceleration and deceleration have time lags similar to full-scale ships. Device also simulates wind and water currents. Control is proportional, utilizing three audio channels modulating a single carrier frequency in the 30 to 42-mc band.

INTENDED for use at naval training schools and reserve training centers for demonstration and exercise in the art of ship handling, the ships' characteristics demonstrator consists of a control unit, two self-powered radio-controlled ship models and a tank.

Only one model is used at a time. The operator steers the ship and actuates the engines by three knobs on the control-unit panel which correspond to the helm and the engine telegraphs. Rudder control is continuous. Engine control is in the following steps: flank speed ahead, full speed ahead, standard speed ahead, 2/3 speed ahead, 1/3 speed ahead, stop, 1/3 speed back, 2/3 speed back and full speed back.

The control system is the proportional type and utilizes pulse-duration modulation of three audio channels modulating a single r-f carrier. The control unit contains the modulator circuitry, transmitter, power supply and the ships' battery charger. The transmitter is low powered, crystal controlled and conventional. It is presently operating on an assigned frequency of 34.54 mc, but may be tuned to any frequency in the 30 to 42-mc band with suitable crystals.

Single-screw ships are represented by an AK cargo vessel model. The other model, a destroyer escort DE 51 class, has twin screws independently controlled and twin rudders. Both models have molded fiberglass hulls four feet long and are scaled approximately 75 to 1 in length with corresponding scaling of displacement, speed, turning radii and advance and transfer.

Time lags similar to those of a full-scale ship are incorporated into all responses; response of rudder to helm, response of ship to rudder, response of engines to engine telegraphs and response of ship to engines.

The ships' circuitry is transistorized, with servomechanisms to position the rudder and actuate the
Controls Ship Models

The batteries are easily removable, provide 6 hours of continuous operation and can be recharged in less than 2 hours.

The tank has a 20-ft-square water surface corresponding to scaled dimensions of 1,500 ft by 1,500 ft. When filled to a depth of 6 in, it has a scale depth of 37 ft. Associated with the tank are a wind generator and a water current generator. Either or both may be introduced into the demonstration.

Information Control

The information transmission link includes the generation, transmission and reception of the signals used to control the operation of the ship models. Block diagrams and waveforms of the system are shown in Fig. 1. Control information is transmitted to the models at a basic rate of 10 cps. Timing triggers are generated in a ring-of-three counter, and drive three variable-delay gate generators in sequence. The gate widths are determined on the front panel of the control unit by the port engine, starboard engine and rudder Controls. Each gate may be varied from virtually zero to one-third of the repetition period. The three channels time-share the repetition period.

Each gate actuates an audio oscillator. The oscillator generates an audio pulse of the same duration as, and coincident with, its initiating gate. Audio frequencies generated are 2 kc, 5 kc and 12.5 kc for the port engine, starboard engine, and rudder channels respectively. Outputs of the three oscillators are combined and amplitude modulate the radio transmitter.

Gate Generators

The ring-counter trigger generator, shown in Fig. 2, consists of three plate-coupled monostable multivibrators \( V_n \), \( V_i \), and \( V_s \), each introducing a delay of 33\( \frac{1}{2} \) milliseconds. The differentiated output of each stage triggers the next, with diodes used to steer the triggers and maintain unilaterial propagation around the ring.

Ring-counter operation is initiated by pressing a normally-closed pushbutton switch which momentarily interrupts the cathode current of \( V_{cb} \). A neon incator lamp, connected across the plate resistor of \( V_u \), flashes at 10 cps. The output of each ring-counter stage also triggers, through a steering diode, a similar monostable multivibrator \( V_s \) and \( V_i \). However, the duration of delay of these gate generators is controlled by varying the grid return resistors of the normally-on triode sections \( V_s \), \( V_i \), and \( V_n \). The gate width may be varied from 2 to 33 milliseconds. Negative output gates are available at points \( X \), \( Y \), and \( Z \).

Each gate is fed to points \( X \), \( Y \), and \( Z \).
and Z in Fig. 3. This turns off triodes V4A, V4B and V4C, each connected across an oscillator resonant circuit, raising the circuit Q sufficiently to permit sustained oscillation and to shock-excite the oscillator.

**Gated Oscillators**

Each gated oscillator is a grounded-anode Hartley circuit comprising the cathode, control grid and screen grid of a pentode section of V1A, V1B and V1C. Oscillations are electron-coupled to the plates, with the three plates driving a common load.

The combined output is R-C coupled to a paraphe amplifier V2A, which is the phase inverter and driver for a push-pull class-B modulator V2C.

In the transmitter, a Butler cathode-coupled two-stage r-f oscillator, V4A drives a buffer stage V4B that is broadband-coupled to the plate-modulated final amplifier V4C. A pi-section tank couples the final amplifier to a short antenna.

In each receiver, Fig. 4, a diode detector drives a high-gain three-stage transistor audio amplifier. With the transmitter located adjacent to the tank there is a 40-db variation in received signal strength. In lieu of age, the audio amplifier limits at a low input level so that the output amplitude remains constant over a large range of signal strength. Distortion introduced by clipping results in negligible crosstalk since the audio frequencies of the 2 ke, 5 ke and 12.5 ke—channels bear no low-order harmonic relationship.

**Channel Subassemblies**

The resonant filter, gate detector, limiting amplifier, integrator and the electronic portion of the servo system of each of the channels comprise a small subassembly. The schematic is shown in Fig. 5.

**Servo System**

Proportional control is achieved by an on-off or relay-type servo-mechanism. Referring to the servo system block diagram shown in Fig. 6, the varying d-c input from the integrator is fed to a voltage comparator. The second input to the comparator is obtained from the rotor of the control potentiometer mounted on the servo shaft. This voltage is proportional to shaft position. The operation of the servo system is illustrated by examples which relate the sense of all electrical and mechanical quantities involved.
Rudder is 35 degrees right, engine is running flank ahead, Control knob is at 35 deg right rudder flank ahead, 5 kc rudder channel gate or pertinent engine channel gate is at minimum width 2 millsec. The integrator output, as fed to the comparator is at a d-c level of +12 v.

**Flank Ahead**

The servo shaft is fully counterclockwise, resulting in 35 deg right rudder in the one case or a control switch position yielding flank ahead speed in the other. The voltage on the control potentiometer rotor is -12 v.

Since the magnitudes of the two inputs to the comparator are equal, there is no error output.

Relay is at neutral and the control motor is not energized.

In another example of equilibrium the rudder 35 deg left: engine full reverse, control knob agrees with rudder, or engine, state and the channel gate is at the maximum width of 33 millisecond.

Input to comparator from integrator is +6 v d-c, servo shaft is fully clockwise and the control potentiometer voltage is -6 v, zero error, relay at neutral and control motor not energized.

Equilibrium is achieved at any intermediate angle of the servo shaft provided the rudder or engine performance agrees with the corresponding control knob setting.

**Rudder Position**

To Change Rudder Position Or Engine Speed:

With the system in equilibrium, counterclockwise rotation of the control knob, towards 35 deg left rudder or towards full reverse, will increase the duty cycle. The integrator output goes toward +6 v. A positive error appears at the comparator output, is amplified by Q, and actuates the differential relay, applying +6 v to the control motor. The control motor rotates the servo shaft clockwise, driving the control potentiometer wiper towards the -6 v end of the potentiometer and turns the rudder to the left or steps the engine towards full reverse. This movement continues until the comparator is balanced again.

Clockwise rotation of control knob: right rudder correction or engine speed change towards flank ahead:

Integrator towards +12 v, negative error; amplifier Q, actuates relay, relay contacts 2 and 3 close; -6 v applied to motor, motor drives servo shaft counterclockwise; control potentiometer wiper moves toward -12 v; rudder moves right or engine steps towards progressively slower reverse speeds or progressively faster ahead speeds; when system is again balanced, servo shaft stops.

The entire engineering staff of Teletronics Laboratory, Inc. working in cooperation with the engineering personnel of the United States Naval Training Device Center made the development of this device possible.
SUMMARY — All-transistor pulse generator achieves pulse amplitudes of 28-v negative, 50-v positive with widths continuously variable from 1.0 to 10 µsec and rise-decay time of 0.3 µsec. Internally generated repetition rates vary in steps from 50 to 5,000 pulses per second with external triggering by either positive or negative pulses, and 1 to 100 µsec time delay internally.

During the course of the design and development of a completely transistorized pulse generator, it was soon apparent that presently available junction and surface barrier type transistors imposed certain limitations upon the desired performance. The completed unit, presented here, is one approach to the problem and particularly emphasizes how these limitations were overcome and what refinements were necessary to fulfill certain definite requirements. The use of transistors offers several advantages: excellent adaptability to printed circuitry; economy of power consumption; reliability over an extended period of time, and small size.

Basic Circuit

Figure 1 shows the basic circuit in block form. The overall schematic diagram is shown in Fig. 2. The repetition rate generator is an astable multivibrator with a provision for switching to monostable operation so that it can be externally triggered. The common-emitter circuit used allows for phase reversal between base and collector. The 904 npn silicon-junction transistor used allows a maximum collector potential of 30 volts and a collector current of 25 ma.

Common Emitter

A typical measured set of common-emitter characteristics is shown in Fig. 3. To achieve an amplitude of about 22 volts, the load line is drawn from \( I_c = 0 \text{ ma} \), \( V_c = 30 \text{ v} \) to \( I_e = 10 \text{ ma} \), \( V_e = 0 \text{ v} \). The calculated load resistor is \( 22 \text{ v/0.010 ampere = 2,200 ohms} \).

The load line is intersected by base current \( I_e = 300 \mu\text{a} \) at \( V_e = 8 \text{ volts} \) which allows for the 22-volt collector swing. Therefore, the value of \( R_e \) must be determined for

\[
I_e = 300 \mu\text{a} \quad \text{and is calculated at 100k ohms.}
\]

The values of the coupling capacitors are determined to give the proper R-C time constant to generate the designated repetition rates. Because the inherent resistance between the base and the emitter is considerably smaller than the value of \( R_e \), timing capacitor \( C_e \) will discharge through the transistor between base and emitter to ground, thus limiting the value of the R-C time constant.

To insure that the R-C time constant is determined solely by \( R_e \) and \( C_e \), a diode is placed between the emitter and ground. The back resistance of the diode is so large that the capacitor \( C_e \) must discharge through \( R_e \).

The circuit is unsymmetrical to free-run over a wide range of repe-
tition rates, especially at values below 500 pulses per sec (where $R_{t2}$ should be approximately twice the value of $R_{t1}$). To achieve a large variation in the repetition rate, the value of $C$, is varied from 0.018 to 0.22 $\mu$F, as changing the value of $R$, changes the d-c operating point of the transistor, seriously affecting the voltage waveform.

Triggering

For monostable operation, a negative bias is applied to the base of $Q_s$. The circuit permits self-triggering or external triggering either positively or negatively. An external signal of $\pm$ 5.5 volts with a width greater than 0.7 $\mu$sec triggers the generator during monostable operation. When the emitter of $Q_s$ is triggered positively, it is grounded directly instead of being connected to ground through a diode, as in the free-running position. This allows the multivibrator to trigger on a smaller signal than when the diode is in the circuit. The output waveforms are shown in Fig. 2.

Delay

To achieve delay, a variable-width, monostable multivibrator circuit is used with an R-C differentiating circuit. To attain a pulse width of less than 1 $\mu$sec, a transistor with a high $\beta$ cutoff frequency is used.

In the common emitter configuration, the $\beta$ cutoff frequency ($f_{c0}$) = ($f_{c0}$(1-$\alpha$), where $\alpha$ and $f_{c0}$ are the common-base configuration gain and bandwidth parameters.

The 904 A transistor was considered. Of those measured, $F_{c0}$ varied from 7.5 mc to 15 mc and $\alpha$ from 0.981 to 0.964, giving values of $f_{c0}$ from 0.171 to 0.480 mc. The other transistor considered was the SB-100 surface-barrier type. The measured $f_{c0}$ was in excess of 50 mc for all of the transistors tested and $\alpha$ varied from 0.944 to 0.978, giving values of $f_{c0}$ greater than 1.1 mc.

The 4.5-v max collector voltage and 5-ma max collector current of the SB-100 limit the magnitude of the output signal to a value of less than 4.5 volts, but this value is sufficient for a delay generator.

The surface-barrier transistor gave a much narrower pulse in a monostable multivibrator circuit than any of the other available types of junction transistors. Pulse width of 0.3 $\mu$sec were obtained with rise times of 0.03 $\mu$sec and decay times of 0.05 $\mu$sec.

The value of $R_{t1}$ was determined to give a collector voltage swing of 4.2 volts and the base resistance value was taken from the load line in the same manner described for the repetition-rate generator.

Stage $Q_1$ is normally on and $Q_s$ is held off by a positive bias on the base.

To vary pulse widths from less than one $\mu$sec up to 100 $\mu$sec, the R-C time constant must be varied. The conventional R-C circuit used in the repetition-rate generator allows only $C$ to be varied. Over a range of one to 100 $\mu$sec, the dynamic range of the capacitor would be excessively large. Therefore, the pulse width variation is brought about by a special R-C circuit.

Pulse Shape

The base resistance for $Q_1$ equals 27,300 ohms and the value of $C$ is determined by the values of $C_{t1}$ and $C_{t2}$ in series with each other. $C_{t1}$ isolates the collector of $Q_1$ from the base resistance of $Q_2$ and the 25,000-ohm variable resistor allows a pulse width variation from about 0.8 $\mu$sec up to over 100 $\mu$sec. Although pulse widths narrower than 0.8 $\mu$sec can be obtained with the SB-100, the R-C values are not practical when widths of 100 $\mu$sec are to be achieved with the same
The pulse amplitude for pulse shapes is excessively large, causing widths of pulses, ohms, and other components. The delay time can be improved by lowering the value of $R_{eb}$ so that the transistor is just into saturation. Values lower than 2000 ohms are feasible for narrow pulses, but attempts to achieve widths greater than about 10 µsec cause the pulse amplitude to droop excessively.

The delay multivibrator output pulse shapes are shown in Fig. 4 for widths of 1, 10, and 100 µsec. The pulse amplitude is 4.2 volts in a positive-going direction. The differentiated pulse gives a delayable positive voltage spike of 1.1 volts.

**Pulse Forming**

The pulse waveform generator is a monostable multivibrator. As the surface-barrier SB-100 allows a maximum voltage swing of only about 4.3 volts, the output pulse must be greatly amplified making their use in this application impractical.

Transistors capable of swinging a signal of 100 volts are the 953 and 970 npn silicon-junction transistors, whose collector potentials are rated at 120-v maximum. The 953 transistors were tried out in a monostable multivibrator circuit.

**Transistor Selected**

Though the output pulses had amplitudes greater than 100 v, the minimum pulse width obtainable was about three to four µsec, with poor rise and delay times. In addition, the output impedance of a common-emitter configuration is high, necessitating the use of an emitter follower when pulsing a low impedance oscillator so that the output stage of the multivibrator is not loaded.

The transistor finally chosen for the pulse generator was the 904-A npn junction type which has $f_{ce}$...
greater than 8 mc and a maximum collector potential of + 30 volts. This transistor possessed the best high frequency characteristics of any of the higher-voltage transistors investigated (maximum collector potentials of at least 25 volts) and proved to be the best compromise, giving consideration to both collector potential and bandwidth.

Varying capacitor $C_x$ from 9 to 135 $\mu$F gives a continuously variable pulse width ranging from 1 to 10 $\mu$sec. This width may also be varied as was shown for the delay generator. The minimum and maximum width output waveforms are shown in Fig. 5. The amplitude is 29 v in the negative-going direction.

**Trigger Amplifier**

The negative-going spike of the differentiated pulse from the collector of $Q_3$ has an amplitude of 1.1 volts, which is not sufficient to trigger the pulse generator, and requires amplification. Turning off the normally conducting transistor of the pulse generator gave a better waveform than turning on the non-conducting transistor. Therefore, the triggering waveform was taken from the collector of $Q_x$. It is important that this spike remain as narrow as possible since its width affects the minimum width of the pulse generator.

The amplifier utilizes a 904A transistor. A voltage gain of six was achieved with no noticeable loss of fidelity. This signal trigger the pulse generator for a pulse as narrow as one $\mu$sec.

**Emitter Follower**

The pulse output taken from the collector of $Q_3$ is negative-going. The positive-going waveform at the collector of $Q_x$ has poor shape and is not suitable for use as the positive output pulse.

To get a good positive-going pulse, it is necessary to invert the negative pulse through a common-emitter amplifier circuit, the only configuration that gives phase inversion.

**Amplifying Input**

The common-emitter circuit also has a low input impedance, which would load the multivibrator output. Thus, to generate a positive pulse, the negative pulse must be passed through the emitter follower and then amplified.

The 953 and 970 transistors are the only ones capable of passing and amplifying an input signal of 28 volts. Emitter follower $Q_3$ presents a higher impedance to the collector $Q_x$ and prevents any loading effects by the low impedance inputs. The 47,000-ohm resistor from the collector to the base of $Q_x$ puts the necessary positive bias on the base so that the large negative-going signal can be passed properly.

Amplifier $Q_3$ inverts this negative-going signal and $Q_x$ is an emitter follower which provides a low impedance output.

The amplifier output waveforms at both one and 10 $\mu$sec are shown in Fig. 6A. The negative and positive pulses from the bases of emitter followers $Q_{10}$ and $Q_2$ respectively are shown in Fig. 6B and C.

**Performance**

The achieved results were as follows: 1) pulse amplitudes 28-v negative, 50-v positive; 2) pulse widths continuously variable from 1.0 to 10 $\mu$sec; 3) rise and decay times of 0.3 $\mu$sec; 4) internally-generated repetition rates varied in steps from 50 to 5,000 pulses per second; 5) external triggering by either a positive or negative pulse at any repetition rate from 50 to 5,000 pulses per second; 6) internally generated time delay from 1 to 100 $\mu$sec.

**Available Transistors**

These results bring out the two inherent weaknesses of the present transistors: low collector potential and limited high-frequency response. However, the use of recently developed transistors will increase the pulse amplitude and allow for the generation of a much narrower pulse.

The author thanks Thomas O'Brien for his encouragement and comments, and George Pate and William Shephard for their suggestions and assistance.

**Bibliography**


Transmitter Tuned By

By C. Richard Ellis, Kenneth Owen and G. R. Weatherup

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McIntosh Electronics Inc. Binghamton, N. Y.
U. S. Air Force RADC Rome, N. Y.

SUMMARY — High-power, quick-tuning uhf transmitter system uses low-distortion amplifier-modulator to cover the 225 to 400 mc range. Demodulated output feedback gives less than 3-percent rms harmonic distortion over the audio range 200 to 20,000 cps and over the stated r-f range, with 80-percent amplitude modulation of a 1,000-watt carrier.

Development of scatter communications techniques to improve operation over line-of-sight distances reaffirms the need for a high-power, quick-tuning uhf transmitter capable of radiating an amplitude-modulated signal having very low distortion over a wide audio-frequency band.

The amplifier-modulator, AN/GRA-24, described here provides a high-level modulated one-kilowatt signal from 225 to 400 mc when driven by an 80-watt exciter. Eighty percent continuous amplitude modulation of the one-kilowatt carrier is obtained from 200 to 25,000 cps with less than 3 percent total rms harmonic distortion at any frequency in the range. Over 90 percent amplitude modulation on a continuous basis is possible from 200 to 22,000 cps.

Operation

Figure 1 is a block diagram of the system. The r-f input is coupled to the GL 6182 grid circuit. A lumped circuit equivalent of the grid and plate cavities is shown.

Audio input, at about +20 dbm, is supplied from the remote pre-amplifier thru the test-operate switch to the modulator. Both the plate and screen of the r-f tube are modulated and the amplified and modulated r-f is coupled out of the tuned plate cavity to the antenna.

A diode detector recovers a sample of the modulation envelope in the output transmission line. This recovered audio is amplified and applied to the modulator input as negative feedback.

The r-f Amplifier

The GL 6182 tetrode, designed for full plate input operation up to 900 mc, is housed in a re-entrant coaxial cavity. Variable conductive coupling is employed in both the input grid and output plate circuits.

In Fig. 2, the plate coaxial cavity and the outer conductor of the grid coaxial cavity are cross hatched, while the thick horizontal cross-hatched area represents the main drive casting which supports the cavities. Above this casting, the

FIG. 1—Block diagram of the 1-kw high-level modulated uhf amplifier

Operator at left is adjusting power supply of amplifier-modulator while co-worker records data. Left to right are the power controls, r-f amplifier and radio modulator. Transmitter is at the right.

September 1, 1957 — ELECTRONICS
Distortion Indicator

The coaxial cavity consists of four concentric cylinders. The outer two form the plate coaxial cavity, the inner two the grid cavity. Between the inner cylinder of the plate coax and the outer cylinder of the grid coax is a dead space through which the d-c leads for the control and screen grids are brought.

No socket resonances exist over the operating range. The screen contacts and by-pass capacitor are critical to avoid holes in the operating range. A low inductance contact system provides nonresonant operation over the 225 to 400-mc range.

Straightforward tuning provides smooth operation over the entire frequency range. The conductive coupling permits a continuous increase in coupling from almost zero to extreme overcoupling, with motion in one plane only and with no problems of direct cavity radiation. Tuning and coupling adjustments will match a wide range of impedances.

For sufficient emission in limited space, the GL 6182 employs a bombarder. This element, indicated as a cathode in Fig. 2, is operated approximately 600 v above the filament potential. The resulting diode current causes the bombarder to emit the main electron stream. The bombarder is operated at d-c ground potential and the filament at about 600 v negative, depending on the setting of the bombarder-adjust.

The entire coaxial cavity is operated at d-c ground with a convenient bias supply for the control grid. The grid operates at −500 v d-c with no r-f and the filament at −600 v. Under drive, the tube operates class C with a plate efficiency of from 40 to 60 percent, depending on frequency.

An attenuator switched into the input circuit limits the vswr presented to the exciter to less than 3 to 1, regardless of amplifier tuning. When the amplifier has been tuned, the input vswr drops to better than 1.2 to 1. The attenuator is removed automatically when the amplifier is switched to operate.

A two-position coaxial switch allows quick selection of either of two antenna connections. It was found during the development period that a lower distortion modulation envelope could be obtained if the screen grid of the 6182 were modulated more than 100 percent in the positive direction. A diode is incorporated, as shown in the modulator schematic, to allow positive over-modulation and prevent the screen from going negative.

**Distortion Indicator**

It was also found that minimum distortion was obtained only when the load presented to the r-f amplifier tube was a pure resistance. There are many combinations of output tuning and coupling which present the proper load to the tube to obtain one kilowatt output. However, only a load with zero reactance allows minimum distortion operation. Consequently, it was necessary to provide an indication to the operator of minimum distortion tuning conditions, if the maximum performance capability of the equipment was to be realized.

**The Modulator**

The modulator output circuit works into a high-impedance load which has one end connected to ground and is shunted by the capacitance of the r-f amplifier plate circuit by-pass capacitor. Difficulty in obtaining an acceptable load balance to the audio output tubes from this type load, using a conventional push-pull class B output circuit, made it advisable to employ the output circuit shown in Fig. 3.

In this circuit one output tube is plate loaded and the other is...
cathode loaded. The grids of these tubes are driven push-pull at 180 deg but their outputs are in phase. This makes possible parallel connection of the two primary sections.

**Advantages**

Important advantages of this arrangement are first, the end-to-end primary impedance is reduced to one fourth. Second, the in phase, unipotential voltage distribution along the two primary sections and including most of the secondary coil allows these coils to be tightly coupled without concern over the intercoil shunt capacitance thereby reducing leakage inductance and the resultant switching transients to negligible values. The third advantage is that load balance of the two output tubes over the entire bandpass of the output transformer is automatically attained.

Most of the secondary of the modulation transformer is common to the plate load section of the primary winding. An extension of this common portion of the winding raises the modulating voltage to the value required for the desired modulation.

An additional winding on the output transformer develops the modulation voltage required for the screen grid of the r-f amplifier.

Cathode follower \( V_a \) eliminates oscillation, provides a low driving impedance and allows convenient adjustment of the d-c voltage on the screen grid. Variation of \( R_c \) changes the bias on \( V_a \) and in turn the d-c voltage to the screen grid of the tube.

Diode \( V_a \) allows more than 100 percent modulation of the screen grid in the positive direction, but prevents excessive negative swing.

**Reducing Distortion**

The circuitry required to provide low-distortion performance is shown in Figs. 4 and 5.

The 10-kc oscillator, Fig. 5, generates the sinewave test signal to tune for minimum distortion. Dual triode \( V_e \) is a phase-shift oscillator with networks connected as low-pass filters to attenuate higher harmonics. Two ganged pots allow frequency readjustment and compensate for component aging. Oscillator output is isolated from the grid-cathode capacitance of the following amplifier by a 10 to 1 voltage divider.

The amplified signal from the plate of the second stage of \( V_e \) drives the cathode follower \( V_a \). The signal at the cathode of \( V_e \) is a 10-kc wave with about 4 percent rms harmonic distortion. The low-pass filter in the output of \( V_a \) has a cut-off frequency of 12 kc and an attenuation at 15 kc of about 60 db. Distortion products of the 10-kc wave are virtually eliminated and the test signal gives less than one-tenth of one percent distortion.

When the modulator input test-operate switch is in the test position for final tuning, the 10-kc test-oscillator signal is applied to the modulator. Voltage across the cathode resistor of \( V_e \) consists of the original 10-kc wave plus distortion added by the system. The input filter has a cut-off frequency of 12 kc and an attenuation at 10 kc of 60 db. The fundamental 10-kc component is practically eliminated, leaving the distortion products. Amplified by \( V_a \) in Fig. 4, the signal is applied to the vertical deflection plates of \( V_e \). No horizontal deflection is used. With 80 percent modulation of a 1,000-watt carrier, and with the cro gain at...
maximum, a one-inch vertical deflection on the cro represents about 5 percent distortion. When the amplifier is tuned properly, this deflection drops to about one-quarter inch, representing less than 2 percent distortion.

**Test Results**

Data was recorded with a 1,000-cps test signal applied to the audio input, audio gain set for 80-percent amplitude modulation and the equipment tuned for minimum distortion consistent with 1 kw or more output by means of the cro. Maximum distortion at the high end of the r-f band is 2.1 percent. Increasing modulation to 90 percent gives about 4 percent distortion across the band.

With the equipment tuned at 300 mc, the audio input frequency is varied over 200 to 20,000 cps. There is an increase in distortion at both ends of the audio range. This is due to the characteristics of the feedback circuit, the capacitive load on the modulator, and the modulator itself. At 25,000 cps, the distortion is estimated to be under 4 percent.

**Distortion Values**

Maximum and minimum distortion values were obtained for all audio frequencies from 200 to 20,000 cps. When tuned by the cro for minimum distortion at all radio frequencies in the band and over the audio range 200 to 20,000 cps, the equipment provides at least 1,100-watt output with less than 3 percent rms total harmonic distortion.

All data was taken with a carrier power of at least 1,100 watts and with at least 80 percent amplitude modulation.


Special acknowledgement is made to Gordon R. Weatherup of Rome Air Development Center, who had chief responsibility for the U. S. Air Force in the design and development of this equipment.

The material in this paper was presented at the Second National Symposium on Aeronautical Communications held at Utica, N. Y., and sponsored by the I. R. E.
SUMMARY — Pulse-type transistor voltage regulator uses voltage-controlled pulse generators. Astable multivibrator has square-wave output over frequency range of 100 to 3,600 cps; frequency is determined by magnitude of control voltage over 12-to-one range. Pulse width of monostable multivibrator is varied over 10-to-280 microsecond range.

By WILLIAM A. SCISM
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LOW SATURATION RESISTANCE of presently available power transistors suggests their use in pulse-type power voltage regulators.

In the pulse-type regulator shown in Fig. 1, reduction of the input voltage is accomplished by turning a gate transistor off at a repetition rate determined by the regulation requirements. The gate is controlled by a series of drivers which, in turn, are controlled by a variable-width one-shot transistor multivibrator. The pulse of no conduction at the gate is smoothed by the low-pass filter which delivers the average value of the wave to the load. This load voltage is attenuated and compared with a Zener reference diode.

The difference voltage is amplified and used to control the frequency of a voltage-controlled multivibrator as well as the width of the one-shot pulse. Since the one-shot is triggered by the variable-frequency multivibrator, the net result is that increasing line voltage increases the width and repetition rate of the pulse cut out of the line by the gate. The average value of the load voltage is thus kept constant.

Voltage-Controlled Multivibrator

Figure 2 is the block diagram of the variable-frequency multivibrator and Fig. 3 the circuit diagram. The chief difference between transistors and vacuum tubes in this application is that the transistor requires power into the base to turn it on or off, whereas the tube will bottom if no power is applied to the grid.

A transistor multivibrator will oscillate if the bases are returned to ground, but the waveform is most unsatisfactory and the period is subject to considerable variation with temperature and transistor interchange.

Returning the bases to a negative
USES MULTIVIBRATORS

supply (in the case of pnp transistors) through a resistor will permit sufficient current to be drawn to hold the transistor in the saturated condition. The voltage return for the base resistors can then be varied so the frequency of the multivibrator will be proportional to the base return voltage.

The collectors of multivibrator transistors $Q_1$ and $Q_2$ in Fig. 3 are returned to a large voltage and are clamped at a small voltage by diodes $D_1$ and $D_2$, utilizing only the first position of the rise time which is, by nature, fast. Emitter followers are also used between the collectors and the bases of the opposite transistors to permit the collector of the cutoff transistor to rise against the base resistor of its emitter follower for a rapid rise of voltage. The associated timing capacitor is driven by the low output impedance of the emitter follower, which also provides a convenient output takeoff point.

The collector resistor can thus be a fairly high value, as shown in Fig. 3. This offers the advantage of a short-base base which is comparable to the grid base of a tube. The transition region of operation is thus made short compared to the voltage swing of the timing capacitor.

Starting Characteristics

The base resistors could be returned directly to a variable voltage, but the circuit will not start when the control voltage is large. Application of power will bottom both transistors when there is a large value of base return current present. Advantage is taken of the fact that the circuit will always start when the base is returned to zero volts; the base resistors are returned to the collector of $Q_2$ which is also connected to the control voltage.

When the circuit is oscillating properly, there is a square wave at the emitters of both emitter followers, $Q_1$ and $Q_2$. Summation of both these square waves through the 22,000-ohm resistors at the base of $Q_2$ keeps $Q_1$ in the saturated condition. This in turn biases $Q_2$, so it draws no current.

In this condition, the control voltage is applied to the base-return resistors through the 10,000-ohm resistor connected to the collector of $Q$. Failure of the circuit to oscillate, either upon application of power or due to excess loading in operation, will result in the emitters of $Q_1$ and $Q_2$ remaining at essentially zero volts; $Q_2$ is cut off and $Q_1$ is turned on, effectively grounding the base resistor return.

With zero volts on the return, the circuit starts oscillating and control voltage $V_c$ governs the frequency of operation.

Calculation of the frequency of operation at $V_c = -20$ v gives a period of 2,750 $\mu$sec compared to the measured 2,500 $\mu$sec.

Performance

Figure 4 is a plot of voltage versus frequency for the circuit of Fig. 3. Base return voltage $V_r$ is also plotted against the control voltage to determine the loading of $Q_2$ when the circuit is oscillating. The circuit provides a useful square-wave output from 100 cps to 3,600 cps. The output voltage over the
FIG. 10—Variable pulse-width monostable multivibrator with compound control

operating range is fixed at a constant level of 12 v by the diodes.

Figure 5 shows the output waveform with the control voltage near the low and high ends of the range. Figure 6 shows the base waveform. Note that the timing exponential still has considerable slope as it enters the transition region, resulting in greater stability of the half-period.

**One-Shot Multivibrator**

Development of the regulator called for a one-shot multivibrator whose pulse width is a function of a d-c control voltage.

A conventional transistor one-shot multivibrator is shown in Fig. 7. Transistor Q, is held on in the absence of a trigger by the current through R,. The collector of Q1 is at a potential of +E, and the current from positive return +E, keeps Q2 nonconducting.

A positive pulse applied to the base of Q1 cuts it off; its collector voltage drops toward ground causing it to draw current through the base of Q2, turning it on and holding it in the saturated condition. As the collector voltage of Q, rises toward +E, the voltage across C drives the base of Q1 positive, cutting it off.

If R_ is returned to some voltage V_r other than ground, the pulse width can be varied. Figure 8 shows the effect of changing V_r.

The range of pulse widths is limited by this arrangement because the current drawn through R,, becomes insufficient to keep Q1 on in the no-pulse condition as V, approaches E,. This condition can be partially remedied by increasing R,, so less base current is required to keep Q1 saturated. However, this necessitates an increase in R_ and the net result is a lower limit for the value of R_.

By using emitter followers in the coupling networks, R_ and R_ can be made quite large and low-impedance outputs are made available at the emitters of the followers. To extend the degree of control, the collector of Q1 can be clamped to variable voltage V_c. Figure 9 illustrates the effect on pulse width of different values of this clamp voltage with timing-capacitor return voltage V, held constant.

The clamp voltage is derived from a grounded-emitter amplifier as in Fig. 10, whose base is driven from control point V_r. This amplifier provides the necessary phase inversion for the control voltage and compounds the effect of V_r on the pulse width.

Figure 11 shows pulse width with variation in the timing capacitor return voltage, for constant clamp voltage, and the pulse width for the compound-control circuit shown in Fig. 10. There is a noticeable improvement in slope and range due to the clamp voltage.

Figure 12 shows regulation action of complete circuit.
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19 CONTACT PRINTED CIRCUIT PLUG AND SOCKET

23 CONTACT PRINTED CIRCUIT PLUG AND SOCKET

Nos. 24139 and 24140 (Left, above) Insulation material MME. Socket tail termination turret type. Plug has right angle pins for terminating in printed wire board on .1"x.1" grid. Hollow rivets are molded in the plug unit for mechanically fastening to board prior to soldering.
Plug: Phos. Bronze and Socket-Beryllium Copper both have .00003 gold over .0002 silver contacts. Adequate float in socket to allow for misalignment.

Nos. 24339 and 24338 (Left) Insulation material MME. Socket tails terminate in solder pot for No. 20 AWG wire.
Plug has right angle pins on .1"x.1" grid.
Threaded mounting stud for mechanical retention prior to soldering.
Plug: Phosphor Bronze, Socket; Beryllium Copper contacts; both with .0003 gold over .0002 silver. Floating socket contacts.

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Diode-Clamp Nomograph

By GEORGE H. MYERS*

Rosie Air Development Center
Griffiss Air Force Base, New York

SUMMARY — Chart simplifies determination of standard diode clamp circuit parameters for rectangular wave input when maximum tilt and deviation from clamp voltage are specified.

Clamp circuits can insure that a portion of a waveform is kept at a certain voltage with respect to ground or is clamped to that voltage.

If the signal of Fig. 1A is applied to the clamp circuit in Fig. 1B, the actual waveform at the output is that shown in Fig. 1C where the positive section of the wave, of duration $T_1$, is clamped to $E_a$. The positive portion rises slightly above $E_a$, while the negative part has a slope or tilt.

The nomograph of Fig. 2 permits determining the parameters for the circuit of Fig. 1B and a rectangular input voltage if the maximum deviation from the clamp voltage and the tilt are given, or conversely, determining the deviation and tilt if the circuit values are given.

Parameters

Time $T_2$ is that during which the input is most negative in Fig. 1A; the input is most positive during $T_1$. The circuit time constant when the diode is conducting heavily is $T_2 = C R R / (R + R)$, where $R$ is the forward resistance of the diode. In most cases, $T_2 = R C$ and $R$ may be neglected.

The circuit time constant when the diode is conducting in the reverse direction is $T_3 = C R / (R + R)$, where $R$ is the back resistance of the diode. In most cases, it is accurate enough to use $T_3 = R C$. The peak-to-peak voltage of the input rectangular wave is $E$.

In Fig. 1C, the maximum deviation of the output from the clamp voltage when the diode is conducting is $E_a$, and the tilt is the slope of the output during the period the diode is conducting in the reverse direction; tilt $= (E_a - E')/E_a$. If the diode is reversed, $T_1$ and $T_2$ would be interchanged. It is desirable to have $E_a/E$ and the tilt as small as possible, because then the output will be more nearly a replica of the input, except for a change in d-c level.

Example

Suppose it is desired to clamp a rectangular wave for which $T_1 = 400 \mu$s, $T_2 = 200 \mu$s, and the peak-to-peak amplitude $E$ equals 50 v. The maximum deviation from clamp voltage $E_a$ is to be 3 v and the tilt 4 percent. If a diode with a forward resistance of 200 ohms and infinite back resistance is available, what are $R$ and $C$?

A line is drawn on Fig. 2 connecting 0.04 on the tilt scale and 0.06 ($= 3/50$) on the $E/E'$ scale. From Fig. 2, $T_2/T_1$ equals 0.04 and $T_2/T_3 + T_3/T_1$ equals 1.1; $T_2/T_1$ is then 1.06.

Using the given data and assuming $T_1 = R C$ and $T_2 = R C$, $T_2$ becomes 378 $\mu$s and $T_3 = 5,000 \mu$s, leading to $C = 1.89 \mu$F and $R = 2,650$ ohms.

From the value of $R$, it may be seen that the decision to neglect it in $T_1$ was justified. For a germanium diode, it may be necessary to include the effect of $R$, in calculating $T_1$.
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The Japanese equivalent of our FCC, the Kanto District Radio Regulatory Office, tested the devices and gave approval for their use. Field strength measurements and tests with radio and tv receivers showed that interference would not be produced farther than five meters from the transmitter.

The bus receiver uses a coherer, a glass envelope filled with carbon powder. The antennas indicated in Fig. 1 are short vertical whips. The drive mechanism of the bus is mechanically arranged so that successive pulses cause the bus to start, turn right, go straight, turn left, go straight and stop.

SLOW DIFFUSION of charge carriers through an essentially field free base region is the principle reason for the high frequency limitations of the transistor. Many attempts to extend the transistor's frequency range have been directed at decreasing transit time by applying a field to the base region.

Latest addition to the semiconductor amplifier family, the spacistor, takes advantage of the high field strength found in the space-charge regions of reversed-biased junctions. Electron transit times are such that Raytheon, who developed the spacistor, predicts it will eventually amplify effectively at 10,000 mc.

The body of the spacistor is a reverse-biased p-n junction with a space-charge region marked SC in Fig. 1. In Fig. 2, contact I is the injector, a tungsten-wire pressure contact, and M, the modulator is a gold-wire alloyed contact containing p-type doping material.

As shown in Fig. 2, battery B, biases M negatively with respect to the underlying space-charge region SC. Contact I is still positive, however, with respect to point B. Emission of electrons from I into SC is space charge limited.

Modulator M is connected to SC between I and the N region of the body. Battery B, biases M negatively with respect to SC preventing holes from flowing from the p-type doping materials to SC. As a result, M draws practically no current.

The field produced by M affects the entire space charge region, varying the emission of the injector I and thereby modulating the d-c bias with the input signal. The modulator also makes the injector bias practically independent of the base-to-collector voltage. As a result, the output impedance is greater than 30 megohms for an injected current of 0.3 ma.

Because of the wide space-charge region, the output capacitance is very small. Values less than 1 µf are feasible.

Present experimental spacistors have transconductances considerably smaller than those of good vacuum tubes. Nevertheless, they are expected to operate at over 1,000 mc. This frequency is equivalent to the inverse transit time through the space-charge regions.

Operation of the spacistor is practically independent of charge carrier lifetime. This makes it feasible to supplement germanium and silicon with other semicon-
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OUTPUT = 1
OUTPUT VOLTAGE DC: 0-30 volts continuously variable.
OUTPUT CURRENT DC: 0-1.5 amperes continuous duty.
REGULATION: In the range 0-30 volts, the output voltage variation is less than 0.02 volts for load variation from 0 to maximum current, and less than 0.02 volts for line fluctuation from 105-125 volts.
RIPPLE VOLTAGE: Less than 3 millivolts RMS.
FUSE PROTECTION: Input and output fuses on front panel.

OUTPUT = 2
OUTPUT VOLTAGE DC: 0-30 volts continuously variable.
OUTPUT CURRENT DC: 0-1.5 amperes continuous duty.
REGULATION: In the range 0-30 volts, the output voltage variation is less than 0.02 volts for load variation from 0 to maximum current, and less than 0.02 volts for line fluctuation from 105-125 volts.
RIPPLE VOLTAGE: Less than 3 millivolts RMS.
FUSE PROTECTION: Input and output fuses on front panel.

RECOVERY TIME: Less than 50 microseconds. The excursion in the output voltage during the recovery period is less than .05 volts for line fluctuations from 105 to 125 volts or load variations from 0 to maximum current.
STABILITY: The output voltage variation is less than .05 volts for a period of 8 hours.
OUTPUT IMPEDANCE: Less than 0.1 ohms from 1KC to 100KC. Less than 0.01 ohms from DC to 1KC.
POWER REQUIREMENTS: 105-125 volts, 50-400 cycles.
OUTPUT TERMINATIONS: DC terminals are clearly marked on the front panel. All terminals are isolated from the chassis. Either positive or negative terminal of each DC output may be grounded. A terminal is provided for connecting to the chassis. The DC terminals are also brought out at the rear of the unit.
PHYSICAL SPECIFICATIONS: Height 7", width 19", depth 11", color gray hammertone. This unit is designed for relay rack mounting or bench use. Carrying handles are provided.
METERS: Voltmeters: Two 0-30 volts, 2½"
Milliameters: Two 0-1.5 amperes, 2½"
CONTROLS: Power on-off switch; outputs 1 and 2 DC on-off switch; outputs 1 and 2 ten turn voltage controls.
SEND FOR BROCHURE B-576 — SPECIFICATIONS ON NEW MAGNETIC, TRANSISTOR AND TUBE VOLTAGE REGULATED POWER SUPPLIES AND SEMI-CONDUCTOR DC TO DC CONVERTERS
Focusing Oscilloscope Cameras

CLELLAND D. NAIL  
University of California  
Radiation Laboratory  
Livermore, California

FOCUSING an oscilloscope camera having a fast lens requires accurate adjustment, since the depth of the field of such lenses is very limited. A simple accurate focusing system requiring minimum apparatus is needed.

An extension of the Foucault knife-edge test can be used to determine the exact focal point of a lens very simply and accurately. The apparatus needed consists of a point source of light and a sharpened tool or knife.

Method—The Foucault knife-edge test is made by directing a point source of light upon a lens or reflector and observing by eye the illumination at a point slightly beyond the focal point as shown in Fig. 1. A sharp edge is moved into the region of the light rays at the suspected focal point, and by the distinct characteristics of the illumination the exact point of convergence can be ascertained.

When the rays are intercepted at their exact point of focus, the illumination of the field appears to diminish uniformly as shown in Fig. 2A. If the knife edge enters the cone of light rays at a point in distinct characteristics of the illumination will appear to be eclipsed by a dark shadow that moves in opposition to the tool motion. Conversely, if the knife edge is beyond the point of focus, the shadow will appear on the knife side and will move across the field as the knife is moved. Figures 2A and 2B illustrate the latter cases.

To adjust an f/1.5 oscilloscope camera a knife-edged tool was made of brass. The undeflected

Deluxe Automobile Transistor Receiver

The Delco transistor radio used in the Cadillac El Doro brougham employs 11 transistors together with two more in the relay control circuits. Push-pull output stage supplies 10 watts to loudspeakers.
you “build-in” Accessibility with

**GRANT INDUSTRIAL SLIDES**

**IF** it’s important to keep your electronic equipment functioning with as brief interruptions as possible...**IF** even minor testing and replacement takes undue time because of the nuisance of getting at the equipment mechanically...**IF** certain components must be accessible for on-the-spot servicing in seconds... **THEN** you should investigate Grant Industrial Slides.

Grant Industrial Slides provide built-in accessibility, without effort or costly loss of operating time. Unlimited varieties of standard and custom types are available and Grant offers complete engineering services including at-your-plant discussions regarding the development of slides that fit your requirements perfectly.

Write for Grant Industrial Slide technical data. Free copy will be mailed on request.

Five seconds to put chassis in testing position. Slides smoothly out of rack, locks. Pivoting mechanism brings under-chassis parts to easiest working angle. Functioning of unit need not be interrupted!

**Grant INDUSTRIAL SLIDES**

Grant Pulley & Hardware Corporation, 23 High Street, West Nyack, N. Y., Long Beach Avenue, Los Angeles 21, Calif.
**The Front Cover**

Development of jet aircraft engines requires precise measurement of many variables within the engine while it is in operation.

Electronic equipment is used at the Pratt & Whitney Aircraft Co. to translate and record this information while the engine is running on the test stand under the wide range of temperature and pressure conditions that it would encounter in actual flight.

Shown in the photograph, here, is a bench of equipment in a test-stand control room. In the racks second from right are strain-gage translators. These units translate variations in resistance of strain-gages located at various points in the engine into a varying voltage. These are amplified by oscillograph recording amplifiers for display on a 12-channel oscilloscope. These units monitor the signals from the strain-gage translators on separate channels.

Information other than strain gage readings such as fuel flows, engine speeds, and pressures can also be monitored.

An oscilloscope beam was used as a point source of light. With the lens aperture and shutter open and the camera back removed, the knife edge was positioned at the film plane and the spot viewed from the open back of the camera, placing the viewing eye quite close to the film plane.

When the lens was properly focused, the image was clearly seen to darken uniformly over the entire area of illumination. The 0.006 in. thickness of one film layer placed beneath the knife-edge tool was sufficient to cause the illumination to darken from one side. Clear and sharp pictures taken after the adjustment confirm the focus accuracy.

Since phosphor illumination is used as the light source, no error from tube glass reflection or refraction can be present. A low-intensity spot, not harmful to phosphor, has been found to be sufficient.

This technique was originally developed about 1850 by telescope makers to determine the shape and nature of the parabola of a reflecting element.

The work described here was performed under the auspices of the U. S. Atomic Energy Commission.

---

**Exact Calibration From a Standard**

**BY OVE SIMONSEN**

U. S. Navy Electronics Lab. San Diego, Calif.

In most cases the technique employed when a standard-frequency source is unmodulated, is to adjust the frequency meter undergoing calibration until zero beat is obtained. This method fails when extreme accuracy is required because zero or near zero beat note between the equipment to be calibrated and the standard will not pass an ordinary receiver such as is generally found in communication systems.

The best that can be hoped for would be limited to the lowest note the ear can detect (perhaps not below 27 cycles a second). If an oscilloscope is used, accuracy is limited to the lowest frequency the receiver will pass (perhaps not much below the limit of the ear).

This article describes a simple method requiring no precision equipment. Two ordinary receivers and a radio-frequency oscillator, which does not even need to be extremely stable, are arranged as shown in the diagram.

**System Features**—The difficulty of not being able to pass low audio frequencies does not now exist as the r-f oscillator is set to give any convenient difference frequency. Only when the meter is at exactly the same frequency as the standard will the pattern be a circle. The r-f oscillator does not have to be stable. Should it drift, the effect will show up on both receivers and the net effect will be zero.

Suppose the two difference frequencies between the common and the standard and the common and the meter to be calibrated are 1,000 and 1,005 cycles, respectively. If the common generator drifts five cycles downward, the difference frequencies would become 1,005 and 1,010 cycles respectively. Consider now that the common generator drifts upward five cycles; the difference frequencies now will be 995 and 1,000 cycles.

As far as the inaccuracy in frequency between the standard and the substandard is concerned no change

---

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September 1, 1957 — ELECTRONICS
wcc TANTALUM
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Better Service from Exclusive "know-how"
Teamed with New Production Facilities

Latest member of the Wah Chang Corporation's growing family of vital metals is TANTALUM...in ever increasing demand because of its corrosion resistant, high thermal conductivity, and non-oxidizing properties.

Culminating 45 years' extractive metallurgy experience WCC TANTALUM is now available in oxide and powder form...and scheduled for production in wire, rod, ingot, strip and foil too!

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Set your purity limits to fit the most stringent specifications, WCC TANTALUM can meet them...meticulous quality control from ore to finished form guarantees it!

Wah Chang Corporation is already one of the world's foremost producers of such critical metals as: tungsten, molybdenum, zirconium, hafnium and columbium...metals with a significant share in your future!

Investigate the possibility of improving your products with WCC TANTALUM...send today for technical information, prices and delivery schedules.

More WCC Metals are on the way...look for them.

BRINGING TOMORROW CLOSER WITH NEW METALS
has occurred and any necessary adjustments to the substandard therefore can be made as if the common generator did not exist. In other words, drift in the common generator will not be noticed and neither will it effect the accuracy of the calibration.

- **Approach** — When using this method, it is essential that if the standard is below or above the common generator, the substandard should be made to approach the standard from a frequency that also initially is below or above the common generator. Otherwise, the meter when calibrated to the standard will be off by twice the difference frequency of the common signal generator and the standard. This is verified by an example.

Suppose the standard frequency is above the common and the meter to be calibrated is below an equal amount, like 1,000 cycles. The standard and the meter to be calibrated are then separated by 2,000 cycles and the circle obtained in this case evidently does not indicate frequency coincidence between the standard and the substandard.

Fortunately there is little danger that the precaution given above will be overlooked as there are unmistakable signs when error exists. A drift now in the common signal generator of 5 cycles upwards would make the upper frequency difference 995 cycles while the lower would become 1,005 cycles.

The change in separation of two difference frequencies \( f_{cm} - f_{cm} \) and \( f_{cm} - f_{substand} \) would be twice the common signal generator drift. The result would make it nearly impossible to obtain a circle on the scope. However, if by careful manipulation it is possible to arrest the pattern, the least bit of drift in the common would quickly wipe out this counterfeit circle.

In short, should abnormal difficulties be experienced when trying to obtain coincidence between standard and substandard, it should be suspected that the frequencies of the two equipments are not arranged on the same side of the common signal generator frequency.

- **Drift Advantage** — The inference might be made that it is desirable that the common signal generator drift and such is actually the case.

The 2-megohm resistors shown in the circuit are not critical as long as they are large enough to prevent the signals from the frequency standard from reaching receiver 2 and small enough to permit a signal of desirable strength from the r-f oscillator to reach both receivers.

---

**Rocket Telemeters Weather Data**

RAPID gathering of weather information is promised by DART, a high altitude missile now under development at the Naval Ordnance Laboratory.

Launched from a ship's five-inch gun and driven by a rocket motor to a speed of 3,000 mph, the missile will reach a height of 110,000 ft. in 70 sec. Future models will reach

Test firing of weather missile from land based five-inch gun. Rocket motor, fired electrically, causes blast. There is no recoil since gun is not fired.
For the record...

it's **IMMEDIATE-PRINT** scope photos with the **dUMONT** 302

- **NOW, ULTRA-FAST**
  - TRANSPARENT POLAROID-LAND FILM FOR
  - HIGH SPEED RECORDING!

- **CONTACT AND PROJECTION**
  - PRINTS... NO IMAGE REVERSAL.

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  - WAVEFORM COMPARISON.

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  - ON ANY STANDARD 5" SCOPE. NO
  - ADDITIONAL SUPPORTS REQUIRED.

- **EASY ACCESS FOR LENS AND**
  - SHUTTER ADJUSTMENT.

- **BUILT-IN DATA RECORDING SYSTEM.**

---

**SPECIFICATIONS**

- Wollensak-Du Mont 75 mm f/2.8 three element lens, or 75 mm f/1.9 six element lens.
- Image reduction ratio 2.25:1.
- Alphax f/2 shutter, bulb and 1/25 to 1/100 sec, with f/2.8 lens. Alphax f/3 shutter, time, bulb and 1 sec with f/1.9 lens.
- Writing rate dependent upon film used.
- Mounting clamp featuring two element lens.
- Type 302 with f/2.8 lens $314.00
  - Type 302 with f/1.9 lens $391.00

---

**WHATEVER YOUR REQUIREMENTS... dUMONT HAS THE CAMERA**

**TYPE 352**
- High-speed, single frame 35 mm featuring automatic film advance. 8 frames/sec. automatically. Wollensak f/1.5 lens. $648.00

**TYPE 339**
- Immediate-print type utilizing Polaroid film. Special f/2.8 lens for distortion-free images. Binocular viewing of screen. $246.00

**TYPE 299**
- General-purpose camera accepting backs for roll-film, film-pack, or cut film. Converts to Type 302 for Polaroid recording. 1/100 lens $369.00, f/2.8 lens $292.00

**TYPE 296**
- Low-cost, general-purpose single-frame camera. Uses standard cassette wound 35 mm film. Corrected f/2.8 lens. Viewing port. $164.50

**TYPE 321-A**
- Permits either continuous or single-frame recording, perforated or unperforated film or paper in 100 or 400 foot reels. Variable film drive speeds from 0.8 to 10,800 ft/min. 321-A with f/1.5 lens $1275.00, 321-A with f/2.8 lens $1250.00. (50 cps models available)

---

The Du Mont Type 302 Recording Camera provides the most convenient and flexible means for applying the many advantages of the immediate-print Polaroid-Land process to oscilloscope recording.

And now the utility of the Polaroid-Land process has been greatly extended with the development of the new Polaroid-Land projection film—a transparent base material with a specified emulsion speed of 1000 (ASA).

This new film not only permits contact and projection prints, and eliminates image reversal, but also enables use of the Polaroid-Land process in recording ultra-high-speed phenomena—even single transients.

Utility of the 302 is further broadened by the availability of adapter backs which permit the camera to use various standard roll and cut films.

Write for full information...
300,000 ft. At the height of its trajectory, the missile will split open, allowing an instrument case, slowed by balloon, to float earthward.

Continuously telemetered temperature and humidity data together with position data obtained from the ship radar, will furnish meteorological information.

**Missile**—The rocket nose section shown in Fig. 1 after its rocket engine has detached, is 40 inches long, with 26 cu in. available for electronic equipment.

The balloon, inflated by chemically generated nitrogen, is six feet in diameter. The difficulties involved in tracking a six-foot object over 20 miles distant are avoided by an active system of radar. The missile receives signals from the ship-based X-band radar and retransmits them on a 403-me carrier. The repeated pulses are of constant height, but each has a length proportional to the received strength of the corresponding X-band pulse.

The radar beam is slightly inclined with respect to the antenna axis and rotates about the axis at 30 rps. Thus, if the balloon is close to, but not exactly on the antenna axis, the envelope of the received pulses is amplitude modulated at 30 cps. This appears as pulse-width modulation of the repeated pulses. From the amplitude of this modulation and its phase with respect to the rotation of the beam, the position of the balloon referred to the axis of the radar antenna can be determined.

**Telemetering**—Since the reply pulses are at most 10 µsec wide, at 408 me an interval of nearly 700 µsec between pulses is available for telemetering. By omitting pulses periodically, the pulse train is divided into groups. A specific position in each group is then assigned for temperature data, humidity and reference pulses.

Positioning half microsecond pulses in a 700 µsec band, allowing for the accuracy of the equipment, over 400 graduations are available.

**Pickups**—The temperature sensor is about ten feet of half-mil tungsten wire coiled about the outside of the instrument case. The wire forms one arm of a bridge circuit whose output drives a transistor amplifier.

Humidity sensors with the rapid response required are still a problem, but development of thin film electrical conductivity type sensors appears promising.

As shown in Fig. 2, the outputs of the sensors and the signals derived from the X-band radar are connected through individual gates to an amplifier supplying the phantastron. Upon being triggered,
For top precision performance in the oscillator field it's elin oscillators that can speed your results, save dollars! Ideal for pre-flight missile system checkouts, precision 400 cycle gyro testing, special power sources, time correlations, etc.—wherever you need "tuning fork" Frequency Stability, Absolute Voltage values, extremely low Output Impedance, Ultra-low Distortion and High Power Capacity!

The elin Precision Power Oscillator gives you all this through an exclusive High-Q LC tuned circuit and special voltage-sensitive bridge combined in a circuit employing a large amount of negative feedback.

Standard model—2 watts power output (6 watt model, DK-106) and at audio frequencies between 250 to 15,000 cps. Special models available in higher power capacities and at other frequencies or to customer specifications. Write for literature TODAY!

**SPECIFICATIONS:**

- **Model DK-102**
  - Frequency: 250 CPS to 15,000 CPS.
  - Power: 2 Watts (DK-102, DK-102R).
  - 6 Watts (DK-106, DK-106R).
  - Voltage: 10, 30 & 100 volts RMS. All with floating, center tapped output.
  - Distortion: 0.1% maximum harmonic content, 0.05% maximum AC hum, 0.01% maximum noise.

- **Model DK-102R**
  - Frequency: 250 CPS to 15,000 CPS.
  - Power: 2 Watts (DK-102, DK-102R).
  - 6 Watts (DK-106, DK-106R).
  - Voltage: 10, 30 & 100 volts RMS. All with floating, center tapped output.
  - Distortion: 0.1% maximum harmonic content, 0.05% maximum AC hum, 0.01% maximum noise.

**ELIN LEADS A "DOUBLE LIFE"** of quick-change versatility providing fast modification from a DK-102 (cabinet model) to a DK-102R for rack mounting! All models are smartly styled, compact (5¼"H x 9"D x 16¾"W) and built to give reliable, trouble-free service. 115V AC plug-in power is made to either lugs or AN adapter at rear of chassis!

**FREQUENCY STABILITY**

- ±0.5% maximum, under usual ambient conditions.
- ±0.02% maximum, per ±10 volts variation in line voltage.
- ±0.05%, maximum, zero to full load.

**AMPLITUDE STABILITY**

- ±0.1% maximum, under usual ambient conditions.
- ±0.02% maximum, per ±10 volts variation in line voltage.
- ±0.2% maximum, zero to full load.

**PRICE:** $295.00 (Subject to change without notice.)

elin / ELECTRONICS INTERNATIONAL CO.
145 West Magnolia Blvd., Burbank, California

Special Products Division of International Electronic Research Corporation, Burbank, California

ELECTRONICS — September 1, 1957
Circle 139 Readers Service Card
Bird can supply you with sapphire and borosilicate glass precision jewel bearings in a wide range of standard types, sizes, and complete assemblies — or, custom-built to your specifications. Special mounting techniques provide exact tolerance jewel assemblies, mounted or set in bushings or screws, ready for assembling into your product without further inspection. Jewels mounted with resilient silicone rubber or spring cushions provide additional protection to further inspection.

Because of the exact tolerances, maintained through the most rigid quality-control methods, Bird jewels are used by the foremost manufacturers of electrical, aircraft, and timing instruments — and recorders.

Typical products include:
- Aircraft Instruments
- Weather Recorders
- Ammeters
- Voltmeters
- Wetmeters
- Compasses
- Dial Gages
- Timers
- Test & Recording Instruments
- Marine Instruments

*Illustrated — Concentricity check of mounted ring jewels — one of the inspection processes in Bird's quality control program.

Our engineering staff is at your service for all small bearing problems. A request on your letterhead for Bulletin 100-6 will receive our prompt attention.

Transistor Complementary Symmetry

For measurement of $r_{sw}$, which is one of the most important high-frequency figures of merit of transistors, Giacoletto proposed a multifrequency bridge for which the schematic circuit is shown in Fig. 1 (see also Electronics, p 144, Nov. 1953). Since one of the output terminals of the square-wave generator is grounded in this case, a differential oscilloscope is required for the detector. If, however an ideal transformer that will pass square waves without distortion is obtained, the circuit can be altered to a normal bridge arrangement as shown in Fig. 2.
now! 400 mA
600 volts PIV
in a glass package

immediately available in production quantities

a new solution to your inventory and spare parts problems:

You can now get big voltage operation (to 600 V) plus a new high in forward conductance (400 mA) along with a 2 million-to-1 forward-to-reverse current ratio...from new TI diffused silicon glass diode/rectifiers! This means you can eliminate scores of diodes and rectifiers from your inventories...and stock only five TI diode/rectifiers for virtually all your requirements. For your magnetic amplifiers, modulators, demodulators, networks or subminiature power supplies, this new TI diode/rectifier series—with its extremely wide 225 to 600 voltage range—will meet your exacting circuitry needs.

To see why, check these significant parameters:

**maximum ratings**

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**specifications**

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<tr>
<td>Maximum Reverse Current at PIV at +100°C</td>
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<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Maximum Voltage Drop at I₀ = 400 mA; at +25°C</td>
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<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Put TI diode/rectifiers to work for you now!
Write today for Bulletin No. DLS-770
Connecting printed circuits with AMPHENOL Prin-Cir components assures both ease of operation and high performance reliability. Available as plugs and receptacles, Prin-Cirs feature rugged, smooth-working gold-plated contacts and tough dialllyl phthalate bodies. Application versatility is provided through a wide choice of contact terminals: Standard, Pin, Wire Wrap and Open End in receptacles; arrangements allowing for straight or angled board attachment, modular design, and cable plug-in for plugs. Plugs and receptacles available in 10, 15, 18 and 22 contacts; 6 contact receptacle also available.

Average voltage breakdown between contacts at sea level is 5400 V. DC for receptacles and 2300 V. DC for plugs.

Electrons at Work

...stors can be used for this purpose. The circuit of the bridge is shown schematically in Fig. 3. Analysis of the equivalent circuit
Now you can use molybdenum permalloy powder cores in miniaturized circuits

When your engineering neighbor talks about "Cheerios" these days, he's apt to be discussing a new breakfast cereal-sized molybdenum permalloy powder core which has found a happy niche as a miniaturized filter component. Guided missiles, which are filling the troposphere these days, typically use these little fellows in their amplifier circuits. Small (down to .300-in. ID), they are tough and easy to use. They also provide a markedly high degree of stability with time, temperature and magnetization.

Made by Magnetics, Inc. (Performance-Guaranteed, of course) they provide the highest permeability and lowest core losses possible in use in filter, audio and carrier frequency circuits. We provide extras, too—you may specify our very exclusive feature—color-coding. Color-coding tells your assemblers how many turns to put on your cores without the lost time and extra expense of special testing.


MAGNETICS inc.
Advanced designs in heater and cathode structures, which made possible controlled warm-up time, established Tung-Sol as the pioneer producer of 600 ma series-string heater tubes for TV.

Tung-Sol, while continuing to add to this select circle of most widely used 600 ma types, further expanded its series-string line to include 450 and 300 ma tubes for sets requiring fewer tubes.

At present Tung-Sol supplies a complement of nearly 200 of these tubes to the initial equipment manufacturers and the replacement field... a solid indication not only of the success of the series-string principle, but also of Tung-Sol’s un-failing ability to meet the strictest performance requirements and production schedules.

ANYWAY YOU ADD IT... IT'S TUNG-SOL FOR SERIES-STRING TV TUBES
ELECTRONS AT WORK

In this age of the seller's market in engineering talent we're often asked the question, "Just why is the turnover rate of Tung-Sol engineers the lowest in the industry?"

Fair question, because on the surface Tung-Sol looks pretty much like every other manufacturer. Nothing too unusual about plant layouts. The machinery—and some of it is pretty remarkable—by and large appears the same as everybody else's. Our foremen can be spotted by their white shirts and ties, too. And our engineer roster probably contains the same mixture of talented youngsters and seasoned veterans as yours.

Yes, it's all the same, except for one thing: At Tung-Sol engineers are given definite responsibilities (like the development of the series-string tube complement) and the necessary latitude to do the job superlatively well.

They handle absorbing assignments in design, development, production, research and applications of electronic tubes, cathode ray tubes, semiconductors and current intermitors. Engineers like it this way because they can move up, not away, at Tung-Sol.

Interested? If you've had two to five years' experience, let's see what we have to offer each other. Write, wire or phone: David C. Bellat, Personnel Director, Tung-Sol Electric Inc., 200 Bloomfield Ave., Bloomfield, N. J. Pilgrim 8-8700.
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GAMEWELL

Sinusoidal Precision Potentiometers

A specially designed oblong resistance element rotating under 4 wipers generates precision sine and cosine voltages, proportional to the sine or cosine of the shaft rotation angle. Functions produced to an inherent accuracy and smoothness unobtainable by other resistive methods. Can replace eccentric gears, cams and complicated mechanisms in computing, analyzing, navigational and control systems.

Send for technical data!

Functional detail, dimensions and specifications will help you apply.

Sketch of Gamewell Sine-Cosine Precision Potentiometer Design

Can be used as a 1 brush device, 2 brush (sine) and 2 brush (cosine) device, or in combinations — to produce various sinusoidal variations.

\[ E-F = V_{in}, \quad A-C \& B-D = V_o. \]

Table 1 — Accuracy Check with Dummy

<table>
<thead>
<tr>
<th>Dummy  ( r_{AB} )</th>
<th>Measured ( r_{AB} )</th>
<th>Error in percent</th>
</tr>
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<tbody>
<tr>
<td>99.7</td>
<td>100.4</td>
<td>+0.7</td>
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<tr>
<td>199.9</td>
<td>199.5</td>
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<td>300.0</td>
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<td>500.0</td>
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<td>-0.5</td>
</tr>
<tr>
<td>599.2</td>
<td>596.5</td>
<td>-0.52</td>
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<tr>
<td>699.2</td>
<td>695.0</td>
<td>-0.6</td>
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<tr>
<td>799.0</td>
<td>791.3</td>
<td>-0.6</td>
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<tr>
<td>901.0</td>
<td>891.0</td>
<td>+0.78</td>
</tr>
<tr>
<td>1001.0</td>
<td>992.0</td>
<td>-0.9</td>
</tr>
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</table>

halves is almost negligible up to 1 \( \text{m} \) in comparison with \( 1/1 \ k \).

The accuracy of this bridge was checked with a dummy transistor like that shown in Fig. 6. The dummy, with accurately measured value of \( r_{AB} \), was inserted in place of the transistor specimen and the bridge was balanced. Examples of the inserted \( r_{AB} \) and measured \( r_{AB} \) are given in Table 1. Fairly good agreement can be seen.

Long Scope Probes Using Passive Elements

By W. F. SanteLmann, Jr.
and A. J. Hingston
Massachusetts Institute of Technology
Lexington, Mass.

IN MAINTENANCE of large digital computers, it is desirable to have all critical waveforms on hand at the maintenance console for oscilloscope monitoring. To accomplish this, cathode-follower probes driving long terminated lines have been necessary, but a successful probe has been designed using completely passive elements.

A typical computer waveform, Fig. 1A, the output of a mercury-wetted contact relay, is a step with
Do-it-yourself
or hire an expert?

YOU CAN'T TOP HUDSON FOR PRECISION ACCURACY AT COMMERCIAL PRICES!

Check these facts on Hudson closure quality and costs!

PRECISION — Hudson accuracy in metal forming is assured by the closest adherence to critical tolerances. Standard design or custom components, you can be sure of metal products that meet requirements.

UNIFORMITY — Whether you order sample quantities or large products runs, Hudson closures are of true uniform quality...eliminate rejects, speed assembly all along the line.

ECONOMY — Hudson's standardized methods of design and manufacture produce custom quality parts at commercial prices. Thousands of economical standard closures are available to solve your problem.

HUDSON TOOL & DIE CO. INC
18-38 MALVERN ST., NEWARK 5, N. J. — Tel. MARKET 3-7584
Now...shake-test to 5000 cps with 1750 lbs force!

Here is an electrodynamic vibration exciter with highest operating frequency in its force range. The Model C10 VB exciter extends the range of vibration testing systems to 5000 cps with no table diaphragming or disturbing resonances under 5000 cps. Liquid cooled, it delivers up to 1750 lbs force output for continuous sinusoidal testing...and extends the range of random motion testing to 5000 cps.

This exciter can be used with the MB Model T666 amplifier and TEMC control cabinet to subject specimens such as relays, electronic and control components through a wide range of vibratory frequencies to as high as 58 "g". Also, by the addition of the MB Model T88 complex motion console, it can be used for complex motion testing where specimens are subjected to the actual "noise" spectrum of the environment.

Design Advances
A UNIMODE rocker system (pat. pend.) restrains the 30 lb. moving table on its suspension. It assures linear motion over the total stroke of 1" (D.A.)—continuous duty. A packaged oil system and heat exchanger cool this equipment and permit its use in environmental chambers.

For Other Needs
Present MB exciter ratings range up to 25,000 pounds force. Remember, too, that MB has a field service organization, including a Western office, ready to help you. Send for Bulletin 420-C.

Electrons at Work (continued)

**Figure 1**—Significant waveforms on scope with 12 µsec rise time

a rise time of a few µsec. Figure 1B shows the deleterious results on this step of a 227-ft unterminated line.

When the center conductor of this coaxial cable is replaced by resistance wire, the reflections are absorbed, as shown in Fig. 1C. Best results are found when the total line resistance is between 350 and 700 ohms.

**Skin Effect**—The skin-effect impedance of the resistance wire causes the knee in the waveform of Fig. 1C. The knee distortion increases with cable length. Up to about five feet, no knee distortion is evident, however with 227 ft of cable, the effect is severe.

To transmit the step waveform faithfully, it is then necessary to provide an equalizer with the characteristic shown in Fig. 1D. Such a network, constructed with completely passive components, is available from the Division of Textron, Inc., New Haven, Connecticut.

Manufacturing Company
A DIVISION OF TEXTRON INC.
1075 State Street, New Haven 11, Conn.

Headquarters for products to isolate...excite...and measure vibration.
CHATHAM 6528

MEDIUM MU, HIGH CURRENT TWIN POWER TRIODE

PROVIDES NEW STANDARDS OF PERFORMANCE FOR SERIES REGULATOR SERVICE

see other side for additional information
Requires Fewer Passing Tube Sections
Permits Lower Range Control Circuits

DESIGN FEATURES
For reliable long life operation the 6528 features:

1. Hard Glass Envelope—permits tube to be more fully out-gassed in manufacture and to run at higher temperatures during life without gas evolution—more resistant to thermal shock.

2. Graphite Anodes—zirconium coated to provide one of the best "gettering" agents known—graphite undergoes virtually no expansion with temperature changes.

3. Extra Rugged Grids—gold plated molybdenum lateral wires supported by massive chrome copper side rods.

4. Oversized Cathodes—provide adequate emission reserve—no deterioration on standby.

5. Rugged Construction—mount is supported by six flexible metal snubbers and ceramic stand off insulators—heavy button stem has widely separated support leads.

RATINGS
Max. Plate Dissipation per tube 60 watts
Max. Plate Dissipation per section 30 watts
Max. Steady State Plate Current per section 300 ma
Max. Plate Voltage 400 volts
Max. Heater Cathode Voltage 300 volts
Amplification Factor* 9
Transconductance per section* 37,000 umhos
*Average characteristics at Eb = 100v, Ec = —4v, Ib = 185 ma.

TYPICAL VALUES FOR REGULATOR SERVICE

<table>
<thead>
<tr>
<th>Current per Triode Section</th>
<th>Range of Tube Voltage Drop</th>
<th>Minimum Tube Drop</th>
<th>Grid Voltage Swing</th>
</tr>
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<tbody>
<tr>
<td>200 ma</td>
<td>65 v.</td>
<td>70 v.</td>
<td>10 v.</td>
</tr>
<tr>
<td>150</td>
<td>120</td>
<td>60</td>
<td>20</td>
</tr>
<tr>
<td>100</td>
<td>225</td>
<td>45</td>
<td>35</td>
</tr>
</tbody>
</table>

This Chatham Twin Power Triode provides both low internal drop and excellent control sensitivity. Series regulators have previously had to compromise these characteristics. The very low-mu triodes provided adequate low tube drop while the high sensitivity control characteristics could be obtained only from beam power tubes. Where both performance features were demanded it was often necessary to resort to parallel operation of a large number of tubes, or by complicated control amplifier circuits.

Circuitwise, the 6528 may be used with both triodes in parallel for one high current output, or they may be separated to provide two different regulated outputs. The possibilities for circuit simplification, space conservation and production economies are, of course, apparent.

For more information about the 6528, or for help with any special tube problem, write Commercial Engineering Section, Chatham Electronics, Division of Tung-Sol Electric Inc., Livingston, N. J.
When Project Vanguard sends the first man-made satellite aloft during this Geophysical year, the Earth's first messages from outer space will be transmitted from it by fantastically precise telemetering equipment.

We are proud that James S. Spivey, Inc. selected Midland Crystals in designing and constructing these telemetering transmitters.

If you have special requirements in frequency control units, you will probably find what you're looking for in Midland's FREE illustrated catalog. Write for it.

first message from outer space...

WITH FREQUENCY CONTROL BY MIDLAND CRYSTALS
Uniform toroids and high-production economy

A speedy, low-cost winder with mechanical core holder assembly...

... for laboratory and production

Designed for easy set up and minimum manual operation... TW 201 winds toroids quickly, efficiently, economically. Just one hand inserts core and removes finished coil. One lever opens and closes shuttle. Wires wound include all types of magnet and filar wire including silk, cotton. Teflon and sleeve covered wire. Toroid size ranges from .218" ID through 5" OD in wire sizes #20 through #42 AWG. Speed (fixed at 600 rpm or variable to 1200 rpm) and quickly interchangeable shuttle equipment easily adapts the Semi-Automatic to either experimental work or full-scale production. 360°, segmental and longitudinal winding... automatically pre-set wire and turns counters are some of many features on TW 201. For full details on this and all Boesch winders, write for Catalog 57A today.

One-piece shuttle, speed and easy operation of the Boesch Fully-Automatic and Semi-Automatic machines make these the industry's most capable winders.

Comparison is the best test of excellence. See for yourself why Boesch manufactures the world's most superior winding machines.

BOESCH MANUFACTURING CO., INC., DANBURY, CONN.

ELECTRONS AT WORK (continued)

shown in the circuit of Fig. 2. The purpose of each element of the attenuator-equalizer may be shown by reference to Fig. 3A. The output of a resistance wire cable when driven by standard attenuator, \( R_a \), \( R_c \), and \( C_a \) has a large overshoot, as shown in Fig. 3A. This may be controlled, Fig. 3B, by the addition of \( R_e \) and \( C_e \). The height of the leading edge may then be controlled by adjusting \( C_a \).

During the first 0.5 \( \mu \text{sec} \) after the rise, a bulge is evident in the waveform of Fig. 3C, identical to Fig. 3B, but taken at a sweep speed five times slower. The addition of \( R_a \), \( R_e \), \( C_a \), \( C_e \), and \( L_a \) reduces the bulge considerably as shown in Fig. 3D. If transient distortions up to five percent are tolerable, then it is often practical to omit this network.

Resistor \( R_e \) is added to prevent ringing in the input leads when viewing extremely fast waveforms. If input leads no greater than 2 in. are used, the resistor may be omitted, thereby decreasing the probe rise time. \( R_c \) and \( R_e \) must be 1-percent units for accuracy of d-c attenuation. Otherwise, the fixed components require no more than the customary five-percent tolerance, and some will perform consistently with ten-percent tolerances.

Application—The Sage installation at Lincoln Labs uses 200 ft cables wired in the computer frame. Each cable goes from a conveniently located connector on the frame to a jack board at the maintenance console. Each passive probe, with its 27 feet of cable, may then be plugged into the nearest cable outlet and selected at the jack panel for viewing in the

![Figure 2](URL)

FIG. 2—Total cable resistances of 350 to 700 ohms may be used, but cables between 400 and 500 ohms perform best.
Whether specifications call for standard types of ceramic-metal bushings or specially designed assemblies for unusual applications, designers and electronics equipment manufacturers can rely on the uniform high quality and dependability of Alite ceramic-to-metal seals.

Vacuum-tight seals and bushings made of high alumina Alite are ideal for use in electronic applications where service conditions are extremely severe or critical. Alite has superior mechanical strength and thermal shock resistance. It maintains low-loss characteristics through a wide range of temperatures and frequencies. It resists corrosion, abrasion, and nuclear radiation. The extra-smooth, hard, high temperature glaze on Alite seals assures continuing high surface resistivity and dependable operation.

Another important reason for outstanding reliability of Alite components is our ability to perform and carefully supervise, in our own plant, every manufacturing step. From design to finished assembly—including formulating, forming, firing and testing—Alite is equipped to develop and produce high precision hermetic seals and bushings at one location. This permits an exceptionally high level of quality control, and results in what we sincerely believe to be the finest ceramic-to-metal seals available.

Our ceramics specialists are anxious to assist you on problems involving ceramic-to-metal seals. Tell us about your specific requirements today.

New FREE Bulletins

NEW DESIGN MINIATURE RELAY

RESISTS 15 G VIBRATION

THROUGH 500 CYCLES

The new Series 5400 Husky Miniature Relay is designed for continuous duty, general purpose DC use to give superior performance in aircraft, missiles, communications and other circuit control applications.

- **Vibration Resistance**: withstands 5 to 70 cps at 0.060" double excursion and 15 G from 70 to 500 cps without chatter or transfer.
- **Contacts**: available in arrangements up to 6 Form A or 4 Form C [total of 12 springs]. Standard contact material is palladium, rated at 3 amperes 26.5 VDC or 115 VAC resistive. Can be supplied in ratings up to 10 amperes per contact.
- **Available**: in any standard voltage up to 115 VDC. Normally supplied with coil resistance of 280 ohms ± 10% for operation on 26.5 VDC.
- **Weight**: 1.7 oz.
- **Available** hermetically sealed also. Write for Bulletin No. 6.

Fig. 3—Waveforms showing operation of attenuator-equalizer. Final response of the system is seen in Fig. 1E and Fig. 3D to different scales

oscilloscope. As each probe is at the end of 227 ft of cable, all time relations are preserved.

Since the probe must be grounded

**Antenna Test Chamber**

Altitude chamber designed for use at Stanford Research Institute to simulate high altitude conditions for testing antennas is set up by designer Jerry Brisco. Under the simulated high-altitude conditions, r-f power is applied to the antenna from measurements of voltage breakdown characteristics.
DESIGN ENGINEERS! ELECTRICAL ENGINEERS! REPAIR SHOP FOREMEN!
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A Complete Westinghouse Leadership Line of Military-Approved Insulating and Fungicidal Varnishes for Original Equipment Manufacturers and Repair Shops.

<table>
<thead>
<tr>
<th>GRADE</th>
<th>TYPE</th>
<th>MILITARY DESIGNATION</th>
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<tr>
<td>B-161</td>
<td>Clear Baking</td>
<td>Grade CB, Type M</td>
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<tr>
<td>B-163-N</td>
<td>Clear Baking</td>
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<td>B-166-1</td>
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<td>B-222-N</td>
<td>Clear Air Drying</td>
<td>Grade CA, Type M*</td>
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<tr>
<td>B-340-N</td>
<td>Black Baking</td>
<td>Grade BB, Type M*</td>
</tr>
<tr>
<td>B-451-N</td>
<td>Black Air Drying</td>
<td>Grade BA, Type M</td>
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MIL-V-173A—FUNGICIDAL

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<tr>
<td>B-219-F</td>
<td>Clear Air Drying</td>
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<tr>
<td>B-220-F</td>
<td>Clear Air Drying</td>
<td>I</td>
</tr>
</tbody>
</table>

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Whether you’re designing, manufacturing, or repairing military electrical apparatus, or whether you simply need quality insulating or fungicidal varnishes or enamels for critical applications, you can’t do better than the Westinghouse Leadership Line of insulation materials, field proven in over 100 million applications!

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Please send free copy of Leadership Line Catalog.

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1. G-M Servo Motors are available in standard sizes.
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3. Creative engineering in designing special servo motors with special characteristics.
4. Fast production—better service.

Measuring Elastic Moduli By Ultrasonics

Direct-coupling still exists since the waveform source and the oscilloscope are both grounded to the computer ground bus.

The 227 ft probe displays a 16 µsec rise time, one percent transient distortion, and 30 µf input capacitance at an attenuation ratio of 100 to 1. A similar probe, 55 ft long, for a medium-size computer, has a rise time of 14 µsec, transient distortion of 2 percent, input capacitance of 15.5 µf and an attenuation of 50 to 1.

Since the probe must be grounded at the waveform source and the oscilloscope must also be grounded, it is often found that power-frequency voltages on the computer ground bus are delivered by the probe system to the oscilloscope. A capacitor of about 0.001 µf in series with the probe ground lead, will block the flow of the hum without disturbing computer waveforms. Direct-coupling still exists since the waveform source and the oscilloscope are both grounded to the computer ground bus.

Diamond specimen to be measured in place on top fused-silica buffer rod. Quartz transducer is at lower end of rod.

AN ULTRASONIC technique for the determination of elastic moduli has been developed. Basically, the system measures the velocity of propa-
15kw S-Band Amplifier Klystron has no heavy magnets

Exclusive Space-Charge Focus cuts weight to only 6½ lbs.

Available for immediate delivery, Sperry's new S-band transmitting tube is a 3-cavity pulse amplifier of high gain and extra-long service life.

Exclusive Sperry Space-Charge Focusing design eliminates heavy, cumbersome magnetic structures—a feature of prime importance in equipment design. Although the SAS-61 weighs only 6½ lbs., its sturdy construction withstands extreme vibration and environmental conditions.

Main applications for the SAS-61 are as an output tube in low-power radars, or as a driver for higher-powered klystrons in radar and linear accelerator systems. Its unusually long service life, however, makes it highly desirable for any application requiring 15 kw in the S-band. The SAS-61 with its internal tunable cavities is a complete microwave unit. No external equipment is required.

Sperry can deliver SAS-61 tubes in quantity at once. Write or phone your nearest Sperry district office.

ELECTRONIC TUBE DIVISION

SPERRY ELECTRONIC TUBE COMPANY
Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION
CLEVELAND • NEW ORLEANS • BROOKLYN • LOS ANGELES • SAN FRANCISCO • SEATTLE • IN CANADA: SPERRY GYROSCOPE COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC

ELECTRONICS — September 1, 1957

Circle 156 Readers Service Card
ELECTRONS AT WORK

FM TRANSMITTER
MODEL 3115

- SMALL SIZE
- HIGH STABILITY

New, improved model designed for extreme environmental conditions (100g shock; 2000 cps vibration; -55 to +75°C). Subminiaturized and crystal-stabilized with telemetry band spurious output better than 60db below carrier.

Frequency Range: 215-235 mc
Frequency Stability: 0.01%
Power Output: 2 watts
Weight: 1.7 pounds

RF POWER AMPLIFIER
MODEL 3052

- RUGGED
- COMPACT
- RELIABLE

Provides 50 watts output from 2 watts input. Rugged construction and the use of a stacked ceramic tube makes this amplifier stable and reliable over a wide range of environmental conditions:

Temperature: -55° to +75°C
Shock: 100g
Vibration: 20g, 20-2000 cps
Altitude: 0-70,000 feet

PERTINENT PATENTS

By Norman L. Chalfin
Hughes Aircraft Co.
Culver City, Calif.

Computers and stable oscillators are among the devices of high current interest. Included here are details on a readout device, a crystal
Phase Shift Compensation Eliminated
In New HELIPOT® Precision Potentiometers

SPECIAL D-H ALLOYS MAKE
AIR-CORE WINDINGS PRACTICAL!

Helipot's purpose in designing its new, air-core wound series 7700 Potentiometers was to make possible operation at higher frequencies with 0° phase shift—thereby eliminating compensation circuitry.

In nearly all multi-turn potentiometers, resistance wire is wound on an insulated copper-wire mandrel. This type of mandrel is used because it has uniform diameter, good heat conductivity and high thermal capacity. However, a disadvantage of such construction is the relatively large distributed capacitance between the resistance winding and the mandrel. When such a potentiometer is used as an AC voltage divider, the output generally differs in phase and magnitude from the desired output. This interferes with the effective use of high accuracy potentiometers unless compensation is applied somewhere in the circuit.

Helipot engineers desired to eliminate these problems by eliminating the copper-wire mandrel. But the elimination of the mandrel also eliminated the support for the winding. Needed, therefore, was a type of wire that would make a self-supporting air-core winding.

At Helipot's request, Driver-Harris went to work with these specifications: The wire must be of dependable uniform hardness so that in stretching it, equal spacing between turns is obtained, free of creep. This is essential to linearity. The wire also must be of unvarying diameter for uniform resistance. And its surface must be extremely clean—free of oxide coating to minimize contact "noise".

Driver-Harris produced the wire—a special hard-drawn form of Karma* and Nichrome® V. And Helipot produced its new 10-turn series 7700 potentiometers in a resistance range from 200 to 5000 ohms. With this radically new air-core winding, linearity approaches the resolution of the unit without resort to padding or shunting. And phase shift in AC circuitry is reduced to less than 0.1°.

Since 1899, Driver-Harris has produced 132 special-purpose alloys in just this fashion—in answer to a particular problem and extraordinary specifications. If your own engineering and product development plans currently hinge upon a special alloy—why not bring your problem to Driver-Harris. Your inquiry is invited.

*H.R. REG. U.S. PAT. OFF.

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HARRISON, NEW JERSEY • BRANCHES: Chicago, Detroit, Cleveland, Louisville
Distributor: ANGUS-CAMPBELL, INC., Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES;
UAC tubeless
DC to AC Converters
replace bulky dynamotors
and inefficient vibrator power supplies

- COMPLETELY TRANSISTORIZED
- COMPACT—as little as 1/2 cu. in. per VA.
- LIGHTWEIGHT—as little as 1/2 ounce per VA.
- RUGGED— withstand in excess of 100 G's

CAN BE MADE TO MEET MIL SPECS
UAC high efficiency power supplies solve size, weight, vibration and shock problems in hundreds of mobile and aircraft applications. Efficiency over 90%; temperature stability from -55°C to 100°C can be achieved. 400 cps. and 1000 cps. both available.

Standard DC to AC units to 250 VA; custom units to 2 KVA.
DC to DC and AC to DC units also available, including unusual input-output combinations such as 28 VDC input, 115 VAC output; 115 VAC, 400 cps.; 250 VDC regulated output. 3 phase input; 250 VDC regulated output.

TYPICAL STANDARDS From 24 to 28 VDC Input

<table>
<thead>
<tr>
<th>Contact Voltage</th>
<th>Voltage</th>
<th>Amps.</th>
<th>Case Size (inches)</th>
<th>Weight</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10VA/50-400</td>
<td>10VA</td>
<td>50-400</td>
<td>2 3/4 x 21/2 x 4 1/2</td>
<td>2 lbs.</td>
<td>$200.00</td>
</tr>
<tr>
<td>10VA/115-400</td>
<td>10VA</td>
<td>115-400</td>
<td>1 3/4 x 21/2 x 4 1/2</td>
<td>2 lbs.</td>
<td>200.00</td>
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<tr>
<td>100VA/50-1000</td>
<td>100VA</td>
<td>50-1000</td>
<td>2 1/2 x 3 1/2 x 5 1/2</td>
<td>3 1/2 lbs.</td>
<td>300.00</td>
</tr>
<tr>
<td>100VA/115-1000</td>
<td>100VA</td>
<td>115-1000</td>
<td>1 3/4 x 3 1/2 x 5 1/2</td>
<td>3 1/2 lbs.</td>
<td>300.00</td>
</tr>
</tbody>
</table>

FIG. 1—Complete assembly of the illuminated indicator

FIG. 2—Arrangement of lamps (top) and baffles alternating with plastic (bottom)

alternate numerals and baffles. The baffles all have central openings so that any numeral may be viewed from the front of the stack. The positions of the lights on the side of the plastic sheet are such that the greatest illumination of the engraved numeral will be obtained.

In Fig. 1 the complete assembly is shown. Figure 2 shows the arrangement of lamp positions for uniform illumination of each numeral and the arrangement of the stock is shown in exploded form.

Crystal Oscillator
A crystal-controlled oscillator that has an inherent stability of one.
“Engineers—here’s the story of the ‘G-Limiter’ development.”

“...The specifications for Convair’s F-102A required that this supersonic delta-wing interceptor fly itself during part of a tactical mission.

“To safeguard both pilot and aircraft while operating in this automatic flight mode, it was necessary to develop a ‘fail-safe’ feature in the control system.

“This ‘G-Limiter’, as it came to be called, is an electronic measuring device which sums the angular and normal acceleration of the aircraft. Then, by comparing the ‘sum’ to a critical reference, this device anticipates the point at which the structural limits of the aircraft will be exceeded, and initiates corrective action.

“You, as an engineer, will appreciate this kind of creative assignment—and the resulting atmosphere of accomplishment at CONVAIR—SAN DIEGO. You will also appreciate being an integral part of a ‘systems team’ of specialists—while actively contributing to programs like the USAF F-102A and our 880 commercial jet transport. Not least, you’ll enjoy living at its best in beautiful San Diego.”

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Preferred where moisture conditions prevail. Coil winding, completely encapsulated in PERMASEAL thermostetting epoxy, resists water, humidity, oils, salt air, acid and alkaline solutions, ether, alcohol, hydraulics and other fluids. High dielectric strength, resistance to abrasion and thermal or mechanical shock enable it to operate at top efficiency.

This new special version of Guardian's standard No. 2 Solenoid provides extra power and longer life. Available in A.C. or D.C., for intermittent or continuous duty. Stroke adjustable from 1/16" to 3/8" — lift more than 60 oz. Unit has surpassed 15 million continuous operations at peak operating efficiency.

Tiny but powerful, this new Guardian Midget Solenoid packs a decisive punch. Strokes range from 1/2" to 3/8" and it lifts over 24 oz. Size 3/5" x 3/4" x 1 1/4" is ideal when space is at a premium. Available in D.C. only, for intermittent or continuous duty applications.

Select Your Solenoids from GUARDIAN'S COMPLETE LINE

... Proved for Superior Performance!

Many Guardian solenoids are available with Guardian PERMASEAL encapsulated coils. Most standard units are sufficiently flexible in design to meet "special" requirements and thereby eliminate costly pre-tooling. Adjustable strokes up to 2 inches; pull or lift up to 20 pounds. All D.C. units available for 400 cycle operation. Write for Bulletin SOL-8.

Large selections of Guardian relays, solenoids and steppers are carried in stock by franchised distributors in the U.S. and Canada. Write for name of nearby distributor and Bullet. SD-11.

GUARDIAN STEPPERS

Get Guardian's free Bulletin P-84. Gives complete operating data on sequence selecting, latching, automatic homing, remote homing, pulsing, electrical reset, slave and master sets, continuous rotation, add/foreground.

MER

ELECTRONS AT WORK

FIG. 3—Modified Hartley oscillator circuit

part in 10° is described in patent 2,765,288 issued to L. R. Jacobsen of Lynwood, California. The patent is assigned to Hoffman Electronics Corp. of California.

In Fig. 3 a Hartley oscillator is shown in the dotted outline. The Hartley oscillator cathode return, which conventionally is connected to a tap on the oscillator tank coil, in this instance is connected through a triode to the tap. Quartz crystal Y in series with capacitor C, is coupled between the control grid of the series cathode tap tube and the hot side of the oscillator tank coil and tuning capacitor.

Circuit stability of 1 part in 10° is claimed to be independent of B+ potential and independent of any variations in oscillator parameters.

If, for example, the oscillator tank circuit should be tuned slightly higher than the series resonant frequency of the crystal, the currents in the circuit will appear capacitive while with respect to the same conditions the current in the crystal is inductive.

These 180-deg opposed relationships result in similarly opposed voltages impressed on the grid and cathode of the series tube. The resonant frequency is thus restored regardless of the changes in the parameters of the oscillator tube.

Storage Technique

A new and highly complex Spin Echo Storage Technique is the subject of a patent 2,714,714, issued to A. G. Anderson and E. L. Hahn, assignors to the International Business Machines Corp. of New York.

Spin echo technique in general is a method of storing information in the form of electrical pulses applied to samples of suitable chemical substances and thereafter recovering...
The Arnoux Model TDS30-1 Decommutation System is compactly designed for use in airborne or trailer installed telemeter receiving stations and in portable check-out equipment.

- Miniaturization is the natural result of a new circuit design allowing the entire system to contain only 76 tubes as opposed to several hundred in competitive systems.
- Modular construction permits easy expansion of system to any desired channel capacity.
- Novel circuitry design does not reflect errors due to center frequency drift of sub-carrier oscillators, drift of discriminator D.C. output level, or tape playback speed errors.
- Built-in test selector permits visual inspection of waveforms throughout system for quick malfunction detection.
- Neon indicators on each gating unit give continuous visual indication of correct sequential operation.
- System accepts all standard IRIG inputs, either PAM or PDM, at any sampling rate from 75 to 900 per second.
- Overall linearity is within $\pm 0.5\%$ at maximum level. Long term level drift is within $\pm 0.2\%$. Gain drift is negligible.
- Modular plug-in gating units allow quick replacement of faulty channels.
- Two spare units are maintained on standby for instant use.
- Power required is 115 volts, 60 cps, single phase. Optional 115 volt, 400 cps, power supply available for airborne application.
You get the WHOLE story in one high-resolution display

WITH Federal LARGE-SCREEN

Excellent resolution for accurate visual reading of large quantities of data or complex signals is provided by Federal’s 17” and 21” oscilloscopes. Guesswork, reading errors and eye strain are reduced to a minimum.

Almost perfect linearity and close control of orthogonality result from the magnetic deflection system used. Pin-point examination is permitted without sacrificing the total display.

Federal’s 21” rectangular tube cabinet model is illustrated above. Standard 19” rack-mounting models are also available with 17” rectangular tube.

OUTSTANDING FEATURES:
- High Resolution.
- 1% Linearity.
- Calibrated Time Base—10 microsec/in to 1 sec/in.
- Calibrated Gain Controls—1 millivolt peak-to-peak/in to 100 volts/in.
- Frequency Response—±0.1 db from DC to 50 kc; down 1 db at 100 kc.
- Long-term stability, accurate voltage calibration, linearity and constant deflection sensitivity eliminate the need for an internal voltage calibrator.

Federal INSTRUMENTS
Industrial Products Division

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
100 Kingsland Road • Clifton, N. J.

ELECTRONS AT WORK (continued)

the information as echo pulses produced by free nuclear induction.

A sample of a material such as glycerin or water is surrounded by coils to which is applied a r-f field. The sample and its coils are placed in a strong magnetic field so the r-f field is perpendicular to the magnetic field. Coils excited by d-c are placed in the field to provide another field across the magnetic field to correct any irregularities in the permanent magnet field and add any additional desired inhomogeneities.

Figure 4 shows the energy sources for the r-f and d-c coils. In the balanced condition of the r-f circuit there will be essentially no signal applied to the receiver from junction X even though considerable r-f power is applied to the r-f coils.

To initiate a spin echo effect the sample is first exposed to the field of fixed magnets $H_e$ until its gyromagnetic nuclei become aligned. The sample is then subjected to two or more pulses of the r-f current creating a field $H_r$. After a quiescent interval the sample spontaneously develops its own magnetic field also normal to field $H_r$ and rotates about the direction of the $H_r$ field.

The rotating field builds up to a maximum and then decays. The build-up and decay is picked up by a properly oriented coil and applied to the receiver where it is detected and amplified as an electrical pulse which can be displayed on the oscillograph. This pulse is termed an echo of one of the pulses of the $H_r$ field.
For over three and a half decades, CLAROSTAT has done just one job but that job thoroughly — turning out controls and resistors for electronic and electrical requirements. Millions upon millions of such CLAROSTAT components in daily use attest to the engineering and production skills of CLAROSTAT.

And now, with ever-growing and ever-more-critical demands for precision potentiometers, CLAROSTAT again is the specialist. A separate, super-specialized production entity — the Precision Control Division — now operates in the Dover plant. CLAROSTAT remains the world's leading winder of fine wire, with an output greater than all other winders combined. The resulting precision potentiometers are worthy products of "The House of Resistors."

Therefore, specify CLAROSTAT. It always pays to deal with the specialist.

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Controls and Resistors
CLAROSTAT MFG. CO., INC., DOVER, NEW HAMPSHIRE
In Canada: CANADIAN MARCONI CO., LTD., TORONTO 17, ONT.
Reciprocating Filer Removes Flash Inside Welded Waveguides

Development of a reciprocating filer for flexible-shaft drive has eliminated tedious hand filing formerly required at Dalmo Victor to remove molten metal left inside the intricate shapes of waveguide assemblies after welding.

Many methods of mechanical filing had been tried, but nothing contained the successful combination of light weight and sturdiness until employee Lloyd Larsen devised a reciprocating filer which vibrates automatically to do the profiling job. Reciprocating motion is attained by using a Fordom electric motor with flexible shaft coupled with eccentric drive. Files are soldered to a threaded shank which may be locked in any radial position in the chuck of the filer.

Card-Programmed Automatic Tester for Ganged Potentiometers

Ganged precision potentiometers used in computers for fire control systems are automatically rotated in precise angular increments and checked for resistance with a new card-programmed tester developed by Westinghouse engineers in their Baltimore Air Arm Division plant.

Over 50 checks of resistance to 0.05 percent per exact angular position can be made for each cup of a 5 to 13-cup gang. The equipment will test a computing potentiometer gang for resistance, linearity of conformity, dielectric strength and electrical noise.

A specially connected combination of stepping switches and mercury relays is used to accomplish a fixed program of switching among the six terminals of each potentiometer.

Shaft Positioning. The function conformity test presents, in addition to voltage programming and measurement, the problem of accurate shaft positioning. This is accomplished by a special indexing device capable of indexing the shaft.
THERE'S NO SUBSTITUTE FOR EXPERIENCE...

YESTERDAY - TODAY - TOMORROW

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INDUSTRY-TESTED AND PROVED FOR OVER 50 YEARS...
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Newark 5, New Jersey, Brantford, Canada
through 360 degrees in 7.5-degree increments at the rate of one increment per second. The great variety of function curves requires the use of an extremely flexible system of generating voltages corresponding to the various shaft angles. A punched card system controlling a set of digital voltage dividers is used to generate voltages accurate to 5 parts in 100,000. Test time is speeded by 16-to-1 factor.

**Printer Eliminates Drying Of Resist on Printed Wiring Boards**

Removing panel after resist pattern has been applied, to complete printing cycle

Thermoplastic melted resist is applied through a temperature-controlled screen onto copper laminate for printed circuits by a new semi-automatic press having a capacity of over 600 panels per hour. The resist hardens almost instantly as it reaches the relatively cool copper surface of the laminate, so that printed boards can go directly into the etching bath or be turned over immediately for printing the resist on the reverse side.

The operator loads and registers the laminate panel on the illuminated bed of the press. Panels may be up to 18x28 inches in size. Pushing a button starts the printing stroke, wherein a squeegee forces the preheated resist through the screen to the panel. After printing, the machine opens automatically for unloading.

At the end of the work day, the

**Design of the Month: SOCKET FOR CERAMIC TRIODE**

Floating contact design in new Jettron grounded-grid uhf socket for GE's 6BY4 ceramic-titanium high-mu triode makes pressure contact around almost entire periphery of grid ring while achieving required low socket inductances and capacitances. Silver-plated beryllium-copper contact strips are easily assembled in slots of base molded from Alkyd 446 plastic, rated for up to 400 F. Grid contact has fixed lower shield and removable upper shield, to permit easy removal of tube. Lower shield is sandwich, with thicker center member making over 200 deg of wrap-around contact with recessed grid ring of tube; two thin outer members serve to align upper shield. Grid contact assembly floats in base insulator to allow for accumulated tolerances in tube element diameters and concentricity. Cathode and anode connections are made with single fork-shaped floating pieces. Offsets in heater contacts prevent tube from going into socket unless heater buttons are in horizontal position at end of tube. With grid grounded, capacitance between cathode and plate is only 0.02 micromicrofarad. Socket was developed by Jettron Products, Hanover, N. J. Tube is shown here greatly enlarged, being only 5/16 inch in diameter and 7/16 inch long.

September 1, 1957 — ELECTRONICS
30-channel, analog-digital converter connecting 300-amplifier analog computer to 1103A digital computer

Production of communications equipment in new Los Angeles manufacturing plant

Data Reduction Center designed and built by Ramo-Wooldridge

One of three new research and development buildings completed this year

First unit of Denver manufacturing plant now nearing completion

Input-output unit of the Ramo-Wooldridge RW-30 airborne digital computer

Pictorial PROGRESS REPORT

The photographs above illustrate some of the recent developments at Ramo-Wooldridge, both in facilities and in products. Work is in progress on a wide variety of projects, and positions are available for scientists and engineers in the following fields of current activity:

- Communications and Navigation Systems
- Digital Computers and Control Systems
- Airborne Electronic and Control Systems
- Electronic Instrumentation and Test Equipment
- Guided Missile Research and Development
- Automation and Data Processing
- Basic Electronic and Aeronautical Research

The Ramo-Wooldridge Corporation

5730 ARBOR VITAE STREET - LOS ANGELES 45, CALIFORNIA

ELECTRONICS — September 1, 1957

Circle 165 Readers Service Card
Stacking Stator Laminations of Servo Motors

FRAGILE PUNCHED laminations for outside-wound stators of synchronous motors are stacked in precise alignment and compressed with the aid of a simple positioning fixture on an air-actuated arbor press. The operator first places in the fixture a temporary steel arbor having the precise inside diameter of the stator. A stiff end spider is placed on the fixture and forced down with the press. The operator places laminations on the projecting positioning pins of the fixture a few at a time and operates the press to push them down against the end spider. The stacking and pressing is repeated until the desired stack height is reached, after which the final end spider is dropped on and driven into position. An ejection button is then pressed to push the arbor and stack far enough out of the fixture so the operator can grasp the arbor and complete the withdrawal.

Stack height is indicated automatically.

The machine can be shut off without cleaning. The resist will harden overnight, but printing can be continued the next day after only a few minutes of warmup.

After etching, the resist can be removed with wet steam, leaving a clean surface ready for punching, assembling and soldering. The machine is made by Dry Screen Process, Incorporated, Pittsburgh, Pennsylvania.

Mechanized squeegee forces molten thermoplastic resist through stainless steel cloth screen, which may be either 180 or 230 mesh depending on detail required.
Centralized Air Data System

This AiResearch computer system eliminates duplication of components, cutting down space and weight requirements over decentralized systems by many times. It can cover a wide area of functions while meeting the most rigid specifications in regard to accuracy and dependability. Since the great majority of its components are AiResearch products, both compatibility and reliability are assured.

We are prepared to assume overall responsibility for systems or sub-systems.

- Outstanding opportunities for qualified engineers

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ELECTRONICS — September 1, 1957
Circle 166 Readers Service Card
assembly technique is used in the Mechatrol Division of Servomechanisms, Inc., Westbury, L. I., N. Y.

Potting of Connectors Cuts Airborne Weight

By Charles DeLaHaye
Production Design Engineer
McDonnell Aircraft Corp.
St. Louis, Mo.

Development of new potting techniques for waterproofing electrical connectors on aircraft electrical systems and elimination of back shells has saved as much as 64 lb per plane at McDonnell Aircraft Corp., as compared to the old grommet and clamp method of holding wires at connectors.

Material—The potting compound now being used is specified by MIL-S-8516B and consists of a two-part mix, classified as an accelerated synthetic rubber sealing compound. More technically, it is a two-part catalyzed organic polysulphide liquid polymer, one commercial version of which is PRC compound.

STEP 1—Preparing potting compound. After accelerator is added, whipper in slow-speed air motor is used to achieve thorough mixing.

STEP 2—Pouring mixed potting compound into plastic liners used in commercial potting gun. At left are foil liners used with modified caulking gun.
Bell Laboratories chemist Field H. Winslow, Ph.D., Cornell University, with a scale model of a small section of a polyethylene molecule. Branch formation indicated by pencil is vulnerable to oxidation. Dr. Winslow and his associates worked out a simple way to protect long polyethylene molecules needed for durable cable sheathing.

THE DILEMMA OF GIANT MOLECULES

Solution: 2 plus 2 equals 5

Polyethylene is used to protect thousands of miles of telephone cables. It is tough, light and long lasting. Its strength lies in its giant molecules—a thousand times bigger, for example, than those of its brittle chemical cousin, paraffin wax.

But polyethylene has a powerful enemy: oxidation, energized by light and heat, shatters its huge molecules to pieces. This enemy had to be conquered if polyethylene was to meet the rigorous demands of cable sheathing. Paradoxically, it was done by making the whole better than the sum of its parts—just as though 2 plus 2 could be made to add up to 5.

To check the ravages of light, Bell Laboratories chemists devised the simple yet highly effective remedy of adding a tiny dose of carbon black. Then antioxidants, such as those commonly used to protect rubber, were added to check attack by heat. But here the chemists encountered a dilemma: although the carbon black protected against the effects of light, it critically weakened the effectiveness of the antioxidants.

To solve this dilemma, Bell Labs chemists developed entirely new types of antioxidants—compounds not weakened by carbon black but which, intriguingly, are very much more effective when carbon black is present. The new antioxidants, plus carbon black, in partnership, provide long-lasting cable sheath—another example of how research at Bell Telephone Laboratories works to improve your telephone service.
**Doré Tape of Teflon**

**GREAT ADVANTAGES:**

1. All tape spark tested to ASTM D149-55T
2. Maximum Elasticity
3. Packaged to your specifications in continuous length rolls of maximum diameters handled by your wire wrapping machines.
4. Uniform Density

*DuPont’s Tetrafluoroethylene Resin*

---

**STEP 3**—Wired connectors are dipped in solvent-type cleaner as at left, then dried with filtered air at right. Jet spray is now used instead of dip here.

**STEP 4**—Filling holes in split-back shells with potting compound in squeeze bottle.

**STEP 5**—Applying rubber-band anchors to hold connectors steady for potting.

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**STEP 4**—Filling holes in split-back shells with potting compound in squeeze bottle.

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Type PR-1201-Q-K (Products Research Co., Los Feliz Blvd. & Edenhurst Ave., Los Angeles, Calif.)

The compound does not depend upon solvent evaporation for setting as do some other types of sealants. The solvents present are aromatic hydrocarbons, eliminating benzene and other highly toxic solvents. No elemental sulphur is present either originally or as a result of the curing action. The potting compound, when mixed, is the consistency of heavy cream and is easily pourable at normal room temperature. After curing it becomes about as hard as a pencil eraser. Shrinkage is under 15 percent by volume. Adherence is good to aluminum alloys, cadmium plating and melamine and diallyl phthalate resins. These properties are retained down to -60 F and up to 200 F.

Under normal environmental and operational conditions in aircraft, electrical properties are: Dielectric constant 10.5; dielectric strength 200 volts per mil; power factor 0.01 to 0.03; resistivity $10^9$ to $10^{11}$ ohm-cm; insulation resistance 5,000 to 10,000 megohms.

**Mixing**—A slow-speed air-motor whipper or a newly developed commercial mixer can be used for mixing the potting compound. The mix ratio is 10 to 12 parts of the curing agent or accelerator for 100 parts of the base.

Working time of the mix at room temperature is approximately 90 minutes. It can be stored at -20 F for as long as 24 hours before using. This low temperature temporarily suspends the curing action, allowing a full day’s mix to be prepared at one time.

After mixing, the compound is poured into foil paper liners used in a modified caulking gun or in plastic gun cartridges used in a newly developed commercial potting gun. The filled liners and cartridges are marked with date and time and stored at -20 F in a deep-freeze chest.

Both potting guns are air-operated.
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PROVIDE NEW STANDARDS OF RELIABILITY FOR DESIGNERS

HIGHER TEMPERATURES . . . RADIATION RESISTANCE . . . TOTAL, PERMANENT DIMENSIONAL STABILITY . . .

SUPRAMICA ceramoplastics are precision-molded insulations with temperature endurance greater than any comparable material. Molded parts, such as the commutator plate illustrated above, have complete, permanent dimensional and electrical stability under extreme conditions of humidity and temperature.

Metal inserts molded in SUPRAMICA ceramoplastics cannot loosen during thermal cycling because coefficients of expansion are closely matched. There is no possibility of shrinkage, growth, or age polymerization, as the materials are completely inorganic, made with Synthamica® synthetic mica. Other desirable properties are high dielectric strength, radiation and arc resistance, low electrical loss, imperviousness to moisture, oil and organic solvents.

In thousands of military and industrial applications, SUPRAMICA ceramoplastics are contributing to better, safer, more reliable operation of electrical and electronic equipment.

SUPRAMICA® 560 — for temperatures over 500°C. (932°F.)
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MEASURE NOISE AND FIELD INTENSITY FROM 150 KC TO 1000 MC—WITH ONE METER!

Quickly • Accurately • Reliably

Empire Devices Noise and Field Intensity Meter Model NF-105 (Commercial Equivalent of AN/URM-7)

Noise and Field Intensity Meter Model NF-105 permits measurements of RF interference and field intensity over the entire frequency range from 150 kilocycles to 1000 megacycles. It is merely necessary to select one of four individual plug-in tuning units, depending on the frequency range desired. Tuning units are readily interchangeable...can be used with all Empire Devices Noise and Field Intensity Meters Model NF-105 now in the field.

Each of the four separate tuning units employs at least one RF amplifier stage with tuned input. Calibration for noise measurements is easily accomplished by means of the built-in impulse noise calibrator. With this instrument costly repetition of components common to all frequency ranges is eliminated because only the tuners need be changed. The same components...indicating circuits, calibrators, RF attenuators, detectors and audio amplifier...are used at all times.

Noise and Field Intensity Meter Model NF-105 is accurate and versatile, it may be used for measuring field intensity, RF interference, or as an ultra-sensitive VTVM. A complete line of accessories is available.

For complete performance data, send for Catalog No. N-356

New York—Daly 2-1204 • Syracuse—Canine 2-4623 • Philadelphia—Streetwood 2-3000 • Boston—Telemore 1-1853 • Washington, D. C.—Eustasy 3-0000 • Orlando, Fla.—Orlando 3-3224 • Atlanta—Cent 7-3001 • Detroit—Brindled 2-7000 • Cleveland—Epiphany 2-4116 • Pittsburgh—Ations 1-7000 • St. Louis—Epiphany 2-7729 • Dayton—Fleury 3-4044 • Chicago—Eckerson 9-5700 • Denver—Man 2-0823 • Fort Worth—Arabian 6-6464 • Houston—Hedwig 7-6100 • Albuquerque—Albuquerque 1-995 • Los Angeles—Brockton 2-4503 • Pasadena—Altos 3-4496 • Portland—Ceres 7-5801 • Canoga-Bettleson, Ont.—Henderson 56 • Export—New York—Murray 3-1740

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PRODUCTION TECHNIQUES (continued)

STEP 6—Loading filled plastic liner in potting gun

at. The expendable plastic liner can be reused by allowing the remaining compound to become cured, then stripping it out.

Cleaning—The key to successful potting of electrical connectors lies in cleaning. Connectors as received from the vendor are cleaned by vapor degreasing excepting where the insert material may be affected by this method.

After the connectors have been
now in your hands...

As easy to use as the phone book, your all new 1957 electronics BUYERS' GUIDE features:

**COMPLETENESS:** 1070 pages of products, manufacturers, trade names, manufacturers' representatives, and professional services.

**ACCURACY:** The entire electronic industry is questioned each year. For the 1957 GUIDE, there were 181 changes, 586 deletions (of the deletions, many were due to mergers and name changes), and 872 additions. Total number of manufacturers increased to 4013 from 3727 in 1956. 87 new products were added in 1957 for a total of 1773.

**USE:** Whether you are concerned with the design, production, or use of electronic circuitry, turn to the listings of the electronics BUYERS' GUIDE. Here you will find the page numbers that refer you to catalog-type advertising, specially prepared to supplement the listings and give you the technical information you must have to specify and purchase electronic and allied products.

*The All New 1957 electronics BUYERS' GUIDE*

Use it throughout the year as your standard reference source For 17 years your Buying Guide for electronics
FREQUENCY METER MODEL 802B
Range of 2350 to 10,500 megacycles covers the most used frequencies. Veeder-root digital counter provides accurate, legible readings which are referred to calibration charts for frequency in megacycles to rated accuracy of 0.2% without calculation. Completely self-contained with built-in detector and indicating meter.

SLOTTED LINES
MODELS 219 THROUGH 224
Six portable models, incorporating carriage drive mechanism integral with wave guide assembly measures VSWRs and impedances from 2600 to 18,000 megacycles per second, covering wave guide sizes from 3 X 1 ½ inches to .702 X .391 inches. Can be used with all standard military and commercial RF probes and detectors.

COMPLETE LINE OF COAXIAL AND WAVEGUIDE INSTRUMENTS INCLUDES:
- DIRECTIONAL COUPLERS
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contains much valuable data

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COMPLETE INSTRUMENTATION FOR MICROWAVE AND UHF

Ah precision!

PRODUCTION TECHNIQUES (continued)

STEP 8—Heat lamps provide 120 F temperature for 2-hour cure cycle in oven

wired and made into a wire bundle, a final cleaning operation is performed with an approved solvent-type cleaner, using a jet spray. The cleaner dries quickly without leaving a film. Spray which misses or bounces off the connector is collected and passed through a filtering system for reuse.

Evaporation of cleaner is speeded up by blowing the washed connector with filtered air from the plant's air line.

Preparation—After washing, the threads between the barrel and the back shell are covered with potting compound. On split-back shells the portholes are filled with potting compound. The back shell is then secured to the barrel and the wires tied about ¼ inch from the top of the back shell to keep them centered.

If the back shell is so short that there is less than ¼ inch between its top and the top of the longest solder pot, a snug-fitting polyvinyl sleeve is added to the back shell to

STEP 9—Sealing pigtails by dipping in hot plasticized ethyl cellulose

September 1, 1957 — ELECTRONICS
Further technical data, prices and delivery information—on the 5490/5495 Console Recording Systems and two to eight-channel 5475/5480 Systems—are available on request from your Sanborn Sales-Engineering Representative or the Industrial Division in Waltham.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman Street, Waltham 54, Massachusetts

SANBORN CONSOLE RECORDING SYSTEMS

Up to eight problem variables can be recorded in inkless, permanent rectangular-coordinate tracings—with Sanborn's improved six- and eight-channel 5490, 5495 Console Systems. Less than four feet high and about two feet in width and depth, these Systems are completely mobile and designed for maximum operating convenience. Controls and indicators on the sloping top panel include individual-channel attenuation, position, balance, sensitivity and stylus heat adjustments; switch for turning off B+ of output amplifiers; chart drive motor switch (can also be remotely controlled); code marker and/or one-second interval timer stylus switch. The Recorder unit, either six or eight channels, features paper loading from the top, and nine precisely controlled speeds from 0.25 to 100 mm/sec. Four dual-channel DC Driver Amplifiers of current feedback design are housed below the Recorder, and are mounted on a chassis which may be withdrawn for inspection.

Electrical specifications of the Console Recording Systems include a basic sensitivity of either 0.01 volt/chart division (5490 types) or 0.1 volt/chart division (5495 types); linearity of 1%; drift less than 1/2 chart division/hour (5490); less than 1/20 chart division/hour (5495); flat frequency response to 20 cps, down 3 db at 60 cps for all amplitudes to 5 cm peak; either single-ended or push-pull input signals of 5 meg.:impedance (each input lead to ground).

A useful companion instrument is the new Sanborn Model 183 Programmer, designed to provide a connecting link between an analog computer and the Console Recording System. Shown mounted at the top rear of the Console, the Programmer operates the Console in the following automatic sequence: turns recorder drive on—feeds calibration signals to all channels—reads initial DC levels of computer—closes contacts to start computer problem—records computer output for a preset chart length—turns off recorder drive and resets itself for another cycle.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman Street, Waltham 54, Massachusetts

Visit Sanborn Booths 1318-1320 ISA Show, Cleveland, Ohio, September 9-13, 1957.

ELECTRONICS — September 1, 1957

Circle 172 Readers Service Card
The A. W. Haydon Company offers a Complete Line of...

- Standard and Custom Designed Timing Motors and Devices!
- for military and industrial applications. Illustrated are some of these units... any can be modified to meet your specific requirements if the basic design is not adequate.

Shown below is the new catalog of The A. W. Haydon Company describing all of the basic types of units available and many of the "specials". Included in this 22-page catalog are 60 photographs of timers, 30 dimensional drawings, and 50 charts and diagrams. This complete catalog will be supplied on request.

Long a pioneer in the timing field, The A. W. Haydon Company is prepared to assist you in solving your timing and control problems. When a solution to your problem has been reached, The A. W. Haydon Company is prepared to follow through with production geared to meet your requirements whether a basic timing unit or a highly specialized device is required.

**Production Techniques**

(form a mold so that the potting will extend at least $\frac{1}{2}$ inch above the solder pot. Cellulose or masking tape may also be used to form this potting mold.

Most assemblies are racked to be potted and cured at room temperature. Connector assemblies that are to be oven-cured are hung on an oven rack where the connectors are carefully positioned to be vertical for potting. Rubber-band stays with pins and hooks are used to hold connectors steady.

Potting—A plastic cartridge of potting compound is removed from the deepfreeze chest and placed in a clean potting gun. A trial ejection of potting compound is made on a paper towel to assure a full flow of the compound from the gun without entrapped air.

Filling the connector is done by placing the nozzle deep into the back shell between the wires and removing the gun slowly as the ejected potting compound rises. Connectors thus filled may be left in room temperature to cure within 7 hours or the rack can be lifted into the oven for rapid curing at about 120°F in 2 hours. Higher curing temperatures are not recommended.

All connector pins have either a circuit wire or a pigtail soldered to them. These pigtails must be sealed to keep moisture from creeping into the back shell. This is done by dipping the pigtails into hot plasticized ethyl cellulose and letting them cool and harden.

Testing—Following potting and...
Natvar Isolastane is now making important savings possible. It makes it unnecessary to use expensive Class H materials to solve temperature problems during the manufacture of products which do not require Class H rating.

Isolastane is outstanding in its

- Elasticity (extensibility)
- Resistance to heat
- Resistance to crazing and cracking
- Resistance to solvents, including the askarels
- Toughness and abrasion resistance
- Wet dielectric strength
- Low temperature flexibility
- Fungistic qualities
- Adhesion to glass

Full technical data and samples are available on request.

Natvar Isolastane Fiberglas base tubing ▲ and bias tape ▼ fit snugly when applied, and retain their elasticity at continuous operating temperatures up to 150°C. They withstand higher temperatures during manufacturing processes without embrittlement.

Natvar Isolastane is Natvar's new elastomeric isocyanate type coating for Fiberglas braid and tape. Registration pending.

Natvar Products
- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fiberglas
- Varnished papers—rope and kraft
- Slot cell combinations, Aboglas®
- Isoglas® sheet, tape, tubing and sleeving
- Vinyl coated—varnished—lacquered tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

Ask for Catalog No. 23
10 reasons why the STAT-TRAN® is specified

FOR PULSE COUPLING AND BLOCKING OSCILLATOR CIRCUITS

1. Leads anchored with loop in terminal board in addition to epoxy bonding
2. Epoxy impregnated. Epoxy filled, no voids
3. NEW 2400 µ FERRITE CORE
   - Highest permeability
   - Highest flux density
   - Lowest losses
4. FERRITE CORE WITH GAP
   - Lower losses than toroidal shapes
   - Faster reset, less Br
   - Higher power
   - Improved temperature coefficient
5. Dielectric pad can provide up to 2KV hipot
6. FLAT WINDING BED gives better control of leakage and distributed capacity; greater bandwidth
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At today's engineering costs, if your engineer spends only 30 minutes designing and building a pulse transformer you are losing money. You could purchase a prototype Stat-Tran® and still save! (Figured engineering costs of $10.00 per hour and a prototype Stat-Tran® @ $4.60.)

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Available now, your free copy of our new 12 page, 2-color catalog, giving complete technical specifications on pulse transformers and filters as well as outlining typical circuitry and applications.

Heat Shields and Sinks Improve Reliability

Many equipment failures are traced to the designer's disregard for the heat problem. Tubes fail because of excessive heat; materials deteriorate and insulation breaks down.

- Tube Shields — Heat-reducing tube shields should be used in practically every instance to keep glass envelopes cool. One Pasadena, California, manufacturer had 15 6AQ5 type tubes in service in an installation where maximum tube life was from one to two weeks. When he installed NEL tube cooling inserts in the tube shield, the 6AQ5 failure rate dropped to zero over a period of time in excess of six months.
- Tube Voltages — Where possible, operate tubes at reduced anode and filament voltages. Frequency multiplication, conversion and selec-
OVER 300 BASIC TYPES... countless STANDARD modifications

for TV,
Radio, Audio, and
Instrumentation jobs.

STACKPOLE
VARIABLE composition RESISTORS

TECH DATA ON ALL STANDARD TYPES & MODIFICATIONS.
Write for Bulletin RC-10B or see your local Stackpole representative.

Electronic Components Division
STACKPOLE CARBON COMPANY, St. Marys, Pa.

In Canada: CANADIAN STACKPOLE LTD., 550 Evans Ave., Etobicoke, Toronto 14, Ont.
The Lapp porcelain rod insulator shown at the top of the illustration develops 12,000 lb. strength, and is suitable for the most severe electrical and mechanical duty. It is available with rain shield and/or corona rings. All hardware is silicon aluminum alloy. Smaller insulators, in porcelain or steatite, are suited to lighter duty for strain or spreader use. Lapp engineering and production facilities are always ready for design and manufacture of units to almost any performance specification. Write for Bulletin 301, with complete description and specification data. Lapp Insulator Co., Inc., Radio Specialties Division, 134 Sumner Street, LeRoy, N. Y.

Sinks and Baffles—Heat dissipation devices help get rid of heat. Special heat-reducing tube shields should be used on all applications of electron tubes. Heat sinks should be used to conduct heat from heat-producing parts and tubes to suitable cooling systems. Heat radiation baffles should be used to interrupt and preferably absorb radiant heat from heat sources. Many parts susceptible to damage from radiant sources can be saved by the use of such baffles.

As it becomes necessary, the designer should use blowers to cool equipment. In one case, a two-to-one improvement in reliability was obtained in an equipment containing blowers, as compared to identical equipment without blowers.

The recommendations given here were abstracted from a paper by J. Roy Smith of U. S. Navy Electronics Laboratory, presented at the Third National Symposium on Reliability and Quality Control in Electronics.

Purifying Silicon

Removal of boron as an impurity from commercially available silicon is achieved by reaction of the molten semiconductor material with water vapor, in a process developed by H. C. Theuerer of Bell Telephone Laboratories. This reaction oxidizes the
ASTRON'S reliable sub-miniature capacitors

Write today for complete technical information by Bulletin Number.

BE SURE TO SEE US
AT BOOTH 512
WESCON SHOW

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ASTRON'S reliable sub-miniature capacitors

PERFORMANCE CHARACTERISTICS AND TEST SPECIFICATIONS

ASTRON CAPACITORS

FLAT AND ROUND MINIATURE MYLAR® DIELECTRIC CAPACITORS

ASTRON TYPES XFR & XPF capacitors use Mylar® polyester film as a dielectric. A new series of non-metallic case units employ a plastic thermo-setting resin and seal to provide a secure bond between leads and case. Series XFR and XPF are for use in industrial, high voltage requiring minimum size, high capacitance units. Mylar film is extremely flexible and exceptionally low moisture absorption. For added flexibility in design, they are supplied in both flat and round case styles as listed.

PERFORMANCE CHARACTERISTICS AND TEST SPECIFICATIONS

"SAFETY MARGIN" ELECTROLYTIC CAPACITORS

for miniaturized low voltage D.C. equipment
- Smallest hermetically sealed electrolytic capacitor families of 3/16" x 1/4" (14 x 4.4mm) to 1" x 1" (25 x 25mm)
- Very low leakage characteristics for minimum battery drain
- Long shelf and operating life
- Reliable performance at reasonable price

Astron Types EE (epoxy end fill) and EM (epoxy end metal) are miniaturized electrolytic capacitors for extra high reliability, especially for transistorized circuits and other compact or miniaturized low voltage D.C. equipment. They will find their main applications in military reliability equipment and in critical industrial circuits. Astron's "Safety Margin" construction is your guarantee of performance even under adverse conditions — your assurance for equipment reliability.

PERFORMANCE CHARACTERISTICS AND TEST SPECIFICATIONS

I. PHYSICAL CHARACTERISTICS:
   - Minimum unit size: 0.006 cu in (0.1 cc)
   - Maximum case temperature: 250°F (121°C)
   - Rated voltage: 1000 VDC
   - Minimum capacitance: 0.01uf (10nF)

II. STANDARD OPERATING TEMPERATURE RANGE:

III. VOLTAGE RATING

IV. CAPACITANCE STABILITY

ASTRON CORPORATION
255 GRANT AVENUE
EAST NEWARK, N. J.

*Reg. DuPont Trademark
for Super-Fine Cutting of Hard, Brittle Material...
the S. S. White Industrial Airbrasive Unit

Many unusual operations — some on a mass-production basis — can be performed with our industrial Airbrasive Unit. This photograph dramatically illustrates its precise, delicate cutting ability. Developed from the Air-Dent equipment made by S. S. White for the dental profession, the unit gas-propels a stream of abrasive particles at high speed to provide a fast, cool and shockless cutting action.

The unit can be used to etch glass, cut crystals such as germanium and other crystalline forms, remove deposited surface coatings. It can also be used to etch, drill and light-deburr hard, brittle materials.

This is not all — many other practical uses have been found for the Airbrasive Unit. We'll be glad to test the airbrasive process on your sample parts. For further information, just drop us a line.

S. S. White Industrial Division, Dept. D, 10 East 40th Street, New York 16, N. Y.
Western Office: 1639 West Pico Blvd., Los Angeles 6, Calif.

boron, and the oxidation products evaporate.

To carry out the reaction, a liquid silicon zone supported only by surface tension is caused to traverse a vertical silicon rod around which flows a mixture of hydrogen and water vapor. This technique prevents contamination from crucibles and provides a large interface between the silicon and the atmosphere. Under these conditions, removal of boron is very effective, increasing both with time and with water vapor concentration.

This method, used together with the zone refining technique, makes possible the production of silicon having a boron concentration below one part in ten billion and having a resistivity greater than 3,000 ohm-cm.

Press Speeds Assembly of Selector Switch

PRODUCTION AND assembly of multi-deck banks used in telephone selector switches by means of punch press techniques has definitely improved quality and reliability of this Kellogg Switchboard and Supply Co. product, now being made in the Clifton, N. J. plant of Federal Telephone and Radio Co., which is also a Division of IT&T. The eleven contacts and terminals for each
NEW miniature switch...

**MINIMUM DEPTH BEHIND PANEL—**
ONLY ⅛" FOR A
SINGLE-SECTION SWITCH

**SWITCH SECTION IS ONLY 1/16" THICK**

**MINIMUM SPACE BETWEEN SECTIONS—**
5/16" WITH CLIPS ON FRONT AND BACK

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**OAK SERIES “A”**

**LOW-CURRENT ROTARY SWITCH**

**UP TO 18 CONTACTS PER SECTION**

**1/4” SHAFT, STANDARD**

**LOW CAPACITANCE**

**SAME HIGH QUALITY AND RELIABILITY AS LARGER OAK SWITCHES**

Here's new help in the battle of miniaturization. This tiny switch can pare critical space and weight from your designs. The large number of contacts it provides enables you to handle complex circuits, too. The clips on the Series “A” are a miniature version of the famous Oak double-wiping design—long accepted as the standard of the industry for reliability and long life. Oak engineers will be glad to furnish complete information, and work with you in developing the exact variation you need.

Write on Company Letterhead for
a Copy of the Oak Switch Catalog

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**SPECIFICATIONS**

**Index**—Double ball bearing, hill and valley type with stainless steel spring. Fixed and adjustable stops, and locating key available.

**Shafts and Bushings**—1/4" shaft with ⅛-32 bushing is standard; 5/32" shaft with ⅛-32 bushing and ⅛" shaft with ¼-32 bushing can be supplied also. Water seal bushings optional.

**Sections**—8, 10, or 12-position, stacked in any number up to a total depth of three inches. The 12-position section provides up to 18 insulated contacts—12 on front, 6 on back. No insulating blocks are needed on back.

**Clips**—Solid spring-silver alloy or silver-plated spring brass, fastened by solid rivets.

**Insulation**—Stator is silicone fiber glass, meeting specification MIL-P-997 type GSG; rotor is KEL-EP, known for its excellent mechanical and electrical properties.

**Finish**—Commercial or 50 and 200-hour salt spray.

---

**1260 Clybourn Avenue, Dept. G, Chicago 10, Illinois**

Phone: MOhawk 4-2222

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**SWITCHES • ROTARY SOLENOIDS • CHOPPERS • SPECIAL ASSEMBLIES • VIBRATORS • TUNERS**

**ELECTRONICS — September 1, 1957**

Circle 180 Readers Service Card 245
HOW TO BOOST A BLIP...

**you could**

make your dish a "spectacular"

... perch it on a peak

... go "king-size" tube-wise

... and

pour on the coal

**But... why do it the hard way when**

You can do it with E's

... and get a signal that really sings... in smaller space... for pennies instead of kilobucks, ($12.50 in quantity)... without changing your existing system or equipment.

The 1N23E at X and C band and the 1N21E at S and L band provide a typical receiver noise figure of 7.0 db.

Send for technical bulletin and prices

**MICROWAVE ASSOCIATES INC.**

Burlington, Mass.
BUrlington 7-2711

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But... why do it the hard way when...
EVERY DAY MORE SOLDERLESS CONNECTIONS ARE MADE WITH KELLER "Wire-Wrap®" TOOLS

Five years ago Keller "Wire-Wrap" tools began saving time and materials in the assembly of electrical connections. The electronic industry was quick to see the advantages of a solderless, metal-to-metal connection that resisted vibration failure and corrosion. Today, "Wire-Wrap" tools have made well over 700 million connections without a reject.

ADVANTAGES
- SPEED—2 seconds total time per connection.
- NO OPERATOR FATIGUE—"Wire-Wrap" tool weighs only one pound.
- AIR OR ELECTRIC POWER TOOL—straight or pistol-grip handles.

WRITE FOR INFORMATIONAL BOOKLET

ENGINEERING FORESIGHT—PROVED ON THE JOB IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER - DENVER
Gardner-Denver Company, Quincy, Illinois

ELECTRONICS — September 1, 1957  Circle 182 Readers Service Card

247
BALLANTINE SENSITIVE ELECTRONIC

VOLTMETER

Better than 2% accuracy over entire frequency and voltage range AT ANY POINT ON METER SCALE!

- Stability insured by the exclusive use of wire-wound resistors in the attenuator and feedback network.
- Same accuracy of reading at ALL points on the logarithmic voltage scale and linear decibel scale.
- Only ONE voltage scale to read with decade range switching.
- No "turn-over" discrepancy on unsymmetrical waves.
- Accessories available to extend the range to 20 µv and to 42,500 volts.
- Available Precision Shunt Resistors convert voltmeter to microammeter covering range from 1 microampere to 10 amperes.
- Provides 70 DB amplifier flat within 1 DB from 10 cps to 15C ke.

SPECIFICATIONS

VOLTAGE RANGE
.001v to 100v

FREQUENCY RANGE
10 cps to 150 kc

ACCURACY
2% ENTIRE RANGE

INPUT IMPEDANCE
½ meg shunted by 30 µf

Featuring a Logarithmic Voltage Scale and Uniform Decibel Scale

MODEL 300
Price $210.

Write for catalog for more information about this and other Ballantine voltmeters, amplifiers, and accessories.

BALLANTINE LABORATORIES, INC.
100 FANNY ROAD, BOONTON, NEW JERSEY

STEP 2—With bank assembly in position on slide, operator inserts positioning pin. Right hand is on lever which will later be pulled to move slide under press.

STEP 3—After shearing, operator removes positioning pins, then retracts slide of a special Denison Hydraulic Multipress, for sale as scrap.

Shearing—The press operator pulls out the loading slide of the press and drops the untrimmed bank unit into it. The bank is so positioned that metal holding pegs can be inserted through holes in the bank end plates and through mat-
Douglas will train you to
PROGRAM
BIG COMPUTERS

...a challenging new field that
offers ground-floor opportunities to qualified personnel

Five years ago, there were less than 100 specialists programming big computers. It is expected that by 1965, industry's needs will exceed 100,000.

Douglas Aircraft, a pioneer in this field, is rapidly expanding its computing operations. You will be trained while working with expert programmers. In Southern California, you can conveniently attend some of the nation's leading universities offering specialized courses in computing. Advancement will be as rapid as your ability to apply your new talents.

Our computing engineers are involved in every phase of aircraft and missiles work...including many long-range commercial and military projects of vital importance.

Programming requires an alert and logical mind and the ability to organize large projects without losing sight of details. If you have had formal training in mathematics, science or engineering, your professional future at Douglas in programming can be unlimited.

For complete information, write:

JOHN LOWE
CHIEF, COMPUTING ENGINEERING SECTION
DOUGLAS AIRCRAFT COMPANY
BOX F-620
SANTA MONICA, CALIFORNIA

ELECTRONICS—September 1, 1957
According to Mrs. L. B. Q. (who is pictured in the above candid photograph of the advertising department's mail department and is in charge of Sigma premiums, box tops, blown tops and the like) Sigma's July offer of free Slidecharts has turned into a polymorphous hydra.

Now it becomes necessary, due to the laws of Kirchoff and diminishing returns, to terminate the free offer.

Hereafter we'll be glad to oblige, but at 25¢ (C. I. A.) per. (It's either this, fellows, or raising the price of Sigma relays.)

Don't think we do not appreciate the interest displayed— it's just . . . .

Still free is the EBG reprint which resumes SIGMA products and is big enough so you can read it.

*Cash, stamps or rare fiduciary objects.
Three HEADLINERS from a broad line of fine quality capacitors

METAL ENCLOSED Tubulars per MIL-C-25A

“CP” capacitors are the widely accepted standards of military equipment designers.
Quality of product and dependability of service bring a steady flow of new customers to Good-All Electric for “CP” requirements.
Good-All specializes in Types CP04, CP05, CP08, CP09, CP10 and CP11. Approvals are listed by ASEA in the current issue of the QPL.

Good-All Type 663-UW SPACE-SAVING Sub-Miniatures with a SKIN-TIGHT Case

Type 663-UW is an ideal choice for miniaturized and transistorized products. The space-saving possibilities are amazing.

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Available for delivery from Stock.
Mylar, DuPont's trademark for polyester film.

Good-All EPOXY Coated Ceramic DISCS

Something really new! The tough, durable Epoxy coating provides excellent moisture resistance and high voltage breakdown strength. The lead entries are tightly sealed.

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Immediate Delivery on Standard Items.

Write or phone for consultation on specific design problems or to secure detailed specifications on our complete line of Tubular and Ceramic disc capacitors.

Soon in stock at your local distributor.

GOOD-ALL ELECTRIC MFG. CO., O'GALLALA, NEBRASKA
MARS-LUMO CHROM

makes possible an important new drafting technique. It's not just a colored pencil; it's a color-drafting pencil. Twenty-four colors—and every one reproduces perfectly. Lets you draft with as many colors as you need. Saves time, prevents mistakes.

- won't fade
- won't smear
- really waterproof
- erases perfectly
- keeps finest point

Send for free sample

Other new Mars products include: the Mars-Pocket-Technico for field use, the Mars "Draftsman's" Pencil Sharpener with the adjustable point-length feature, and the efficient, clean Mars lead sharpener. All available—along with the established standards: Mars-Lumograph black graphite drafting pencils, Mars-Technico lead holder and leads, and Tradition-Aquarell painting pencils—at all leading engineering and drafting supply dealers.

J.S. STAEDTLER, INC. HACKENSACK, NEW JERSEY

STEP 6—Rubbing terminals across iron plate to knock off surplus solder while still molten

position, the permanent comb on the press pushes out the two temporary spacer combs. These slide down a chute into a pan below, in easy reach of the operator for use on the next bank.

With the bank unit in position, the operator pushes down the two actuating valves of the press. This shears all surplus metal at once. The scrap metal and the spacer assembly drop down through a hole in the bed of the press onto a forward-facing chute. The operator then takes the scrap pieces out of the spacer unit and places the spacer back on the press after removing the positioning pins, retracting the slide, and taking out the sheared assembly.

Tinning of terminals is the final operation. The operator rocks the terminals first through a pan of rosin flux, then slowly through a solder pot. Immediately after withdrawing from the pot, the terminals are quickly rubbed across an iron plate alongside the pot. This removes surplus solder and prevents bridging across terminals.

Installing Coils In Servo Motor Stator

CAREFUL ATTENTION to product design makes possible the installation of 16 coils in the external slots of stators for precision miniature servo motors with a minimum of
Sled trains snowhaul 34,000 tons of supplies to speed new Nickel mines into production

3 Nickels help Philco step up life of new HF transistors

These new Philco Surface Barrier Transistors demonstrate top-notch stability, life and performance to 50mc and above.

One reason is low power consumption ... under one milliwatt. Another is Philco's use of three Inco Nickels.

To insure a strong, contamination-free support for the germanium, Philco makes the tabs of Electronic Grade "A" Nickel. Ductile "A" Nickel is used for the can, too . . . makes it rugged, corrosion-resistant. And for tolerance stability, the whisker wires are made from spring-temper Permanickel* age-hardenable, electrically conductive nickel.

New Name for Old Alloy

Recently a wrought alloy, widely used in cable shielding and in CR and other special tubes, was renamed. Formerly "S20" Monel alloy, it is now "403" Monel nickel-copper alloy. Above room temperature, this highly workable alloy stays practically non-magnetic. Permeability is 1.2 max. at 27°F. max. (H = 0.5 oersteds.)

"403" Monel alloy . . . Nominal Composition %

Ni (+Co) 58.65 Cu 38.75 Mn 1.80 S 0.005 Fe 0.40 Si 0.30 C 0.12

Power Klystron for Scatter Transmission

Nickel in gun components steadies tube operating characteristics

Last winter Inco-Canada shuttled 24 diesel sled trains over a 35-mile snow trail in northern Manitoba south-west of Hudson Bay. Object was to get a flying start on the construction of two new Nickel mines . . . part of an Inco program for adding over 100 million pounds a year to Nickel output.

1000 trips

In this gigantic snowhaul, sled trains made 1000 trips laden with equipment to start work on the mines and the new townsite while a railroad spur line was being built.

In addition to new mines, the project includes new concentrating, smelting and refining facilities. The expected boost in Nickel availability is good news for many now working on designs calling for the special properties of Nickel and Nickel alloys.

This is a typical Eimac Klystron, employing an oxide coated Nickel cathode. A similar Klystron has shown no drop in cathode emission or efficiency after more than a year of operation at 8000 volts and 500 milliamperes.

To help achieve this, Eimac uses Inco Electronic Grade "A" Nickel . . . in cathode button, as the oxide base; in shields, cylinders, supports. The Nickel boosts life, aids conductivity, retains dimensions despite bombardment at high temperatures.

THE INTERNATIONAL NICKEL COMPANY, INC. • 67 Wall Street • New York 5, N. Y.

For more information on Inco products mentioned above, use reader service number or write.

ELECTRONICS — September 1, 1957  Circle 182 Readers Service Cord  253
special tools and fixtures. In the procedure used at the Mechatrol Division of Servomechanisms, Inc., the coils come in strings of eight, with coil sides already protected by Teflon tape and with color-coded leads attached.

- **Insulating**—At the assembly position, the operator places in a simple holder the temporary supporting arbor for the stator stacks, then applies Teflon tape over the sleeves projecting from the heavier end spiders of the stack.

- **Loading** — The operator now places the coils in the stator slots with her fingers. A packing tool is used to bottom the coils which have been inserted, to facilitate insertion of the second coil in each slot.

After all 16 coils have been in-
Get up in the world!

Your engineering career will thrive on the opportunity at Western Electric

How would you like to work in a place where there’s a constant need for new products, new processes, new ideas? Where the technical job brings engineers in touch with such broad managerial functions as production, merchandising, installation, and many others? Where promotion from within is the policy and over 8,000 management positions must be filled in the next ten years by newly promoted people?

Sounds good, doesn’t it? Well, that’s the kind of opportunity that awaits you at Western Electric. Here engineers shoulder key responsibilities in our job of making, distributing and installing Bell telephone equipment... in carrying out, at government request, major defense contracts such as the Nike guided missile system and Sage, the continental defense system.

As a member of this team you’d handle challenging assignments that could involve electronic switching, automation, radio relay for TV and long-distance calls. Your ideas would be welcome... you’d learn... you’d grow!

What’s more, you’d be given every encouragement to grow. We sponsor a full-time Graduate Engineering Training Program during working hours to help new engineers more rapidly assume a full engineering role and to increase the capabilities of experienced engineers. We also offer a Tuition Refund Plan for out-of-hours study at nearby colleges.

You owe it to your ideas and your future to determine the openings for which you may be qualified (mechanical, electrical, chemical, civil engineers, physicists and mathematicians). To apply, send resume of education and experience to Engineering Personnel, Room 1066 Western Electric Co., 195 Broadway, New York 7, New York.


ELECTRONICS — September 1, 1957
For saturating Alnico magnets weighing up to 34 lbs. and high flux ceramic magnets of any shape or pole configuration. Operates on condenser discharge principle from regular 115-volt, 60-cycle line.

Charging outputs from 100,000 to 200,000 ampere-turns through plug-in transformers, up to 3600 watt-seconds using wire-wound fixtures. Adapters for multi-pole rotors, rod, bar, ring and various other shapes available. Designed for continuous production use with low power consumption. Price of basic unit is less than $2100.

A basic condenser discharge unit for most medium size magnets, the Model 107A provides ranges of 12,000 and 24,000 ampere-turns. It is capable of saturating most instrument magnets, including the new core type mechanisms, using adapters or wire-wound fixtures. Designed for continuous duty. Operates from 115-volt, 60-cycle line. Price $530.

A low cost, condenser discharge unit employing novel, plug-in wire-wound type charging fixtures, the Model 1221 is designed for the user of small magnets. Its 10,000 ampere-turn output will saturate about 2" of Alnico V. Charging cycle rate is approximately 3 seconds, continuous duty, operates from 115-volt line. Price $180.

Performance of all models is rigidly guaranteed. Prices are net f.o.b. Boonton, N.J. and subject to change without notice.

stalled, a flat-bladed packing tool is run into each slot in turn to make room for the Phenolite fiber-glass slot wedges which hold the coils in place. As the flat tool is pulled back, this stiff insulating strip is pushed in after it to the full length of the slot. The strip is then bent up sharply to break it off. The other 15 slots are closed in the
How 'dag'® can spell the difference between possible and impossible!

Take the case of International Business Machines Corporation, for example. At the company's Kingston, New York plant, a dip in a 'dag' dispersion makes it possible to plate a conductor through holes in copper clad phenolic sheets.

Used in the production of printed circuit cards, the pierced sheets are dipped in a solution of 'dag' dispersion #154 and alcohol. The sheets then pass through rubber rollers which remove excess solution from the surface and are then conveyed through an oven to dry. Following this, an automatic sanding machine removes excess graphite from the surface, leaving a graphite coating on the walls of the holes in the sheet.

Conductors are then plated through these holes in production of printed circuit cards for the IBM SAGE Computer produced for the U.S. Air Force.

This is only one of many practical benefits of 'dag' colloidal graphite dispersions. An Acheson Service Engineer will be glad to consult with you on any problem you may have, where a graphite coating can help you. Bulletin 433 will provide additional valuable information; for your copy, address Dept. E9.

ACHESON COLLOIDS COMPANY
Port Huron, Michigan...also Acheson Colloids Ltd., London, England

ACHESON COLLOIDAL DISPERSIONS:
Graphite  Mooydenum Disulfide  Zinc Oxide  Mica and other solids

Offices In: Boston - Chicago - Cleveland - Dayton - Detroit - Los Angeles
Milwaukee - Philadelphia - New York - Pittsburgh - Rochester - St. Louis - Toronto

ELECTRONICS — September 1, 1957

Circle 190 Readers Service Card
Here's the famous Revere glaswitch in a relay...individual contact pairs hermetically sealed...immune to contact contamination and mechanical "bugs"...operating time less than 2 milliseconds. Tamper proof...small...easily stacked. Used for telemetering read-out and many other applications. Suitable for explosive atmospheres.

The Revere glaswitch relay shown consists of an actuating coil and four SPST magnetically operated, hermetically-sealed glaswitches. Assembly is mounted in shock-resistant rubber and enclosed in a steel housing for magnetic shielding and protection. Relays can be stacked in any combination without interaction; number of contacts can be varied; 6, 12, 24 or 48 V.D.C. coils, mounting and plug-in provisions to suit specific applications.

**CHARACTERISTICS (24-Volt Coil):**
- **Contact Rating:** At 24 V.D.C.: 0.5 amp inductive
  \( (L/R = 0.026) \) or resistive.
- **Contact Form:** Normally open or normally closed.
- **Contact Surface:** Electro-plated rhodium.
- **Sensitivity:** Approximately 500 milliwatts.
- **Operating Time:** 4.5 milliseconds at 24 volts D.C.
  1.9 milliseconds at 50 volts D.C.
- **Temperature Rise:** 10°C at 24 volts D.C.
  (Continuous) 30°C at 50 volts D.C.
- **Contact Life:** 100,000 cycles guaranteed at rating specified above; increases rapidly as load decreases.
- **Small Size:** 0.88" x 0.88" x 0.25"

---

**NEW**

**glaswitch* relay**

...hermetically sealed contacts

**LIGHTNING RESPONSE ...LOW CAPACITANCE**

(Shown Actual Size)

**How would you apply it?**

- **HIGH SPEED SWITCHING**
- **LOW CAPACITANCE REQUIREMENTS**
- **DRY CIRCUIT SWITCHING**
- **EXPLOSIVE ATMOSPHERES**
- **HIGH CYCLING REQUIREMENTS**
- **PULSE CIRCUITS**

Send for Engineering Bulletin 1001

---

Operator has placed yoke rings in position on thimble and is preparing to operate press controls with both hands to push rings down against those already on stator. Complete stator with yoke rings can be seen on bed of press the same manner to complete assembly of the stator.

**Installing Yoke**—The stator assembly is placed in a holding fixture on the bed of the press and a guide thimble is slipped over the top end of the temporary stator arbor to protect the windings. The electrical steel yoke rings are placed on this thimble a few at a time, then pushed down over the stator laminations with the air-actuated arbor press. The process is repeated until sufficient rings have been applied to cover the laminated section of the stator. These rings complete the magnetic paths.

**Conductive Films**

**OFTEN IT IS DESIRED** to obtain a resistive coating of known resistance which will remain stable when heated in air. A method devised by H. O. McQuary of Naval Research Laboratory, Washington, D. C., eliminates many shortcomings of the conventional painting procedure. In this method a metallic coating is evaporated onto a clean nonconductor, such as glass in a vacuum of \( 10^{-3} \) mm Hg or better. A test strip with electrodes attached is placed in the same plane close to the piece to be coated. Resistance of the test piece is monitored with an external meter. An auxiliary evaporator is arranged in the same bell jar to place a protective coating of silicon monoxide...
Ohmite offers the most complete line of wire-wound, vitreous-enameled POWER RESISTORS on the market... fixed, adjustable, tapped, noninductive, and precision resistors in many sizes, types of terminals... available in a wide range of wattages and resistances.

Write on company letterhead for Catalog No. 40.

BE RIGHT WITH OHMITE

RHEOSTATS - RESISTORS - RELAYS - TAP SWITCHES TANTALUM CAPACITORS - VARIABLE TRANSFORMERS

OHMITE MANUFACTURING COMPANY
3510 Howard Street
Skokie, Illinois

WELDED RESISTANCE WIRE Ohmite Resistors have the resistance wire welded to the terminals instead of soldered or brazed. This provides a perfect and permanently stable electrical connection that is unaffected by vibration or high temperature.

WELDED TERMINALS Another Ohmite Resistor feature is the welded terminal band. The band is permanently held together around ceramic core by means of welding, providing a strong, permanent fastening.

STRONG CERAMIC CORE This strong, rugged core has excellent electrical characteristics, and is unaffected by cold, heat fumes, or high humidity.

EXCLUSIVE HIGH TEMPERATURE VITREOUS ENAMEL This special-formula enamel was developed by Ohmite after extensive research. Its thermal expansion is properly related to that of core, terminal, and resistance wire.

Ohmite offers resistors in more than 60 sizes—ranging from 2½” diameter by 20” long to ¼” diameter by 9/16” long—to meet your exact requirements. MANY SIZES ARE CARRIED IN STOCK.
Let the Bureau solve your etched wiring problems

Whatever your needs in boards...routine or extraordinary...custom quantities or hundreds of thousands...the Bureau offers you the complete service. Bureau engineers are fussy about specifications. You get the accuracy and quality control you need. Bureau engineers appreciate deadlines. You receive delivery as ordered.

We offer the following services...

- Drafting
- Photoetching
- Tool Design
- Fabrication
- Flushing
- Silk Screening
- Post Forming
- Custom
- Laminating
- Through-hole
- Plating
- Electroplating
- Solder
- Copper
- Nickel
- Rhodium
- Gold
- Silver

Write! Wire! Phone! Let the Bureau help you!

FREE 8-Page Booklet No. 120
Come along on a photo tour of the Bureau's fully-equipped research laboratory and factory facilities for the quantity production of etched wiring boards.

Inserting R-C Networks in Plated Wiring Boards

Epoxy-encapsulated resistor-capacitor networks designed for high humidity resistance and adaptability to manual or automatic placement in printed wiring boards are now in production at General Electric's Specialty Electronic Components Dept. in Auburn, N. Y.

The network plate is encapsulated in an epoxy resin inside a molded nonporous phenolic case. The uniform size and surface of the network plate are maintained by a molded projection on the phenolic housing. The uniform size and surface of the network plate are maintained by a molded projection on the phenolic housing.

Manual placement in plated wiring board. Molded projections on phenolic housing keep unit above board so solder can form fillets around leads on top of board.

PRODUCTION TECHNIQUES (continued)

over the resistive coating before the latter is exposed to air.

By this method it has been possible to apply resistive coatings within 5 percent of a required value and stabilize these coatings to within 1 percent over a temperature range of 20°C to 450°C. The method has proved very valuable in the development of resistive vanes for variable r-f attenuators as well as broadband r-f loads.

UN RETOUCH ED PHOTO
3 TIMES ACTUAL SIZE

Talk about precision! This tiny nickel and rhodium plated board of epoxy glass for a micro timing switch is accurately etched to a minimum path width of 0.0035" with a minimum distance between paths of 0.0025". This is typical of precision production by the Bureau.
Single New Rectifier Outperforms

12 full size conventional stacks!

Radio Receptor HCD* Petti-Sel *High current density

Industrial Type Selenium Rectifiers

Produced by the improved new vacuum process developed by Siemens of West Germany and now manufactured exclusively by Radio Receptor in the U.S.

- Smaller cell sizes
- Lower voltage drop
- No artificial barrier
- Negligible aging with an estimated life of 100,000 hours!

Because the exclusive Siemens vacuum process eliminates the need of an artificial barrier layer, it is possible for Radio Receptor to offer smaller cell sizes operating at high current density, yet with lower voltage drop. In actual dimensions this means that just one RRco. HCD rectifier measuring 8" x 16" x 25", rated at 26V AC, 4500 amps DC, replaces twelve usual stacks 6" x 7¾" x 10".

RRco. Petti-Sel rectifiers do far more than save space. They reduce assembly time, require fewer connections and cost less per ampere. Their dependability has been proved for years in European circuits and the outstanding electrical characteristics are not even approached by other standard cells available today. For further information please write today to Section E-9R.
network case, and an index chamfer on the upper left corner of the case, facilitate magazine loading for automatic placement.

The networks have such radio and tv receiver applications as coupling, pulse-forming and R-C filter networks.

Resistor values range from 1,000 ohms to 10 megohms and capacitor values range from 100 to 10,000 micromicrofarads. Leakage resistance of the capacitors is greater than 10^10 megohm-micromicrofarads. The operating temperature range of the networks is from 10 to 85°C.
Here's the answer to prototype parts and short run production...

DEEP DRAWING, HYDROFORMING, SPINNING, STAMPING, PIERCING, ASSEMBLING, SPOT WELDING, ANNEALING, TOOL MAKING, ETC.

PRECISION METAL FORMING

Complete Service from Design to Delivery!

Consult KAUPP for accurate metal components in production quantities, short runs or prototype pieces. Precision metal-working machines combined with a quarter century of experience assures high speed metal forming to closest tolerances. KAUPP engineers will be happy to discuss your requirements and make recommendations on the economical production of your precision metal parts or sub-assemblies. New catalogs and bulletins available now. Request your copies, today!

C. B. KAUPP & sons
NEWARK WAY, MAPLEWOOD, N.J.—Tel. SOuth Orange 3-2490

Metal Craftsmen since 1924
X-BAND MAGNETRON

Microwave Associates, Inc., Burlington, Mass. A 40-w, high reliability, X-band pulsed magnetron has been developed for operation in the frequency range from 8,800 to 9,600 mc. It is particularly suited for use in airborne radar beacon and navigation systems.

The tube is rated at 40 w peak pulsed power output at a 25-per cent duty cycle for maximum pulse lengths of 5 µsec. Substan-
tially higher peak powers may be achieved with shorter pulse durations and reduced duty cycle requirements. Frequency and amplitude modulation of the magnetron output pulse has been measured at less than ±30 kc modulation deviation in experimental models. Operating efficiency of the MA-215 is 20 to 30 percent. A ceramic cathode bushing structure is used for increased reliability.

The new magnetron weighs approximately 20 oz. Circle 401 on Reader Service Card.

SILICON RECTIFIERS

Hoffman Semiconductor Division, Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ill. Especially suitable for airborne supplies and other military and industrial applications, the Top Hat design silicon medium power rectifiers are available in the following RETMA types: IN536, IN537, IN538, IN539, IN540 and IN1095.

These rectifiers are the result of much research, testing and experimentation. Current ratings are up to 250 ma at 150 C ambient; peak reverse working voltages up to 500 are just two of the many features which can be found in technical data now available from the firm. Diffused junction of the rectifiers offers long life and high efficiency. Circle 402 on Reader Service Card.

PULSE TRANSFORMERS

Telex, Telex Park, St. Paul 1, Minn. High reliability encapsulated and hermetically sealed pulse transformers are now being manufactured to meet military and civilian requirements.

These units meet rigid military specifications such as MIL-T-27 and operate at ambient temperatures up to 85 C. Special designs for high acceleration applications are available for specific customer requirements.

Also available are subminiature pulse transformers for printed wiring board, transistorized circuit and miniaturized circuit applications. All units meet standard voltage, life, pull, temperature, immersion and moisture resistance tests. Circle 403 on Reader Service Card.

COUNTER TUBE

Anton Electronic Laboratories, Inc., 1226-1238 Flushing Ave.,
Because your production lines must roll evenly, we've geared our production to roll in valleys and peaks, if need be—so that your C-D capacitors will arrive the day you need them. That's why seasonal production peaks are never too much for C-D's 16-plant manufacturing capacity.

Typical C-D "Million-Dollar Body" Ceramics:

**DISC TYPES:** Temperature compensating, stabilized capacity, general purpose bypass, high voltage, A-C line bypass.

**AUTOMATION:** Plug-in termination available in temperature compensating, stabilized capacity, general purpose bypass, close tolerance disc types.

**SPECIAL DESIGN TYPES:** Feed-thru, stand-off, spool types are among the many special design ceramic types developed by C-D in accordance with customers' specific requirements, with particular reference to the high frequency field.

Write for catalog to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.
Brooklyn 37, N. Y. Type 307 is a miniaturized and ruggedized high sensitivity beta and gamma radiation counter tube especially designed to provide quantitative measurement of radioactivity for such purposes as uptake studies, medical diagnosis, tracer work and process control. It is especially useful for the localization of small amounts of radioactive tracers in body cavities.

The type 307 is filled with neon plus a halogen admixture; operates in the Geiger region; and cannot be damaged by overvoltage. Temperature changes within the range −55 C to +75 C will not affect the response or sensitivity. Transmission characteristics of the wall are given in the AEL tube catalog. Other technical information is available. Circle 104 on Reader Service Card.

SERVO DIGITIZER operates from 400 cps line

Industrial Control Co., 805 Albin Ave., Lindenhurst, L. I., N. Y. The SL-1004 is a packaged, servo driven digitizer, designed to digitize an a-c input signal. It operates directly from the 400 cps line, and is packaged for inclusion in larger equipment. It includes a miniaturized, high gain transistor-magnetic servo amplifier and power supply.

The output is binary-decimal, and the encoder shaft is driven ±170 deg from null. Full scale corresponds to 10 v rms 400 cps, in phase with the line. The static error is 0.15 percent of full scale, and fast rates can be followed with a velocity error constant of 500 sec⁻¹.

Typical applications are ground and flight instrumentation, analog translation to feed digital computers, as an input to a card or tape system, and for laboratory demonstrations. Circle 405 on Reader Service Card.

BINARy TRANSFORMER is tape wound

Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass., announces a tape wound binary transformer which is shock mounted to withstand 10 g's at 2,000 cps. The tiny toroid coil is supported top and bottom with special silicone rubber which does not change in environmental conditions. This type of support prevents shock and pressure upon the core from changing the hysteresis characteristics.

These transformers have been produced in production quantities for a military project and each has been hi-potted at 110 v for 100 hours while being cycled between −65 and 80 C. Binary transformers of this type are now available for general application to specific customer ratings. Circle 406 on Reader Service Card.

TIME INTERVAL METER with ±1 µsec accuracy

Computer-Measurements Corp., 5528 Vineland Ave., North Hollywood, Calif. Model 251-A time interval meter is designed for precise measurement of elapsed time between two events occurring in the range of 3 µsec to 1 sec. Optional features permit extension to 10 or 100,000 sec. Typical applications are: ballistics measurements, relay timing, photographic timing and testing of timing devices.

Among the features are two independent, continuously adjustable trigger level controls permitting full rated sensitivity—0.2 v rms—at any voltage level between −300 and +300 v. There is provision for oscilloscope marker signals for trigger level adjustment of start and stop points for time interval measurement of complex waveforms. Circle 407 on Reader Service Card.

POWER SYSTEMS for electronic equipment

Dynamic Controls Co., 1955 Massachusetts Ave., Cambridge, Mass. These control systems for the application of power and protection of electronic equipment are constructed to minimize downtime for the entire system. They contain the following features: automatic
For ACCURATE HIGH SPEED SWITCHING...
Specify ELECTRO TEC

Precision Selector Switch

- Withstands Shock and Vibration
- Offers High Accuracy Measurement
- Operates at High Speeds

This new Electro Tec Precision Selector Switch is ideal where miniature size, low friction torque, high accuracy, and low electrical noise at high speeds are requirements. Simplified circuits and long service life recommend it for a wide variety of uses including sampling, pulse generation for precision measurement, telemetering and strain gage applications, in aircraft, missiles, servos, computers, etc. Switch design incorporates many exclusive features that have gained industry-wide acclaim for Electro Tec precision slip rings, commutators and brush blocks.

CALL OR WRITE FOR ILLUSTRATED BROCHURE

8 or 10 position switches in standard size 10 synchro housings are available for immediate delivery; other circuit combinations supplied to specifications.

Electro Tec Corp.  
SO. HACKENSACK  
NEW JERSEY  
Tel. Hubbard 7-4940
**ERA'S NEW**

**automatic transistor noise figure meter**

- For Transistor laboratory and production application
- Simplified automatic operation
- Continuous reading basis
- Maximum stability
- Increased sensitivity
- Increased accuracy

Newly developed Model NFT-2 automatically and accurately measures Noise Figure of all types of transistors and transistor amplifiers on a continuous reading basis. Just plug in the transistor or amplifier and read directly on the meter.

Indispensable for low noise figure selection, optimization of circuit and operating parameters, quality control and production testing, reliability evaluation, and all factory and laboratory Noise Figure applications.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise Figure Range</td>
<td>5 to 65 dB</td>
</tr>
<tr>
<td>Measurement Freq.</td>
<td>1000 cps center f*</td>
</tr>
<tr>
<td>Type of Reading</td>
<td>Direct Reading</td>
</tr>
<tr>
<td>Input Circuit</td>
<td>500 ohm emitter R</td>
</tr>
<tr>
<td>Emitter Supply</td>
<td>1e, 0-1.0/10 MA</td>
</tr>
<tr>
<td>Collector Supply</td>
<td>Ec, 0-10/100 volts</td>
</tr>
<tr>
<td>Indicating Meters</td>
<td>4½&quot; meters</td>
</tr>
<tr>
<td>Size</td>
<td>Dual Panels, 8¾&quot; x 19&quot; x 14&quot;</td>
</tr>
</tbody>
</table>

*Other frequencies on special order

Model NFT 2 .......................... $775

FOR: Nutley, N. J.

Write for catalog on this and other transistor test equipment.

**Electronic Research Associates, Inc.**
67 East Centre Street, Nutley 10, N. J.

---

**NEW PRODUCTS (continued)**

application and removal of power, gradual increase of filament voltage, sequencing of d-c voltages, voltage and temperature monitors, indications and alarms for quick trouble shooting, detection of power line transients, and automatic or manual marginal checking for the detection of weak components. Check 408 on Reader Service Card.

**DATA DISPLAY UNIT**

with built-in memory

ADVANCED ELECTRONICS MFG. CORP., 2025 Pontius Ave., Los Angeles 25, Calif., has developed a self-contained scope-type display unit which will present a visible record up to 20,000 alphanumeric characters per second. Using a 5-in. Typotron storage oscillograph tube, the new unit has a special storage feature which permits characters to remain visible until intentionally erased, by either manual or automatic control.

Designated the Typo-Scope 301, the unit is designed so that any one of 64 characters, approximately 4 in. high, may be selected by a six-digit binary code and recorded on the screen in any one of 1,024 positions selected by a

---

September 1, 1957 — ELECTRONICS
El-Menco Dur-Mica
CAPACITORS

Rugged Endurance up to 18 years!

A series of the toughest trials prove El-Menco Dur-Mica DM15, DM20 and DM30 capacitors outlast all others under accelerated conditions of 1 ½ times rated voltage at ambient temperature of 125° centigrade. Can be used at higher operating temperatures with slight voltage derating. Longer life and greater stability made possible by specially treated phenolic casing.

El-Menco Dur-Mica DM15, DM20, DM30, DM40 and DM42 Capacitors Provide:

1. LONGER LIFE
2. POTENT POWER
3. SMALLER SIZE
4. EXCELLENT STABILITY
5. PEAK PERFORMANCE

Take Your Own Word For It by making your own test of El-Menco Capacitors. Write for Free Samples and Catalog.
ACEPOT*—ACETRIM* sub-miniature, precision wire-wound potentiometers and trimmers are shooting to new highs!

X-500 "Hotpot" operates from -55°C to 150°C. 3/8" size up to 250K ± .3% linearity proved in use

ACEPOTS and ACETRIMS meet unusually rigid functional and physical requirements and are setting new standards for dependability in sub-miniaturization. The designs are the result of 4 years' development and over a year of successful use by leading electronic and aircraft equipment manufacturers.

Condensed Engineering Data

<table>
<thead>
<tr>
<th>ACEPOT</th>
<th>ACETRIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance Range</td>
<td>10 -t 250K ± 2%</td>
</tr>
<tr>
<td>Size</td>
<td>3/8 x 3/8&quot;</td>
</tr>
<tr>
<td>Linearity</td>
<td>± .3%</td>
</tr>
<tr>
<td>Resolution</td>
<td>extremely high</td>
</tr>
<tr>
<td>Ambient Temperature</td>
<td>-55°C to 150°C</td>
</tr>
<tr>
<td>Torque</td>
<td>low or high</td>
</tr>
</tbody>
</table>

The above specifications are standard — other values on special order.

All units sealed, moistureproofed, and anti-fungus treated. Meet applicable portions of JAN specs and MIL-E-5272A standards.

Ace also offers larger size precision potentiometers, to RETMA specifications, manufactured to highest standards to meet your most rigid requirements. Expedited delivery from special order section.

For applications where you must be positive, answer your potentiometer and trimmer needs with space and weight saving, highly accurate and dependable ACEPOTS and ACETRIMS.

Available in threaded bushing, servo, flush tapped hole or flange mounts, and ganged units. Special shaft lock is self-contained. Internal stops and tabs as required. Indexing pin provides non-rotational mounting.

Expedited delivery on prototypes; prompt servicing of production orders. Write for Fact File and application data sheets.

null indicator
with oscilloscope display

MILLITEST Co., 88 Madison Ave., Hempstead, N. Y., offers a new electronic null indicator, Model 457, for use as a d-c voltage null detector in bridges. Use of a chopper-stabilized amplifier results in a sensitivity of 20 uv/in. with less than 1-µv drift and 1-uv noise.

The balanced input shows an input resistance of 2 megohms. Power consumption is 40 w. Units are available for either cabinet or standard rack mounting. Circle 410 on Reader Service Card.

R-F PROBE
all transistorized

KAY ELECTRIC Co., 14 Maple Ave., Pine Brook, N. J., has introduced the Transiprobe, a new all transistorized broad-band, low capacity r-f probe. It has unity gain which
How to cope with an avalanche of urgent data

Tape keeps ballistic missile tests in manageable form

Nobody intends to get buried, drowned, suffocated or trampled as the floodgates open on one of the biggest of all data-acquisition programs. For its ballistic missile development contracts, General Electric's Missile and Ordnance Systems Department has installed a data-processing and computation center to match the challenge.

A PREFERENCE FOR TAPE

Of the test information received, about 90 percent will be on tape. Two facts about magnetic tape recording help keep the sheer mass of information under control: (1) hundreds of simultaneous parameters are recorded on one tape with a common time base; (2) tape gives live electrical voltages, hence reducing, correlating, computing and handling steps can be done automatically. General Electric's goal is to provide all interested engineering groups with both analog and computed data within three days of receipt of raw tapes.

Tapes from flight test, ground test and component development will be received from sources all over the U.S. These tapes will include quarter, half and one-inch widths. Hence most "tape stations" in the data-reduction system will have three Ampex FR-100 tape transports for the three widths. They will share electronics.

NOVEL USE OF A TELEPHONE TECHNIQUE

The right data must get to each of a large number of research and design groups. No traffic snarls allowed -- so General Electric's engineers have made ingenious use of taped data's electrical form. They use a "telephone central station." After the necessary conversion steps, hundreds of channels of data from magnetic tape are fed into an automatic relay switching system. This connects them into 450 channels of oscillographic writeout (30 oscillographs with 15 channels apiece). When desired one input can go through a multiple relay putting the same data trace on two or more of the oscillograph records. Programming is done by a carefully checked paper tape. The end result is visual traces in a desired side-by-side relation. And each oscillograph record contains the data of interest to particular engineering groups.

Magnetic tape comes to life again in computation. The visual records are marked wherever special computer effort is required. Another group

of Ampex FR-100 Tape Reproducers plays the tapes through a high-speed analog-to-digital conversion system which finds and converts selected sections to digital form at a rate of 45,000 conversions per second.

If mass of data is your problem, we would be pleased to discuss some practical answers. Or would you like to have this informative ad series mailed direct? For either request, write Dept. E-7.
DECADE RESISTANCES

... with precision wirewound resistors mounted on steatite-insulated switches. TEN resistors per decade ... giving better than 0.1% accuracy above 10 ohms.

<table>
<thead>
<tr>
<th>Type</th>
<th>Dials</th>
<th>Ohm Steps</th>
<th>Total Resistance (Ohms)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>817</td>
<td>3</td>
<td>0.01</td>
<td>11.1</td>
<td>$60.00</td>
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<tr>
<td>818</td>
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<td>111</td>
<td>51.00</td>
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<tr>
<td>820</td>
<td>3</td>
<td>1</td>
<td>1,110</td>
<td>16.00</td>
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<tr>
<td>821</td>
<td>3</td>
<td>10</td>
<td>11,100</td>
<td>60.00</td>
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<td>824</td>
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<td>10,000</td>
<td>11,100,000</td>
<td>120.00</td>
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<td>0.01</td>
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<td>75.00</td>
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<tr>
<td>819</td>
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<td>10</td>
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<tr>
<td>833</td>
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<td>10</td>
<td>111,110,000</td>
<td>160.00</td>
</tr>
</tbody>
</table>

*Knob (P/N-25594) not included. Available at additional cost.

DECADE VOLTAGE DIVIDERS

... same quality construction as in Decade Resistances. Choice of Kelvin-Varley or conventional potentiometer circuits.

KELVIN-VARLEY CIRCUIT

<table>
<thead>
<tr>
<th>Type</th>
<th>Dials</th>
<th>Ohm Steps</th>
<th>Input Resistance (Accuracy ±0.05%)</th>
<th>Price</th>
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<tr>
<td>8350</td>
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<tr>
<td>8348</td>
<td>4</td>
<td>0</td>
<td>100,000</td>
<td>150.00</td>
</tr>
</tbody>
</table>

*RESOLUTION—Any ratio between 0.0060 and 1.0000 in steps of 0.0001.

POTENTIOMETER CIRCUIT

<table>
<thead>
<tr>
<th>Type</th>
<th>Dials</th>
<th>Ohm Steps</th>
<th>Total Resistance (Accuracy ±0.1%)</th>
<th>Price</th>
</tr>
</thead>
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<td>0.1</td>
<td>10,000</td>
<td>$126.00</td>
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<tr>
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<td>836</td>
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<td>849</td>
<td>5</td>
<td>0.1</td>
<td>10,000</td>
<td>165.00</td>
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<tr>
<td>848</td>
<td>5</td>
<td>1</td>
<td>100,000</td>
<td>175.00</td>
</tr>
</tbody>
</table>

NEW PRODUCTS

is held constant by a transistorized feedback amplifier, insuring complete stability. The unit is powered by mercury cell batteries. Standard BNC connectors are provided to the scope and battery-box power supply.

The Transiprobe's low input capacity makes it ideal for use with all types of broad-band oscilloscopes and as an oscilloscope isolation amplifier.

Features include low power dissipation, no hum and open design for easy manipulation. Frequency response is 20 cps to 15 mc; 1 db down at 50 cps and 12 mc; 3 db down at 20 cps and 15 mc. Circle 411 on Reader Service Card.

SILICON RECTIFIERS

are hermetically sealed

WESTINGHOUSE ELECTRIC CORP., P.O. Box 2099, Pittsburgh 30, Pa. Two new silicon power rectifiers (types 302 and 303) are now available. They are hermetically sealed silicon rectifying cells providing d-c currents up to 35 amperes and 22 amperes halfwave, respectively, with a maximum peak inverse voltage up to 600 v.

The forward voltage drop of cell 302 will not exceed 0.9 v at a forward current of 10 amperes in ambient temperatures of 25 to 35 C. Reverse leakage of the cell is a maximum 20 ma at rated peak inverse volts and maximum temperature. Maximum operating junction temperature is 190 C.

For cell 303, the forward voltage drop will not exceed 1.2 v at
New Horizons for Electronic Measurement

Symbol of progress . . . Panoramic's New Home. Modern, up-to-the minute, it provides greater engineering and production facilities . . . helps to open the door for future development in the electronic field still further.

A pioneer in the field of panoramic instruments since 1938, Panoramic Radio Products, Inc., now brings to the service of American industry the result of a long-established and far-sighted program. It is the new and modernly-equipped plant shown above—designed and built for advanced engineering and ultra-efficient production.

Throughout industry from coast to coast Panoramic instruments for measurement and visual analysis are simplifying and speeding analyses . . . eliminating slow, less-certain methods of measurement . . . aiding research and development . . . clearing production test bottlenecks.

But industry's need for instruments of advanced design is never static. And as the need expands, both for quality and quantity, Panoramic will continue to meet it with its new and modern facilities.

PANORAMIC RADIO PRODUCTS, INC.
New Address: 522 South Fulton Ave., Mount Vernon, New York Phone: OWens 9-4600 Cables: Panoramic, Mount Vernon, New York State
**Laboratory Type Current Transformer**

Accuracy 1/2 of 1%.

This NWL current transformer is for measuring extremely low power factors down to 5% with phase angle error to 2.4 minutes leading. The accuracy is 1/2 of 1%.

The current rating of the transformer pictured above is 500.5 amperes. Can be made from 1 to 10,000 amperes.

The same laboratory accuracy can be applied to instrument potential transformers.

Nothelfer Transformers are vacuum-pressure impregnated ... all joints over 10 amperes are silver plated, conserving copper and steel. Laminations, oriented and most silicon steels are annealed in accurately controlled nitrogen atmosphere electric furnaces.

---

**High Power Diode for Long Trouble-Free Use**

International Telephone and Telegraph Corp., Components Division, 100 Kingsland Road, Clifton, N. J., has introduced a high power, high vacuum diode, for use in charging, shunt or rectifier applications.

Designated the F-7030, the new tube has a maximum peak inverse voltage of 25 kv. Under shunt conditions, maximum peak plate current of 75 amperes and average plate current of 200 ma are obtainable. In rectifier applications the ratings are 30 amperes maximum peak plate current and 6 amperes maximum average plate current, respectively. Tube impedance at 250 plate volts is within the range of 65 to 80 ohms.

The external anode of the F-7030 is forced air cooled and is capable of dissipating 2.5 kw at 2.5 in. of water, static air pressure, and 150 cu ft per minute air flow. The tube is also obtainable...
why wait for
RELAYS

LEADING MAKES—LATEST TYPES IN STOCK!

C. P. CLARE
Mercury Wetted Contact

We maintain complete distributor stocks of the following makes:
Advance Relays  Phillips Controls
Automatic Electric  Struthers-Dunn
Clare  Leach Relays
Neomite-Elgin  Terado and Others
Potter & Brumfield

We Anticipate Your Relay Needs
Relay Sales cannot get better delivery from manufacturers than you. Relays now in stock were ordered as long as 10 months ago and selected by men who have specialized in supplying relays to the industry for many years. The items illustrated are typical of hundreds of thousands in stock. They are available in all popular coil ratings and contact arrangements. Why wait for relays? Call us today!

Write or Phone for Same Day Shipment
Phone West Chicago 1100

RELAY SALES, INC.
P.O. BOX 186-A
West Chicago, Ill.
All the unusual qualities required by precision equipment

- and more!

EVANOHM RESISTANCE WIRE

- FOR HIGH SPECIFIC RESISTANCE
- LOW TEMPERATURE COEFFICIENT AND LOW THERMAL EMF TO COPPER
- GREAT STABILITY OVER WIDE TEMPERATURE RANGES

EVANOHM is recommended for all precision applications where complete dependability over a wide temperature range is essential. It is especially well suited for aircraft instruments, guided missiles, rockets and other airborne equipment.

EVANOHM RESISTANCE CURVE

ANALYSIS — Ni 74.75%, Cr 20.00%, Al 2.75%, Cu 2.50%
CORROSION RESISTANCE — Excellent
RESISTIVITY — 800 ohms per circular mil foot (134 microhm cm.)
TEMPERATURE COEFFICIENT OF ELECTRICAL RESISTANCE — Plus or minus .00002 ohms max. per ohm per degree centigrade between -50° C. and +150° C.
THERMAL E.M.F. VS. COPPER — .0025 mv. per deg. between -50° and +105° C.
NON-MAGNETIC
HIGH TENSILE STRENGTH IN FINE SIZES — 150,000 to 200,000 p.s.i.
WORKABILITY — May be readily welded or brazed and soft soldered with special care.
AVAILABLE IN: (A) bare wire .0005 and heavier. (B) Enamelled .0179 and Ener. (C) Formex .008 to .013 on silk, cotton, mica and glass .0179 to .0015.

WITH THE ANODE LIQUID COOLED WITH PLATE DISSIPATION RATINGS UP TO 6 KW. FILAMENT EXCITATION REQUIREMENTS ARE 15 AND 13.75 V FOR RECTIFICATION AND SHUNT APPLICATIONS RESPECTIVELY, AT APPROXIMATELY 36 AMPERES.

MAXIMUM OVERALL LENGTH AND WIDTH ARE 7 IN. AND 3 17/32 IN. RESPECTIVELY. APPROXIMATE WEIGHT IS 6 LB. CIRCLE 413 ON READER SERVICE CARD.

MOLDED RESISTORS FOR MINIATURE APPARATUS

OHMITE MFG. CO., 3631 HOWARD ST., SKOKIE, ILL. MOLDED COMPOSITION RESISTORS IN A TINY 1/10 W SIZE HAVE BEEN ADDED TO THE COMPANY'S LINE OF 1/3, 1 AND 2 W "LITTLE DEVIL" UNITS. THESE NEW RESISTORS, ONLY 0.067 IN. IN DIAMETER AND 0.140 IN. LONG, ARE INTENDED FOR USE IN MINIATURIZED ASSEMBLIES WHERE SMALL SIZE IS MANDATORY.

THE LEAD WIRES ARE MOLDED SOLIDLY INTO THE RESISTANCE MATERIAL FOR A MECHANICALLY SUPERIOR, RELIABLE ELECTRICAL CONNECTION. LEAD WIRES ARE HOT-SOLDER-COATED FOR RAPID SOLDERING.

USED WITHIN THEIR RATINGS, THESE UNITS MAINTAIN THEIR RESISTANCE VALUES CONSISTENTLY UNDER LONG USE AND ARE AVAILABLE IN RETMA VALUES FROM 100 OHMS TO 1.0 MEGOHM, ± 10 PERCENT TOLERANCE. BULLETIN 150 IS AVAILABLE. CIRCLE 414 ON READER SERVICE CARD.

CERAMIC TRIODE HIGH-TEMPERATURE TYPE

FITEL-MCCULLOUGH, INC., SAN BRUNO, CALIF., HAS ANNOUNCED A NEW PREMIUM QUALITY CERAMIC PLANAR...
New positions in INERTIAL GUIDANCE

Few areas of engineering or science offer greater problems—or greater opportunity for achievement—than inertial guidance. At Lockheed Missile Systems, engineers and scientists are performing advanced work on all phases of inertial guidance and navigation.

New positions have been created for those possessing backgrounds in mathematics, physics, electronics, servomechanisms, flight controls, precision instrumentation and computer design. Openings are on the Sunnyvale, Palo Alto and Van Nuys staffs. Those possessing strong interest in inertial guidance are invited to write the Research and Development Staff at Palo Alto 18, or Van Nuys 17, California.

Here R. G. Rickey (left), components specialist, discusses new accelerometer designs with E. V. Stearns, head of the Inertial Guidance Department.
Design with STANCOR stock transformers

You avoid costly delays and special engineering charges by using the wide range of Stancor stock transformers available to you.

Six hundred different units—for almost any electronic application—are as close as your nearest Stancor distributor. Whether you need one transformer or one hundred, you can get immediate delivery through your Stancor distributor.

Write for the latest Stancor catalog, with detailed electrical and physical specifications on all Stancor transformers.

NEW PRODUCTS

Triode. Designated the 3CX100A5, this high temperature ceramic triode has been designed to overcome all disadvantages of the 2C39 types, and is mechanically and electrically interchangeable with that series.

Among the advantages achieved over the 2C39 family are: longer life, 10 percent more power output at 2,500 mc, full ratings to 60,000 ft, lower interelectrode leakage and sustained performance at temperatures to 300 C. It can be employed to 3,000 mc. High quality and close tube-to-tube uniformity are achieved by a series of rigid production tests, including a long pulse cathode evaluation test and a positive grid voltage-current division test. Circle 415 on Reader Service Card.

INSTRUMENT AMPLIFIER

General purpose type

ENDEVCO Corp., 161 East California St., Pasadena, Calif. Designed for impedance matching of piezoelectric transducers or other high impedance signal sources to the direct driving of galvanometers or meters, the new model 2616 amplifier features 3 channels with indi-
individual gains of 1, 3 or 10. A three-decade shunt capacitor is built into each channel to make possible standardization of each transducer to the desired exact sensitivity, such as 10.0 mv/g. Addition of capacity in steps of 10 µf to 10,000 µf is also used to attenuate large signal voltages from piezoelectric transducers.

Input conditions may be selected as 1,000 megohms, with or without d-c isolation, or 22 megohms. Output will drive a 2,500-ohm or higher load, or a 25-ohm load such as galvanometer recorders. Model 2816 features extremely low noise levels and gain linearity of 1 percent. Frequency response is ± 1.5 percent, 2 cps to 15 kc. This compact unit mounts in standard rack and is only 5 in. high. Circle 416 on Reader Service Card.

PUNCHED CARD READER simplifies circuit switching

CINCH MFG. CORP., 1026 S. Homan Ave., Chicago 24, Ill. This punched card reader is a simplified circuit switching device having great versatility, which provides a substitute for patch cord panel systems used in the changing of circuit connections at random intervals. It features a molded block with 400 floating contacts passing from one face to the other. This block is sandwiched between two printed wire boards having strip conductors in various grill-like formations. The contacts make connections between groups of conductors on one of these printed wire boards to other groups on the other, except where a card interposes an insulation. Perforations in the card permit connections to be made where desired, and to be changed by substituting a new card.

Ordinary 3 in. by 5 in. cards are used, containing the 400 hole positions, in a 20 by 20 array. In use, a card is inserted in the slot at the top and the lever closed. Safety features include means for insuring that the card is inserted in the correct position, and that closure is not made while a card is missing. Provision is also made so that the circuits are disconnected before the contacts are opened. This insures that all circuits are dead when closures are made or opened. Due to the wide variety of configurations possible with the printed wiring boards, this reader will find applications in the most complicated circuit switching. Circle 417 on Reader Service Card.

TEST CHAMBER has 10-cu ft work space

TENNEY ENGINEERING, INC., Environmental Division, 1090 Springfield Road, Union, N. J. A new temperature test chamber, the series 10, has a full 10-cu ft work space.

The low-cost chamber incorporates single stage and cascade refrigeration systems with fully hermetic compressors and fitted with air-cooled condensers. Compactly arranged, they require no installation service other than single plug-in electrical connections.

Four standard assemblies are offered with low temperature ranges of -40 F, -85 F, -100 F and -120 F; high temperature ranges of +240 F, and +350 F. Optional relative humidity could be...
NEW PRODUCTS

20 to 100 percent (limited by +35 F dewpoint) and 5 percent at +160 F.
Interior dimensions measure 2 by 2 by 2 ft high, covering floor space of 3 by 3 by 2 ft high. Positive seal is guaranteed by a dual door gasket. Circle 418 on Reader Service Card.

FLAT-TOP RESISTORS
for printed circuits

RESISTANCE PRODUCTS Co., 914 South 13th St., Harrisburg, Pa., has introduced a new flat top, encapsulated wire wound precision resistor design for easy, rapid mounting on printed circuit panels with no support required other than the wire leads.

This new type P resistor is a single ended, miniature series available in 7 sizes—from 3 in. diameter by 5/8 in. long, up to 1 in. diameter by 6 in. long. It features resistance values to 3 megohms, ratings from 1/4 w to 0.4 w. The units can be operated in ambient temperatures up to 125 C. Tolerances are from 1 percent to 0.02 percent. Type P resistors will withstand all applicable tests of MIL-R-93A, Amendment 4. Circle 419 on Reader Service Card.

INERTIA SWITCH
with Automatonic operation

SAFE LIGHTING INC., 527 Lexington Ave., New York, N. Y. A new

NEW LINE of HAYDON *
TIMING MOTORS

Here is a complete line of timing motors that includes the right choice for every APPLICATION...entirely re-designed for finer performance. Features include: slower basic rotor speed (450 rpm), controlled lubrication, total enclosure, smaller size, superior accuracy, quieter operation and longer life.

HYSTERESIS...the ideal general-purpose motor.
INDUCTOR...extra torque (30 ounce inches) for display and other heavy-duty jobs.
CLUTCH...allows automatic resetting without external clutches.
REVERSIBLE...a hysteresis type with 2 coils, each producing opposite rotation.
DIRECT CURRENT...a permanent magnet type for 6 to 32 volts.
400 CPS...miniature and heavy-duty models for airborne instrumentation.

FOR COMPLETE INFORMATION, write today for new catalog...or contact the HAYDON Field Engineer nearest you.

A SUBSIDIARY OF GENERAL TIME CORPORATION

HAYDON Manufacturing Company, Inc.
2433 ELM STREET, TORRINGTON, CONN.
miniature inertia switch operates by a radically new, simple principle. It is designed to eliminate usual "stiction" (causing unreliable function), costly, complicated mechanisms, and waste space.

One single moving part, frictionless in operation, momentarily closes electrical contacts, following impact or acceleration above a preset value. Switch setting is easily adjustable from 1.5 g up, tolerance ±0.15. Volume is 1/4 cu. in., weight 3/4 oz.

The switch is used now for aircraft, missiles, electronic and automatonic components. Special designs are available to specifications. Circle 420 on Reader Service Card.

**CRYSTAL FILTER**

priced at $44.50

HYCON EASTERN, Inc., 75 Cambridge Parkway, Cambridge 42, Mass., has introduced a standard line of i-f band-pass crystal filters for improved design of single conversion receivers in the h-f and vhf bands.

Model 2215 KA is designed for voice utilizing a 2,800 cycle 6 db bandwidth. Model 2215KB has a band of 250 cycles and is of primary interest in c-w reception. The units are electrically and mechanically interchangeable and may be cascaded in any combination to achieve selectable selectivity. They may be incorporated between the mixer and i-f amplifier of a single conversion receiver. No padding or transformation networks are required between the two filters since they are designed to operate at the same impedance level. Complete instructions including mixer and i-f circuitry are supplied with the filters. Circle 421 on Reader Service Card.

**TRANSFORMERS**

use new sealing method

TRIAD TRANSFORMER CORP., 4055 Redwood Ave., Venice, Calif., announces a new method of epoxy molding called Tri-Seal. The process provides all the advantages of hermetic sealing plus greater ease of handling and installation.

The transformers illustrated possess the additional advantages of (1) holding close tolerances on terminal positioning for use in printed circuitry, and (2) hollow goldplated terminal pins which rivet over for better mechanical and electrical connections.

Tri-Seal transformers are designed to exceed MIL-T-27A requirements. Circle 422 on Reader Service Card.

**CHOPPERS**

for top application utility

THE BRISTOL Co., Waterbury 20, Conn. The company's Syncroverter...
We Like to Help Control Quality

...it's Our Business!

Quality control at Lewis Spring is the most important factor in our business—it is present through every department in our plant from receipt of raw materials to final shipping. It is reflected in our engineering and design and equipment maintenance. It is a basic reason why Lewis Spring has so many good customers—they apply quality control in making their products, too. As an example, Lewis Spring was recently presented an award by Argus Cameras Division of Sylvania Electric Products Inc., Ann Arbor, Mich., for “Excellent Cooperation in Controlling Quality.” We highly appreciate the compliment.

Lewis Spring would like to help your plant control quality...and we wouldn't have to get an award for it, because It's Our Business.

LEWIS SPRING & MANUFACTURING COMPANY
2656 W. North Avenue, Chicago 47, Illinois

LEWIS PRECISION SPRINGS
The finest light springs and wireforms of every type and material

NEW PRODUCTS (continued)

switch, a precision, non-resonant inverter, is now being offered in over 75 optimized variations for low power and dry circuit applications. These different models were designed primarily to meet customer requirements for specific applications.

Wide variations in contact ratings, vibration and shock resistance, and frequency ranges are available to fit specific circuit requirements. Special low-noise and high temperature units are available where needed. Mounting arrangements to meet particular conditions are offered, including standard 7-pin plug-in bases or solder lug connectors with mounting flanges.

The chopper can be furnished in either spdt or dpdt switching action. Miniature and larger sized unit are available. Circle 423 on Reader Service Card.

HIGH PURITY ALUMINA for microwave applications

KEARFOTT Co., INC., 1378 Main Ave., Clifton, N. J., has available high-purity, aluminum oxide ceramics for use in radomes, waveguide components, v-t envelopes and for applications where high resistance to radiation is required.

This alumina has unique dielectric properties in the microwave region. At 50 kmc its loss factor is only 0.000093; X-band and Ku-band loss factors vary from 0.0017 at room temperature to 0.00017 at 1,000 F. Most significantly its dielectric constant of 9.38 ±1 percent remains stable over the entire temperature range, up to 1,000 F. Kearfott's high purity alumina ceramics have a low frequency loss at high temperatures.

Electrical properties, along with high mechanical strength and di-
dimensional stability at high temperatures, recommends the use of this material as microwave insulators and windows. Circle 424 on Reader Service Card.

TAPE RECORDER
for audio-visual field

AUDIO DIVISION OF AMERICAN ELECTRONICS, INC., 655 W. Washington Blvd., Los Angeles 15, Calif. Series AV lightweight recorders, for half track or stereophonic record and playback, are of die-cast construction with three integral motors—one for tape drive and two for take-up.

With push-button operation and safety erase interlock, the recorders accommodate reel sizes up to 10½ in. and are built to operate in either a vertical or horizontal position. All recorders are designed for standard 3½ and 7½ ips, 60 cycle operation; 50 cycle units are also available. Circle 425 on Reader Service Card.

AMPLIFIER
for proportional counting

BAIRD-ATOMIC, INC., 33 University Road, Cambridge 38, Mass. Model 255S amplifier is a nonoverloading, stable instrument designed for use with gas flow counters operating in the proportional region. It is designed to receive power from an associated scaler. High voltage for the instrument's detector can be supplied from a scaler or separate h-v supply. The unit measures 9½ by 4 by 2 in. plus tube height; weight is 4 lb; shipping weight is 10 lb.

Gain is approximately 300; input, from proportional counter; minimum output, 6 v negative, 2 µsec duration. It has a built-in delay line for pulse shaping. Circle 426 on Reader Service Card.

PREAMPLIFIER
photomultiplier type

HAMNER ELECTRONICS CO., INC., P. O. Box 531, Princeton, N. J. The N-352 photomultiplier preamplifier is designed to achieve greater flexibility and wider application in the field of scintillation spectroscopy.

The preamplifier is particularly suitable for driving long coaxial cables with characteristic impedances between 65 and 78 ohms, such as RG6, RG11, RG12, RG59 and RG81. A slight modification will permit a match for 51 ohm cable. Circle 427 on Reader Service Card.

SAMPLING SWITCH
in hermetically sealed case

GENERAL DEVICES, INC., P. O. Box 253, Princeton, N. J. Series 300 high speed sampling switch has up to two poles with 30 nonshorting channels per pole. The switch is driven by either a 28 v d-c motor equipped with a governor, arc-suppression and an r-f filter, or an 115 v, single phase, 400 cps hysteresis synchronous...
Here's the "HOTTEST" AC Relay on the market —

New High-Temperature UNION AC Relay rated from -65° C. to 125° C., 115 Volt, 60 to 400 cycles. Suitable for airborne circuits, including jet planes and missiles.

OTHER ADVANTAGES
Vibration resistance up to 1,000 cycles at 15 G's and shock in excess of 50 G's.
Life expectancy. Tested through 1,000,000 operations.
Coil resistance. 2,400 ohms.
Small size, lightweight. Measures only ½" higher than our DC relays and weighs about 5 oz. All other construction features are the same as the DC relay.
Types and Mountings. Available in 6 PDT or 6 PDT models, plug-in or solder-lug connections and all the usual mountings. Meets or exceeds all requirements of MIL-R-5757-C, MIL-R-25018, and MIL-R-6060E.
Write for complete information. Ask for Bulletin 1012.

Miniature relay applications are getting hotter all the time—and many of them call for self-contained AC relays.

To meet these needs, UNION has developed AC relays incorporating silicon rectifier assemblies. They'll withstand temperatures from -65° C. to 125° C.

The size is the same as the 85° C. UNION AC Relay.

New Hi-Lo Contacts, too! These contacts permit switching loads of two amperes or dry-circuitry level in the one relay. Or, you can get gold alloy contacts for dry-circuitry use.

PNP TRANSISTOR
features high gain

BENDIX AVIATION CORP., Red Bank Division, 201 Westwood Ave., Long Branch, N. J., announces the 2N285A high gain germanium PNP audio power transistor. Current gains are up to 250 at 0.5 ampere collector current, 125 at 2 amperes collector current, and 50 at 3 amperes collector current. It has a maximum collector dissipation of 25 w and a maximum junction temperature of 95 C.

Because of its very high gain, the transistor is especially useful in feedback circuits to provide superior performance. There are also numerous applications to high current switching circuits such as static inverters and power motor. The company's constant force perma brushes and lifetime semi-molded contact plates insure long service free life.

Approximate dimensions are 2.750 in. by 4.940 in. by 3.870 in. Typical applications include high altitude telemetry systems, multi-channel data systems and error indicating systems. Current models include single or multiple pole, stacked, concentric, opposed, raised contact, segmented or printed circuit design. A brochure is available. Circle 428 on Reader Service Card.
oscillators, and to servo amplifiers and motor control circuits. Circle 429 on Reader Service Card.

R-F SWITCH
for use up to 60 mc

The Daven Co., Livingston, N. J., announces the availability of a new miniature r-f switch, No. 6034. This rotary switch is a miniature unit for use up to 60 mc. It consists of 9 completely shielded decks with 10 position—one pole per deck. All contacts and wipers are of coin silver and all metal parts are silver plated brass. The wiring of this switch is all done with Micro-dot cable and all leads are terminated in Micro-dot connectors. The special feature of this switch is its extremely small size. The entire switch exclusive of shaft is held to 3 in. by 3 in. by 6 in. in depth.

The use of sectional shielding and r-f grounding fingers in conjunction with the outer case results in exceptionally good r-f characteristics. Circle 430 on Reader Service Card.

LOW PASS FILTER
uses tiny trimmer capacitors

Radio Condenser Co., Davis & Copewood Sts., Camden 3, N. J. A new 400-mc low pass filter measures just 1 in. by 1 in. by 4 in. It combines a low maximum insertion loss from 200 to 400 mc of 0.75 db with rapid attenuation above the passband. Minimum attenuation above 450 mc is 45 db; and at 1,000 mc, 60 db.

Originally designed for a specific application in the defense

Digital Indicator (left) can display a possible 16 characters and is about half the size of the alpha-numerical Indicator (right) which displays 64 characters.

UNION
INDICATORS

for Data Display
Storage and Transfer

Union Digital and Alpha-numerical Indicators are electro-mechanical, D.C.-operated readout devices for displaying characters in accordance with a predetermined code. The character display may be made to suit the users' requirements.

Indicators are designed for plug-in mounting in a row so that data or messages of any desired length can be stored, displayed or transmitted at will. The indicators can be applied to the output of digital computers, teletype receiving equipment in conjunction with a buffer storage unit, telemetering systems, or wherever data needs to be displayed.

An important feature of these indicators is their inherent storage and transmitting characteristics, which provide for data entry and retransmission. The indicators can be used to accept data from a source, free the source for other programs, and disseminate the data from one indicator to another as required.

Two interesting applications: The Alpha-numerical indicator is being used in data display equipment for flight control built for CAA wherein data enters the system by keyboard or via teletype at 60 words a minute, or from magnetic drum storage at speeds up to 1000 words per minute.

The Digital Indicator is being used in pipeline remote control systems, for displaying and storing telemeteral data such as temperature, pressure, flow, etc. in a central office. Write for Bulletin No. 1011 for further information.
HELP LICK HIGH VOLTAGE ARC-OVER IN AIR-BORNE RADAR UNIT

WHEN MOTOROLA designed this 10 inch air-borne radar indicator to operate at 60,000 ft. they eliminated high voltage arc-over by pressurizing the unit. But this created excessive heat.

TO DISSIPATE HEAT an air-to-air heat exchanger, using three Joy Axivane fans was built in. Two external fans blow outside air between two plates separated by aluminum tubing. Another Joy fan, sealed inside the pressurized radar unit circulates hot inside air thru this tubing.

THESE JOY FANS must operate in the wide temperature range of —55°C to +125°C ... tough treatment.

Joy has over 250 models and 1300 designs of these high performance fans ready to solve your toughest air-moving problem ... be it electronic cooling, de-icing and defogging or ventilation. Write Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa. In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario.

Write for FREE Bulletin 143-39

JOY ... EQUIPMENT FOR AVIATION ... FOR ALL INDUSTRY

D-C POWER SUPPLY uses ultronics

OPTIMIZED DEVICES, INC. Box 38, Gedney Station, White Plains, N. Y. A new ultra-regulated low voltage d-c power supply utilizes an ultrasonic carrier system to achieve optimum performance consistent with light weight, compactness and efficiency. It can produce 0 to 7.0 v at up to 1.5 amperes. Typical uses are for strain gages, d-c filaments, transistors, precision electroplating, bias supply, and for a precision laboratory reference even under load.

Weight of the unit is 23 lb. Efficiency is pointed out by the fact that the unit draws only 70 w from the a-c line at full output.
Temperature limited DIODE type 1236C is designed for service as an RMS detector for a-c voltage and current stabilizers... as a detector for d-c voltage and current stabilizers... as an RMS detector for differential voltmeters and in other similar applications.

Rigid test conditions and rugged construction assure long dependable tube life under all conditions.

**ELECTRICAL CHARACTERISTICS**

<table>
<thead>
<tr>
<th>CATHODE (Tungsten)</th>
<th>AVERAGE</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLTAGE</td>
<td>1.9 Volts A-C or D-C</td>
<td>2.3 Volts A-C or D-C</td>
</tr>
<tr>
<td>CURRENT</td>
<td>440 MA</td>
<td>520 MA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PLATE</th>
<th>VOLTAGE</th>
<th>CURRENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLTAGE</td>
<td>600 Volts D-C</td>
<td>700 Volts D-C</td>
</tr>
<tr>
<td>CURRENT</td>
<td>0.7 MA D-C</td>
<td>1.0 MA D-C</td>
</tr>
</tbody>
</table>

**MECHANICAL CHARACTERISTICS**

<table>
<thead>
<tr>
<th>MOUNTING POSITION</th>
<th>Any</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM OVER-ALL LENGTH</td>
<td>3 3/8 inches</td>
</tr>
<tr>
<td>SEATED LENGTH</td>
<td>2 13/16 inches ± 1/8 inch</td>
</tr>
<tr>
<td>MAXIMUM DIAMETER</td>
<td>117/64 inches</td>
</tr>
<tr>
<td>WEIGHT (APPROXIMATE)</td>
<td>1 ounce</td>
</tr>
<tr>
<td>BULB</td>
<td>T9 with bakelite base</td>
</tr>
<tr>
<td>BASE</td>
<td>Locking-in type DB-1, 8 pin</td>
</tr>
</tbody>
</table>

Ask for DIODE type 1236C at your local distributor or write for complete technical data.

---

Be sure to see SUPERIOR ELECTRIC'S Mobile Display when it is in your area.

---

A precision product of THE SUPERIOR ELECTRIC COMPANY

209 BRADLEY AVENUE, BRISTOL, CONNECTICUT

Please send data sheet on DIODE type 1236C. Have your representative call.

Name:  
Company:  
Street:  
City:  
Zone:  
State:  

---

ELECTRONICS — September 1, 1957  
Circle 220 Readers Service Card
NEW PRODUCTS

SELF-INSULATED
SPACE-SAVING
EASILY-INSTALLED
FEED-THRU AND STAND-OFF TYPES

Another Sealectro First!

Now... Taper-Pin Receptacles combined with “Press-Fit” Teflon-insulated terminals for quick and easy mounting directly on metal chassis or panel. Eliminates usual phenolic board with its troublesome and costly breakage.

“Press-Fit” Taper-Pin Receptacles are individually-insulated units that can be installed in a jiffy at any required spacing. Available in feed-thru and stand-off types as well as high-voltage units with long leakage path. Choice of eight RETMA colors for coding and in a wide range of lug combinations.

New Manual

... brand-new edition, more pages, bigger listings, more engineering information. Write for your copy today.

|Trademark of E. I. du Pont de Nemours & Co., Inc.

SUBMINIATURE TUBE
beam power pentode

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass. Type CK5902 has been added to the company’s line of reliable subminiature tubes. This is a high perveance beam power pentode for use as an audio power amplifier, series regulator or in other functions requiring a tube capable of more current and power dissipation than available with other Raytheon subminiature types. The CK5902 has a 6.3 v, 450 ma heater, a 4.1 w plate dissipation, a 165 v plate rating and a maximum plate current of 30 ma in addition to meeting the requirements for military reliable subminiature tubes for guided missile and other critical applications. Circle 433 on Reader Service Card.

ISOLATION AMPLIFIER
has selectable bandwidths

KEITHLEY INSTRUMENTS, INC., 12415 Euclid Ave., Cleveland 6, Ohio. Model 102B serves as either a general purpose preamplifier or...
Get out your pencil and . . .

Help yourself to electronics’ READER SERVICE
it’s free—it’s easy—it’s for your convenience

Now!

All Advertisements
New Product, and New Literature are numbered for your convenience.

Each Advertisement, New Product, and New Literature item is numbered. For more information simply . . .

(1) Circle number on postpaid card below that corresponds to number at the bottom of Advertisement, or New Product item. Follow the same procedure if you desire New Literature.

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Correct additional postage MUST be added to cards for all FOREIGN MAILINGS.
NOW IN YOUR HANDS . . .
THE ALL NEW 1957 electronics BUYERS' GUIDE!
USE IT THROUGHOUT THE YEAR AS YOUR STANDARD REFERENCE SOURCE

As easy to use as the telephone book, your all new 1957 electronics BUYERS' GUIDE features:

COMPLETENESS: 1070 pages of products, manufacturers, trade names, manufacturers' representatives, and professional services.

ACCURACY: The entire electronic industry is questionnaired from scratch each year. For the 1957 GUIDE, there were 181 changes, 586 deletions (of the deletions, many were due to mergers and name changes), and 872 additions. Total number of manufacturers increased to 4013 from 3727 in 1956. 87 new products were added in 1957 for a total of 1773.

USE: Whether you are concerned with the design, production, or use of electronic circuitry, turn to the listings of the electronics BUYERS' GUIDE. Here you will find the page numbers that refer you to catalog-type advertising, specially prepared to supplement the listings and give you the technical information you must have to specify and purchase electronic and allied products.
FINEST, MOST COMPLETE LINE of Precision Slotted Sections

TYPICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model</th>
<th>Equivalent Wave Guide Type</th>
<th>Frequency Range km/sec</th>
<th>Insertion Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>200-C</td>
<td>7/8&quot;</td>
<td>1.0 to 4.0</td>
<td>17&quot;</td>
</tr>
<tr>
<td>215-A</td>
<td>3/4&quot;</td>
<td>1.0 to 4.0</td>
<td>14 1/4&quot;</td>
</tr>
<tr>
<td>203-E</td>
<td>RG-52 U</td>
<td>8.20 to 12.4</td>
<td>7 1/4&quot;</td>
</tr>
<tr>
<td>210-A</td>
<td>RG-71 U</td>
<td>12.4 to 18.0</td>
<td>8 1/8&quot;</td>
</tr>
</tbody>
</table>

For full technical details on the complete line of PRD Slotted Sections, or for consultation on the particular model best suited to your needs, call your local PRD Engineering Representative; or write to Applications Engineering Group F.

Ready for IMMEDIATE Delivery!

Whether you are working up VSWR or impedance data in the design or testing of new transmission line components, or are designing an impedance matching device for monitoring antenna and transmission line VSWR in communications systems...PRD Slotted Sections provide the superlative answer for precise and accurate information with simplicity and dependability of use.

They have no equal in providing precise standing wave and impedance measurements. PRD Slotted Sections are built of precision-machined "micro-finished" transmission line. The probe is secured to a ball-bearing carriage that travels in precision-ground, hardened grooved runways. Thus the probe travels in a path exactly parallel to the axis of the transmission line. A marked advantage of PRD Slotted Sections is their permanent adjustment, at the factory, to zero slope—there is no need for adjustment to correct for changing slope characteristics. PRD Slotted Sections are designed to mate with standard MIL type connectors and flanges. Low reflection adaptors are available where additional types of connectors are used.

The ultimate in precision measurements is achieved when PRD accessory items such as Type 250-A Broadband Probe and Type 218-K Accessory Kit are used.

POLYTECHNIC RESEARCH & DEVELOPMENT CO., Inc.
202 Tillary Street, Brooklyn 1, N.Y.
has been a pioneer in the field of Deposited Carbon High Stability Resistors. ERIE “Hi-STAB” Resistors are available in Molded, Non-Insulated, and Hermetically Sealed Ceramic Encased types, in RN 20 and RN 65 styles. “Hi-STAB” Resistors are extremely stable under severe environmental conditions and are designed to exceed MIL-R-10509B specifications.

ERIE “Hi-STAB” stability has been proven by performance in actual operation in many widely varied applications. It has also been tested under severe controlled conditions. “Hi-STAB” Resistors were submitted for a period of three years to exposure in a humid underground atmosphere, during which they experienced an average resistance change of only .3%. In another test these same resistors were immersed in tap water for more than 4,500 consecutive hours, with a negligible average resistance change.

**ADVANTAGES of ERIE “Hi-STAB” RESISTORS:**

1. More economical than wire-wound resistors.
2. Ideal for low noise applications.
3. A “must” where High Stability with low inductance is essential.
4. Unexcelled for long shelf life.

**APPLICATIONS for ERIE “Hi-STAB” RESISTORS:**

- **MILITARY** Radar . . . Guided Missiles.
- **COMMERCIAL** Critical Computer Circuits . . . All types of Communications . . . Quality Radio, TV, Hi-Fi Sets . . . Instrumentation.

Write for consultation on what ERIE “Hi-STAB” Resistors can accomplish in your equipment.

as an excellent isolation amplifier covering both audio and ultrasonic frequencies. It has a 5-v, 50-ohm output to drive oscilloscopes, sound level meters and pen recorder power amplifiers. Frequency response is from 2 cps to 150 cps or 1.7 mc with selectable bandwidths and accurate decade gains of 0.1 to 1,000.

Other features include a high impedance input of 400 megohms, 3 µf to reduce circuit loading errors; noise below 10 µv with 150 kc response; and two accessory probes for low-capacitance connection to the circuit being measured.

Typical uses include work with accelerometers and hearing aids, pulse amplification, and vibration and noise studies. Circle 434 on Reader Service Card.

**CIRCULAR POT**

_**for missile systems**_

HUMPHREY INC., 2805 Canon St., San Diego 6, Calif., has introduced a new circular potentiometer ruggedly designed for missile systems. Designated type CP05-0101-1, the instrument is moisture-proof and will meet explosion-proof requirements.

It has 1½ in. square base and ¼ in. diameter stainless steel shaft with Graphitar bearings. The temperature range is -65 F to 400 F; vibration, 10 g to 2,000 cps. The 10,000 ohm winding can be furnished with taps. Circle 435 on Reader Service Card.

**EPOXY COATINGS**

_**for printed circuits**_

Houghton Laboratories, Inc., Olean, N. Y., has announced full
Individual Initiative in Research and Engineering

The Jet Propulsion Laboratory has brought together an outstanding staff of engineers of exceptional talent and ability. Working individually within the group these men now comprise a highly progressive and productive entity.

A recent survey of this staff indicated that the most important reason for their preference of JPL as a work center is the high degree of responsibility and freedom given the individual to pursue his own assignments. The intriguing nature of the work, challenging problems, professional association, fine residential location, pay scales and opportunities for career development were also important considerations.

This appreciation, from within, of the Laboratory's principle of recognizing ability and talent and allowing it to operate with freedom and confidence under its own initiative is a gratifying tribute in itself.

Working for the U.S. Army on a research and development contract with many ramifications, JPL has broad interests and constantly searches for new approaches to modern technical problems. This provides exceptional career opportunities for those qualified individuals who are interested.

Career Opportunities Now Open in These Fields

- Electronics
- Physics
- Aerodynamics
- Mathematics
- Mechanical Engineering
- Chemical Engineering

JET PROPULSION LABORATORY
California Institute of Technology
PASADENA • CALIFORNIA
commercial production and use of their Hysol modified epoxy coatings for printed circuits.

Hysol 6231 and Hysol 6232 series of compounds, developed for military use, are designed to protect printed circuits against high humidity and low temperature shock conditions. The strong bond produced between the components and the base laminate protects the circuits against mechanical shock and vibration.

Hysol 6231 can be applied by brush or spray and Hysol 6232 by dipping and brushing. No special cleaning is required prior to coating to either system. Both are two component systems.

These coatings exceed the specifications of military standard MIL-STD-202A, test methods for electronic and electrical component parts. Write for technical data bulletin 6230 for detailed information and specifications. Circle 436 on Reader Service Card.

TRANSISTOR TRANSFORMERS
Encapsulated miniatures developed out of Triad's long experience with precision design and high quality workmanship. A partial listing of our available types is shown on the right. For complete specifications, including Hermetically Sealed types, write for Catalog TR-57.

<table>
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<th>Secondary Impedance</th>
<th>Maximum Level</th>
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<td>32 CT. (575 Ma.)</td>
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<td>6000/4000/3000</td>
<td>10W</td>
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<td>100 CT. (60 Ma.)</td>
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<td>10W</td>
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<td>125 CT. (5 Ma.)</td>
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<td>500Mw</td>
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<td>250 CT. (60 Ma.)</td>
<td>10W</td>
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<td>2000Mw</td>
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<td>2000Mw</td>
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NEW PRODUCTS

TRANSFORMER NEWS FROM TRIAD

TRANSFORMER NEWS

FROM TRIAD

NEW PRODUCTS

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TRANSISTOR TRANSFORMERS
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</tr>
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</table>

(Continued)
TACAN unit shown with covers removed; plane is a composite model.

78-page road map for jets

An 800-foot carrier may be as hard to find as a needle in a haystack, when the plane seeking it is at 20,000 feet and the time is 0200 hours.

To make the homing plane a homing pigeon, we build the “ARN-21” TACAN equipment illustrated above. Its 78 tubes and associated components add up to a self-contained transmitter and receiver, rugged in its ride-resistance and accurate to pin-point tolerances.

The manufacture of equipment as important and complicated as this demands perfection, and nothing less. On the military as well as the home front, Stromberg-Carlson has long displayed the ability to take such problems in stride.
HERE’S WHY: You can order in quantity and in a wide variety of sizes—and be certain of complete uniformity throughout. Our strict density control assures you thoroughly non-porous Teflon—free from any flaws which might possibly affect your end use or product. Dimensions are accurate to your most critical tolerances—no rejects, waste of material or loss of time. You get product purity—Teflon at its best in every one of its remarkable characteristics. Delivery is prompt—you get the quantity you want when you want it.

Since the availability of Teflon, "John Crane" engineers have worked with Industry to successfully solve innumerable problems and develop new applications. You can benefit from their experience and know-how.

Request full information and ask for our bulletin, The Best in Teflon. Crane Packing Co., 6/02 Oatton St., Morton Grove, III. (Chicago Suburb)
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

NEW PRODUCTS (continued)

A-C MOTORS
with outputs up to 1 hp

INDUCTION Motors Corp., 570 Main St., Westbury, N. Y., has announced new a-c motors designed for induction, torque or hysteresis synchronous applications, with outputs up to 1 hp.

The 3800 Frame series is available with input voltages of from 26 to 230 v a-c, one, two and three phase; input frequency from 25 to 400 cycles. For induction applications, units in this series are offered in outputs to 1 hp; torque motors 10 to 200 oz in. stall torque; hysteresis synchronous 1/200 to 1 hp. Motors can be wound for single, dual or three speed, and can be supplied as self cooled with internal fan.

Units in this frame series vary in weight from 8 to 11 lb. All can be supplied for use as fan and blower motors and as p-m generators. Circle 438 on Reader Service Card.

FREQUENCY DETECTOR
range extended to 10 kc

AIRFAX PRODUCTS Co., Fort Lauderdale, Florida. Frequency range of
Westinghouse SILICON (Si) RECTIFIERS put more muscle in DC power converter!

Successfully proven in rigorous welding, aircraft and guided missile applications, Westinghouse Silicon Power Rectifiers offer many advantages for power supplies.

Used in the Westinghouse 50KW Power Converter to drive the boring mill above, the WN-5082 bridge assembly supplies greater power and higher efficiency in less space. The 3-phase 60-cycle 440 v. power supply operates with a full load efficiency of 90% and an even higher half load efficiency. Regulation is approximately 8% from no load to full load with a Power Factor of 96 to 97.

Especially rugged for varying duty cycles, the WN-5082 withstands heavy loads of constant on-off operation, high-voltage transients, alternate heating and cooling.

YOU CAN BE SURE...IF IT'S Westinghouse

Westinghouse can supply single diodes or complete bridge assemblies built to your specifications. For full information on how Westinghouse Silicon Rectifiers can bring new efficiency and economy to your applications, mail the coupon today.

WESTINGHOUSE ELECTRIC CORPORATION
P. O. Box 868, Pittsburgh 30, Pa.
Please send me data on the new Westinghouse WN-5082 Silicon Rectifier.
Please send me data on other Westinghouse Silicon Rectifiers. (Describe types or applications)

NAME
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CITY
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DESIGNS RELAYS
TAILORED FOR AIRBORNE SYSTEMS

... relays designed to overcome environmental problems for such customers as: Boeing • Douglas Aircraft • Ford Instrument • Hughes Aircraft • Lockheed Aircraft • Minneapolis-Honeywell • Radio Corporation of America • Reeves Instrument.

Now... Relays TAILORED for Flight Control • Automatic Approach • Engine Control • Missile Guidance • Missile Stabilization • Bomb-Navigation • Inertial Navigation • Fire Control • Automatic Flight.

Why not test Leach’s ability to solve some of your toughest environmental problems? Please write Sales Manager, Relay Division or contact your nearby Leach representative. Send for your copy of the Leach Balanced-Armature Catalog.

TRIODE MODULATOR
for instrumentation radar

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP., Components Division, 100 Kingsland Road, Clifton, N. J., has developed a new hard tube triode modulator, the F-6920, for use in instrumentation radar.

The tube has a peak plate current and hold-off voltage of 150 amperes and 35 kv respectively. The F-6920 is intended for switching applications within the range of 0.002 duty factor and 15 μsec pulse length. The anode is forced...
**Tests by Remington Rand Prove...**

**Du Pont MYLAR® provides greater reliability, longer life for capacitors used in Univac®**

**Problem:** The Remington Rand Division of the Sperry Rand Corp. had to find a capacitor of high reliability that could meet the requirements of extra-sensitive circuits found in Univac® Data Automation Systems.

**Solution:** In a series of accelerated tests by Remington Rand, various types of capacitors were exposed to conditions more exacting than those found in normal operation of Univac Systems. These tests proved that capacitors made with “Mylar” polyester film offered greater reliability and longer life, with an extra margin of safety in moisture resistance. The tests documented the fact that “Mylar” provides excellent insulation resistance at high temperatures. “Mylar” does not deteriorate with age or voltage stresses within normal operating ranges.

**Results:** By using capacitors made with “Mylar”, Remington Rand has improved the performance of another component in Univac Systems... has helped improve the performance of Univac Systems themselves.

**How can “Mylar” help you?** Whether you make guided missiles or tiny components, it will pay you to investigate the unique advantages of using “Mylar” film... or products made with “Mylar”. Send for a copy of our new booklet containing detailed information on properties and applications.

---

“MYLAR” offers a unique combination of properties valuable for electrical design

**High Tensile Strength.** “Mylar” is the strongest plastic film. Instron tester shows an average strength of 20,000 lbs. psi.

**High Dielectric Strength.** Average of 4,000 volts per mil... average power factor of 0.003 at 60 cycles... dielectric constant above 3.0 at 72°F., 1,000 cycles.

**Thermal Stability.** Tests prove “Mylar” has an effective operating range, -80°F. to 300°F... won't brittle with age.

---

**Du Pont MYLAR® polyester film**

**Better things for better living... through chemistry**

---

**Univac** is a registered trademark of Sperry Rand Corporation.

**Mylar** is Du Pont's registered trademark for its brand of polyester film.

---

Please send your booklet listing properties, applications and types of “Mylar” polyester film available (MB-11).

---

**Electronics — September 1, 1957**

**Circle 229 Readers Service Card**

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297
send for the most widely used electronic supply guide free! on request

ALLIED'S 404-PAGE 1958 CATALOG

WORLD'S LARGEST STOCKS OF ELECTRONIC SUPPLIES FOR INDUSTRY
- Receiving Tubes
- Power & Gas Tubes
- Diodes & Transistors
- Relays & Switches
- Test Instruments
- Meters & Supplies
- All Connectors
- Metal Chassis Bases
- KNIGHT Public Address Equipment

Simplify and speed your purchasing of electronic supplies and equipment at ALLIED. We make fast, expert shipment from the world's largest stocks of everything in Electronics. Our expert Industrial supply service saves you time, effort and money. Manufacturers' prices available on quantity purchases. Send today for your free 1958 ALLIED Catalog—the complete Buying Guide to Electronic Supplies for Industrial and Communications use.

one complete dependable source for everything in electronics

ALLIED RADIO
100 N. Western Ave.,Dept. 11-J7
Chicago 80, Illinois

ANTENNA COUPLING or matching transformer

NEMS-CLARKE INC., 919 Jesup-Blair Drive, Silver Spring, Md. Type 803 antenna coupling or matching transformer is designed to match a 700 or 200-ohm receiving antenna balanced transmission line to a 72 or 52 ohm coaxial line with a minimum transmission loss over the range of 1 to 50 mc.

This transformer employs the use of a new type core material which extends its frequency response considerably beyond that of former units. The insertion loss has also been kept quite low, less than 1 db at mid-band. A spark gap arrangement has been provided for protection against the effects of lightning.

The transformer and circuitry have been arranged to provide d-c continuity through the antenna for checking purposes. The transformer has been designed with an octal plug to allow easy replacement. Printed circuitry is...
The solution to antenna problems begins when someone says: “Let’s ask Kennedy!”

A few of the many reasons why are shown on this page. These Kennedy antennas are setting new standards for all-weather reliability and versatility wherever they serve throughout the free world.

Kennedy antennas come in many shapes, many sizes (the world’s largest scatter antenna is being built here). But whatever the type, and whatever the conditions under which it must serve, Kennedy can offer a design that fully measures up to specifications. And there are additional advantages in Kennedy’s advanced construction techniques—like the extra ease in shipping and handling made possible by sectionalized aluminum construction, for example.

Kennedy engineers are available to supervise installations anywhere in the world. It’s a part of the complete, integrated service that is still another reason why more and more people in communications are “asking Kennedy” about antenna problems.
**Mechanical Assembly**

High quality MECHANICAL ASSEMBLIES are shipped to satisfied customers every day from Daystrom Instrument.

The close tolerance work of our machine shop is transferred to mechanical assembly. In our modern 350,000 sq. ft. plant we can handle a wide range of precision mechanical assemblies on a production-line basis.

Let Daystrom Instrument assist you in meeting your mechanical product needs. One of our sales engineers is ready to discuss our qualifications with you. Write us, and he will call at your convenience.

---

**NEW PRODUCTS**

(continued)

used to assure uniformly high performance. Overall dimensions are 52 by 7 in. by 4½ in. Circle 441 on Reader Service Card.

**D-C BRIDGE**

and calibrator

ALLEGANY INSTRUMENT CO., INC.,
1091 Wills Mountain, Cumberland, Md. The BC-1 is a companion component for any amplifier. It provides an input circuit for conveniently connecting one, two or four active wire strain arms into Wheatstone Bridge form. Means for bridge balancing, automatic 4-step signal calibration, and event or phenomenon initiation are provided along with terminals for external bridge power. Circle 442 on Reader Service Card.

**DELAY LINES**

continuously variable

ADVANCE ELECTRONICS LAB., INC.,
249-259 Terhune Ave., Passaic, N. J. Type 521 series was developed to meet an increasing need of continuously variable time delay
TELEMETRY APPLICATIONS

- QUICK-LOOK monitoring in the telemetry ground station permits continuous observation of missile in-flight programing results.
- ON-THE-SPOT monitoring permits making in-flight function corrections in controlled missiles or piloted aircraft.
- A NATURAL for mobile telemetry vans . . . compact, rugged, low power consumption, record is PERMANENT, no fading or fogging when exposed to direct sunlight.

ENGINEERS . . .
Check your requirements against these FEATURES!

- Permanent continuous record produced within recorder.
- Developed record may be viewed an INSTANT after exposure.
- HIGH CONTRAST photographic qualities . . . black intelligence traces are recorded on light colored background.
- As many as 24 intelligence channels may be recorded on the 8-inch x 200-foot record roll.
- Record is REPRODUCIBLE without loss of contrast by Ozalid, Bruning, etc., processes . . . NO deterioration due to ultra-violet exposure.
- Eliminates need for costly darkroom facilities.

COSTS NO MORE THAN OLD-FASHIONED METHODS

Century Electronics & Instruments, Inc.
1333 NO. UTICA, TULSA, OKLAHOMA

For further information, call our nearest representative:

EXPORT OFFICE: 149 BROADWAY, NEW YORK CITY — TEL.: BARCLAY 7-0562
NEW PRODUCTS
(continued)

with maximum delay over 15 µsec. It consists of two parts: (1) a continuously variable delay line, which is essentially a condensed r-f cable with one conductor...  

The unit features a coaxial shaft. It measures 4 in. by 4 in. by 4 in., and weighs approximately 2½ lb. There are three models available, and complete specifications may be had for writing. Circle 413 on Reader Service Card.

DIRECTIONAL COUPLERS
cover 68 to 73 kmc

MICROWAVE ASSOCIATES, INC., Burlington, Mass., has announced the MA-668A and B side wall directional couplers for the 68 to 73 kmc range. Nominal coupling values are 20 db and 30 db respectively. Directivity is 25 db minimum while maximum vswr in the main arm is 1.1 and in the auxiliary arm 1.15 for both the MA-668A and B. These measurements are performed at mid-band and at specified band extremes. The coupling accuracy is within ±½ db.

The value and frequency of calibration is stamped on each unit. UG-385/U coupling flanges are used on all arms of both the MA-668A and B. Overall length is 3½. Height from the center line of the main arm to the auxiliary arm flange surface is ½ in.

Each coupler is fabricated from coin silver waveguide. Mating surfaces are flat and mirror smooth to prevent r-f leaks. All

ANOTHER EXAMPLE OF Waterman PIONEERING...

The S-12-C series of Systems RAKSCOPES have been developed for the dual purpose of monitoring and troubleshooting of rack-mounted equipment. These oscilloscopes obtain a new degree of flexibility with the multiple input selector making possible selection of different signal sources. This optional vertical input selector, with built-in attenuators, selects either front panel connectors for troubleshooting or rear mounted connectors for systems monitoring. This permits the omission of an entire switching panel from an overall system resulting in circuit and space economies. A ruggedized construction philosophy has been carried throughout. Vertical and horizontal amplifiers are identical, each having a frequency response from dc to 700 kc (—2 db). Their sensitivities are 50 and 72 millivolts rms per inch of deflection. Signal amplitude calibration employs a direct reading meter. The time base is operative in either trigger or repetitive modes with a range from ½-cycle to 50 kc. Synchronization is independent of polarity. Sync lockout circuits are employed for stable operation over wide range of writing speeds and amplitudes. A unique plug-in elliptical sweep network makes frequency calibrations more simplified. Power requirements: 105-125 volts, 50 to 400 cycles. Accessory probes available; attenuator and amplifier types.
New 65,000 sq. ft. plant at Wapakoneta, Ohio. Completely modern in every respect. Close to the Mid-U.S. electronics industry.

Main plant at Norristown, Pa. Where most of the cathodes used in this country for more than 20 years have been made.

Two Modern Plants
FOR SEAMLESS NICKEL CATHODES
OFFER YOU DOUBLE DELIVERY ASSURANCE

Just like a second source of supply for every cathode order you place—without the inconvenience of dealing with two suppliers or worrying about product uniformity.

Each of these two big Superior Tube cathode plants follows exactly the same manufacturing methods and quality control procedures. Each employs the same laboratory checks on materials and finished cathodes. So cathodes can be produced at either plant and exactly meet the specifications.

Now there’s more reason than ever to make Superior Tube your regular source for electron tube cathodes. Get complete technical information in the new Catalog 51. Write Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.

*Manufactured under U. S. patents

Superior Tube cathodes. Typical examples. Seamless, Lockseam,* and Weldrawn® cathode sleeves are available in a wide variety of lengths and cross-section shapes. New Cathaloy® cathode materials offer new properties and superior performance.

Superior Tube
The big name in small tubing
NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N.Y.—an affiliated company making precision metal stampings and deep-drawn parts

ELECTRONICS — September 1, 1957  Circle 235 Readers Service Card
NOW from Amco...

a complete "package" for enclosing, mounting, cooling
ELECTRONIC, NUCLEAR, ELECTRICAL
TEST INSTRUMENTS AND EQUIPMENT

NEW PRODUCTS
(continued)

NOW from Amco...

Electronic, nuclear, electrical
Test Instruments and Equipment

New Products

NOW FROM Amco...

A complete "package" for enclosing, mounting, cooling
Electronic, nuclear, electrical
Test Instruments and Equipment

LITTLE CONNECTORS
cable-to-chassis types

Amphenol Electronics Corp.,
Chicago 50, Ill. Cable-to-chassis types have been added to the company's Micro-Ribbon series of connectors. Available in 14, 24, 36 and 50 contacts, these new types feature cadmium-plated brass shells with clear chromate treatment, gold-fover-silver plated contacts and diallyl phthalate dielectrics. Truly miniature in size, a matched pair of largest 50 contact size types occupy only 3.7 cu in.

At 5 amperes Micro-Ribbon connectors are rated at 700 v d-c at sea level, and at 200 v d-c at 70,000 ft.

IRIS-FOCUS UNIT
is remotely controlled

Kin Tel (formerly Kay Lab), 5725 Kearny Villa Road, Box 623, San Diego 12, Calif. Model ARC-1 provides vibration-free remote control of tv camera lens aperture and focus. Both operations may be accomplished simultaneously from

Amco ENGINEERING COMPANY
7337 West Ainslie Street, Chicago 31, Illinois

Our 15th Consecutive Year of Design and Manufacturing

WRITE for complete Catalog
and information.

Factory Representatives in all Principal Cities and Canada

SEE US! Booths 1312 & 1315, Instrument-Automation
Conference, Cleveland, Sept. 9-13

Surfaces are silver plated. A coat of blue-gray lacquer is applied to external noncontacting surfaces. Circle 141 on Reader Service Card.
NOW! A complete single-turn-pot line from Waters

Built, tested, and certified to such rigid specifications as AIA, RETMA, JAN-R-19, MIL-E-5272A, and other applicable military specifications, this new line of pots packs reliable performance into tight spots.

*Complete test data available on request.

Waters PRECISION MINIATURE POTENTIOMETERS

Sizes from 1/2" to 1 1/8"... values from 1/2 ohm to 500K ohms... high-precision linear and non-linear... write for catalog that describes the complete line.

Waters ROTARY TRIMMER POTENTIOMETERS

... include the most compact half-inch pot on the market... resistances to 500K... non-linear models... bushing, servo, or 3-hole mount... solder terminals or wire leads... write for complete catalog.

Waters LOW-TORQUE PRECISION POTENTIOMETERS

Ball-bearing and jewel-bearing models for ultra-low torque... servo or 3-hole mounting... solder terminals or... wire leads.

Check Waters first for all your single-turn-pot needs.
Big-pot performance in miniature-pot size.

Waters MANUFACTURING, Inc.
Wayland, Massachusetts
APPLICATION ENGINEERING OFFICES IN PRINCIPAL CITIES
Circuit high-temperature potentiometers continue to deliver precision performance under extreme ambient conditions. Conservatively rated, they dissipate all of their full rated power at 100° C. Furthermore, special insulation and "hard" soldered connections provide extra safety in derating applications up to 150° C. ambient. This superior high-temperature performance is available from Circuit Instruments in precision miniature, moisture sealed, hermetically sealed, ball bearing, and high precision type potentiometers... in 10, 5 and single turn models... at resistance values from 1 to 600,000 ohms... and with ratings from 1 to 6 watts.

SEND FOR BULLETIN

CIRCUIT

INSTRUMENTS INC.
an LRC subsidiary

DEPARTMENT E, 2801 ANVIL STREET NORTH, ST. PETERSBURG, FLORIDA
IRC®

Distributed Parameter Delay Lines

**FEATURE UNIFORMITY, STABILITY AND LOW COST**

IRC's extensive mass production experience and technique in the manufacture of continuous lengths of wire wound resistive elements have now been utilized to produce a uniform, high-quality, low-cost, distributed-constant delay line. Simplicity of design permits close control of electrical characteristics even to providing, in many applications, unusual phase characteristics to meet customers' special requirements.

Encapsulation in phenolic impregnated rigid tubes with axial leads assures good stability under adverse environmental conditions. These delay lines are well suited for either point-to-point wiring or printed board applications.

If you have an application for distributed constant delay lines, we will be pleased to review your requirements. Send coupon for full details.

**Features**

- **TIME DELAY** 0.2 to 1.0 microseconds
- **IMPEDANCE** 500 to 2500 ohms standard; higher and lower are available on special request
- **BANDWIDTH** 3.5 MC and greater as required
- **TEST VOLTAGE** 300 volts
- **OPERATING TEMPERATURE** 65°C

**INTERNATIONAL RESISTANCE CO.**
Dept. 239, 401 N. Broad St., Phila. 8, Pa.
In Canada: International Resistance Co., Ltd., Toronto, Licensee

Send technical data and prices on the new IRC Distributed Parameter Delay Lines.

NAME ____________________________
COMPANY ____________________________
ADDRESS ____________________________
CITY ____________________________ ZONE ______ STATE ______

ELECTRONICS — September 1, 1957

Circle 239 Readers Service Cord
Sylvania...your only source for both semiconductor materials

If you need materials for transistors, diodes, or other semiconductor devices...Sylvania is your only dependable source of both germanium and silicon.

The following forms of Sylvania germanium products are available; spectrographically pure germanium dioxide; polycrystalline as-reduced ingots; polycrystalline purified ingots; and undoped single crystals. All Sylvania germanium is n-type, and—in the purified ingot or single crystal form—has a resistivity greater than 40 ohm cm.

Diode and transistor manufacturers report that Sylvania germanium makes it possible for them to use the same doping schedule from shipment to shipment. They report higher yield in the growth of doped single crystals.

For growing doped crystals horizontally, Sylvania germanium ingots are purified in five standard shapes, or to your specification. Cut pieces, which require no further cutting or etching, are supplied to fit your crucible for vertical crystal growing.

Sylvania silicon is available in the form of polycrystalline stalagmitic rod; average density is 2.2 g/cc. The standard diameter for stalagmitic rod is 1 1/2 in., and it is available in pieces or crucible charges to your specification.

If you have special requirements, our engineering department will gladly consult with you. Send for technical literature on Sylvania germanium and silicon. Write to:

Sylvania Electric Products Inc.
Tungsten and Chemical Div., Towanda, Penn.
NEW PRODUCTS (continued)

Do YOU Seek Definite Improvement in...

- Evacuation of Lighting, TV or Radio Tubes
- Purification of Germanium, Selenium and Silicon... and Crystal Growing
- Vacuum Curing of Transistors, Diodes and other Semi-Condutors
- Purification of Metals under Vacuum
- Vacuum Impregnation of Condensers, Transformers, Windings, Cables, etc.
- Vacuum Metallizing and Metal Evaporating

KINNEY HIGH VACUUM

for work in the low micron region
KINNEY Simplex and Duplex Single-Stage Oil Sealed Mechanical Pumps afford a choice of 9 models with displacements from 13 to 780 cfm and ultimate pressures to 10 microns (McLeod). Compound Pumps in 4 sizes—2.0 to 46.0 cfm—develop ultimate pressures to 0.2 micron (McLeod).

for high pumping speed in the low micron region
KINNEY Mechanical Booster Pumps in 4 models with displacements from 30 to 3600 cfm. These revolutionary Pumps produce a clean, dry vacuum in the 0.2 micron (McLeod) range or better without use of cold traps or baffles. Widely used in metallurgical and electronic work.

for metallizing and laboratory evaporation work
KINNEY complete High Vacuum Systems embrace a comprehensive selection of Evaporators, Furnaces, Curing Ovens, High Vacuum Pumping Systems and Power Units. KINNEY-built equipment reflects the know-how of extra years of experience in High Vacuum technology.

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
3565 J. WASHINGTON ST. BOSTON 30 • MASS.

Please send me literature on
☐ KINNEY High Vacuum Pumps
☐ KINNEY High Vacuum Systems

Name__________________________
Company_______________________
Address________________________
City_________________ Zone_______ State__________

Write for literature on new developments in KINNEY Pumps and High Vacuum Systems.

Circle 241 Readers Service Card

ELECTRONICS—September 1, 1957

HEART MONITOR
a medical electronic unit

ALLEN ELECTRIC AND EQUIPMENT Co., Kalamazoo, Mich., has announced a new electronic instrument that lets us hear and see every pulse beat of the heart with controllable sound and large flashing light. The new heart monitor frees the anesthesiologist’s hands from continuous pulse checking. The anesthesiologist can take systolic blood pressure audibly or visibly—without a stethoscope. A bulletin containing operation information and chief features is available. Circle 447 on Reader Service Card.

RELAY
in dust-proof enclosure

LINE ELECTRIC Co., 271 South 6th St., Newark 3, N. J., has available the SM series relay, in a plug-in, transparent, dust-proof enclosure. Utilizing standard octal and 11-pin bases, this relay comes in contact arrangements up to 3 pdt. Contacts are rated up to 10 amperes at 115 v a-c, noninductive. Coils in all standard a-c and d-c voltages are also available for plate circuit applications.

These units are extremely com-
HIGHEST INSULATION RESISTANCE and CAPACITANCE STABILITY

LOWEST POWER FACTOR and SOAKAGE

fci POLYSTYRENE and TEFLOM CAPACITORS

OPERATING TEMPERATURE
up to 85°C for Polystyrene
up to 200°C for Teflon

AVAILABLE IN
hermetically sealed glass tubes with metal end caps
style CP6 metal shells with glass-seal buttons
bathtub cases with low-loss glass terminals
style CP70 metal cans with low-loss glass terminals

SPECIAL UNITS — INCLUDING MULTI-SECTION BLOCKS — AVAILABLE ON SPECIAL ORDER OR MADE TO SPECIFICATIONS

ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>OPERATING TEMPERATURE</th>
<th>POLYSTYRENE</th>
<th>TEFLOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp. Range</td>
<td>-55°C to +85°C</td>
<td>-55°C to +200°C</td>
</tr>
<tr>
<td>Voltage Range, DC</td>
<td>100 to 30,000</td>
<td>100 to 30,000</td>
</tr>
<tr>
<td>Capacitance Range</td>
<td>.001 to 20 mf</td>
<td>.001 to 20 mf</td>
</tr>
<tr>
<td>Power Factor</td>
<td>.002% @ 1 kc</td>
<td>.002% @ 1 kc</td>
</tr>
<tr>
<td>Dielectric Absorption</td>
<td>0%</td>
<td>.01%</td>
</tr>
<tr>
<td>Voltage Derating 85°C</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Voltage Derating 125°C</td>
<td>not operable</td>
<td>none</td>
</tr>
<tr>
<td>Voltage Derating 150°C</td>
<td>not operable</td>
<td>none</td>
</tr>
<tr>
<td>Voltage Derating 200°C</td>
<td>not operable</td>
<td>33%</td>
</tr>
<tr>
<td>Temperature Coefficient</td>
<td>-100 ppm/°C.</td>
<td>-50 ppm/°C.</td>
</tr>
<tr>
<td>I.R. at Room Temperature</td>
<td>10² megohms/mf</td>
<td>10² megohms/mf</td>
</tr>
<tr>
<td>Capacitance Stability</td>
<td>0.1%</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

fci film capacitors, INC.
3400 Park Ave., New York 56, N.Y. • Phone CYPRESS 2-5180

310 Circle 242 Readers Service Card

NEW PRODUCTS

TRANSDUCER ultrasonic type
GULTON INDUSTRIES, INC., 212 Durham Ave., Metuchen, N. J. A new ultrasonic transducer, model UT-2-42, for ultrasonic cleaning, degreasing, and processing is announced.

Using Glennite piezoelectric ceramics, the ultrasonic transducer is designed for modular assembly to cover large areas with non-focusing and uniform sound field. It has a high conversion efficiency and a frequency for many types of processing.

Hermetically sealed in stainless steel housing, model UT-2-42 is completely immersible in organic solvents, aqueous solutions of normal detergents, mild alkalis or acids. Circle 449 on Reader Service Card.

FOUR-LAYER DIODE bistable type
SHOCKLEY SEMICONDUCTOR LABORATORY, Beckman Instruments, Inc., 125 San Antonio Road, Mountain View, Calif., has announced a new low-power four-layer switching
VIBRATION...yet normal operation

No—we don’t use paint mixers to measure the vibration resistance of General Electric miniaturized sealed relays. But, it is a dramatic illustration of the punishment G-E hermetically sealed relays can—and do—witness.

The best of laboratory equipment is used to measure this vibration resistance, and the results prove—General Electric voltage-calibrated Micro-miniature relays withstand vibration of 20 G’s acceleration from 55 to 2000 cycles (.125 inch excursion from 10 to 55 cycles).

Excellent vibration resistance is just one of the many “plus” features—such as high- and low-temperature operation, high shock resistance, and rugged construction—you get with all Miniature, Sub-miniature, and Micro-miniature G-E sealed relays. Today, General Electric relays are proving their reliability on a variety of military and industrial electronics applications.

What’s more, you get all of General Electric’s complete line of standard-listed relays on only 3-week shipment from receipt of order—plus—immediate service on samples and prototypes.

For further information, contact your G-E Apparatus Sales Office—or—write to General Electric Co., Sect. 792-7, Schenectady 5, N. Y., for complete relay data. Specialty Control Dept., Waynesboro, Va.

Progress Is Our Most Important Product

GENERAL ELECTRIC
And if you're the man whose product needs this Tung-Sol Relay, then it's you I'm fishing for.

Tung-Sol makes an extensive line of relays in the general operating range typified by the No. 609. Simplicity of construction provides utmost reliability under extreme service conditions. Snap-action principle of operating permits almost instantaneous response to current conditions. Cycling is extremely uniform. Compact and lightweight, Tung-Sol Relays are ideal for instrument, equipment and missile applications.

<table>
<thead>
<tr>
<th>NOMINAL DESIGN CONSIDERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact capacity .............. 1 amp 30 volt resistive</td>
</tr>
<tr>
<td>Contact arrangement ............ SPST (NC) or SPDT</td>
</tr>
<tr>
<td>Operating power ................ As low as ½ watt</td>
</tr>
<tr>
<td>Time delays ........................ Up to 5 seconds</td>
</tr>
<tr>
<td>Operate on current differential as small as .05 amps</td>
</tr>
<tr>
<td>Operate on voltage differential as small as .3 volts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOMINAL CHARACTERISTICS OF 609</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage ............... 6.4 volts</td>
</tr>
<tr>
<td>Operating time .................. 1, plus or minus .5 seconds</td>
</tr>
<tr>
<td>Release time .................... 1, plus or minus .5 seconds</td>
</tr>
<tr>
<td>Contact capacity ................ 1 amp at 30 volts</td>
</tr>
<tr>
<td>Contact arrangement ............ SPDT</td>
</tr>
</tbody>
</table>

For additional data write:
Electroswitch Division, Tung-Sol Electric Inc., Newark 4, N. J.
Sales Offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Metrote Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash.; Canada: Montreal, P. Q.

NEW PRODUCTS

THERMAL RELAYS

Fishing... that's what I'm doing

diode. It is a two-terminal silicon device which can exist in either of two states: an open or high-impedance state (1 to 100 meg-ohms) and a closed or low-impedance state (1 to 10 ohms). The diode is switched from one state to the other through control of the voltage and current values. It is driven to its closed state by application of a voltage greater than the critical breakdown point, and it will continue conductive so long as a current greater than a critical holding current is maintained. When the current is reduced below the holding value, the device regains its open state.

While the parameters are controllable over some breadth in manufacture, typical ranges of values are as follows: firing voltage ranges from 20 to 60 v; holding currents, 25 ma or somewhat less at about 1 v. The switchable capacity is in the order of 100 ma, and maximum power dissipation is on the order of 100 mw. Switching rates are on the order of 1 mc.

Characteristics of the four-layer diode suggest a versatile range of circuit applications with some of the more immediate probabilities including self-excited saw-tooth oscillator, pulse generators of various types, bistable memory circuits, and ring circuits for counter and computer use. Circle 450 on Reader Service Card.

COAXIAL SWITCH remotely controlled

ANDREW CORP., 363 E. 75th St., Chicago 19, Ill. Type 6710 switch provides four-second switching of 34 in. coaxial transmission line to standby equipment at frequencies up to 1,000 mc. It can be used in
APPROVED
RADIO INTERFERENCE
FIELD INTENSITY
MEASURING EQUIPMENT

STODDART designed and manufactured to Military Equipment Specifications to meet the requirements of Military Measurement Specifications.

APPROVAL DATA

<table>
<thead>
<tr>
<th>STODDART &amp; MILITARY TYPE</th>
<th>FREQUENCY</th>
<th>MIL-I-16910 (Ships)</th>
<th>MIL-I-6181</th>
<th>S.A.E.</th>
<th>A.S.A.</th>
<th>C.I.S.P.R.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NM-40A (AN/URM-41)</td>
<td>30cps-15Kc</td>
<td>CLASS '1'</td>
<td>Not Req'd</td>
<td>Not Req'd</td>
<td>Not Req'd</td>
<td>Not Req'd</td>
</tr>
<tr>
<td>NM-10A (AN/URM-6B)</td>
<td>14Kc-250Kc</td>
<td>CLASS '1'</td>
<td>Not Req'd</td>
<td>Not Req'd</td>
<td>C63.2 (Proposed)</td>
<td>Not Req'd</td>
</tr>
<tr>
<td>NM-20B (AN/PRM-1A)</td>
<td>150Kc-25Mc</td>
<td>CLASS '1'</td>
<td>CLASS '1' CATEGORY 'A'</td>
<td>Not Req'd</td>
<td>C63.2 (Proposed)</td>
<td>**</td>
</tr>
<tr>
<td>NM-30A (AN/URM-47)</td>
<td>20Mc-400Mc</td>
<td>CLASS '1'</td>
<td>CLASS '1' CATEGORY 'A'</td>
<td>APPROVED</td>
<td>C63.3 (Proposed)</td>
<td>**</td>
</tr>
<tr>
<td>NM-50A (AN/URM-17)</td>
<td>375Mc-1000Mc</td>
<td>CLASS '1'</td>
<td>CLASS '1' CATEGORY 'A'</td>
<td>Not Req'd</td>
<td>C63.3 (Proposed)</td>
<td>Not Req'd</td>
</tr>
</tbody>
</table>

STODDART’S 5 self-contained Radio Interference Measuring Equipments, each designed for its specific frequency range, provide:
- 5 instruments, which can be used by—
- 5 engineers, to measure over—
- 5 different frequency ranges, at—
- 5 different locations, at—
- 1 time.

FEATURES:
- Each equipment performs Quasi-Peak, Peak, and Average (Field Intensity) measurement functions.
- Approved for use by all Departments of the U.S. Department of Defense.
- Commercial and military equipments are identical.
- Precision laboratory equipment with rugged all-weather design for field use.
- Immediate delivery from stock.

STODDART AIRCRAFT RADIO CO., INC.
6644 Santa Monica Blvd., Hollywood 38, California

Circle 245 Readers Service Card
BEAVER GROUND THREADS

UP TO 8" LENGTH
PRECISION TOLERANCES
SMALL AND MEDIUM-SIZE WORMS,
LEAD SCREWS, ETC.
PITCHES — 12 TO 72
VEE — ACME — WORM THREADS
ALL STANDARD HARD OR SOFT STEELS
STAINLESS — BRONZE — ALUMINUM

Send Prints for Quotation

THE Finest IN GEARS

Beaver Gear Works Inc.
1021 Pomona St., Rockford, Illinois

Circle 246 Readers Service Card

NEW PRODUCTS

(continued)

high power communication systems, as well as uhf and vhf tv stations.

Use of these switches eliminates time-consuming manual changes of coaxial transmission line connections. Standby equipment may be quickly and easily checked under actual operating conditions. In the event of main equipment failure, the spare equipment is switched in with negligible off-the-air time.

This remotely controlled switch is operated by a dependable, long-life motor. The a-c motor normally supplied operates on 115 v, 60 cycle a-c. Other motors are available on special order. Control circuitry includes a wafer switch for use in remote position indication circuits. The micro-switch is mechanically linked to the switching mechanism so that transmitter power is removed before switching and is reapplied only after new contact is made. Circle 451 on Reader Service Card.

TELREX LABORATORIES

Designers and Manufacturers of

COMMERCIAL SERVICE "BEAMED-POWER" ARRAYS

Calibrated for the commercial
13 to 14 mc. band.
Other frequencies available.

Precision Tuned. Matched and Calibrated for easy assembly and repetition of our Specifications at your
site, providing optimum gain per element and hi-signal-
to-noise, hi-signal-to-interference “Balanced Pattern.”

Electrical Specifications: Gain 8 db, F/B ratio 28 db,
V/S/W/R 1.2/1 or better! Impedance, 52 ohm thru
coaxial halfwave “Balun” (supplied). Power capacity
5 KW — Higher power models available at extra cost.

Mechanical Specifications: Wt. 60 lbs., 3" OD x 26
ft. boom, taper swaged elements, tapering from
1/4" OD to 1/8" OD, incorporating stainless steel
hardware, "Borg-Warner" Cycloidal moldings,
1/4"-20 S.S. junction terminals and heavy cad-
mium plated mounting plate. Wind surface
area: 7 sq. ft. Wind load at 100 mph. 210 lbs.

Price $338.00 f.o.b. Asbury Park, New Jersey
Available three (3) days after receipt of order.
Descriptive literature on request.

TELREX LABS.

COMMUNICATION & TV
ANTENNAS SINCE 1927

ASBURY PARK 25
NEW JERSEY, U.S.A.
Tel. PROspect 5-7725

CONNECTORS

with snap-in contacts

CONSOLIDATED ELECTRODYNAMICS
CORP., 740 Salem St., Glendale, Calif., has announced a new series of rectangular electrical connect-
ors featuring removable snap-in contacts. The specially made contacts have retention springs which permit attachment of the contacts to the wires prior to installation in the connector body. This fea-
ture also allows easy insertion or removal for replacement or re-
rangement. The contacts are not of the usual tapered design. Neither do they require soldering. This cuts time in the assembly and field maintenance of the connect-
ors.

A split-hood design is another exclusive feature. The hood is
Surviving Impact is an Eimac Ceramic Tube Extra

Aeronautical electronics demands extras from vacuum tubes. Among them is the ability to withstand heavy impact without impairing electrical characteristics. The photograph dramatically shows what happens to a 250 watt glass envelope tube and an Eimac 300 watt ceramic tube when both are dropped from a height of seven feet. The ceramic tube "took it."

Other advantages of Eimac ceramic tubes are: resistance to damage by vibration and temperature; smaller size without sacrificing power; ability to undergo optimum processing techniques that lead to tube reliability and longevity.

The small Eimac ceramic 4CX300A, shown above, will withstand 50G shocks of 11 millisecond duration. It will operate in airborne or ground station service at full ratings up to 500mc.

In its new line of ceramic tubes, Eimac has the answer for the aeronautical engineer who needs a tube that will deliver full output under extreme environment.

---

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

Eimac First with Ceramic Tubes that can take it

---

<table>
<thead>
<tr>
<th>4CX300A Maximum Ratings to 500MC</th>
<th>FM</th>
<th>AM</th>
<th>SSB</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-C Plate Voltage</td>
<td>2000</td>
<td>1500</td>
<td>2000</td>
</tr>
<tr>
<td>D-C Screen Voltage</td>
<td>300</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>D-C Grid Voltage</td>
<td>-250</td>
<td>-250</td>
<td>-</td>
</tr>
<tr>
<td>D-C Plate Amperes</td>
<td>.250</td>
<td>200</td>
<td>250</td>
</tr>
<tr>
<td>Plate Dissipation, watts</td>
<td>300</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Screen Dissipation, watts</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Grid Dissipation, watts</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
For years, Calidyne has been building Vibration Test Systems to meet specific military, aircraft, automotive and industrial requirements. Most Systems have been custom-constructed for special applications. Although they were representative of the most modern equipment available at the time, it may now be to your advantage to modernize to meet the newer requirements of this fast-moving field.

Some of the older Calidyne Vibration Test Systems may have become obsolete to a point where they cannot be revamped to meet more modern requirements. With others, it is possible for us to upgrade the equipment so that its performance will compare favorably with any now being offered. In many cases this can be done without serious sacrifice of the original investment.

When you want to investigate the possibility of bringing your Calidyne Vibration Test System up to date, get in touch with us here at Calidyne — we can quickly tell you what can be done. The telephone number is Winchester (Boston) 6-3810, or write:

**THE CALIDYNE COMPANY**

120 CROSS STREET, WINCHESTER, MASSACHUSETTS

**SALES REPRESENTATIVES**

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**NEW PRODUCTS (continued)**

made in two parts to facilitate assembly, inspection and contact replacement or rearrangement.

The new series of connectors equals or exceeds the specifications for rectangular connectors contained in MIL-C-8884A. They will be available in 34, 42, 50 and other standard contact capacities. Any of the new connectors will mate with existing, ordinary connectors having similar contact arrangements. Circle 452 on Reader Service Card.

**TINY A-C VOLTMETERS**

with expanded scales

INTERNATIONAL INSTRUMENTS INC., P. O. Box 2945, New Haven 15, Conn., announces a new line of a-c voltmeters using D'Arsonval type movements. Accuracy on all meters is ±5 percent of the expanded portion of the scale; for example, ±1.5-v on a 90 to 120-v a-c scale.

Standard ranges are 90-120, 90-130 and 90-140 volts a-c. Special ranges are available however; minimum scale span is 30 v and lowest scale starts at 80 v. Scales are linear with black markings on a white background.

All meters, except Model 1145, are for use on nonmagnetic panels. Watertight seals can be included, if required. Circle 453 on Reader Service Card.

**SWEEP OPERATED RELAY**

for studying transistors

ENGELHARDT ENGINEERING CO., 38 Burritt Ave., South Norwalk, Conn. In the study of single transient phenomena with an oscilloscope, the sweep operated relay will be found useful by initiating the tran-
How to keep informed on the

"with what" part of your business

At your finger tips, issue after issue, is one of your richest veins of job information — advertising. You might call it the “with what” type — which dovetails the “how” of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better — save your company money.

Each advertiser is obviously doing his level best to give you helpful information. By showing, through the advertising pages, how his product or service can benefit you and your company, he is taking his most efficient way toward a sale.

Add up all the advertisers and you’ve got a gold mine of current, on-the-job information. Yours for the reading are a wealth of data and facts on the very latest in products, services, tools... product developments, materials, processes, methods.

You, too, have a big stake in the advertising pages. Read them regularly, carefully to keep job-informed on the “with what” part of your business.
Your prototype is arriving
by air from
PHILLIPS

Phillips has the ready answer for controlling large numbers of circuits in its Type 2 relay. Available in countless variations, contact combinations and coil windings. Type 2 offers a large coil winding capacity. This permits single and double wound coils and the use of copper or aluminum slugs for time delay on pick-up and drop-out. Large contact capacity permits assemblies of 24 contacts on one relay in a variety of types. Choice of single or twin contacts using precious metals or snap action switches. Type 2 is built from standard precision parts with special features included to fill specific requirements.

If any relay problem has you up in the air, let the "man from PHILLIPS" help.

COIL CHARACTERISTICS:
Operating Voltage: up to 750 volts D. C.
up to 440 volts A. C. 60 cycles.
Resistance: up to 50,000 ohms.
Single or double wound. Operating Current: 0.001 amps. D. C. Minimum Operating Time: 0.099 secs., minimum 0.400 secs., maximum

CONTACT ASSEMBLY:
All forms A through E. Single or double pileup. Code #4 Palladium contacts, standard. Other contacts available.

VARIATIONS:

SOLDERLESS CONNECTORS
for solid sheathed cable

ENTRON, INC., Bladensburg, Maryland has begun production of the first group of a series of compression-type fittings and adapters for use on Foamiflex solid sheathed cable. The couplings feature very low vswr's, corrosion resistant finishes, and a flared seal for the cable end. Units of the same series have interchangeable bodies allowing extension cables or connectors to be readily changed.

A combination gaged sheath cutter, ferrule wrench, and counterboring and flaring tool has been especially designed for the installation of these connectors. Both
tools and connectors are made for 1⁄4 in. and 3⁄16 in. cables. Circle 455 on Reader Service Card.

FLEXIBLE LEADWIRE
Teflon insulated

HITEMP WIRE, INC., 1200 Shames Drive, Westbury, Long Island, N.Y., has available a Teflon insulated flexible leadwire that has had its surface so treated that it will provide adequate adhesion with impregnated and casting materials. Heretofore, the lack of adhesion caused serious moisture paths, which greatly degraded the hermetic seal.

With Hitemp's new, specially treated Teflon lead wire, the non-stick properties have been completely alleviated. The treated Teflon wire exhibits the same outstanding thermal and electrical characteristics as conventional Teflon insulated conductors. It can be provided in all the available color codings. Circle 456 on Reader Service Card.

PRESSURE WINDOW
for half-X waveguide uses

MICROWAVE ASSOCIATES, Inc., Burlington, Mass., has developed a new flange-mounted waveguide pressure window for use in half-X waveguide applications.

Designated the MA-1339, the new window covers the frequency range from 9.5 to 10.1 kc with maximum VSWR of 1.10 at the band edges. Resonant frequency is 9,880 mc. It is used in 0.2 b 0.9 i.d. waveguide applications. Window flange thickness is 0.060 in. Maximum power rating of the MA-1339 is 20 kw. Maximum pressure handling capability is 45 lb on the glassed side of the window. Pressure-handling capability in the reverse direction is 30 psi. The windows are constructed of kovar and glass. All metal surfaces are silver plated. Circle 457 on Reader Service Card.

PREAMPLIFIER
weatherproof, pressurized

NEMS-CLARKE, Inc., 919 Jesup-Blair Drive, Silver Spring, Md., announces a new design in preamplifiers for use with their tele-metering receivers. The unit is weatherproof and pressurized so that location at the antenna can be made without encountering moisture problems. Line losses as high as 6 db will not decrease the sensitivity of the receiving system by more than a few tenths of a db when this preamplifier is used.

The pass band has a uniform response of 3 db over a frequency range of 215-245 mc. The PR-200 will improve the noise figure of the type 1400 or 1401-A receivers by approximately 1 db assuming lossless connecting cables. The unit has a self contained power supply which is controlled from a 1⁄4 in. power control panel designed for mounting in the relay rack with other receiving equipment. Similar units are available.

Jam nut receptacles are convenient to install, easy to service and to replace. Their use offers positive savings in harness assembly time. These receptacles permit easy bench wiring of harnesses and subassemblies prior to installation.

Just consider these design advantages: only one mounting hole required per receptacle; no extra gasket required; no user problem of sealing around screw holes; no extra hardware necessary, such as screws, washers or nuts.

Write for complete detailed specifications.
MINIATURE COAX CABLE by Tensolite

Here is a "Pixie Eye View" of Tensolite's new miniature Coaxial Cable... and here are the answers to some of the questions you will ask:

**TEMPERATURE RANGE:** From -90° to +250°C... depending on jacket used. Teflon jackets approved for entire temperature range listed.

**IMPEDANCE VALUES:** 50, 70, 75, 93 and 95 OHMS available from Tensolite as standard constructions.

**TO MILITARY SPECIFICATIONS:** MIL-C-8721 (with KEL-F jacket); RG-178, RG-179 and RG-180. MIL-C-176 (with Teflon jacket); RG-187/U, RG-188/U, RG-195/U and RG-196/U.

**COLOR CODED JACKETS:** In standard colors and striped combinations.

... AND FOR YOUR CUSTOM REQUIREMENTS: Tensolite Factory and Field Engineers are ready to assist you in the Design, Development and Production of any miniature Coaxial Cables for specific or unusual applications. Simply write or call Tensolite for complete descriptive literature and samples.

© Tensolite

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**NEW PRODUCTS**

having a uniform response within 3 db over a frequency range of 225-260 mc. Circle 158 on Reader Service Card.

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**SUBMINIATURE RELAY**

for low-level circuits

PRICE Electric Corp., Frederick, Md., announces production of the new Husky subminiature relay—style 506—to meet the requirements of MIL-R-25018 (USAF).

Style 506 relay is available in two designs: for critical applications in low level circuits, and for general purpose use on aircraft and missiles. Both types are hermetically sealed. The low level circuit design permits isolation of all organic materials from the contact chamber. To positively eliminate contamination, each relay is assembled and adjusted under ideal conditions in the company's pressurized room. The general purpose design does not have the isolation feature.

These continuous duty relays, d-c operated, have a mechanical life expectancy of 20 million cycles. Each relay weighs 1.5 oz. Bulletin No. 5 gives more detailed information and a schematic presentation. Circle 159 on Reader Service Card.

---

**VOLTAGE DOUBLERS**

silicon cartridge type

INTERNATIONAL Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif., announces compact, dual purpose silicon cartridge voltage doubler rectifiers. The small size, light weight, and rectifying characteristics of these silicon cartridges make them especially applicable to airborne military equipment, and industrial equip-
NEW PRODUCTS (continued)

ment operating in high ambient temperatures (−55 C to 150 C). Hermetic sealing in metallized ceramic housings permits their use in corrosive atmospheres.

Each of these cartridge rectifiers is a voltage doubler having a maximum rating per leg of 3,200 piv. Therefore, two units can be connected as a single-phase, full-wave bridge, capable of delivering 1,900 v d-c at 90 ma for an input voltage of 2,240 v rms at 75 C. Measuring 1½ in. in diameter, the rectifiers are available in two standard lengths: 2½ in. and 4½ in. The cartridge design permits mounting in standard 30-ampere fuse clips.

They are well suited to applications such as: mounting in d-c relay housings to eliminate the need for separate power supplies; replacing a-c relay units where hum is objectionable; providing d-c power for solenoids, counters, variable speed controls and for the supply of power to the fields of small d-c motors. Circle 460 on Reader Service Card.

SERVO MOTOR

high temperature type

JOHN OSTER MFG. Co., Avionic Division, 1 Main St., Racine, Wisc. A new smaller lighter high temperature continuous duty servo motor for transistorized operations has been announced. Type

look what $24.50 buys
in test equipment!

HEATHKITS GIVE YOU TWICE AS MUCH equipment for every dollar invested

The famous model V-7A Vacuum-Tube-Voltmeters is a perfect example of the high-quality instruments available from Heath at ½ the price you would expect to pay! Complete, only $24.50

Get the most out of your test equipment budget by utilizing HEATHKIT instruments in your laboratory or on your production line. Get high quality equipment, without paying the usual premium price, by dealing directly with the manufacturer, and by letting engineers or technicians assemble Heathkits between rush periods. Comprehensive instructions insure minimum construction time. You'll get more equipment for the same investment, and be able to fill your needs by choosing from the more than 100 different electronic kits by Heath. These are the most popular "do-it-yourself" kits in the world, so why not investigate their possibilities in your particular area of activity! Write for the free Heathkit catalog now!

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Contains detailed descriptions of Heathkit models available, including VTVM's, scopes, generators, testers, bridges, power supplies, etc.

Electronics—September 1, 1957
SMALL SIZE: Can for 5 to 25 ampere unit measures only 1 3/4" x 1 1/4" x 3/4". Other sizes in proportion. Tolerance: (general) ± 1/16" (mounting centers) ± 1/16".

LIGHT WEIGHT: 5 to 25 ampere unit weighs only 72 grams; 10 to 50 ampere unit 135 grams; 20 to 100 ampere unit 202 grams.

HIGH TEMPERATURE OPERATION: Continuous duty operation at full rated amperage up to 125°C. Up to 5 times rated amperage at low temperatures and intermittent duty.

SPECIFIC PERFORMANCE CURVES ON EACH UNIT: Graphs show exact performance to be expected for each unit under outlined condition of load current and ambient temperature. Current ratings from 2½ to 100 amperes.

SCREW TYPE COMPRESSION GLASS SEALS: (1) provide a hermetically sealed unit (2) withstand torque up to 14 pound inches and (3) are 100% fungus resistant.

VIBRATION RESISTANT: Internal components "locked" in place by thermo setting resin fill. New triangular mounting ears on both the 10 and the 20 ampere units.

* Request informative bulletin.

THE Potter COMPANY
Specialists in Layer Wound Capacitors Since 1925
1950 Sheridan Road, North Chicago, ILL.

NEW PRODUCTS (continued)

8-5001-02 measures only 0.863 in. long by 0.750 in. o.d., weighs only 1.2 oz, has an operating temperature range of -65 C to +125 C and meets MIL-E-5272. Voltage is 40/20 on control phase and 26 on fixed phase 400 cycle. No load speed is 6,500 rpm and stall torque 0.15 oz in. It is furnished with synchro mount and pinion type shaft. Circle 461 on Reader Service Card.

TUBE SHIELD
for printed circuit use

INTERNATIONAL ELECTRONIC RESEARCH CORP., 145 West Magnolia Blvd., Burbank, Calif. A new miniature and subminiature series of right-angle heat-dissipating tube shield clamps for printed circuit application are announced.

The shields contain integral sockets for miniature and subminiature tubes. Subminiature shields have flat press and round button base sockets and miniature shields are available with 7 and 9 pin sockets. All sockets are of a standard Mica filled type cast on to the shield assembly in a Mica filled epoxy resin of good electrical and mechanical properties. The epoxy resin withstands continuous operating temperatures of 175 C.

Bulb temperature of the tube is maintained to within 5C of the heat sink temperature per watt of heat dissipation and gives excellent retention, shock and vibration protection in extreme environmental conditions.

With the IERC right-angle printed circuit design the base of the shield attaches directly to a metal heat sink which lies adjacent to the printed circuit board. Socket leads extending
NEW PRODUCTS

from the right-angle epoxy resin head fit through holes near the edge of the printed circuit board and are affixed by hand or automatic dip-soldering.

Installation illustrations and engineering data are available for the asking. Circle 462 on Reader Service Card.

RECTIFIERS

for h-v applications

HOFFMAN SEMICONDUCTOR DIVISION, Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ill., has announced the HDMP series of h-v medium power silicon diffused junction rectifiers. Designed for applications requiring up to 1,000 peak inverse working volts, these rectifiers are finding wide application in both commercial and military equipment.

Rated for operation in free air with no external heat sink, there is a choice of axial or single ended body construction. Maximum dimensions are only 0.220 in. diameter by 0.360 in. length. The line of HDMP rectifiers includes ten different models at the present time.

Charts, technical information and literature are available for the writing. Circle 463 on Reader Service Card.

INDUSTRIAL RELAY

general purpose type

WHEELOCK SIGNALS, INC., Long Branch, N. J. A new general purpose relay incorporating such design features as interchangeable coils and a removable multiposition base is now being offered to the equipment manufacturer and industrial user. Contacts rated

4 Ways Better...

SILICONE RUBBER
Tubing and Sleevng

1. WON'T CRACK, PEEL OR CRAZE
2. GREATER FLEXIBILITY
3. HIGH DIELECTRIC RETENTION
4. LONG LIFE CUTS REPLACEMENT COSTS

THERMAL PROPERTIES:
Heat aging: 1000 hrs. at 250° C without appreciable change in physical or dielectric properties.

FLAMMABILITY:
Self-extinguishing, when tested in accordance with ASTM and NEMA procedures. (NEMA Acceptance Test).

ABRASION RESISTANCE:
Durable and extra tough. Withstands unusual rough handling at all times.

CHEMICAL INERTNESS:
Has good resistance to all oils, alcohols, dilute acids and alkalis. Fine water resistant qualities.

FLEXIBILITY:
Unaffected throughout life of Tubing. Stays flexible from minus 90° F. to plus 600° F.

FUNGUS RESISTANCE:
Inert. No fungus growth was visible at 40 x magnification after 28 days incubation under "ideal" surroundings.

Twist, bend, wrap or knot it and this tubing remains pliable and efficient, even under the most severe operating conditions. Send for free samples today.

Names: ____________________________________________
Title: _____________________________________________
Company: _________________________________________

VARFLEX SALES CO., INC.
308 N. Jay St., Rome, N.Y.

Please send me sample with Bulletin and Prices.

SALES CO., INC.
SPECIALISTS
Rome, N. Y.
As shown in Fig. 1, the fitting of Micro-Bearings, like the fitting of larger ball bearings, chiefly involves the clearances between the inside diameter of the bearing and the outside diameter of the bearing; the bore of the bearing and the shaft diameter.

The achievement of the desired fit by dimensioning is illustrated in Fig. 2. The bearing ID is represented by the top blocks and the shaft OD is represented by the lower blocks. Such a block diagram could also be applied to housings and bearings outside diameters. In this block diagram, it will be noted, the bearing ID is represented by a 0.0003 tolerance with a similar tolerance for the shaft. A resulting fit of line to line to 0.0003 loose is shown.

An interference fit not tighter than line to line is suggested for the following reasons:
1. Difficult in assembly.
2. Difficulty in disassembly. This is often more hazardous than the assembly operation and may result in total bearing destruction.
3. Reduction in radial play.
4. Danger of bearing ring conforming to possible poor geometry of mating shaft or housing.

TOLERANCE DISTRIBUTION
The maximum 0.0003 loose condition shown in Fig. 2 may be excessive in some applications. The fitting problem then resolves itself to reducing this extreme, and yet maintain the maximum tight fit of line to line. The looseness may be reduced by redimensioning the shaft to 0.12490/0.12475 as shown in the block diagram, Fig. 3.

If the frequency distributions of shaft and bearing ID sizes were statistically normal, the modal fit of all parts would be 0.0001 loose. Accordingly, an insignificant percentage of parts would be mated to the extreme values, and for practical purposes could be ignored.

With regard to bearings' outside diameters and bores, however, normality of the distribution curve cannot be assumed. During the grading operation, the "most metal tendency" tends to skew the frequency distributions for bearing ID's and OD's in the direction of most metal.

In grading and finishing shafts and housings, similarly skewed distributions occur.

Operating on a modified probability distribution of tolerance is possible if the volume of parts is sizable. But the approximate distribution of shaft and housing sizes must be verified if this method is to be used.

MATERIALS and SURFACE FINISHES
The ease of assembly is also affected by materials and finishes. The following factors must be considered:
1. The galving characteristics, hardness and ductility of the materials involved.
2. Finish lay patterns produced by various tools and techniques used.
3. R M S surface finish values achieved.
4. Geometry of shafts and housings as regards out-of-roundness, taper, etc.

The possible combinations of these elements in any single application are so numerous that their gross effect can only be ascertained by trial and error, or by a detailed study of operations on individual applications. A more complete discussion of fitting practices, including sizing methods and coding, is found in our design handbook.

DESIGNERS HANDBOOK FREE TO ENGINEERS
If you work with miniature bearings, you'll find this new, 70 page authoritative publication a great help in solving problems in designing instruments or small electro-mechanical assemblies.

It will be sent free to engineers, draftsmen and purchasing agents.

Write to:

NEW HAMPSHIRE BALL BEARINGS, INC., PETERBOROUGH 1, NEW HAMPSHIRE

at 20 amperes, 115 v 60 cycle a-c or 24 v d-c, are single-and-double pole, single-and-double throw. Mounting arrangements are provided for auxiliary spdt contacts if desired. The relay is 2½ in. high with a base measuring 1 in. by 3¾ in.

Small size and compactness, choice of mounting base (metal strap or Bakelite), choice of coil voltages (a-c—6 through 230 v, or d-c—6 through 115 v), and choice of terminal connections combine to make the relay truly versatile.

Typical applications include: motor control circuits; as a starter for fractional h-p motors; operation of signalling devices; as a relay in circuits controlled by thermostats, pressure switches, float switches, photoelectric devices, and the like. Circle 164 on Reader Service Card.

RELIABLE RELAYS for printed circuits
MAGNECRAFT ELECTRIC CO., W. Grand Ave., Chicago 51, III., has announced adaptation of the versatile miniature class 11 relay series for printed circuit application. These relays are especially...
adaptable to low-voltage sensitive applications where reliability is important and for requirements where one relay must perform a number of switching functions with minimum input power. They can be furnished with great resistance to shock and vibration and to withstand wide temperature variations in compliance with military specifications.

The relays are available for d-c operation, any voltage to 230, also with full wave rectification for operation from 20 to 400 cps. They are furnished with a great variety of contact combinations: snap action contacts, time delay, and heavy current contacts. Descriptive literature is available on request. Circle 465 on Reader Service Card.

MAGNETIC AMPLIFIER
sensitive and reliable

MAGNETIC CONTROLS Co., 6405 Cambridge St., Minneapolis 16, Minn.
Type PA3C-1 magnetic amplifier is designed specifically to provide proportional temperature control of a heating element in response to a change in resistance of a temperature sensor.

Power output is proportional from 0 to 100 w, 400 cps, as the temperature sensing element resistance changes by approximately 1 ohm. Nominal output load is 130 ohms.

The two-stage amplifier combines a high degree of sensitivity and reliability. It is designed to operate in ambient temperatures of −55 C to 100 C and to exceed all other environmental conditions of MIL-E-5272. Internal circuitry design is such that open or short circuit sensing elements will cause the output voltage to automatically reduce to zero. The ampli-
**Diagnose:**

Hidden danger of moisture damage to precise electronic, electrical and mechanical equipment.

**Prescribe:**

**Dampp-Chaser**

the new low-surface temperature heater always on guard against destructive moisture.

Moisture is the great deprecator. Hard to tell where or when it will strike — but later easy to prove. No sooner has one replacement part restored equipment to service, than another one fails due to moisture attacks.

End moisture with Dampp-Chaser — and end all untimely and critical breakdowns moisture causes even in the most adverse environments. End moisture-caused failures due to leakage in wiring, condensers, insulators, transformer. Dampp-Chaser chases moisture without the danger of creating hot spots. Remember these key features of Dampp-Chaser:

- Gives equipment-wide heat distribution
- Low surface temperature 150°F
- Low wattage
- UL and CSA listed
- 5-year guarantee
- Wide range of shapes, lengths and wattages
- Meets Government specs
- Free problem analysis
- World-wide distribution

For specifications, prices and information, write, wire or phone us today.

**Dampp-Chaser, Inc.**

General Offices and Plant

P.O. Box 520, Dept. E-9 / Hendersonville, North Carolina

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**Commutator**

For airborne telemetry

Arnoux Corp., 11924 W. Washington Blvd., Los Angeles, 66, Calif. Series ETC-30 electronic commutator is offered with any sampling rate from 75 to 900 points per second. The unit meets all IRIG requirements for PAM and PDM commutated telemeter and magnetic tape systems under MIL-E-5272A environment. It may be used as a direct replacement for mechanical commutators in 0-3 v and 0-5 v systems. Errors due to drift, crosstalk and nonlinearity are less than 0.50 percent.

The unit is designed to give noise-free operation, without maintenance of any kind, for at least 5,000 hours. The ETC-30 series features 27 information channels and one master pulse. A built-in limiting feature eliminates the necessity for signal limiters elsewhere in the telemeter system.

Power required is 150 v d-c at 12 ma. Size is 3 in. diameter by 5 in. long. Total weight is less than 2 lb. Circle 467 on Reader Service Card.

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**Tiny Toroids**

for printed circuits

Torotel, Inc., 11505 Belmont, Hickman Mills, Missouri. A new series of printed circuit subminiature toroids, designed and built for use with automatic production techniques, is now available with
 Who put out the “fire” in the tail?

Hallicrafters ... with a revolutionary, mass produced cooling unit for airborne electronics. Dissipation up to 7,000 watts ... 20% less costly ... 30% lighter.

POWER JUNCTIONS
liquid-cooled germanium type

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., has introduced highly efficient, liquid-cooled germanium power junctions, rated at 670-ampere rectified d-c, specifically engineered for heavy power conversion.

Six junction types are available in the range of 20 to 66 v rms. The 1-v junctions provide 98.5 percent efficiency, and will lower the power consumption of rectifier equipment. Connected in a three-
IERC's FREE TUBE SHIELD GUIDE helps you improve electron tube reliability—

—provides information you need to properly match over 1,400 sizes and types of electron tubes and heat-dissipating tube shields for best cooling, retention and protection against shock and vibration!

New 20 page IERC Heat-dissipating Tube Shield Guide has been carefully and accurately compiled in answer to many hundreds of Electronic Engineer suggestions and requests for just such a practical Guide. New design applications and retrofittting of electronic equipments with IERC Heat-dissipating Tube Shields (for the excellent cooling, extended tube life and reliability they provide) created the need for this type of professional information—plus another "first" for IERC—the first reference manual of this type to the electronic industry!

For a free copy, please send request on your company letterhead to: Dept. TSG.

International Research Corporation
145 West Magnolia Boulevard, Burbank, California

Heat-dissipating tube shields for miniature, subminiature, octal/power electron tubes

phase bridge circuit, six of these junctions will deliver 170 kw.

The junction measures 5 in. by 3½ in. by 3½ in.; features a copper housing cast around special alloy steel tubing for maximum cooling. Circle 469 on Reader Service Card.

DELAY LINE
lumped constant type

PCA ELECTRONICS INC., 16799 Schoenborn St., Sepulveda, Calif., has developed a highly miniaturized 120-µsec delay line with a rise time of 1.4 µsec. Taps can be supplied as desired with the tolerance in delay of 0.25 percent at taps and output. This line offers the low attenuation of 3 db and has a temperature coefficient of less than 25 ppm from -40 C to +105 C.

The units can be supplied with pin terminals recessed for plug-in to printed circuit board or with conventional hooked terminals. All units are hermetically sealed in a metal case measuring 17 in. by 4½ in. by 13 in., plus studs and terminals. Circle 470 on Reader Service Card.

D-C POWER SUPPLIES
are transistor regulated

RAMSEY ENGINEERING CO., 2451 University Ave., St. Paul 14, Minn., announces a line of transistor regulated d-c power supplies having line regulation better
than 0.05 percent, load regulation better than 0.1 percent, and ripple less than 5 mV rms. Present models are for 115 V, 50-65 cps line, with output voltages from 2 to 200, adjustable ±5 percent of specified value, at 50 W. Custom design is readily available.

Special features are size, absolute short circuit protection, adjustability, stability, ease of custom design, and design to military specifications. Circle 471 on Reader Service Card.

**OUTPUT TRANSFORMERS**

**two high fidelity types**

**THE UNITED TRANSFORMER CORP.,**
150 Varick St., New York 13, N.Y., announces two new high fidelity output transformers in its linear standard series. Type LS-35 has a 5,000 ohm center tapped primary with 43 percent screen taps for use with EL-34 tubes in AB-feedback. Secondary impedances are 4, 8, and 16 ohms; frequency response, 1 db from 7 to 50,000 cps, 35 W level.

The LS-65 transformer is a similar unit of 60 W rating, providing a 3,300 ohm center tapped primary with 40 percent screen taps for 6550's in AB, feedback.

Both units are furnished with a recommended circuit which provides maximum fidelity and stability. Circle 472 on Reader Service Card.

**SELENIUM RECTIFIER**

**for industrial applications**

**INTERNATIONAL RECTIFIER CORP.,**
1521 E. Grand Ave., El Segundo, California, announces a new selenium rectifier for industrial applications

This new Speer Packaged Assembly Circuit offers you a wide variety of custom, preassembled units of high-quality components for use in conjunction with printed board applications.

P.A.C. permits the insertion, as a group, of a full range of capacitors and resistors in simple or complex circuitry. Each P.A.C. is based on components of uniform dimensions, ¼" diameter and ¼" long. Component availability includes Jeffers tubular ceramic capacitors and Speer fixed composition resistors, providing wide circuit flexibility in a single P.A.C. unit.

**ADVANTAGES OF SPEER P.A.C.**

- Simplifies chassis design and assembly
- Reduces printed circuit board area and insertion operations
- Permits easy and low-cost component change-over to accommodate circuit revisions
- Broad choice of characteristics—low capacitance temperature compensating units and high capacitance bypass capacitors mounted in same P.A.C. unit
- Isolation of individually mounted units provides low shunt capacitance across resistors
- Pretested components achieve unusually close tolerance assembly

Learn more about the new Speer P.A.C.

For information write to:

**JEFFERS ELECTRONICS DIV.**

Speer Carbon Co., Du Bois, Pennsylvania

Circle 261 Readers Service Card
NEW PRODUCTS (continued)

CALIF., has announced high current density selenium rectifiers for high temperature industrial applications.

Individual rectifier plates are capable of handling twice the current of conventional plates of the same dimensions, and feature input voltages up to 36 v per plate. The low forward drop and h-v capacity resulting from the new Dualtron process reduces the number of plates required to provide the same output as other selenium rectifiers available to this date.

Rectifiers of all circuit types will be available in plate sizes ranging from 1 in. square to 6 by 7 in. Circle 473 on Reader Service Card.

TEST JIG
for magnetic cores

BURROUGHS CORP., Electronic Instruments Division, 1209 Vine St., Philadelphia 7, Pa., has announced development of a new test jig designed for precision testing of magnetic tape wound bobbin cores. The jig provides a means of applying either positive or negative current driving pulses to the core being tested and incorporates circuits permitting direct viewing on an oscilloscope of the current

TECHNITROL
standard or specially designed
by TECHNOLOGY

These extra-compact delay lines assure a minimum of pulse distortion with maximum stability under ambient temperatures ... and in a minimum of space. They can be had pencil-thin in plug-in, pig tail or fuse-clip mounting. Available cased or dip-coated in epoxy resin as well as hermetically-sealed units for military application ... with any desired characteristics of impedance or frequency response. Typical are:

- Delay: 0.01 to 6 μs
- Characteristic Impedance: 400 to 5600 ohms
- Band Pass Characteristics: Unique windings furnish maximum band width for given delay per inch.

We are prepared to design lumped constant or distributed constant delay lines for your particular circuit applications.

Write today for Bulletin E 174.
pulse at the point of application to the core and also the output pulse induced by the switching of the core.

The jig is available in two models, types 8040 and 8041, the difference between models being the size of bobbin flange each will accommodate. In operation the two models are identical. The core is inserted into the jig by placing it between two pairs of sensing pins. When the cover arm is pulled down, the two pins in each pair are connected, thus forming a tight, single-turn winding on each side of the core; one for the input, the other for the output. In both models the pin spacing is adjustable in order to assure a tight loop around the core for different size bobbins.

Types 8040 and 8041 test jigs have been designed as part of Burroughs core tester BCT301, a complete system for individually testing tape wound cores. Circle 474 on Reader Service Card.

WIRE WRAP TERMINALS for printed circuit assembly
MALCO TOOL AND MFG. CO., 4025 West Lake St., Chicago 24, Ill. A recently developed line of wire wrap terminals is presently being used by electronic, tv and radio manufacturers to speed up assembly and cut production costs. Available in loose or chain form, this terminal features a clinch-type design which holds the individual terminal firmly in the printed circuit board during additional assembly operations and until permanently soldered.

When used in chain form and in conjunction with the Malcomatic lug inserter, the new terminals make possible a fully automatic assembly of 20 wire wrap termin-
MicroMatch Directional Couplers* measure RF Power and VSWR—giving you, the designer, positive confirmation of your transmitter’s performance and providing your customer with a monitor that constantly watches his transmission line and antenna.

Built into major military communications and ballistic missile programs, these compact, rugged—and low cost—couplers produce an output essentially independent of frequency over the range of 3 to 4000 megacycles. They are adjusted for full scale meter deflection at power levels of 1.2 watts to 120 KW. Accuracy of power measurement is plus or minus 5% of full scale.

WRITE FOR OUR 46-PAGE CATALOG...or see page 376 of Electronics Buyers Guide for more information

WHEN MICROMATCH® IS BUILT IN—YOU KNOW WHAT’S GOING OUT

* U. S. Letters Patent No. 2,588,390

M. C. JONES ELECTRONICS CO., Inc.
BRISTOL, CONNECTICUT

NEW PRODUCTS

nals into printed circuit boards, in any pattern, at rates up to 20 boards per minute. For semiautomatic operation, they can be used in chain form for rapid insertion by means of the Malco single terminal inserter.

The new wire wrap terminals are engineered to meet the rigid specifications required for automatic wire wrap connections. Variations in designs can be quoted on request. Circle 475 on Reader Service Card.

CABLE BELT for printed wiring

TAPE CABLE CORP., 790 Linden Ave., Rochester 10, N. Y. has introduced a transparent flexible polyester film in which are imbedded flat copper conductors 0.0015 in. thick. A saving of 85 percent in copper over conventional cable having round conductors of the same current-handling capacity is claimed. Each conductor is rated at 1 amp in free air at 300 v, with an interconductor capacitance of less than 5 µf/ft. Tensile strength is 80 lb/in. of width. Other advantages include reduced assembly and maintenance costs due to high-speed stripping, soldering and insulating. Circle 476 on Reader Service Card.

PRECISION POT five-in. type

DeJUR AMSCO CORP., 45-01 Northern Blvd., LIC 1, N. Y. Series HP-500 potentiometers are an extension of the characteristics of the HP-300 series (3-in.) for use where resolution and linearity requirements are more important than physical considerations. The HP-
NEW PRODUCTS (continued)

500 series uses a 14 in. long Kohler-Rauch cylindrical resistance element, resulting in linearities of ±0.3 percent (std) to ±0.05 percent (on order) and in very high resolution.

Depending on the spacing required, up to 32 taps can be provided. Resistance tolerances are ±5 percent (std) to ±1 percent (on order) at 12 watts. Mechanical rotation is 360 degrees. Aluminum end-plates have three tapped mounting holes. All contact materials are precious metals with terminals and slip rings gold-plated. Circle 477 on Reader Service Card.

WINDING MACHINE for toroidal coils

DONALD C. Harder Co., 3710 Midway Drive, San Diego, Calif., has added the Model M-24 toroidal coil winding machine to its line of products. The M-24 is a heavy duty machine designed to wind toroids from 2 in. to 8 in. outer diameter such as those used in magnetic amplifier and control systems.

Wire sizes 18 to 36 are wound up to a maximum speed of 500 turns per minute. An electronic system using a thyatron pulsing circuit counts the turns. Footage of wire loaded is registered by means of an electronic counter.

This highly accurate instrument is widely used in all phases of industry where measurement of AC and DC voltages and DC current and resistance are encountered.

- High sensitivity—20,000 ohms per volt, AC and DC.
- One selector switch.
- Accurate rugged meter movement.
- Batteries replaceable without opening case.
- Easy vision case design.
- Particularly suitable for portable applications.

For complete information on the above and other instruments in the RCA line, write to RCA, Dept. X-46, Building 15-1, Camden, N.J.

*Price in U.S.A., f.o.b. Camden, N. J. Subject to change without notice.

This instrument is widely used in all phases of industry where measurement of AC and DC voltages and DC current and resistance are encountered.

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*Price in U.S.A., f.o.b. Camden, N. J. Subject to change without notice.
CHOPPER STABILIZED D-C AMPLIFIER

for use with galvanometer-type recording instruments such as Esterline-Angus, etc.

- 10 mv. input across 1/2 megohm produces 1 ma. in 1500 ohm load
- Less than 1% zero drift
- Linearity 1%
- Accuracy 2%
- Freq. resp. 0-2 cps.
- Power 15 watts, 115 v 60 cps.
- 5 1/2 x 5 1/2 x 8 inches

$120.00
Inquire about Model M-10

NEW PRODUCTS (continued)

of a 1-ft circumference measuring wheel.

The grooved 24 in. diameter winding ring operates in conjunction with a circumferential retaining coil spring. A maximum of 1 1/4 lb of wire may be loaded. The feed is manual, resulting in a random winding. Total price is $1,250. Circle 478 on Reader Service Card.

TAPE ERASER priced at $20

MICROTAN Co., INC., 145 E. Mineola Ave., Valley Stream, N. Y., has introduced a magnetic tape bulk eraser. Model HD-11 erases recorded signals and noise from magnetic tape below level of standard erase heads. Spindle mounting of reel permits rapid, thorough, coverage without missed spots.

The eraser is usable with magnetic tape reels from 5 in. through 10 in. diameter. It may also be used for demagnetizing record-playback-erase heads, tools, and other metal objects. Size is 8 in. by 5 in. by 8 in. Weight is 8 1/2 lb. Circle 479 on Reader Service Card.

TUBE ANALYZER

an automatic unit

RHEEM MFG. Co., 7777 Industry Ave., Rivera, Calif. The REL-1001 is an automatic tube analyzer incorporating new concepts of design for faster, more accurate, highly flexible and extremely simple operation. The unit provides 17 test positions, which can be set up to perform any combination of 19 basic tests, utilizing the “programmer” principle con-
sisting of individual, easily inserted patch panels, each unique to a particular tube type. Tests may be conducted singly or in sequence, and may be accomplished automatically, semiautomatically, or manually at the rate of 3,000 tests per hour, to ±3.0 percent accuracy. The analyzer tests practically all basic tube types. The unit will accommodate new types and is adaptable for special tests. A bulletin giving complete specifications is available. Circle 480 on Reader Service Card.

TRIPLE POWER SUPPLY for strain gages

Kin Tel, 5725 Kearny Villa Road, San Diego 11, Calif., Model PSG-3 supplies three independent 6 or 10 volt sources for 120 or 350 ohm strain gages. A single front panel switch sets all three channels to either 6-v or 10-v. A screw-driver control for each channel allows ±1-v adjustment on both voltage settings. Adjustment resolution is 0.05 percent.

Output noise is less than 5-μv with supply ungrounded and feeding a grounded 350 or 120 ohm bridge. Ripple is 2-μv peak-to-peak. Resistance to ground is greater than 1000 megohms and capacity to ground is less than 500μf per channel. Nominal load resistance is 120 or 350 ohms, while internal impedance is less than 15 ohms.

Pushbuttons on the front panel allow voltage measurement of each channel by an external voltmeter. The chassis requires 3.5 in. vertical space in a standard 19-in. rack. Including space for cable and connector, 19.5-in. is required behind the front panel. Circle 481 on Reader Service Card.

Here's a neat switch...

G-E GLOW LAMP PROVIDES NEW, LOW-COST CIRCUIT CONTROL

Before a G-E Glow Lamp starts, it is essentially an open circuit. When the lamp is biased to a point just below its starting voltage, the application of a pulse sufficient to raise the applied voltage to that which is required for starting causes the lamp to conduct—and the pulse to be transmitted to the other components. Apply reverse pulse and the lamp is extinguished, the circuit broken.

A Single G-E Glow Lamp May Serve As A:

RELAXATION OSCILLATOR • LEAKAGE INDICATOR
SWITCH • VOLTAGE REGULATOR • VOLTAGE INDICATOR

If you'd like more information on the amazing G-E Glow Lamps, send today for your free copy of the folder, "G-E Glow Lamps as Circuit Control Components". Write: General Electric Co., Miniature Lamp Dept. E-97, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Electronics - September 1, 1957

Circle 268 Readers Service Card
L-V Relay Service, Pyramid Instrument Corp., 630 Merrick Road, Lynbrook, N. Y. Now that the company has made its Remcon low-voltage relays available to manufacturers of original equipment, it has published a service bulletin (RT-100) which gives full engineering specifications on this silent, modern relay with its own built-in transformer. Circle 501 on Reader Service Card.

Energy Cartridge. Associated Spring Corp., Bristol, Conn. To describe its new compact energy cartridges—which consist of pre-assembled stacks of multiple Belleville spring washers held together by pins or rivets passing through the washers at or near their neutral axis—the company has published a six-page bulletin.

Exploded views show how the washers are assembled, and schematic drawings illustrate several typical applications for the cartridges. A few of the possible applications listed are: as a shock absorber, in vibration-isolation mounts for such products as airborne electronic equipment, in aircraft, missiles and ordnance projectiles; in machinery such as impact presses; and in spring mountings for punches and dies in industrial and powder metal compacting presses. Circle 502 on Reader Service Card.

Rotary Transducer. Crescent Engineering & Research Co., 5440 North Peck Road, El Monte, Calif. A one-page bulletin gives description and data on the 3-oz model RT-22A-120 rotary transducer. The unit discussed is an electro-mechanical instrument designed to sense angular position or rotary displacement and to transmit a proportional signal to measurement apparatus or control circuitry. Circle 503 on Reader Service Card.

Distributed-Constant Delay Lines. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Catalog data bulletin S-2 covers distributed-constant delay lines. It contains comprehensive data on functions, applications, principal equipment uses, characteristics, specifications, nomenclature, time delay, bandwidth and rise time. The four-page bulletin includes detailed graphs and illustrations. Circle 504 on Reader Service Card.

Precision Electronic Equipment. The Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y., has recently made available a short form catalog of their precision electronic equipment. The brochure includes in a precise form the description and specifications of various instruments, such as a phase meter, null meter, impedance comparators, precision power oscillators, a frequency standard, an automatic hi-pot tester and others. Circle 505 on Reader Service Card.

Magnetic Hum & Electrostatic Shielding. Magnetic Shield Division, Perfection Mica Co., 1322 North Elston Ave., Chicago 22, Ill., has issued data sheet 129 with 14 photographs and captions which illustrate and describe how to wrap audio transformers, chokes and other square or rectangular components using newly developed Co-Netic flexible foil to prevent magnetic hum. Circle 506 on Reader Service Card.

Tube Tester Roll Charts. Sylvania Electric Products Inc., 1891 East Third St., Williamsport, Pa., has available three new electronic tube tester roll charts. Designed for use with Sylvania tube testers, the new charts feature approximately 100 new tube types.

Chart PC15845-N is for use with tube testers 139 and 140. Chart PC18325-K can be used with tube testers 219 and 220. Chart PC25700-C is designed for use with tube tester 620.

The charts are priced at $1.50 each. Circle 507 on Reader Service Card.

Linear Transducers. Automatic Timing & Controls, Inc., King of
Prussia, Pa., has announced a handbook completely treating the theory and most advanced application of differential transformers. Characteristics of various differential transformers are described, tabulated and charted. Basic circuits are shown and described. Fifteen typical applications are completely covered.

The 32-page, plastic-bound handbook provides necessary data for design engineers who wish to apply linear magnetic transducers in replacing precision potentiometers and synchros as well as develop new low impedance automatic circuitry of high precision and great reliability.

Text includes 22 circuits, 37 diagrams and 12 charts. Price is $2. Circle 508 on Reader Service Card.

Power Supply. B. M. Harrison Laboratories, Inc., 80 Winchester St., Newton Highlands 61, Mass., has announced a descriptive bulletin covering a new fixed or variable frequency regulated power supply. The model No. 5014 described can be used for supplying power requirements up to 125 w at exact frequencies of 60, 400 or 1,000 cycles ±0.01 percent. In addition to these fixed frequencies it can be driven by an external signal generator to supply 125 w over a range of 50 cps to 2,500 cps.

The power supply discussed is recommended for use as a prime laboratory source of regulated voltage and frequency for the testing of equipment in the fields of missile controls, servomechanisms and gyro instrumentation. Circle 509 on Reader Service Card.

Instruments Catalog. Beckman-Berkeley Division, 2200 Wright Ave., Richmond 3, Calif. Seventeen new instruments are described in short form catalog C704.

New instruments include preset EPUT meters with variable time base for direct digital readout without conversion and a series of moderately priced portable EPUT meters. Expanded scale volt and frequency meters, transformation ratio meters, and resistors.

NEW and DIFFERENT

PREM-O-RAK by PREMIER

AVAILABLE IN 20 DIFFERENT SIZES — FROM 7” to 35” PANEL SPACES

BOTH 15¼” and 18” DEEP FOR STANDARD 19” PANELS

• Shipped knocked down for easy assembly, storage and shipping.

• Handsomely finished in two-tone Gray and Brown Hammertone.

• Both front and rear of top have attractive ball corners.

• Panels may be mounted on both front and rear if desired.

• Interlocking removable top and rear panels made of perforated metal and held by captive screws.

• Panels fit into ¾” recess. Base supplied with 4 rubber feet.

• Components may be mounted on base before assembly or rack into a complete unit.

• Screws for assembling not visible from outside.

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GOES DIELECTRIC STRENGTH
(Up to 2,500 VRMS* as required by MIL Specs—even up to 3,000 VRMS*)

GOES INTERNAL TEMP. RISE
(25% cooler internal hot spot)

NEW SAGE Type "M"
(Metal-clad) "Silicohm"
Resistors Give You BOTH!

If you have been stumped because miniature, chassis-mounted resistors in the past offered only 1,000 VRMS dielectric, then here's good news. Thanks to a superior, new type of filling material and new production techniques, SAGE now offers this new, improved, precision wire-wound resistor with a standard rating of 1,500 VRMS dielectric strength—and up to 3,000 VRMS on special order. And the cooler hot-spot means longer life, improved stability and greater all-around reliability.

Complete data available on request

SAGE ELECTRONICS CORPORATION
302 North Goodman St., Rochester 7, N. Y.
NEW

ALI VTVM TYPE 810

Featuring:
- Balanced amplifier for high stability
- 700 mc high frequency probe — smallest in the industry
- Voltage regulator provides stable dc for ohmmeter, minimizing line voltage effects
- High loop gain in the amplifier and total feedback assure long-time accuracy and nullify tube parameter variations
- Balancing diode used to match characteristics of probe, adding further stability

This VTVM, a new presentation from Acton Laboratories, provides circuit improvements and techniques which combine to give stable characteristics and long-time accuracy. The mechanical design provides an instrument of convenient size, and a miniature thermionic diode probe. Color coded meter scales, properly grouped, provides exceptional readability on all ranges.

SPECIFICATIONS
Voltage Ranges:
DC — Full scale ranges 1-3-10-30-100-300-1000 Volts (Plus and Minus)
AC — Full scale ranges 1-3-10-30-100-300 Volts (RMS)
Resistance Ranges:
0.2 — 500 ohms scale; multipliers, X1, X10, X100, X1K, X10K, X1M
Accuracy:
DC: ±2% AC: ±3%
Frequency Response:
±1 db; 10 cps to 700 mc


NEW LITERATURE (continued)

ance bridges are also covered.

The catalog also covers new nuclear scales, recorders and readouts, and the EASE 1100 analog computer with digital input and output. Circle 510 on Reader Service Card.

Calibration With Frequency Standard Broadcasts. Specific Products, 21051 Costanso, Woodland Hills, Calif. Calibration of r-f and a-f signals with standard frequency transmissions is described in an informative 4-page folder.

Designated bulletin 557, the literature details a number of methods for utilizing the standard transmissions from stations WWV and WWVH, National Bureau of Standards. It discusses with diagrams, such topics as calibration of low f-f sources, upward extension of standard frequencies, a-f comparisons, and the use of 1,000 cycle time pulses. The bulletin includes a discussion on code symbol notices of propagation disturbances, as well as the conditions necessary for obtaining various levels of signal accuracy. Circle 511 on Reader Service Card.

Epoxy Encapsulation. Rue Products, 1628 Venice Blvd., Venice, Calif. A new bulletin offers encapsulation service, engineering, development and production of all types of electronic components, assemblies and circuitry. Units discussed are designed and produced to meet the most exacting requirements of the design engineer for his specific applications. Properties of the epoxy offered are noted. Pointed out is the featured low-cost molding technique for short-run requirements. Circle 512 on Reader Service Card.

Power Supplies & Converters. Kepco Laboratories, Inc., 131-38 Sanford Ave., Flushig, N. Y., has published the new condensed brochure, No. B576. It introduces the new lines of: semiconductor voltage regulated power supplies; semiconductor d-c to d-c converters; and magnetic amplifier voltage regulated power supplies.

This literature also lists the latest improved specifications on both the company's side range and frequency response. Note: All units covered have been designed for use with instrument voltage supplies. Circle 513 on Reader Service Card.

Circle 280 Readers Service Card

ELECTRONIC & COMMUNICATIONS ENGINEERS

pioneer with page

WORLD LEADER
IN SCATTER COMMUNICATIONS

As pioneers in scatter and other advanced types of radio communications systems PAGE has earned an international reputation. Members of our organization work closely with representatives of the U. S. and foreign governments and industries in the development of multimillion-dollar tele-communications networks. Challenging assignments take our engineers to many corners of the globe.

Due to the increased demand for PAGE-designed, installed, tested and operated systems, we now offer a few high-salaried positions in our Washington, D. C., office as well as overseas (Europe, Pacific, Near East). We require engineers with a minimum of 5 years experience in installation, adjustment and maintenance of communication receivers and associated terminal equipment, as well as engineers experienced in high-powered transmitters, antennas and transmission lines.

Engineers who locate in the Washington, D. C., area find that it offers outstanding educational, cultural and recreational facilities. As a center of Government-sponsored engineering and research laboratories, it is particularly interesting to the engineer desirous of pursuing advanced studies.

New, attractive housing in all price ranges is readily available in the city's beautiful suburbs, within easy reach of our main offices in the heart of the capital.

We'll send you full information upon receipt of your inquiry.

Write: J. P. Gaines, Director of Personnel

Communications Engineers, Inc. 710-B 14th St., N. W. Washington 5, D. C.

Page

September 1, 1957 — ELECTRONICS
narrow range electronic type voltage regulated power supplies. Circle 513 on Reader Service Card.

Digital Voltmeter Application. Non-Linear Systems, Inc., Del Mar Airport, Del Mar, Calif., announces the availability of a new 28-page booklet which describes the company's full line of digital voltmeters, digital ohmmeters, a-c/d-c converters and complete data logging systems. The book, profusely illustrated with charts, diagrams, and photos of instruments, is available free upon request. Circle 514 on Reader Service Card.

Logarithmic Count Rate Meter. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio, has announced a bulletin on the model 727 logarithmic count rate meter.

The new two-page, two-color, illustrated bulletin outlines suggested uses and applications and gives complete specification data such as range, accuracy, dimensions, shipping weight and the like.

Copies of Form 3002-7 are available on request. Circle 515 on Reader Service Card.

Germanium Power Transistor. Clevite Transistor Products, 241 Crescent St., Waltham 54, Mass. A 4-page technical data sheet covers the type 2N297 military specified germanium power transistor. Included are a general description and mechanical and electrical specifications. Circle 516 on Reader Service Card.

All Transistor Amplifier. Beckman Instruments, Inc., 325 Muller Ave., Anaheim, Calif., has available a 4-page brochure on the company's all transistor amplifier. The unit discussed is a high gain, broad band, chopper stabilized, precision amplifier designed specifically for use in analog computation and amplification for low level d-c signals such as strain gage transducers or thermocouple output. High reliability over conventional amplifiers is due primarily to its being fully transistorized, light weight, cool and free of microphonics, plus a built-in

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**NEW ADVANCE MIDGET RELAYS**

...open or plastic enclosed

Elgin's new GH series combines the high efficiency required of general purpose relays with low cost. Their midget size suits them for installations where space is a problem (see specifications below). Open relays in 5 and 10 ampere ratings and clear plastic dust-tight enclosed 5 ampere relays are immediately available from stock. Specify dependable ELGIN performance...specify GH from your electronic parts distributor!

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**NEW LITERATURE**

ELECTRONICS — September 1, 1957

Circle 289 Readers Service Card

339
Regulated Power Supply

0.001% Regulation at 1/2 Ampere

KROHN-HITE Model UHR-240 POWER SUPPLY provides up to 1/2 amp. at 0-500 volts with 0.001% regulation and less than 100 microvolts of ripple. Line voltage stabilization is 0.005%. The internal impedance is less than 0.005 ohms for low frequencies and d-c, and less than 0.1 ohms for frequencies as high as 100 kc. A 0-150 volt, 0-5 ma bias supply is available with 0.05% stabilization and less than 2 millivolts of ripple. A 2.5 amp. d-c heater supply, adjustable from 5 to 13 volts with less than 20 millivolts ripple, is included in addition to two independent 6.3 volt a-c heater supplies of 10 amp. capacity. The ultra-high regulation applies over the entire operating range. Full maximum current can be drawn continuously at any output voltage, from 100 to 125 volt line. Price $625.00 f.o.b. factory.

For Further Details Write Dept. E

KROHN-HITE CORPORATION
580 Massachusetts Avenue • Cambridge 39, Massachusetts

Circle 290 Readers Service Card

NEW LITERATURE

Electronic Components Guide. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Comprehensive data on IRC's complete line of resistors and other electronic components (including those of its subsidiary, Circuit Instruments Inc. and the HyCor Division of IRC) are listed in the 1957-1958 Electronic Components Guide. Data given include JAN or MIL equivalent, rated wattage, standard tolerance, temperature rise, temperature coefficient, maximum operating temperature, ohmic values available and dimensions. Circle 518 on Reader Service Card.

Electronic Timer. G. C. Wilson & Co., 1915 Eighth Ave., Huntington, W. Va. A new 4-page bulletin describing the manufacturer's line of electronic timers is now available. This bulletin provides specifications, applications and operation of 11 timers of the repeat cycle, interval and delay types. Circle 519 on Reader Service Card.

Protective Closures. Shurclose Seal Co., 3,000 East Grand Blvd., Detroit 2, Mich., has issued a new 4-page catalog on its caps and plugs. Complete specifications are given for both rubber and plastic closures for the protection, sealing or masking of threaded parts, pipe ends or tubing. Seven styles of stock sizes are covered by the specifications. Circle 520 on Reader Service Card.

Operational Mixer. Hoover Electronics Co., 3906 Liberty Heights Ave., Baltimore 7, Md. A four-page brochure describes the model 10022 operational mixer, developed for use in summing the outputs of up to 18 subcarrier oscillators. A high-gain amplifier is used with a large feedback factor, insuring power supply that will accept inputs up to ±15 v and has an output capability of ±15 v at 100 ma.

This brochure is very descriptive, utilizing complete diagrams, block diagrams and photographs explaining operation, typical applications and operations specifications. Circle 517 on Reader Service Card.

Since 1901

SIGMUND COHN CORP. 121 So. Columbus Avenue • Mount Vernon, N.Y.
drift-free operations with a minimum of intermodulation distortion. The unit discussed weighs 9 oz and measures 1 1/4 by 2 1/2 by 4 1/4 in. overall, including connector. Circle 521 on Reader Service Card.


X-Ray Inspection of Electron Tubes. Philips Electronics, Inc., Instruments Division, 750 South Fulton Ave., Mount Vernon, N. Y. A new bulletin gives details on methods used for automatic x-ray inspection of subminiature electron tubes. Illustrated with photos and radiographs, the bulletin describes mass quantity inspection of components for missiles and aircraft systems. The text deals with x-ray work that involves welds on wire stock measuring 0.003 to 0.015 in. in diameter. The bulletin also treats x-ray examinations which determine spacing of parts and discover loose metallic particles, defective heaters and distorted grids.

The new literature discusses details of the new x-ray method including the special disk of spherical section on which tubes and film are positioned. The technique discussed permits 18,000 tubes to be checked daily and the inspection involves lead, glass, nickel, barium, aluminum, iron and many other materials which exist in alloys and chemicals of subminiature tubes. Circle 523 on Reader Service Card.

Phase Sensitive Demodulator. Hoover Electronics Co., 3906 Liberty Heights Ave., Baltimore 7, Md. A 4-page brochure describes the model 10019 phase sensitive demodulator, and associated 400-
Why Hamilton Auto-Shift drafting tables save you money

Draftsmen with Auto-Shift tables produce more. Two simple controls adjust board height and slope so easily that working angle can be frequently changed—board is instantly, effortlessly shifted to most convenient working position.

And Auto-Shift tables put more draftsmen to work in available space. Designed for row installations, there's a reference desk behind each draftsman. Six men work where four do now! Get the whole story—write Auto-Shift, Hamilton Manufacturing Company, Two Rivers, Wisconsin.

Tantalum Wire Capacitors. Ohmite Mfg. Co., 3634 W. Howard St., Skokie, Ill. Bulletin 148B supplement describes two very small "Tan-O-Mite" series TW capacitors (tantalum wire electrolytic capacitors). This release also revises the now expanded line of "Tan-O-Mite" units, gives the maximum capacities and voltages for each of the six case sizes, and lists the stock values immediately available from Ohmite. Technical information and data concerning Mylar-sleeve insulated "Tan-O-Mite" capacitors is also given. Circle 525 on Reader Service Card.

Cycling Timer. Cramer Controls Corp., Centerbrook, Conn. Complete technical information on a new motor driven cycle timer, type 571, is available in bulletin No. PB-571. Application and operation data are presented in detail together with time ranges, ratings, material and construction specifications.

Several nonstandard arrangements for special applications are suggested. A set of graphic instructions on specifying program schedules is also included. Circle 526 on Reader Service Card.

Telephone-Type Relay. Phillips Control Corp., 59 W. Washington St., Joliet, Ill. A comprehensive report on the type 8 multicontact telephone-type relay is available.

The four-page engineering bulletin, complete with photographs and dimensional drawings, provides detailed descriptions of characteristics, special features and general technical data. Standard stock and special contact listing plus in-stock relay listing is included for the type 8, which is

What's Your EQ?

Over and above I.Q. . . Westinghouse-Baltimore is looking for men with E.Q.—Exceptional Qualifications. The company's broad-based operations creates a continuing opportunity in certain specialized areas for engineers with exceptional training and experience.

If you feel that you have the qualifications to accept the responsibility of advanced creative engineering, why not write and tell us about yourself. We'd like to send you our brochure "NEW DIMENSIONS"... it's a picturesque introduction to Baltimore and a behind-the-scenes tour of the Westinghouse-Baltimore operation.

Write directly to Dr. Jules A. Medwin, Westinghouse Electric Corporation, Dept. 704, P.O. Box 746, Baltimore 3, Md.
available enclosed or hermatically-sealed.

This bulletin and others in the series are available in an attractive three-ring, looseleaf binder by writing the company. Circle 527 on Reader Service Card.

Time Interval Measurements. Beckman/Berkeley Division, 2200 Wright Ave., Richmond, Calif. Data File 112 discusses time interval measurements and how to make them. Among the subjects covered in this nine-page booklet are a description of time interval meters, measurement of pulse width and elapsed time, low-frequency period measurements, timing relay operations, testing camera shutter speeds with a time interval meter, and measuring velocity with a time interval meter.

Profusely illustrated, the literature contains diagrams, photos, and schematics describing techniques for using time interval meters. Circle 528 on Reader Service Card.

Computer Bibliography. Remington Rand, Division of Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y., has announced a new bibliography of computer literature for those interested in learning more about this absorbing subject. Booklet EL335 has been prepared with emphasis on scientific and engineering use of computers. Circle 529 on Reader Service Card.

Hermetic Seal Single Terminals. Hermetic Seal Corp., 29 South 6th St., Newark 7, N. J. Drawings and specifications for a large variety of standard hermetic seal single terminal feed-throughs and stand-offs are contained in a new 12-page supplementary catalog No. 657-B. Single terminals are produced in Vac-Tite seals constructed by the company's glass-to-metal chemically bonded compression process and in matched seals with metal and glass of matching coefficients of thermal expansion. Seals are listed in groupings according to types and sizes easily identified with specific part numbers. All are available enclosed or hermatically-sealed.

Here are details of two time-and-money-saving Diamonite services: (1) A 24-hour OFF-THE-SHELF Service from large inventory of hundreds of different standard precision Diamonite high alumina parts; (2) a speedy service on special shapes from pilot plant, engineered to your drawings. Get your ideas into production quickly.

And once in production, you can depend on receiving parts to the same specifications from our mass production facilities.
Complete facilities for precision production of electronic components

Our facilities are geared to meet your production and engineering needs for components of any description. Unusually complete tool room, press shop, hydrogen annealing, machining and polishing operations, glass-to-metal hermetic sealing. Production of completed parts ready for assembly in your own plant.

Call on us for free consultation and quotations.

ZELL PRODUCTS CORP.
279 Main Street, Norwalk, Conn.

Circle 295 Readers Service Card

NEW AMCI AUTOMATIC IMPEDANCE PLOTTER

For lab or production testing

Just turn the oscillator dial, manually or by a motorized sweep drive, and the impedance curve of load Z is traced on a regular or expanded Smith chart. Either an oscilloscope or a two-axis recorder can be used.

Write for descriptive bulletin E957

ALFORD
Manufacturing Co., Inc.
299 Atlantic Ave., Boston, Mass.

INSTRUMENTS - ANTENNA SYSTEMS - COMPONENTS - AIR NAVIGATION AIDS

NEW LITERATURE

(continued)

hot tin dipped or in precious metal finishes. Circle 550 on Reader Service Card.

Components Catalog. Merit Coil and Transformer Corp., 4427 North Clark St., Chicago 40, Ill. Form No. 409 is a 128-page catalog containing a comprehensive and accurate listing of a wide line of i-f and r-f coils, components, transformers, flybacks and yokes found in practically every tv set produced up to early 1956. Circle 531 on Reader Service Card.

Physical Limitations of Magnetic Tape. Minnesota Mining and Mfg. Co., 900 Bush St., St. Paul 6, Minn. The effects of heat, humidity and tension on magnetic tape are discussed in "Sound Talk" bulletin No. 35, now available on request from the company.

The three-page bulletin is illustrated with three graphs which show stress characteristics of the different types of "Scotch" brand magnetic tape. It points out that where magnetic tape is used under abnormal or extreme conditions—as in recording instrumentation data at tape speeds as high as 100 inches per second in conjunction with high head pressures and high environmental temperatures—certain properties of the recording media may become critical. Circle 532 on Reader Service Card.

Electro-Hydraulic Valve Actuator. Askania Regulator Co., 240 East Ontario St., Chicago 11, Ill. Bulletin 38.3 describes the new electro-hydraulic valve actuator. The actuator discussed is designed for use with low level a-c or d-c signals from electronic controllers and measuring elements or remote positioning devices. It can be mounted on valves having .5 to 14-in. stroke, requiring less than 200 lb thrust. Circle 533 on Reader Service Card.

Electronic Megaphone. Kaar Engineering Corp., P. O. Box 1320, Palo Alto, Calif. Bulletin MA-41-7 illustrates and describes the Loud-hailer, a transistorized megaphone of tremendous power adaptable to practically all commercial, industrial and sporting activities. Spe-
NEW LITERATURE (continued)

cifications and many applications are listed. Price of the unit discussed is $125. Circle 534 on Reader Service Card.

Coolant Fluid for Electronic Equipment. Monsanto Chemical Co., 800 N. 12th, St. Louis 1, Mo. Technical bulletin No. O-123 covers OS-45 coolant fluid for electronic equipment, especially the aircraft type. The fluid described is a silicate ester-based material which performs over a wide temperature range—from −80 F to 400 F—and has excellent service life. Major features, properties, handling information and availability are discussed. Circle 535 on Reader Service Card.

Precision Soldering Irons. American Electrical Heater Co., 6110 Cass Ave., Detroit 2, Mich. Bulletin 218-CP shows the latest development in American Beauty electric soldering irons. The irons discussed are designed and intended primarily to do fine precision soldering on miniature and subminiature electronic components and similar assemblies. Features and specifications are included. Circle 536 on Reader Service Card.

Interval Timer. Cramer Controls Corp., Centerbrook, Conn. Catalog and technical data on new manually set, motor driven interval timer, type 271, are now available in bulletin No. PB-271. Details of construction, operation, and application are included.

The bulletin also shows time range selections, ratings, switch capacity, and special accessory information. Circle 537 on Reader Service Card.

Miniature Composition Potentiometers. Ohmite Mfg. Co., 3638 Howard St., Skokie, Ill. The smallest, molded composition potentiometer available is described in bulletin 149 recently released. The reasons for the superior reliability of molded composition construction are outlined in detail. Complete specifications, resistance values, dimensions and prices are included on this dusttight, splashproof, fungus-resistant unit in-

Electronic Engineers

CAREER FULFILLMENT IS A MAXSON TRADITION

Too often ability and ambition go unrecognized; simply because an engineer is associated with an organization whose scope is too shallow to permit complete expression. We sincerely believe that the currently expanding activities of The W. L. Maxson Corporation offer the creative engineer a limitless range of assignments for career fulfillment.

THE W. L. MAXSON CORPORATION

460 W. 24th St., New York 1, N. Y.

ELECTRONICS — September 1, 1957
NEW LITERATURE (continued)

Pulse Calibrator. Burroughs Corp.,
Electronic Instruments Division,
1209 Vine St., Philadelphia, Pa.
The type 1810 pulse calibrator, a
new instrument designed for ac-
curately measuring current and
voltage pulse amplitudes, pulse
durations and rise time, is now
fully described in a technical
brochure.

The four-page brochure shows
how the calibrator operates, illus-
trating and explaining actual
waveforms obtained from different
applications of the unit. Complete
theory of operation of the two sec-
tions of the calibrator, the chop-
per section and the calibrator sec-
tion, along with the specifications,
is included. Circle 559 on Reader
Service Card.

Mobile Air Monitor. The Victoreen
Instrument Co., 5806 Hough Ave.,
Cleveland 8, Ohio. A new two-
page, two-color bulletin describes
the model 900-2 mobile air particle
monitor for continuously monitor-
ing and recording beta and gamma
levels.

Stating that the unit conforms
to ORNL specification Q-1740, bul-
letin 3004-7 outlines special de-
sign features, gives a block
schematic showing applications,
and lists detailed specification
data. Circle 540 on Reader Serv-
ice Card.

Five-Inch Precision Pots. DeJur-
Amsco Corp., 45-01 Northern Blvd.,
Long Island City 1, N. Y. A two-
page illustrated catalog sheet gives
specifications, diagrams and gen-
eral information on a new five-inch
high resolution precision poten-
tiometer. Circle 541 on Reader Ser-
vice Card.

Variable Transformer. The Su-
perior Electric Co., 83 Laurel St.,
Bristol, Conn. A four-page bul-
letin SE-L3578 is now available
giving illustrations, outline draw-
ings and technical rating data on
the new Powerstat variable trans-
former type LW186. The new
double wound Powerstat with an
isolated secondary on a single

THE CASE OF THE EFFERVESCENT ENGINEER

It's no mystery that the guy from I.F.I. has
changed many a real low-down "glum" into
a beaming "gleam" with his practical solu-
tions to some very distracting problems.

Take for instance the Model 500. Here is a
unit that is finding wide application in
industry after industry, as a real laboratory
"workhorse". So versatile that even we at I.F.I. have not yet classified all of its uses.

In recent tests of the Model 500 used in the
pulse mode, a rather amazing peak negative
pulse output of 240 volts into a 185 ohm
load was attained. Many other applications
have convinced those using the new Model
500 that it is well able to perform any task
within its area in a superior way. We'd like
to tell you more about the I.F.I. 500 ... just
write or phone for complete data.

SPECIFICATIONS

Bandpass.........................200 KC to 220 MC
Gain............................12 db
Input Impedance..............90 ohms
Output Impedance..............185 ohms
Power Output Capability........3 watts CW
Output Voltage to Matched Load
22V, RMS to 62 V, peak to peak
Power Supply Included

P.S. We're looking for more and more effer-
vessent engineers to join our growing
staff. If you feel you have what it takes,
give us a ring or send a wire.

INSTRUMENTS FOR INDUSTRY, INC.
168 Glen Cove Road, Mineola, N. Y. a Pflanzer 2-3500
Circle 299 Readers Service Card
September 1, 1957—ELECTRONICS
core is fully described in the bulletin.

Connection diagrams and ratings are given for the Powerstat when used as a source of adjustable low voltage isolated output, a limited range line corrector, or as a limited range buck-boost variable transformer. Circle 542 on Reader Service Card.

Electronic Typer. Shepard Laboratories, Broad St. & Park Ave., Summit, N. J. A four-page folder illustrates and describes the model 190 electronic highspeed typer. Specifications are included. Circle 543 on Reader Service Card.


Major sections cover size and weight reduction and fastener configuration and the relative importance of each factor in choosing the right fastener for the particular job. Comparison charts show weight, size, temperature, and material for nuts in ESNA's hex and clinch series. Standard AN parts and NAS miniatures are graphically compared in chart form. Circle 544 on Reader Service Card.

Production Equipment for Electronics. United Shoe Machinery Corp., 140 Federal St., Boston, Mass. Producers of electronic equipment who are using or planning to use printed wiring can receive help in determining if they can profitably mechanize their component trimming, inserting and clinching operations from a new 12-page booklet.

The booklet illustrates presently available models of Dynasert component inserting machines including both fully automatic conveyor systems and individual bench machines. Representative case histories are used to illustrate applications in high, medium and low volume situations. Circle 545 on Reader Service Card.
Plants and People

Edited by WILLIAM P. O'BRIEN

Electronics manufacturers expand plants and facilities by acquisition, leases or new construction. Top engineers and executives in the industry are promoted and move to new responsibilities. Standards Conference hosted by Moscow

Burnell Moves to Large Pelham Manor Plant

BURNEll & Co., INC., manufacturer of toroidal coils, filters and communications network components, located in Yonkers for the past nine years, has moved to Pelham Manor, N. Y.

The new Pelham Manor plant has undergone extensive remodeling and modernization. The office and production control area occupies 11,000 sq ft, and the factory space 22,000 sq ft. Equipped with an air-control system throughout, the plant employees will enjoy an air-conditioned cafeteria-style lunchroom, a large parking space in the rear of the plant, and a highly advanced assembly layout.

Because of the highly specialized nature of Burnell's products, the company instituted an on-the-job training system several years ago which has resulted in the elevation of numerous workers from the ranks into positions of responsibility.

Burnell's new location in Pelham Manor, New York

It is expected that the present roster of Burnell & Co. employees, which now numbers between three and four hundred, will be increased sharply within the near future, since the new plant production potential has been increased by new equipment and larger space.

Boscia Named Chief Product Engineer at Kin Tel

Appointment of Archie F. Boscia as chief product engineer for Kin Tel Division of Cohu Electronics, Inc., has been announced by William S. Ivans, Jr., vice president for engineering.

Boscia formerly was associated with Stromberg-Carlson Div. of General Dynamics as section head of communications and navigation at the Rochester, N. Y., plant. In this post he had project supervision of the program for production of airborne units for Tacan, the tactical air navigation system built for the armed forces.

At Kin Tel in San Diego, Boscia will supervise all engineering phases of production design on the Kin Tel line of instruments for communication, measurement and control. These include wide-band d-c amplifiers, microvoltmeters, industrial and broadcast tv and other electronic instruments.

Microwave Engineering Labs Has New Quarters

Announcement has been made by Microwave Engineering Laboratories, Inc., of its completed move into a new 3,500 sq ft research and development facility at 943 Indus-
Three voltage ranges:
0-200, 125-325, 325-525 VDC

1.5 AMPERE MODELS NEED ONLY 81/4\" OF PANEL HEIGHT!

<table>
<thead>
<tr>
<th>Model</th>
<th>Voltage Range</th>
<th>Current</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-1580</td>
<td>0-200 VDC, 0-150 MA</td>
<td>580.00</td>
<td></td>
</tr>
<tr>
<td>C-1581</td>
<td>125-325 VDC, 0-400 MA</td>
<td>405.00</td>
<td></td>
</tr>
<tr>
<td>C-1582</td>
<td>325-525 VDC, 0-800 MA</td>
<td>680.00</td>
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800 MA MODELS NEED ONLY 7\" OF PANEL HEIGHT!

<table>
<thead>
<tr>
<th>Model</th>
<th>Voltage Range</th>
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<th>Price</th>
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</thead>
<tbody>
<tr>
<td>C-880</td>
<td>0-200 VDC, 0-400 MA</td>
<td>200.00</td>
<td></td>
</tr>
<tr>
<td>C-881</td>
<td>125-325 VDC, 0-800 MA</td>
<td>325.00</td>
<td></td>
</tr>
<tr>
<td>C-882</td>
<td>325-525 VDC, 0-1500 MA</td>
<td>650.00</td>
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</tbody>
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400 MA MODELS NEED ONLY 51/4\" OF PANEL HEIGHT!

<table>
<thead>
<tr>
<th>Model</th>
<th>Voltage Range</th>
<th>Current</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-480</td>
<td>0-200 VDC, 0-800 MA</td>
<td>400.00</td>
<td></td>
</tr>
<tr>
<td>C-481</td>
<td>125-325 VDC, 0-1500 MA</td>
<td>575.00</td>
<td></td>
</tr>
<tr>
<td>C-482</td>
<td>325-525 VDC, 0-3000 MA</td>
<td>800.00</td>
<td></td>
</tr>
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200 MA MODELS NEED ONLY 51/4\" OF PANEL HEIGHT!

<table>
<thead>
<tr>
<th>Model</th>
<th>Voltage Range</th>
<th>Current</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-280</td>
<td>0-200 VDC, 0-1500 MA</td>
<td>11-11</td>
<td>131READERS SERVICE CARD</td>
</tr>
<tr>
<td>C-281</td>
<td>125-325 VDC, 0-2500 MA</td>
<td>250.00</td>
<td></td>
</tr>
<tr>
<td>C-282</td>
<td>325-525 VDC, 0-3000 MA</td>
<td>350.00</td>
<td></td>
</tr>
</tbody>
</table>

For all power supply needs through 1.5 amperes:

LAMBDA
COM-PAK
POWER SUPPLIES

Less space! Improved performance!
Long, trouble-free service!
Transient free output!

Fills the need for compact, regulated DC power supplies. Economy of panel space, functional simplicity, new quick-service features.

Wiring, tubes and other components readily accessible. You can reach them easily, service them fast.

400 MA, 800 MA, and 1.5 amperes models include new, high-efficiency, long-life, hermetically-sealed semiconductor rectifiers. All Com-Pak models are constructed with hermetically-sealed transformers, chokes and capacitors.

Condensed Data

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line Regulation</td>
<td>Better than 0.15% or 0.3 Volt, whichever is greater.</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>Better than 0.25% or 0.5 Volt, whichever is greater.</td>
</tr>
<tr>
<td>Internal Impedance</td>
<td>C-200 Series: Less than 6 ohms. C-400 Series: Less than 3 ohms. C-800 Series: Less than 1.5 ohms. C-1500 Series: Less than 0.75 ohms.</td>
</tr>
<tr>
<td>Ripple and Noise</td>
<td>Less than 3 millivolts rms.</td>
</tr>
<tr>
<td>Polarity</td>
<td>Either positive or negative may be grounded.</td>
</tr>
<tr>
<td>Ambient Temperature</td>
<td>Continuous duty at full load up to 50°C (122°F) ambient.</td>
</tr>
<tr>
<td>AC Output</td>
<td>(unregulated) 6.5 VAC (at 115 VAC Input).</td>
</tr>
<tr>
<td>AC Input</td>
<td>100-125 VAC, 50-60 CPS</td>
</tr>
<tr>
<td>Overload Protection</td>
<td>AC and DC fuses; built-in blown-fuse indicators.</td>
</tr>
</tbody>
</table>

Send for complete COM-PAK data
LAMBDA Electronics Corporation
11-11 131st Street, College Point 56, New York

By return mail, send complete specifications on Lambda Com-Pak Power Supplies.

Name: ___________________________ Title: ___________________________
Company: ________________________ Address: _______________________
City: ___________________________ Zone: __________ State: ___________

Circle 315 Readers Service Card
Varian Forms Systems Group

VARIAN ASSOCIATES, Palo Alto, Calif., has announced formation of a Systems Group, headed by Dr. William McBride.

The company has been doing some systems work in its Systems Development and Linac departments, and initially the new group will consist of these two departments. Long range plans call for the Systems Group to accommodate new products which do not fall into the company's tube and instrument product lines.

Systems Development has been developing and building prototypes of advanced microwave systems to illustrate new applications and demonstrate workability. It also has built large, complex or unusual power supplies and microwave instrumentation systems for use in its tube engineering and manufacturing operations when such systems were unavailable commercially.

The Linac department designs, develops and builds linear electron accelerators.

Ohmite to Build Plant Addition

CONSTRUCTION of a sizeable addition to the Ohmite Mfg. Co. plant in Skokie, Ill., was recently begun.

The new addition will increase manufacturing facilities by 42,000 sq ft. The expansion is the third in 15 years for this company, a leading manufacturer of electrical and electronic components.

The increased space provided by the new addition will be used for expanding production on the standard Ohmite products and for manufacturing new products recently developed by the company.

Brush Electronics Promotes Ralph Little

RALPH V. LITTLE, JR., has been named manager of the Product Engineering Department of Brush Electronics Co., Cleveland, Ohio.

Most recently, Little served as assistant manager of Brush's Product Engineering Department, and prior to that, was associated with the Univac Division of the Remington Rand Corp., first as a project engineer, and later as engineering manager of its Product Design De-
"Our greatest challenge... the development of men"

Ralph Cordiner, President, General Electric Company

"Few expenditures we can make are more important than those for education. A well-educated person produces more and consumes more, makes wiser decisions at the polls, mounts a stronger defense against aggression, and is better able to perform the grave responsibilities of American citizenship.

"Freedom needs educated people. So do business and industry. I earnestly ask you to support the college or university of your choice in its planning for expansion and a stronger faculty. The returns will be greater than you think."

If you want more information on the problems faced by higher education, write to: Council For Financial Aid To Education, Inc., 6 E. 45th Street, New York 17, New York

Sponsored as a public service, in cooperation with the Council for Financial Aid to Education
CONSULT Ney's Engineering Dept. and find out how precious metals can improve your products.

THE J. M. NEY COMPANY, P.O. BOX 990, DEPT. E HARTFORD 1, CONN.
Specialists in Precious Metal Metallurgy since 1812

precious metal resistance wire. The new space department. Earlier in his business career, he was for many years with RCA, where he became engineering group leader in the design and development of television equipment for the corporation's Victor Division.

In his new post, he will be responsible for the development of basic new products to be manufactured and sold by Brush Electronics.

Printed Circuit Outfit Acquires More Space

TECHNIQUES, INC., announces the acquisition of additional space for its Printed Circuit Division at 52 Jackson Ave., Hackensack, N. J. The new space will be devoted primarily to increasing facilities for sample and short run production on etched circuits.

Additional personnel and equipment have been added to enable shipment of small orders within 24 to 48 hours. Production facilities continue to supply medium and long runs on short notice.

Phileco Builds on West Coast Again

PHILECO CORP. has bought a 24-acre site in Palo Alto, Calif., where it
PLANTS AND PEOPLE  
(continued)

will build a research facility.

The Philco government and industrial division’s Western Development Laboratories, now quartered in nearby Redwood City, will move to the Palo Alto establishment.

Classified government work in electronic research will be done at the new facility. The project is slated for a construction start late this year.

Instruments For Industry Hires Engineer

Selig Lenefsky

SELI G L EN EF SK Y recently joined the engineering staff at Instruments for Industry, Inc., Mineola, N. Y.

Lenefsky was formerly employed with Sperry Gyroscope and while with the U. S. Army worked at the Ballistic Research Laboratory on atomic research at the Aberdeen Proving Grounds.

Brunetti Joins FMC

FOOD MACHINERY AND CHEMICAL CORP. has announced the appointment of Dr. Cledo Brunetti as executive assistant to James M. Hait, FMC executive v-p and manager of the company’s Ordnance Division, San Jose, Calif.

Dr. Brunetti has been managing
**WELWYN**

**High Stability Carbon Resistors**

Uniformity and reliability are essential criteria in the selection of critical components. Availability is another. And these relate directly to the experience and facilities of the manufacturer.

Four full-time Welwyn Plants in Britain and in Canada are today supplying a steady flow of precision resistors to meet an ever-growing American demand. With sales engineering and service facilities operating out of Ohio, these Welwyn users in the U.S. are enjoying prompt, efficient and reliable handling of all their quality resistor requirements.

The Welwyn organization has been devoted to the study and development of carbon film techniques for nearly a quarter of a century. The value of this experience is being constantly demonstrated in the superior performance and dependability of Welwyn Carbon Resistors in critical applications.

For complete information, write to:

**WELWYN INTERNATIONAL INC.**

3355 Edgecliff Terrace, Cleveland 11, Ohio, or phone Winton 1-1333

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**Those in the KNOW don’t gamble...**

they specify

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Electronic WIRES and CABLES

Since the very birth of Radio, the ace-high standard for comparison! Write for our new catalog of Wire Products, including:

- T-V LEAD-IN CABLES
- MICROPHONE CABLES
- INTERCOMMUNICATION CABLES
- SHIELDED INTERCOMMUNICATION CABLES

Custom CORD SETS

Designed and manufactured to your requirements. Leading producers of Electronic Equipment and Appliances choose CORNISH, for better and LONGER service on the job...they’re GLUTTONS for punishment.

"MADE BY ENGINEERS FOR ENGINEERS..."

**CORNISH WIRE COMPANY, INC.**

50 Church Street New York 7, N.Y.
agagement, products or policies are involved. Headquarters remain in Van Nuys, Calif. The purposes are to feature one name, Networks Electronic, in advertising the rapidly expanding program of new electronic components, and to simplify the financial structure in preparation for a public stock issue.

Twenty acres of land have been purchased for a new plant in the Canoga Park-Chatsworth area, where building will start this winter on the first unit, 25,000 sq ft of precision manufacturing and laboratory space. Five acres have also been purchased for a Tucson, Arizona, facility. Current volume exceeds a rate of $1½ million per year.

Sytron Ups Perlmutter To Vice President

NORMAN PERLMUTTER has been named vice-president of Sytron Corp., Concord, Calif. His responsibilities will include overall administration and planning of the company's technical development activities.

Perlmutter has served as chief engineer of Sytron Corp. for the past six months. In this capacity he has been very largely responsible for the company’s entry into an entirely new field of instrumentation based upon the use of magnetron beam switching tube techniques.

Prior to his affiliation with Systron, Perlmutter was close to the head of the company's technical development activities.
Magnetic Core Moves to Larger Quarters

JOHN C. WEBB, president of Magnetic Core Corp., has announced the move of this company’s general and executive offices from Ossining, N. Y., to their expanded manufacturing plant at John and Lawrence St., New Windsor, Newburgh, N. Y.

For many years this company has specialized in the manufacture of electronic powder metallurgy.

CEC Establishes New Division

ESTABLISHMENT of a new division to specialize in the engineering, design and manufacture of a standard instrumentation line of magnetic-tape recording and reproducing equipment has been announced. It is being called the Data Tape Division.

Philias H. Girouard

Philias H. Girouard, formerly assistant director of engineering, has been appointed director of the new division. Prior to joining CEC last...
year. Girouard was for 13 years chief engineer of the U.S. Navy Bureau of Ordnance.

Saunders Rejoins NBS Staff

CLARENCE J. SAUNDERS, an electronic scientist, has rejoined the staff of the National Bureau of Standards. A member of the Data Processing Systems Division, he will be working on the design and development of electronic circuits to be utilized in the Division’s work. This program includes not only the design, development, construction, procurement, and evaluation of advanced digital and analog computers, but also the development of new electronic control systems utilizing these computers.

Prior to returning to the Bureau, Saunders was with the Mine Fuze Laboratory of the Diamond Ordnance Fuze Laboratory. He first joined the NBS staff in 1941 and was a member of the NBS ordnance electronics group when that group was reorganized under the Department of the Army as the Diamond Ordnance Fuze Laboratory in 1953.

Electra Mfg. Gets Engineering Director

RAY W. KIDDER has been named director of engineering for Electra Manufacturing Co., Kansas City, Mo., manufacturer of deposited...
TRANSFORMERS FOR
ELECTRONICALLY REGULATED POWER SUPPLIES
Now...over the counter

Avoid delay in making your breadboards, no waiting for a special when a

STERLING 2K SERIES

transformer will meet your requirements exactly. Stock STERLING 2K units are available for supplies from 100 milliamperes at 100 volts to 400 milliamperes at 300 volts

Each 2K transformer provides:

+ PLATE VOLTAGE ALLOWANCE FOR PASS TUBE
+ VOLTAGE DROP
+ RECTIFIER FILAMENT POWER
+ PASS TUBE FILAMENT POWER
+ REGULATOR CIRCUIT FILAMENT POWER
+ AUXILIARY FILAMENT POWER FOR
+ OTHER CIRCUIT REQUIREMENTS
+ REGULATOR CIRCUIT PLATE POWER...
+ APPLICATION BULLETIN WITH EACH UNIT

Military versions of each of these units is also available. Technical data on the complete line is available on request.

SAMPLES? SPECIALS? SHORT RUNS?

The 2K series is only one of the many types we make. We specialize in custom-built transformers to your specifications. Let our engineering staff help solve all your transformer problems.

Samples delivered in 1 to 3 weeks.

Circle 318 Readers Service Card

PIX
WIRE FORMING SPECIALISTS

Precision Parts to meet your production and engineering needs.
From .002" dia. to 18" dia. Modern Facilities, Hi-Production Equipment. Inductive parts, stampings, drawings, relay components, transistor bases; terminal lugs, multi-side stampings, beryllium copper contacts and printed circuit connections.

Metal Crystal Holder Parts, Swed sketch or print for quotation.

PIX Manufacturing Co., Inc.
81-A Hudson St.
Newark 3, New Jersey

PLANTS AND PEOPLE

carbon resistors and ceramic disk capacitors. He was formerly with Texas Instruments, Inc., and a consulting engineer immediately prior to joining the Electro staff.

Eicher Joins Tobe Engineering Labs

THE Tobe Deutschmann Corp. recently announced the appointment of Jerry G. Eicher as a project engineer at the company's Engineering Laboratories in Venice, California.

Eicher will be responsible for the design and manufacture of electronic components such as pulse-forming networks, pulse capacitors, high-voltage capacitors, delay lines and band pass filters.

He comes to Tobe Deutschmann from Hughes Aircraft in Culver City, Calif., where he has been on the engineering staff since 1954.

Moscow Host to Standards Conference

CLOSER scientific and engineering liaison between the Soviet Union and the West is indicated by the recent meeting in Moscow of the 32-nation International Electrotechnical Commission.

Significance of Russia's invitation this year to all member nations lies in the fact that the IEC aims to provide common terminology and standards in lighting, power, communications and electronics to aid

September 1, 1957 — ELECTRONICS
international trade. The U.S. sent 24 delegates from the U.S. National Committee of the IEC, an arm of the American Standards Association. The conference lasted from July 2-12, with 16 technical committees holding meetings on semiconductor rectifiers, lightning arrestors, switch gear and control gear, rotating machinery electric traction equipment, cables, lamps, lighting and bushings.

The U.S. delegation was headed by R. C. Sogge, manager Standards Engineering, General Electric Co., who is president of the U.S. national committee of IEC. It included national committee officers H. Blackmon of Westinghouse, S. David Hoffman and G. F. Hussey Jr. of ASA.

Gulton Industries Acquires CG Electronics

ACQUISITION of CG Electronics Corp., Albuquerque, N. M., by Gulton Industries, Inc., has been announced.

The company will retain its corporate identity, operating as the CG Electronics Corp., a wholly-owned subsidiary of Gulton Industries, Inc.

Maxson Instruments Hires Leeds

IRVING LEEDS has joined Maxson Instruments, Division of The W. L. Maxson Corp., Long Island City,

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N. Y., as manager of transformer engineering.

Prior to joining Maxson, he was assistant chief engineer at American Bosch Arma Corp., and chief engineer of Ferranti Electric, Inc.

Continental Connector Corp. Move Completed

DeJur-Amsco Corp. recently announced that Continental Connector Corp. has completed its move into a three-story building located at 34-63 56th St. in Woodside, L. I., N. Y. This new location represents an increase of over three times the space previously available for the design, development and production of precision miniature electrical connectors. Increased business and anticipated future requirements prompted the expansion move of assembly operations, engineering staff, model and machine shops, and molding department.

Neely Enterprises Promotes Two

ROBERT L. BONIFACE, vice-president and general manager of Neely Enterprises, Western electronic manufacturers' representatives, has announced the appointment of Michael Z. Laslo and George A. Phillips to the position of field engineer.

Laslo joined the Neely organiza-
tion in 1954 as an engineer on the Mobile Lab operation.
Phillips has been with Neely Enterprises as a staff engineer since 1956.

CEC Changes Division Name

CONSORTIUM ELECTRODYNAMICS Corp., Pasadena, Calif., has changed the name of its Electronic Industries Division to the Alectra Division. Hugh F. Colvin, president, said the name was changed to eliminate confusion caused by the existence of several other companies with names similar to Electronic Industries.

The Alectra Division, formerly Electronic Industries, Inc., of Burbank, Calif., was acquired by CEC in June 1956, and moved to a new Pasadena facility in November.

Products of the division include portable test instruments, printed wiring, transistor circuitry, and specialized electronic components. Division manager is George B. Clark.

Weston Announces Expansion

The Vamistor manufacturing division of the Weston Electrical Instrument Corp., Newark, N. J., is
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E. V. Roberts & Associates
Open San Diego Office

OPENING of a San Diego office at 4379 30th St. has been announced by Ernest V. Roberts, president of E. V. Roberts and Associates, electronics representatives. Headquarters of the firm is in Los Angeles.

Richard B. Blayney

Manager of the new EVRA branch is Richard D. Blayney, who was formerly an electronic engineer with Amelco, Inc., Santa Monica.

Bomac Announces
$1 Million Expansion

BOMAC LABORATORIES, INC., Beverly, Mass., is building a new, million dollar plant at its Route 128 site which will virtually double the company’s present engineering and manufacturing capacity. Now occupying expanded quarters in a new building recently completed in Union, N. J. Weston is a subsidiary of Daystrom, Inc.

The Vamistor is the precision metal film resistor which has a special resistance alloy fused into the inner surface of a moisture sealed ceramic tube in a dispersed form. The unit, which will handle a full half watt loading at 125 C, is virtually impervious to the effects of abrasion, thermal shock and temporary overloads; and in addition to having a temperature coefficient better than ±50 ppm per deg C, it is noise free with excellent high frequency performance.

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manufacturing facilities.
The new building will house complete manufacturing and assembly facilities, engineering offices and a modern cafeteria. The plant will be used principally for magnetron production.

Richards Electrocraft Gets New Location

Due to an increased demand for their electronic components, Richards Electrocraft, Inc., are tripling their manufacturing area in a new location at 4432 North Kedzie Ave., Chicago, Illinois. With new, modern production equipment they will be in a position to give better service on their present line and facilitate the production of many new items.

Cohu Doubles Plant Facilities

President LaMotte T. Cohu has announced that Cohu Electronics Inc., will double its plant facilities in the San Diego area.

Cohu Electronics, successor to Kay Lab, will begin construction of a 50,000 sq ft production building to cost approximately $250,000 late this year on a seven-acre tract in San Diego's Kearny Mesa industrial area. The site adjoins seven acres where Cohu Electronics and its Kin Tel division occupy two leased buildings totaling some 50,000 sq ft.

Lockheed Promotes Jatras

Stephen J. Jatras has been appointed to the newly-created position of assistant to the director of Lockheed Missile Systems division's research and development branch in Palo Alto.

Jatras, formerly manager of the research and development coordination division, will act in behalf of the branch director in administrative and financial matters. He also will handle special assignments given him by Dr. Ridenour, branch director.

Before joining Lockheed, Jatras [continued]
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PLANTS AND PEOPLE (continued)

was vice-president and research engineer with Mid-Western Instruments in Tulsa, Oklahoma.

Lindquist Joins
Andrew Corp.

APPOINTMENT of J. Rilee Lindquist as sales engineer, Andrew California Corp., was recently announced.

Lindquist joined Andrew Corp. of Chicago in 1953. Engaged in design and development engineering of antennas, coaxial cables and waveguide, he was transferred to the company's sales department in 1956 as sales engineer for communication antenna equipment.

SRI Names Eldredge to Key Post

DR. KENNETH R. ELDREDGE has been appointed assistant director of the Engineering Research Division of Stanford Research Institute, Menlo Park, Calif.

Eldredge, who set up and managed SRI's Control Systems Laboratory, has done outstanding work in high-speed mechanical paper handling techniques, printed circuitry and electronic control systems for industry. He was basically responsible for developing systems for electronically reading arabic
numerals and symbols, which have been adopted as the standard of the banking profession by the American Bankers Association.

He spent 10 years with Standard Oil Co. of Calif. as supervisor of special electronic instrumentation development. From 1946 to 1955 he was employed in the London branch of the U. S. Office of Naval Research. He joined the SRI staff in 1953.

New laboratory manager is Dr. Manning Hermes, who has headed the Basic Sciences Group since 1956.

Topp Mfg. Appoints Baddorf Chief Engr.

ROBERT LEE BADDORF has been ap- pointed chief engineer of Topp Mfg. Co., Los Angeles, a Division of Topp Industries, Inc., Beverly Hills, Calif.

He joined Topp Mfg. after service as chief engineer and works manager of Mechaponents Division, Servomechanisms, Inc., El Segundo, Calif., prior to which he was chief engineer and general manager of Electro, Inc., Los Angeles.

Northeast Electronics Has New Home

A RECENTLY occupied new home at Concord Municipal Airport, Concord, N. H., has been announced by Northeast Electronics Corp. The building answers an acute need for increased space for office, laboratory and manufacturing facilities.

Completion of Northeast's new home will permit further expansion of the corporation's activities, previously limited by lack of space.

Ericksons Joins Daystrom

WILBUR ERICKSON, formerly with the Ampex Corp., has joined the Daystrom Systems Division of Daystrom, Inc., as a systems engineer specializing in input-output equipment.

At the Ampex Corporation,
Wilbur Erickson supervised systems testing in the special products engineering department. He has also designed the electronics for a low-frequency loop recorder-reproducer for use in the Distant Early Warning line.

Westinghouse Promotes Brandt

Dr. W. H. Brandt has been named director of advanced systems engineering at Westinghouse Electric Corp.'s Sunnyvale, Calif., plant. With Westinghouse since 1936, he served most recently as engineering manager of the director systems department.

In his new post he will direct work on studies related to handling and launching systems for the Polaris, the Navy's new intermediate range ballistic missile.

Calidyne Co. Moves to New Quarters

A GROUNDBREAKING ceremony was recently conducted at The Calidyne Company's new 12-acre manufacturing site in Woburn, Mass. A modern plant will occupy 46,000 sq ft of floor space on the property and will house all Calidyne Company operations now carried on in four buildings located in Woburn and Winchester, Mass.

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PLANTS AND PEOPLE (continued)

plant facilities should be ready for occupancy in early 1958.

The Calidyne Company manufactures vibration test equipment used in the design and production of many types of industrial, military and commercial products.

CBS TV Announces Several Appointments

WILLIAM B. LODGE, vice-president of station relations and engineering at CBS Television, recently announced the following appointments:

A. B. Chamberlain, formerly chief engineer, becomes director of engineering.

Howard A. Chinn, formerly chief engineer, Audio-Video Division, assumes the new title of chief engineer, CBS Television.

Richard S. O'Brien, formerly chief project engineer, becomes assistant director for Audio and Video Engineering.

At the same time Lodge said that J. D. Parker would continue as assistant director for Radio Frequency Engineering.

Schultz Joins Ramo-Wooldridge Corp.

PETER REDFIELD SCHULTZ, electrical engineer, has joined the Guided Missile Research Division, The Ramo, Wooldridge Corp., Los Angeles, Calif.

While at MIT Schultz participated in the cooperative course in electrical engineering with the General Electric Co. His work on cooperative assignments included testing aircraft compass systems, designing test equipment for aircraft components and the development of pulse circuitry for nuclear instrumentation.

Collins Radio Constructs New Plant

COLLINS RADIO Co. has begun construction of a 235,000-sq ft manufacturing plant in Cedar Rapids,

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PLANTS AND PEOPLE
(continued)

Iowa, at an estimated cost of $2,750,000. The new facility, which upon completion will house the company's fabrication activities, will be located on a 90-acre tract opposite the Collins Engineering Laboratory.

Occupancy of the new plant is scheduled for early 1959.

The company's Dallas officials have announced construction at Richardson, Texas, of a 128,000 sq ft Engineering Laboratory, at a cost of $1,700,000. Both projects are the initial phases of the company's long range plans for facilities expansion and consolidation.

Amphenol Forms British Subsidiary

AMPHENOL ELECTRONICS CORP., Chicago, Ill., recently announced the formation of Amphenol Great Britain Ltd. The new subsidiary, which began immediate operations in Alperton, England, is owned jointly by Amphenol and by Gas Purification and Chemical Co. Ltd. Amphenol Great Britain Ltd. will manufacture and sell the entire line of Amphenol products under an exclusive license in the United Kingdom and other Commonwealth nations, with the exception of Canada, where Amphenol Canada Ltd. successfully operated for many years.

Gas Purification and Chemical Co. Ltd., is a specialized investment company with seventeen subsidiary companies intimately connected with the English electronics industry. Similarly, Amphenol serves the electronics industry in the U. S.—manufacturing electronic components for aircraft, communications, computer projects and other applications.

Perkin Appoints Engineering Supervisor

FRED LILIENTSTEIN was recently named engineering supervisor of the Advanced Development Laboratory of Perkin Engineering Corp., El Segundo, Calif. Perkin manufactures d-c power supplies and a-c line regulators of the tubeless
Eimac Plans New Facilities
A mortgage loan of $1,675,000 was recently acquired by Eitel-McCullough, Inc., manufacturers of Eimac electron tubes, for new facilities in San Carlos, Calif. Cost of the new plant will be approximately $2 million.

The new 150,000 sq ft facility will house the company's administrative offices and production of some tube types, including ceramic receiving tubes. The company will maintain its two present plants in San Bruno, Calif., and Salt Lake City, Utah.

Construction is to start shortly and will take approximately nine months to complete.

Electronics Systems Takes Larger Quarters
Due to expansion of the organization, Electronics Systems, Inc. has moved to larger quarters in downtown Boston. The new address is 105 Chauncy St., Boston 11, Mass.
Microwave Principles

By H. J. Reich, J. G. Scalnik, P. F. Ording and H. J. Krauss

In response to a definite need for a more elementary text aimed at senior level students the authors have abridged their earlier volume, "Microwave Theory and Techniques", into one of about one-half the original size. The authors have accomplished this successfully by eliminating the details that belong to a more advanced book, without sacrifice of adequate treatment of fundamental principles. To help simplify matters for students not familiar with vector notation, the scalar forms of Maxwell's equations have been used.

Microwave Devices — The authors have succeeded outstandingly well in covering the details of a wide variety of microwave devices. About one-half of the book is devoted to a description of transmission lines, wave guides, components commonly used in passive microwave circuits, impedance matching techniques, measurements, antennas and microwave resonators. The remaining half consists of an excellent description of microwave amplifier and oscillator fundamentals, and tubes such as microwave triodes and tetrodes, klystrons, magnetrons, travelling-wave tubes and electron-wave tubes.

The coverage of each subject is necessarily brief, since books could be written about the subject matter of most of the chapters. The presentation is such that a complete overall picture of the important aspects of the microwave engineering field can be obtained. An excellent feature of the text is that equal emphasis has been placed on the active microwave elements, such as amplifiers and oscillators, as has been given to the passive circuit elements.

The authors have made no attempt to cover all of the recent work in the microwave field. This is understandable since this field is rapidly changing and it is often difficult to evaluate the ultimate value of the newer ideas and devices. The reviewer feels, however, that for completeness, material on the important and well-established field of nonreciprocal microwave devices, such as ferrite isolators, should have been included in the text.

Text Use — The material in the book is supplemented by a large number of problems at the end of each chapter and an outline of practical laboratory experiments is included in an appendix, which makes it particularly useful as a college text.

The authors have written a remarkably good text, well unified and carefully developed. It is highly recommended as a senior-level text book and as a reference to practicing engineers needing a review of fundamentals of microwave devices.—C. G. DALMAN, Professor, Cornell University, Ithaca, N. Y.

Transistor Circuits and Applications

By John M. Carroll

By gathering together some of the most important work accomplished in applied transistor circuitry, Mr. Carroll has compiled a valuable reference to the circuit designer and engineer.

"Transistor Circuits and Applications" consists of 106 technical articles that appeared in Electronics during the years 1950 to 1956. The book covers the wide field of transistor circuitry, from principles of design through linear amplifiers, oscillators and pulse circuits. Many illustrations of applied transistor circuitry are described, covering the fields of home entertainment, military, broadcasting, communications, computing (digital and analog), control, industrial, scientific and medical equipment. In many cases complete...
circuit schematics are presented.

**Context**—The two major themes of design and application are covered in eight chapters. The first four chapters consist mainly of articles on transistor characteristics and their effect in designing amplifiers, oscillators and pulse circuits. The latter chapters of the book emphasize applications in commercial and military equipment.

**Design**—Chapter 1 is given over to articles on transistor characteristics, design equations, feedback analysis and techniques, noise and transient behavior of amplifier circuits. Here the transistor is concerned as an active element in design of amplifiers. Here temperature stabilization and feedback are featured at techniques in multistage amplifier designs. Illustrations of power, high frequency, and video, as well as tuned amplifier designs are presented.

Various types of linear oscillators are the topics discussed in Chapter 3. Colpitts, Hartley, bridge and crystal controlled, oscillators typify the circuits presented in this chapter.

Chapter 4 illustrates the use of transistors in pulse circuits. Here flip flops, counters and pulse forming circuits typify the designs discussed.

**Applications**—The remaining four chapters deal with transistor applications. Chapter 5 describes the application of transistors to home entertainment devices (radios, phonographs and television).

In Chapter 6, military and communications equipment, such as telemetering, radar, transmitters and missile applications, are reviewed. Application of transistors to digital and analog computers, as well as servo-amplifiers is the concern of Chapter 7.

The concluding chapter, slightly smaller than the others though not less important, covers industrial, scientific and medical devices.

**Index**—The complete Table of Contents as well as the index will aid the reader in quickly finding topics of particular interest.

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NEW BOOKS

Frequency Modulation Receivers

BY J. D. JONES


Mixed in with some good discussion on practical design problems in f-m and f-m/a-m receivers is a jumble of incorrect formulas (dimensionally incorrect), incorrect, incomplete, improperly labeled diagrams and a host of errors that can best be ascribed to a total lack of editing. To the man in the field the book might provide experience in locating the errors; for the neophyte it can only be confusing.—John Bose, Columbia University, New York, N. Y.

Principles and Techniques of Applied Mathematics

BY BERNARD FRIEDMAN

John Wiley & Sons, New York, 1956, 315 p, $8.00.

The rapidly expanding field of electronic engineering is turning more and more to mathematics for the basic tools of its development. Mathematics, in turn, has been evolving into two diverging realms —the pure or abstract, and the applied. This book constitutes an attempt to relate these two realms in
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Continued →
the subject of ordinary and partial differential equations and as such, is of interest to engineers.

► Linear Spaces—The text opens with a discussion of linear spaces and the relation of operators to these spaces. The properties of both matrices and differential operators are then discussed with a consideration of the two important methods of obtaining solutions of equations involving such operators. These methods are (1) the use of an integral operator to invert a differential operator where the kernel of this integral operator is the Green’s function and (2) the use of the eigenfunctions and the spectral representation of the differential operator whereby the solution of the differential equation is obtained as an expansion in terms of these eigenfunctions.

Before considering the Green’s function in detail, the author considers the theory of delta functions, symbolic functions and distributions as developed by Laurent Schwartz. This topic is especially of interest to electronic engineers who have been using delta functions in such fields as circuit theory or information theory without having a rigorous mathematical justification for their use. However, many of the results of this theory of distributions is presented without proof and the reader is referred to the original work of L. Schwartz if he desires such proofs.

Not only are the methods of mathematical physics systematized in this fashion but also many specific examples are considered which are applicable to specific physical problems. In this manner the propagation of waves, such as sound or electromagnetic waves, through discontinuous media are considered. Similarly, the transmission line equations and their solution with such concepts as characteristic impedance and reflection and transmission coefficients are introduced and related to the abstract mathematical point of view.

► Partial Differential Operators—The book concludes with a brief discussion of partial differential equa-...
The methods used previously to solve ordinary differential equations are found to apply in this case also. Moreover, the separation of variables method is introduced and some common partial differential equations are solved. These are the potential equation, the heat equation and the wave equation. Problems on the various topics that are discussed are distributed throughout the body of the text so this book is suitable as a textbook for a course on this subject.

The book has been written mainly for the mathematician. The engineer who is not thoroughly familiar with the techniques of mathematical physics may have trouble following the discussion. However, it is a well-written account of the applications of the powerful methods of abstract mathematics to the types of problems that concern physicists and engineers and as such it may be very useful as a reference source for the mathematically inclined electronic engineer.—ARMEN H. ZEMANIAN, College of Engineering, New York University, New York, N.Y.

“Impulse und Schaltvorgaenge in der Nachrichtentechnik”
(“Pulses and Transients in Communications Circuits”)

By HEINRICH KADEN.
This book represents an attempt to combine the classical theory of Fourier and Laplace transforms as it applies to impulses, pulses and transients, with modern communications theory. That the author has done a really conscientious job in his attempt to present the modern applications integrally with the basic mathematical tools is evident in the organization of the subject matter.

* Fourier Concepts — The first
chapter deals with the basic concept of the Fourier integral, presented as an extension of Fourier series. This chapter is immediately followed by an introduction to statistical methods, i.e., a treatment of the autocorrelation function and its relationship to the power spectrum.

A long applications chapter for the Fourier transform uses the transmission of signals through cables as its principal illustration. A chapter on the Laplace transform is then presented. This is followed by a Fourier analysis of the distortion encountered in the transmission of telegraph signals.

The concluding chapters of the book deal with the transmission of signals in the presence of noise in wide band systems, the sampling theorem and related topics.

Mathematical Treatment—While the examples which are chosen to illustrate the theory are particularly interesting because of their intrinsic importance, the general style of the book emphasizes the mathematical treatment. As a result of this preoccupation with technique, the discussions of the meaning and interpretation of solutions are generally too brief.

The author assumes that the reader has background in the theory of functions of a complex variable and some acquaintance with the transformations since the former is not treated per se at all and the latter is presented in the form of a review type resumé. This reviewer is slightly mystified by the presence of the chapter on Laplace transform. It appears to be a rather hasty presentation which serves no purpose relative to the rest of the book since the Fourier methods are (quite appropriately) used in the bulk of the volume.

Readers with a reasonable acquaintance with the German language will have no difficulty with this book. The sentences are quite short and the style, though concise, is quite lucid.

In summing up, one is inclined to commend the author for taking a much needed step in the direction of tying together the classical
theory of transient analysis with the modern statistical approach to communications problems so that this volume is a worthwhile contribution to the engineering library.—Egon Brenner, The City College of New York.

**Thumbnail Reviews**


Transistors—Circuits and Servicing. By B. R. Bettridge, Trader Publishing Co., Ltd., 1957, 23 p, 2s.6d. Introduction to transistors for servicemen and technicians including applications and servicing.


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For more information on any of the above or other related fields, contact John J. Oliver, P. O. Box 87E, Raytheon Maynard Laboratory, Maynard, Mass.

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NEW BOOKS (continued)

four chapters on electronics. Material is presented briefly, but competently, with ample supply of problems and has been designed to form basis for conventional one-year course for students not majoring in electrical engineering.

Energy. By Oliver Lodge, John F. Rider Publisher, Inc., New York, 1957, 64 p, $1.25. Modernized reprint of classic has newly added illustrations to dramatize and emphasize important concepts.


Scientific German. By George Condon, John Wiley & Sons, Inc., New York, 1957, 164 p, $2.50. Intended for students of engineering and science, with no previous knowledge of German, this book provides the briefest explanation of the structural aspects of technical German that will permit translation of papers of normal difficulty accurately and completely into English with the aid of a dictionary.

The Icosahedron. By Felix Klein, Dover Publication, Inc., New York, 1956, 289 p, $1.85. New edition of classical mathematical work which was first published in 1884. Of interest mainly to pure mathematicians, it considers the fundamental problem of the solution of quintics and will serve as a source book on those properties of the icosahedron which were known prior to 1884.

Elements of Pure and Applied Mathematics. By Harry Lass, McGraw-Hill Book Co., Inc., New York, 1957, 491 pages, $7.50. This survey of linear equations, reactor and tensor analysis, function theory, differential equations, integral transformations, group theory and probability theory is written for applied mathematicians on the graduate level and includes many problems and examples. It may serve as a good reference book for the research physicist or engineer.


Scientific French. By William N. Locke, John Wiley & Sons, Inc., New York, 1957, 112 p, $2.25. Intended for students of science and engineering, with no previous knowledge of French, this book provides the briefest ex-

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planned on the structural aspects of technical French that will permit them to translate papers of normal difficulty accurately and completely into English with the aid of a dictionary.


Alternating Current Bridge Methods. By B. Hague, Pitman Publishing Corp., N. Y., 1957, 650 p, $12.50. Thorough text on bridge measurements in the frequency range from d-c to 3,000 cps, with emphasis on fundamentals and references to early original literature. An invaluable aid to the experimenter interested in precise physical measurements on surface and barrier-layer phenomena when unusual and difficult bridge measurements at low frequencies are quite useful.


An Introduction to the Cathode Ray Oscilloscope. By Harley Carter, Phillips Technical Library, Eindhoven, Holland, 1957, 100 p, $1.95. Operating principles, construction and applications of crv for technicians include complete circuits of four oscilloscopes of varying complexity. This book may be ordered directly from the publisher.

Who's Who in Electronics. Electronic Periodicals, Inc., 2775 South Moreland Blvd., Cleveland, Ohio, 1957, 495 p. Purchasing index to supply sources of electronic components and equipment lists manufacturers by purchasing, geographical, field salesman, trade name and indexes. Representatives roster is listed geographically and alphabetically; distributors are listed geographically.

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Backtalk

Crazy Ideas?

DEAR SIRS:

ABOUT a year ago I received a form from ELECTRONICS asking for suggestions for improving service to the readers. One suggestion I made was to establish a "crazy idea" department in which those interested could publish ideas which seem rather fantastic or considerably ahead of current developments. I still think that this is a good idea and I believe that this department would be of interest to readers.

I have filed more than 1,000 inventions in the patent office relating to an extreme variety of devices in many different fields. In many cases I have not prosecuted these patents through to completion, in some instances because the ideas seemed rather theoretical and in other cases because I did not recognize the real value.

It has been something of a surprise to me to see many of these inventions brought out by others years later and demonstrated to be of considerable value or usefulness. As examples of these I will cite the fog dissipation system used in England, some oceanographic light development, ionic propulsion of aircraft, certain reproduction papers, pelleted fertilizer, improvements in magnetic recording, analyzing metals by contact potentials, suppression of electrolytic action by magnesium rod counter emf, several improvements in television, pumping by varying magnetic fields, magnetic rubber, etc.

I am enclosing also a copy of patent No. 2,584,641 relating to speed indicator and inertial guidance. This patent discloses broad principles which apparently are used in one recently announced inertial guidance system.

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380
either strength or direction of the earth's magnetic field. This feature should make this type of instrument practical.

If you ever set up the department of futuristic ideas I would be glad to contribute some if you wish.

A. G. THOMAS
Butler, Pennsylvania

Special Items

DEAR SIRS:
I WOULD like to add our little vote to that of Mr. Anderson of Brown University. (Backtalk, p 400, May 1, 1957).

Although we are not engaged in research and development as are a number of similarly small firms; we do occasionally have need of small runs of special components. On several occasions we have discovered that after redesigning our project to use something else, exactly what we needed was available. An exchange ground such as Mr. Anderson suggested is a good start along the right line.

I will also go along with the idea of an idea exchange too. Again we have occasionally worked to the point of frustration on a project, and then stumbled on the solution, or a lead to the solution, quite by accident.

Again, we would like to commend Mr. Anderson on his suggestion, and we hope that it is favorable received by the editors.

DAVID B. TENNISON
Electronics Design
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Technical Personnel Dept. E-674

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Special! TS45 X BAND GENERATOR—$99.00
For IPS Infrared Image Converter from 3 V Battery Source. NEW, Complete with RCA 1644 Tubes.

NEW MICROWAVE TEST EQUIPMENT
TS148/UP SPECTRUM ANALYZER
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Field Type X-band Spectrum Analyzer. Band 8430-5500 Magos.
Will Check Frequency and Operation of various X Band equip.
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Thousands of tubes available at special prices.

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'DIAMOND H' Relays
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The "Diamond H" series K-
Horizontally sealed Relays will match of surplus U.S.A. Spec.

Subminiature Socket of 15 Pin Socket for above Relay. RIGIPS Each 25¢

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1PST Norm. open (4A) 25v. D.C. Coil 500 ohm. Will operate on 115v. D.C. Her-
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Struthers-Dunn No. 1835XKX107 $1.75

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Fig. 1 Dunco No. 2290XCKX10 4PDT (5C) R108
Fig. 2 Dunco No. 2290XDX10 4PDT (4C) R106
Fig. 3 Dunco No. 2290XDX310 4PDT (4C) R106

Each $1.75

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Searchlight Equipment
Spotting Service
c/o ELECTRONICS,
330 W. 42nd St.
N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment
Spotting Service
c/o ELECTRONICS,
330 W. 42nd St., N. Y. 36, N. Y.

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TITLE
COMPANY
STREET
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September 1, 1957 — ELECTRONICS

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Top quality communications and test equipment at low prices. Here are a few leaders:

AN/ TBR-2 — Radio Telephone Repre-Set neural sets.
ARN-2 & ARC-27— Transmitter Receivers.
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Radio Compass Indicators Controls
AS-313 — Loop Antennas for ARN-6
Model PQ-3 — Visual Recording Equipment 14 C-4017 4-A Visual Recorder (Farismile)
R15439-ARN-12 — Marker Beacon Receiver
RC-266 — Antenna Parabolic w/mtr drive for SCR-717
SCR-506— Mobile FM Radio Sets Complete
SHG, GEN Measurements Corp #804
Ferris #180

GROVE, PURPOSE

SECTION

SPECIAL PURPOSE TUBES

Values in milliohms.

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Telegram Station YVY
Cable Address MONTENEQUIP

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C.A.A. No. 4264 Ltd. H.A. 9-2925

ELECTRONICS — September 1, 1957

western engineers

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Orders for less than $10 cannot be processed
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This set consists of an AN/CRN-10 localizer and a AN/CRN-15 glide slope indicator. This equipment can be set up at an airport to provide a complete ILS, that will operate with the AN/ARQ-5 and RC-103 airborne ILS system to provide blind approach facilities. The set can be installed permanently or transported. Each station has complete monitoring facility. Input power is 110V 60 cy.

AN/CRN-1-3-4

100 MC RADIO-RELAY EQUIPMENT
The AN/CRN-1 is a mobile portable set for duplex or simplex radio telephone point to point communication. This unit will operate with the CI-C series carrier systems to provide multi channel operation. The TRC series on 100 MC with output of 100 watts. The set is crystal controlled. Complete sets available. Input 110V 60 cy.

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- SNOOPERSCOPES
- COLOR AND PROJECTION TV
- HIGH VOLTAGE TESTING, ETC.

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regulation. Contains auto protection circuit which cuts 
off at 25 kv. H.V. operation. Entire unit is fully 
regulated via Dumont for Flatbush Avenue, 
Minimum

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**WANTED**

- ART-13/74A Trans-

- BC-346 Re's Unmodi-

- ART-13/747 Trans-

- BC-386C All. $175.00

- A R C - 3 Trans. $255.00

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All comply with govern-ment specifications

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MODEL 3000

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Problem board $95

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812 Galindo Street
Lancord, California

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CHRISTIE ELECTRIC CORP.
Dept. EL, 3410 W. 67th St., Los Angeles 43
Over a Quarter Century of Rectifier Manufacturing

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Deflection YOKES and Systems

We now supply yokes to the largest laboratories and defense projects in the U.S.A. Available to customers spec. in Nickel Iron, Ferrite, Class A or H insulation. Moulded-in slip rings can be supplied.

Linearity ± standard ± 1%, custom build to ± 0.1%
Orthogonality ± 1/8°
Half-axis collinearity ± 1/4°
Mutual interaxis coupling ± 0.5°
Differential capacity unbalance - 5.5 surf max.

High Altitude Performance is limited only by flashover point of the terminals, which can be specified by customer.
Temperature Range - Standard deflection yokes will operate as specified from -10°C to + 60°C. Class H insulated deflection yokes will operate from -50°C to + 160°C.

Humidity: The yoke is unaffected by humidity. Meet JAN and MIL specs.

For further information write:
COSSOR
(CANADA) LIMITED
301 Windsor Street
Halifax, Nova Scotia
Phone 4-6487

Circle 343 Readers Service Card

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It's new!

Metallized Ceramic Coating

Now for the first time you can successfully use a single metallic coating for refractory ceramic bodies which provides a surface for applying either hard or soft solders with melting points between 275° and 1600°. With NICOTE, no expensive preliminary processing is necessary. It's ideal for hermetic and mechanical seals and vacuum applications. Bulletin 155 contains complete details. Write for a copy.

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PORCELAIN COMPANY
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Circle 344 Readers Service Card

HERE'S BIG HELP IN TERMINAL WIRING!

The New JONES FANNING STRIP

Connections are made through Fanning Strip, on bench or anywhere apart from barrier strip, and quickly slipped into assembly. Use with Jones Barrier Terminal Sets, Nos. 141 to 142, for 1 to 20 terminals.

Simplifies soldering. Insures correct connections, saves time. Ideal for harness or cable assembly. Brass terminals, cadmium plated, Bakelite mounting. Send for complete data.

HOWARD J. JONES DIVISION OF HOWARD JONES MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF SMITH-CIRCLE SYSTEMS CORP.

Circle 345 Readers Service Card
September 1, 1957 — ELECTRONICS
QUALITY
at the Indium Corporation of America means: purity of metals, and strict adherence to specifications.

SERVICE
means prompt delivery to customers, and technical help in specific uses of INDINUM.

RESEARCH
means "forward looking" with respect to new products and new techniques.

Metallurgists and engineers in many industries are making startling advances through use of INDINUM in one or more of its various commercial forms. Even we can't begin to imagine the rapidly expanding range of applications.

You may have a product development problem for which INDINUM might be the answer. Why not write us and investigate the possibilities?

COMMERCIAL QUANTITIES AVAILABLE:

- Indium metal (specially refined 99.999% pure)
- Indium metal (99.97% pure)
- Indium wire
- Intermediate "Indalloy" solders
- Indium pellets
- Indium spheres
- Indium powders
- Other high-purity metals

Write Dept. E-9 for new INDINUM bulletin: "Indalloy Intermediate Solders"

THE INDIUM CORPORATION OF AMERICA
1676 LINCOLN AVENUE  UTICA, NEW YORK

ELECTRONICS — September 1, 1957

Circle 346 Readers Service Card
Whatever you want in a V.T.V.M—**PRECISION** has it!

**for High Performance at Low Cost—**

**the Model 68**
Modestly Priced, Metal-Cased V.T.V.M

- 5 Peak-to-Peak Voltage Ranges: 0-8.32-160-800-3200 volts
- 5 (+) Plus and 5 (−) Minus DC Voltage Ranges: 0-3-12-300-1200 volts; 12½ Meg. input
- 5 Hi-Impedance RMS AC Ranges: 3-12-60-300-1200 volts
- 5 Resistance Ranges up to 1000 Megohms
- 5 Zero-Center Reference Ranges
- Extra-Large, 5½" Wide-Angle PACE Meter

Model 68: blue-grey ripple-finished steel cabinet, 5½" x 7½" x 3½". Complete with tubes, ohmmeter battery and manual. **Net Price:** $54.50

**for Battery-Powered Portability—**

**the Model 78**
Battery-Operated, Metal-Cased V.T.V.M

- A MUST Where Power Line is Unavailable
- A MUST Where Power Line Connection is Undesirable
- 6 Zero-center DC Voltage Ranges: 0 = 1.5, 6, 30, = 150, = 600, =1500 volts; 12½ Meg. input
- 5 ohmmeter Ranges to 1000 Megohms
- 5 Hi-Impedance RMS AC Ranges: 0-3-12-60-300-1200 volts
- Extra-Large, 5½" Wide-Angle PACE Meter

Model 78: blue-grey ripple-finished steel cabinet 5½" x 7½" x 3½". Complete with tubes, batteries and instruction manual. **Net Price:** $62.50

**for Wide-Range Laboratory Quality—**

**the Model 88**
Compact, Lab-Type V.T.V.M

- More Functions—More Ranges—More Sensitivity:
  - Functions... 40 ranges...
  - 26½ Megs input
- 6 Peak-to-Peak Voltage Ranges: 0 to 1200 volts specially engineered for accuracy on pulsed and TV wave forms
- 6 Zero Center DC Voltage Ranges: 0 to 1200 volts...
- Also, 6 (+) minus and 6 (+) plus DC voltage ranges
- 5 Electronic Ohmmeter Ranges: to 1000 Megohms
- Extra-Large, 5½" Wide-Angle PACE Meter

Model 88: Molded phenolic case, 5½" x 7" x 3½". Complete with AC line cord, ohmmeter battery, 3-way probe and manual. **Net Price:** $74.50

**for The Ultimate in Performance and Operating Ease—**

**the Model 98**
Laboratory V.T.V.M with 7" Meter

- **PRECISION’S Finest V.T.V.M.**
  - More Ranges—More Functions—High Sensitivity
  - 6 P.k-P. Voltage Ranges to 3200 volts: specially engineered for maximum accuracy on pulsed wave forms
  - 6 True-Zero-Center DC Voltage Ranges: 26½ Megohms input to = 1200 volts
  - 6 Electronic Ohmmeter Ranges to 1000 Megohms
  - 6 Minus and 6 Plus DC Voltage Ranges: to 1200 volts; 12½ Megs input
  - 5 Hi-Impedance RMS AC Ranges to 1200 volts
  - 8 DC Current Ranges: from 0-300 micromamps to 12 Amps
  - 6 Decibel-Output-Meter Ranges: —20 to +63 DB

Model 98-MCP: In blue-grey, ripple-finished cabinet and two-color brushed aluminum panel, 11½" x 13" x 6½". Complete with 3-way V.T.V.M probe and manual. **Net Price:** $119.50

**PRECISION**

**V.T.V.M ACCESSORIES AVAILABLE**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF-10A</td>
<td>High-Frequency Vacuum-Tube Probe (for Models 88 and 98)</td>
<td>$14.40</td>
</tr>
<tr>
<td>RF-12</td>
<td>High-Frequency Crystal Probe (for Models 68 and 78)</td>
<td>$10.95</td>
</tr>
<tr>
<td>TV-4</td>
<td>Super-High-Voltage Safety Test Probe (for Models 68 and 78)</td>
<td>$14.75</td>
</tr>
<tr>
<td>TV-8</td>
<td>Super-High-Voltage Safety Test Probe (for Models 88 and 98)</td>
<td>$14.75</td>
</tr>
<tr>
<td>LC-1</td>
<td>Leather Carrying Case (custom-designed for Model 88)</td>
<td>$9.50</td>
</tr>
<tr>
<td>ST-1</td>
<td>Retractable Snap-On-Tilt Stand for Model 88...</td>
<td>$1.00</td>
</tr>
</tbody>
</table>

**PRECISION**

Apparatus Company, Inc.
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Export: 418 Broadway, New York 13, N. Y., U. S. A. • Cable: MORNHAYNE
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SEPTEMBER 1, 1957 — ELECTRONICS
how large is small?

DAVEN'S NEW MINIATURE WIRE WOUND RESISTORS PROVIDE AS MUCH AS 400K RESISTANCE IN 
$\frac{1}{4}'' \times \frac{5}{16}''$ SPACE

DAVEN's fully encapsulated, miniature, precision wire wound resistors offer the design and development engineer the solution to critical space limitation problems. DAVEN's advanced techniques provide the needed resistance value in a minimum of space, without sacrificing reliability. Where space conservation is a prime factor in your design, specify DAVEN miniature wire wounds.

Types and Specifications

<table>
<thead>
<tr>
<th>Type</th>
<th>Dia.</th>
<th>Length</th>
<th>Max. Ohms</th>
<th>Max. Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1274</td>
<td>3/16</td>
<td>3/8</td>
<td>100K</td>
<td>0.25</td>
</tr>
<tr>
<td>1273</td>
<td>1/4</td>
<td>5/16</td>
<td>400K</td>
<td>0.25</td>
</tr>
<tr>
<td>1283</td>
<td>1/4</td>
<td>5/16</td>
<td>400K</td>
<td>0.25</td>
</tr>
<tr>
<td>1284</td>
<td>1/4</td>
<td>27/64</td>
<td>5 Meg.</td>
<td>0.25</td>
</tr>
<tr>
<td>1250</td>
<td>1/4</td>
<td>1/2</td>
<td>900K</td>
<td>0.33</td>
</tr>
<tr>
<td>1170A</td>
<td>7/16</td>
<td>1/2</td>
<td>1.2 Meg.</td>
<td>0.50</td>
</tr>
<tr>
<td>1170</td>
<td>1/2</td>
<td>1/2</td>
<td>1.8 Meg.</td>
<td>0.50</td>
</tr>
</tbody>
</table>

- Fully encapsulated • Meet and exceed all humidity, salt water immersion and cycling tests as specified in MIL-R-93A, Amendment 3 • Operate at 125°C continuous power without de-rating • Can be obtained in tolerances as close as ±0.02% • Standard temperature coefficient is ±20PPM/°C.

Special temperature coefficients can be supplied on request.

Write for our new resistor catalog.
These remarkable tunable X-band magnetrons feature:

(1) exceptional electrical stability at very high rate-of-rise of voltage pulse, (2) virtually constant power output across the entire tuning range, and (3) rugged mechanical construction to meet stringent military requirements.

Available for either servo- or hand-tuned applications, this new family of RCA tunable X-band magnetrons is interchangeable with the 4J50 type magnetron in many systems. All RCA tunable magnetrons are designed for maximum performance throughout warranted life.

If you are working on new designs or modification kits for government end use, investigate RCA's new tunable magnetrons. For additional information on RCA commercial or custom-designed tunable magnetrons, call the RCA Office nearest you:

190 - radio control toy-spark gap

TUBES FOR MICROWAVES
RADIO CORPORATION OF AMERICA
Electron Tube Division Harrison, N. J.

253 - photo internals SB transistor
165 - uni-junction transistor flip flop

Typical Characteristics of RCA 200-Kw Tunable Magnetrons

<table>
<thead>
<tr>
<th>RCA-6865-A</th>
<th>RCA-7008</th>
<th>Developmental Type*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuning Range</td>
<td>8750 to 9600 Mc</td>
<td>8500 to 9600 Mc</td>
</tr>
<tr>
<td>Pulse Width</td>
<td>Up to 2.5 μsec at full power</td>
<td>Up to 2.5 μsec at full power</td>
</tr>
<tr>
<td>Rate-of-Rise of Voltage Pulse</td>
<td>70 to 180 KV/μsec</td>
<td>70 to 225 KV/μsec</td>
</tr>
<tr>
<td>Stability at Max. Rate-of-Rise of Voltage</td>
<td>less than 0.1%</td>
<td>less than 0.1%</td>
</tr>
<tr>
<td>Type of Tuner</td>
<td>Hand (with tuner lock)</td>
<td>Gearbox (for servo applications)</td>
</tr>
<tr>
<td>Approx. Weight</td>
<td>11.5 lbs.</td>
<td>13 lbs.</td>
</tr>
</tbody>
</table>

*Available with several different tuning mechanisms to meet customer requirements.

Equipment Sales
744 Broad Street, Newark 2, N. J., Humboldt 5-3900
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6355 E. Washington Blvd., Los Angeles 22, Calif., RA 3-8361

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