This standardized group of filters covers most popular filter applications and frequencies. Units are in compact, drawn magnetic shielding cases... 13/16 x 1 1/4 x 1 3/4 inches for BMI, LMI, BML; others 2 1/2 high. There are six basic types:

BMI band pass units are 10K input, output to grip, 3:1 gain. Attenuation is approximately 2 db at 3% from center frequency, then 40 db per octave.

HMI high pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at 0.67 cut-off frequency.

LMI low pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at 1.5 cut-off frequency.

HML high pass filters are same as HMI but 500/600 ohms in and out.

LML low pass filters are same as LMI but 500/600 ohms in and out.

BML band pass units are same as BMI but 500/600 ohms input, output to grid, 9:1 gain.

STOCK TYPES (number in figure is KC)

TMN-.4  TMN-2.3  TMN-14.5  TMW-22
TMN-.56  TMN-2.7  TMN-22  TMW-30
TMN-.73  TMN-5.4  TMN-30  TMW-40
TMN-.96  TMN-5.4  TMN-40  TMW-52.5
TMN-1.7   TMN-10.5 TMN-70  TMW-70

TMN-4 thru TMN-1.7
13/16 x 1 3/4 x 2 inches
Weight 3.5 oz.
TMN-2.3 thru TMN-70
13/16 x 1 1/4 x 1 3/4 inches
Weight 1.2 oz.

UTC standard telemetering filters provide extreme miniaturization with maximum stability, a complete set of 18 filters taking 19 cubic inches. They are 100K in and out and have an insertion loss of less than 6 db, a pin header for small Winchester socket.

TMN units are within 3 db at ± 7.5% of center frequency... down more than 18 db at ± 25%... more than 40 db beyond 1.75 and .58 center frequency.

TMW are within 3 db at ± 15% of center frequency... down more than 20 db at ± 50%... more than 40 db beyond 2.5 and .4 center frequency.

STOCK TYPES (number in figure is cycles)

RECEIVING
TGR-425  TGR-1785
TGR-575  TGR-1955
TGR-765  TGR-2125
TGR-935  TGR-2295
TGR-1125 TGR-2805
TGR-1275 TGR-2465
TGR-1455 TGR-2805
TGR-1615 TGR-2975

TRANSMITTING
TGT-425  TGT-1785
TGT-575  TGT-1955
TGT-765  TGT-2125
TGT-935  TGT-2295
TGT-1125 TGT-2805
TGT-1275 TGT-2465
TGT-1455 TGT-2805
TGT-1615 TGT-2975

These band pass filters for multiplex transmitting and receiving provide maximum stability in miniature sizes. Both receiving and transmitting types are 600 ohms in and out, and employ 7 terminal header for sub-miniature 7 pin socket.

TGR receiving filters are within 3 db at ± 42.5 cycles from center frequency... down more than 30 db at ± 170 cycles... down more than 15 db at adjacent channel cross-over.

TGT transmitting filters are within 3 db at ± 42.5 cycles from center frequency... down more than 16 db at ± 170 cycles... down more than 7.5 db at adjacent channel cross-over.
Transistor Blood Pressure Monitor. Compact unit, developed by National Research Council of Canada, saves operating room space and uses syringe-mounted pressure transducer to provide continuous monitoring. See p 82

Business Briefs

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Meetings Ahead 18

Magnetic Gage Locates Encased Metal Parts. Magnetic field pickup accurately locates exact position of ferromagnetic barrier encapsulated in a high-explosive container. p 65

Line Current Controls Remote TV Receiver. Compact carrier-current transmitter provides both unmodulated and modulated signals to control TV receiver sound level and channel selection. p 68

Electronic Control Times High-Speed Welding Cycle. All electronic resistance welding control affords increased reliability while accurately timing the four-part welding cycle. p 70

Transistors Reduce Relay Servo Size. Relay servo system with step-function potentiometer that provides on-off characteristic of null detector simulates on-off control device. p 74

Logical Design of SAGE Input Monitor. Radar monitor displays range and azimuth of any of 14 targets from any one of 15 radar sites in SAGE system. p 78
Transistor Unit Monitors Blood Pressure. Continuous indication of blood pressure is obtained by using variable-reactance pressure transducer mounted in syringe.

By O. Z. Roy and J. R. Charbonneau

Active Bandpass Filter Has Sharp Cutoff. Sharp cutoff slopes, wide range and low noise makes this bandpass filter valuable for analyzing sound waves.

By J. Ross MacDonald

Amplifier Delay Charts. The delays through various types of amplifiers are given directly when only the designed bandwidth is known.

By J. B. Harrington

Electronics At Work

Electronics At Work

Radiometer Studies Atmosphere

Point-to-Point Communications

Active Bandpass Filter Has Sharp Cutoff

Amplifier Delay Charts

Component Design

Production Techniques

New Products

Literature of the Week

Plants and People

New Books

Comment

Index to Advertisers
Surface Barrier Transistors from Sprague

Surface Barrier Transistors are now available from Sprague in production quantities for general high frequency applications and for high speed computer switching circuits. Orders for the popular types shown here are shipped promptly. They're priced right... and their high quality and excellent electrical characteristics make them the ideal 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., 33 MARSHALL ST., NORTH Adams, MASS.
PROBLEM:
Quick, silent conversion of atomic sub crew quarters to active battle station.

SOLUTION:
Berths mounted on Grant Slides enabling immediate area "clearing".

In a submarine, every inch of space is required to perform several functions. In some cases, a battle station must also serve as living quarters for the ship's personnel. Such was the case of the recently launched third atomic-powered submarine, the U.S.S. Skate. It was found necessary to place sleeping berths in the forward torpedo room. In the event of an enemy contact, berths must be repositioned quickly, to allow space for the vital workings of the torpedo room and silently, to avoid detection by enemy sonar. Grant Slides were chosen by the Electric Boat Division of General Dynamics for this essential job and they perform it well. In addition to operating quickly and silently, the slide used had to be sturdy enough to support a sailor... again the Grant Slide specified proved the perfect answer for this important application.

Grant No. 380 Slides recommended for loads up to 500 lbs./pair

Courtesy U.S. Navy Electric Boat Division of General Dynamics Corporation

GRANT
INDUSTRIAL SLIDES
23 High Street, West Nyack, New York
944 Long Beach Avenue, Los Angeles 21, California

Write for complete technical data on the wide range of Grant Slides.
Model 300-B
Output 0 to ±300 VDC; Output Current 0 to 150 mA; Regulation Accuracy ±0.15%, or 0.3 volt if greater; Ripple (MV-RMS) 5 maximum. Series or parallel operation. Cabinet model $225.

Model 610-B
Output 0 to ±600 VDC; Output current 0 to 1.0 amp; Regulation Accuracy Fixed Line ±0.15 volt for 0 to full load change, or for Fixed Load ±0.15% or 0.3 volt if greater for 105-125 volt input change; Ripple (MV-RMS) 4 maximum. Silicon power rectifier. Independent bias supply in addition to filament currents (6.3 and 12.6 VAC). In cabinet model $670.

HIGHER CURRENT—GREATER FLEXIBILITY—CLOSER REGULATION

All at LOWER COST in these new POWER SUPPLIES

These two new Sorensen "B NOBATRONS" bring a new plateau of performance to DC power supplies. They provide full range continuous voltage selection, from zero to maximum rating at full current... and the floating ground permits choice of positive or negative polarity output, extending the versatility of these improved B supplies even further. Sorensen's external sensing provision assures close control at the load. The current ranges of these two models are: 0 to 150 milliamps, and 0 to 1.0 ampere.

Both models provide isolated filament current at 6.3 and 12.6 VAC. Printed circuit design brings all this in light weight, compact packages, either cabinet or rack mount—and at gratifyingly low costs too!

Call your Sorensen representative for details... or write directly for technical data.
Raytheon's full line of dependable diodes and reliable rectifiers can enhance your design and product performance. This comprehensive range includes:

**Germanium Glass Diodes**
- Working Voltage: 1N55B 150 V, 1N66A 60 V, 1N67A 80 V, 1N68A 100 V, 1N95 60 V, 1N126 60 V, 1N127 100 V
- Reverse Current (Max.): 1N55B 500 mA, 1N66A 50 mA, 1N67A 50 mA, 1N68A 625 mA, 1N95 800 mA, 1N126 50 mA, 1N127 25 mA
- For 10°C at 10 V: 1N55B 3 mA, 1N66A 5 mA, 1N67A 5 mA, 1N68A 5 mA, 1N95 10 mA, 1N126 5 mA, 1N127 3 mA

**Germanium Video Detector Diodes**
- For TV video and portable radio application; low capacity video detection; efficiency controlled at 50 Mc

**Silicon Diffused Junction Glass Rectifiers**
- Wire in Types: 1N645 through 1N648
- Stud Types: 1N253 through 1N256

**Silicon Diffused Junction Rectifiers**
- Wire in Types: 1N536 through 1N540, 1N1095
- Stud Types: 1N253 through 1N256

All illustrations same size. Ratings at 25°C unless otherwise indicated.

Raytheon Semiconductor Division
Silicon and Germanium Diodes and Transistors • Silicon Rectifiers

CIRCLE 4 READERS SERVICE CARD
BUSINESS BRIEFS

ELECTRONICS NEWSLETTER

ATLAS ICBM PRODUCTION PUSH is seen in plans to take the Titan's pure inertial guidance system and put it into Atlas. Move indicates that American Bosch Arma's pure i-g system is good enough for operational use. Contracts for Atlas' secondary system—GE's radio-inertial with Burroughs' ground-based computer system—will still be completed, however, to back-up the Atlas program. Because of the all-out Atlas effort, Titan will fall back on its secondary system—Bell Telephone Laboratories' radio-inertial—for initial flight tests. Later, Arma's pure i-g will go back into Titan. USAF says both secondary systems are satisfactory; shift to self-contained pure i-g is only to avoid electronic countermeasures.

AMERICAN SCIENTISTS IN MOSCOW for the Fifth IGY Congress said Russian data on cosmic radiation encountered by the sputniks agrees closely with findings of U.S. satellites and earlier cosmic radiation studies. McGraw-Hill World News correspondent William Coughlin, who recently arrived in Moscow, reported that two Soviet suggestions have been advanced on the origin of low energy radiation near the earth: (1) Decay of neutrons. This would result from cosmic rays slamming into the earth's atmosphere with secondary products diffusing out and neutrons decaying into protons plus electrons with a half-life of 13 minutes; (2) Electrons from the sun arrive in clouds of gas. Commenting on the similarity of this to U.S. statements, J. A. Simpson, University of Chicago physicist and cosmic radiation expert, said: "Like in zoology, we've got a new animal—we've trapped him—now we've got to find out what he is and where he came from."

NEW RESIN BINDING technique will be used in assembling the magnets for a 6 bev electron accelerator to be completed in 1960 for Harvard and MIT scientists. The $6.5 million AEC-supported machine will have a potential energy level five to six times that of previous electron accelerators. Electrons will whirl around the synchotron for a sixtieth of a second. In that time they'll make 10,000 revolutions and get 160,000 accelerating boosts from 16 r-f cavities between the magnets. Contract for construction of the 612 magnet cores has just been announced by Baldwin-Lima-Hamilton Corp.'s Eddystone division.

FEDERAL COMMUNICATIONS COMMISSION which began vacation period this month will remain in recess until Sept. 1. To handle emergency matters, Commissioners Doerfer and Lee will be in frequent touch with their offices, and both plan to stay in or near Washington.

FIGURES OF THE WEEK

RECEIVER PRODUCTION

<table>
<thead>
<tr>
<th>Source: EIA</th>
<th>July 25, '58</th>
<th>July 18, '58</th>
<th>July 26, '57</th>
</tr>
</thead>
<tbody>
<tr>
<td>Television sets, total</td>
<td>60,164</td>
<td>61,130</td>
<td>72,522</td>
</tr>
<tr>
<td>Radio sets, total</td>
<td>173,079</td>
<td>167,756</td>
<td>234,034</td>
</tr>
<tr>
<td>Auto sets</td>
<td>54,653</td>
<td>49,771</td>
<td>61,394</td>
</tr>
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</table>

STOCK PRICE AVERAGES

<table>
<thead>
<tr>
<th>Source: Standard &amp; Poor's</th>
<th>July 30, '58</th>
<th>July 23, '58</th>
<th>July 21, '57</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio-tv &amp; electronics</td>
<td>50.59</td>
<td>50.43</td>
<td>49.23</td>
</tr>
<tr>
<td>Radio broadcasters</td>
<td>62.20</td>
<td>62.35</td>
<td>62.67</td>
</tr>
</tbody>
</table>

Figures of the Year

<table>
<thead>
<tr>
<th></th>
<th>1958</th>
<th>1957</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiving tube sales</td>
<td>154,136,000</td>
<td>185,847,000</td>
<td>-17.1</td>
</tr>
<tr>
<td>Transistor production</td>
<td>16,895,230</td>
<td>8,954,500</td>
<td>+66.3</td>
</tr>
<tr>
<td>Cathode-ray tube sales</td>
<td>2,964,741</td>
<td>3,710,646</td>
<td>-20.1</td>
</tr>
<tr>
<td>Television set production</td>
<td>3,790,840</td>
<td>2,178,361</td>
<td>+77.8</td>
</tr>
<tr>
<td>Radio set production</td>
<td>4,168,869</td>
<td>6,948,951</td>
<td>-31.4</td>
</tr>
<tr>
<td>TV set sales</td>
<td>1,917,290</td>
<td>2,420,633</td>
<td>-20.4</td>
</tr>
<tr>
<td>Radio set sales (excl. auto)</td>
<td>2,307,610</td>
<td>2,909,548</td>
<td>-20.7</td>
</tr>
</tbody>
</table>

ELECTRONICS engineering edition — August 15, 1958
Infrared Scans Reentry

But it'll be a while before I-R systems are used as part of missile warning networks

Success to date of Operation Gaslight, Defense Department's project to investigate the physics of missile reentry, gives a shot in the arm to hopes for infrared systems that can detect enemy missiles at useful distances.

Gaslight makes use of radiometric and spectrographic techniques to measure the heat generated as Jupiter IRBM's reenter the atmosphere. Judging from the results of Jupiter shots in May and July, infrared technology may provide a valuable adjunct to radar in the foreseeable future.

Wide-angle radiometers (picture, left) were designed especially for the Gaslight project by Barnes Engineering, Stamford, Conn. Infrared radiation at reentry is so strong that the instruments occasionally overload during the half-minute or so that the booster and nose cone are incandescent.

The radiometers are used aboard observer ships down range from Cape Canaveral, some 50 miles from the missile as it hurtles into the atmosphere at 9,000 mph. At this range, they provide more accurate indications of size and shape than radars or optical detectors do.

Infrared experts tell ELECTRONICS that current useful detection range of an infrared mosaic with an efficient optical system is "over a hundred miles." Continued improvement of transducer sensitivity and optical efficiency may double this figure. But useful data for missile detection purposes must start farther out than 300 miles.

With present components, the only answer is to get up above the earth's atmosphere where both masking background radiation and locally generated noise drop to an endurable minimum. This is one reason why the Air Force is seriously considering reconnaissance satellites as part of its missile defense plan.

Typical firing of Jupiter missile from Cape Canaveral on May 18 was picked up 1,500 miles away northeast of Antigua, B.W.I. As it reentered the atmosphere at 9,000 mph, it immediately turned white hot, "perceptibly illuminated" the observer ship, remained visible for 24 seconds, then dived into a large cumulus cloud and lit the cloud up. Brightest of the three parts of the missile (booster, instrument compartment and nose cone assembly, which is designed to protect the nuclear payload) was the booster.

At one point the booster appeared to be 1,000 times brighter than the planet Jupiter, across which it flashed.

A special panoramic spectral camera analyzed visible portions of the spectrum emitted by the incandescent bodies, and motion picture cameras recorded their trajectories. The spectral camera was gyro-stabilized to reduce roll and pitch effects, used a cluster of six aerial recon cameras equipped with spectral gratings.

Navy Telecasts

From 82,000 ft

Recordbreaking manned balloon flight on July 27 was highlighted by the first television broadcast from the inner fringe of space.

Primary purpose of the 34-hour overnight flight was to test the sealed cabin system which will go aloft again in November to take pictures of Mars.

Chief pilot on the flight was Cdr. Malcolm Ross of the Office of Naval Research. His copilot was Lee Lewis, head of balloon flight operations for Winzen Research, Minneapolis, which developed the gondola and the plastic Skyhook balloon. The two men broke the stratosphere endurance record of 32 hours set last fall by USAF balloonist Lt. Col. David Simons.

The balloon flight was one of ONR's Stratolab program (ELECTRONICS, p 24, Jan. 10). Besides rehearsing for the November flight and testing the gondola, the flight aimed to observe atmosphere heat-transfer characteristics, check genetic effects of stratospheric environment on insect life, study human factors, evaluate reconnaissance techniques with conventional photographic and tv equipment.

For the latter tests, the two balloonists transmitted from their peak altitude of 82,000 ft pictures of the sky, the balloon itself, the cabin's interior and each other.

Telecast used a Dage tv camera and a broadband radar transmitter modified for the purpose by Navy's Johnsville (Pa.) laboratories. Picture was transmitted on uhf at 475 mc on a broadbanded quarter-wave stub suspended six feet below the gondola.

Navy and Winzen Research picked up the transmission with a 12-element bedspring array at Fergus Falls, Minn. Tv station KSTP, Minneapolis, put the transmission on the air locally and was "swamped with calls," according to a Navy spokesman, asking for repeat telecasts. The picture, sent through 98 percent of earth's atmosphere and over 150 miles, was "startlingly clear."

Continued on page 12
NEED RELIABLE POWER?

NOW:
PERKIN TRANSIENT FREE DC POWER SUPPLIES WITH PROVEN RELIABILITY...

feature the rugged dependability of magnetic amplifiers combined with the precise regulation of transistors in a unique power supply circuit eliminating load-damaging overshoots.

For further information contact your local representative listed below or wire factory collect.

PERKIN ENGINEERING CORPORATION
345 KANSAS ST., EL SEGUNDO, CALIF.
ORegon 8-7215, EAstgate 2-1375

OTHER RATINGS AVAILABLE

<table>
<thead>
<tr>
<th>MODEL NUMBER</th>
<th>D.C. OUTPUT RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTR28-10</td>
<td>24-32 Volts @ 10 Amps</td>
</tr>
<tr>
<td>MTR28-30</td>
<td>24-32 Volts @ 30 Amps</td>
</tr>
<tr>
<td>MTR28-100</td>
<td>24-32 Volts @ 100 Amps</td>
</tr>
<tr>
<td>MTR060-1</td>
<td>0-60 Volts @ 1 Amp</td>
</tr>
<tr>
<td>MTR060-5</td>
<td>0-60 Volts @ 5 Amps</td>
</tr>
<tr>
<td>MTR636-30</td>
<td>6-36 Volts @ 30 Amps</td>
</tr>
</tbody>
</table>

NEED RELIABLE POWER?

MODEL MTR 636.15
6-36 VOLTS @ 15 AMPS.

NEW YORK AREA OFFICE
Orgeon 8-7215, EAstgate 2-1375

SAN FRANCISCO, CALIF.
Emerson 9-3354

CLEVELAND, OHIO
Redwood 2-7444

DETROIT, MICHIGAN
He 8-2461

SYRACUSE, N.Y.
Gibson 6-0270

PHOENIX, ARIZONA
American 5-0274

ORLANDO, FLORIDA
Ch 1-2128

SAN DIEGO, CALIF.
Academy 2-7516

ATLANTA, GEORGIA
Cedar 7-7801

DAYTON, OHIO
Chapel 4-5551

ALBUQUERQUE, NEW MEXICO
Hunt 2-8608

MINNEAPOLIS, MINNESOTA
Palisade 3-9000

DENVER, COLORADO
PArkway 3-9000

SEATTLE, WASHINGTON
Hunting 2-8608

ELECTRONICS engineering edition — August 15, 1958

CIRCLE 5 READERS SERVICE CARD
Design better products with

SILICONE-GLASS LAMINATES

...low loss factor, high moisture resistance

ITT Laboratories use a silicone-glass laminate as the main coil form in their AN/SRT-14, 15, 16 radio transmitting set. Laminate is tubular, 5.62" dia., wound with .064" silver wire. Primary reason for specifying silicone-glass: low loss factor at high frequencies.

Laminates made with glass or asbestos cloth and Dow Corning silicone resins make excellent dielectric materials. These strong, lightweight laminates maintain their properties at continuous operating temperatures of 250°C...for short periods will withstand greater heat. Silicone-glass laminates have good mechanical strength in addition to low loss factor, low water absorption, superior resistance to arcing, corona, corrosive atmospheres and contaminants. They can be laminated in very thin sections; have fine machinability. Supplied as tubes, sheets, punched or molded shapes by leading laminators. Write for free booklet.

Visit Dow Corning's Booth No. 104 at the 1958 WESCON Show

Dow Corning CORPORATION
MIDLAND, MICHIGAN

August 15, 1958—ELECTRONICS engineering edition
Dow Corning Silicone Dielectrics

SILICONE COMPOUNDS SEAL OUT MOISTURE

Highly effective as dielectrics, Dow Corning compounds are easy to apply. They provide protection against arcs, grounds, shorts... improve surface resistivity. These silicone compounds retain their properties from -75 to 200°C. Employed as filling, potting, or coating materials for various types of electronic gear, they seal out moisture, increase reliability, retain their initial grease-like consistency.

SILICONE VARNISH MAKES IMPROVED RESISTOR CEMENT

Heat-stable and exceptionally moisture-resistant, Dow Corning varnishes make very good bonding cements. In addition, they can take fairly high loadings of inorganic fillers without loss of properties. An appropriately filled Dow Corning varnish is often far superior to conventional materials for sealing wire wound resistors and other electronic devices. Set-up time is good.

WIRE COVERING OF SILASTIC INSULATES FROM -90 to 250°C

Here is a resilient dielectric that keeps its properties from -90 to 250°C. Silastic®, the Dow Corning silicone rubber, forms a durable, moisture resistant coating for wire, cable, and other electronic and electrical components. It resists arcing, corona, ozone, weathering, corrosive atmospheres, and many fuels and solvents. Meets MIL-W-8777 specifications. Available from leading wire manufacturers.
Decoder Shows Plane Number

**VISUAL DECODER** (above) automatically identifies by number or letter specific aircraft seen only as a blip on the controller's ground radar screen.

Through use of a high-speed switching tube and a numerical indicator tube, called Nixie—capable of visually displaying either digits or letters—the innovation would end time-consuming identification of en route and approaching aircraft.

About the size of a portable radio, the unit works in conjunction with conventional radar. Employing a full 360 degrees, search and recognition radar systems establish contact with all aircraft within range and altitude of the systems.

The search radar transmits a pulse which strikes the aircraft and is reflected back to the radar receiver. The pulse’s return then is displayed on a ppi scope.

Almost simultaneously, the recognition radar interrogates the airborne transponder which automatically transmits a binary-coded pulse train which has been pre-assigned to the aircraft. Received by the recognition radar, the pulse train is routed to the decoder.

To enable the controller to accept one binary-coded pulse train while rejecting all others, a “light gun,” or electronic-eye, is placed against the face of the ppi scope over the target blip. This opens the circuit to the decoder. Thus, an aircraft can be singled out by the controller, fed to the decoder, and displayed on the numerical indicator tube.

The beam switching tube that unscrambles the transponder signal

---

**WASHINGTON OUTLOOK**

The National Aeronautics and Space Administration will become an important government contracting agency in electronics—for both space-related research and procurement of specialized hardware.

The new civilian space agency absorbs the 43-year-old National Advisory Committee on Aeronautics and will open shop within the next two months. Unlike NACA, which never went into electronics work extensively and had extremely limited private contracting activities, the new agency will have money to support a broad-gaged program of electronic research and development.

Among the general research fields mapped out by the new agency’s planners: space communication, navigation and guidance; flight simulation; and measurement and observation techniques.

Electronics figures prominently in one specific research project NASA would like to start as quickly as possible: the development of a satellite carrying into orbit an astronomical telescope and auxiliary television equipment, to send close-up views of stars and galaxies back to earth.

According to insiders at NACA, the space agency will not build up a large staff and facilities for electronics and other new fields. Instead, the agency will rely on research and production facilities in private companies and institutions. Military-operated installations with available capacity may also be tapped for civilian space research.

NASA is set up to plan, direct and conduct research and development in the nonmilitary phases of space—that is, basic astronomical research and development of scientific spacecraft. The Defense Dept., through its Advanced Research Projects Agency (which in turn farms out work to the individual services) will continue work on space projects directly tied to military requirements.

For the current fiscal year, NASA will have a budget of $289.9 million. Included is a $117-million fund to be transferred from the Pentagon’s ARPA which had started nonmilitary space research pending the creation of the new agency. Examples: satellite tracking and monitoring systems and meteorological reporting.

- **Success of multiplexing on f-m channels** has brought about a slow—but significant—growth in f-m broadcasting. For the first time, the Federal Communications Commission is receiving competing applications for f-m channels in certain locations.
  Three years ago, FCC permitted f-m stations to engage in certain nonbroadcast services made possible by multiplexing, services for which they could charge, at the same time they were broadcasting their regular programming to f-m home receivers. Hence, f-m stations are on the rise, with some 100 authorized for nonbroadcast services.
  Another possibility: stereophonic broadcasts. FCC approved the test—to end Oct. 31—by WBAI-FM, New York, of a compatible multiplex stereophonic system developed by Crosley.

---

August 15, 1958 — ELECTRONICS engineering edition
Puzzled by ground loop problems? How to rescue microvolt signals from volts of noise?

HERE'S WHY KIN TEL'S DIFFERENTIAL DC AMPLIFIERS FIT IN INSTRUMENTATION SYSTEMS

160 db DC, 120 db 60 cycle common mode rejection with balanced or unbalanced input
Input completely isolated from output
Input and output differential and floating
5 microvolt stability for thousands of hours
.05% linearity, 0.1% gain stability
Gain of 10 to 1000 in five steps
>5 megohms input, <2 ohms output impedance
120 cycle bandwidth
Integral power supply

These are just a few of the many outstanding features of the Model 114A differential DC amplifier...features that make this amplifier really work in instrumentation systems...features that will help solve your instrumentation problems today.

Ideal for thermocouple amplification, the 114A eliminates ground loop problems; allows the use of a common transducer power supply; permits longer cable runs; drives grounded, ungrounded or balanced loads, and can be used inverting or non-inverting.

For additional information and technical literature on this exceptional instrument, write or call KIN TEL—the world's largest manufacturer of precision, chopper-stabilized DC instruments.

KIN TEL 114A differential DC amplifiers...convenient, interchangeable plug-in mounting in either 6-amplifier 19" rack mount modules or single-amplifier cabinets.

5725 Kearnv Villa Road, San Diego 11, Calif.
Phone: BRowning 7-6700
Representatives in all major cities
into proper sequence for the indicator tube operates at the rate of one-millionth of a second. Capable of operating at 10 positions, the vacuum tube can be switched from one position to another in a micro-second. The indicator tube lights up within 20 to 50 millionths of a second.

The decoder was developed by Burroughs and is now undergoing final testing at ARDC's Wright Air Development Center.

**Big Stereo Push Coming**

CHICAGO—LAST MONTH'S convention of the National Association of Music Manufacturers here indicated that stereo is slated for considerable fall promotional activity.

Of 235 exhibitors, more than one-quarter displayed stereo equipment. One trend appears to be the "add-on" package which some manufacturers are turning out. These are packaged stereo record players including either dual-channel amplifiers with a-m/f-m tuners, or single-channel amplifiers with provisions for adding a second plug-in channel later on.

One system displayed features a transistorized low-power two-stage transmitter built into the record player. The signal of one stereo channel is converted to a-m and broadcast within the room to a conventional a-m radio for creation of the stereo effect.

A number of magnetic tape systems were displayed.

In general, convention opinion has not yet crystallized on matters of sales information. The relatively short time span during which stereo has been on the market has not been enough to allow manufacturers to determine whether this fall's sales will be heavier in one-package or building-block systems. No conclusive opinions regarding future sales of stereo conversion kits were voiced.

Meanwhile, in New York, spokes-men for tape recording firms confirmed that they are preparing for production and distribution of four-track stereo tapes this fall.

**MILITARY ELECTRONICS**

- **Big boost in electronics activity will result from Republic Aviation's new $35 million R&D program.** Company's new R&D center will work in three areas: high speed aircraft, missiles and spacecraft. Six R&D laboratories will divide their activities into space environment studies, recently simulation and aerodynamics, materials development, guidance and control and advanced fluid systems development. One project is the study of the problems involved in sending a man to the far side of the moon and back. Next step after that, Republic's vice president Alexander Kurtveli says, will be to land a man on the moon.

- **Federal Government is now empowered by the new Civil Defense Act to supply the states with up to $35 million a year for radiological instruments, detection devices and other defense equipment.** Michigan has already been granted $1.3 million to finance half the cost of a microwave radio network covering the entire state for use in case of atomic attack. Normal usage of the system will be allowed the highway dept., state police and the department of conservation. Two-way radio communications system for the highway department will also be set up.

- **Army expects wide commercial as well as military application for its electronic earphone that shuts out noise.** How noise is canceled is actually accomplished by adding more noise. Inside the earphone are two noise canceling units. One picks up the undesired outside sound. This is fed through an inverter which changes its phase 180 degrees. The inverter output then feeds a tiny loudspeaker inside the earphone to cancel the ambient noise that gets into the earphone. Low pitched sounds are trapped by special foam cushioning. Silence synthesizers resulted from early noise reduction experiments conducted at RCA. Application of the concept to earphones was conceived by the Army.

**More Uses for Cat Eye**

THREE MOONS of Jupiter, with a partially-obscured fourth moon at right of planet, were photographed (above) by an electronic light amplifier called Cat Eye.

Coupled with a 10-in refracting telescope, the device (shown on table above) enables Wright Air Development Command scientists to take previously impossible day-time photographs of planets and stars.

The device senses and amplifies the always present—though not always seen by the human eye—photons, packets of energy which appear as light. A transducer receives the photons and transforms the information into electrical impulses. These impulses are further amplified before reproduction on a cathode ray tube.

Besides telescopic photographs, this light amplifier has been tested for night time aerial reconnaissance. Although it works on tv-like
The Hughes silicon capacitor is a new kind of device whose full impact upon semiconductor electronics has yet to be determined. Most certainly, the silicon capacitor uncovers an entire realm of possibilities. Desirable equipment not now existing can be made for the first time. And, in every instance, bonus benefits of reduced size and weight plus greater simplicity result.

Our brochure, "The Hughes Silicon Capacitor," discusses this series and many of its applications in detail. For your copy, please write:

Hughes Products, Semiconductor Division, international Airport Station, Los Angeles 45, Calif.

Some Suggested Applications:

Non-Mechanical Tuning: The effect upon tuned circuit design is tremendous. Hughes silicon capacitors replace bulky air condensers and permit remote-control tuning at the end of a long wire. With these capacitors, instantaneous and non-mechanical "signal seeking" features can be designed into tuned circuits.

Automatic Frequency Controls: Here the silicon capacitors replace a reactance tube. Output voltage from the discriminator varies the voltage on the silicon capacitor—hence, the local-oscillator frequency—to correct for any frequency drift.

Dielectric Amplifiers: Operation is based on the amplitude modulation of a high-frequency carrier source by a Hughes silicon capacitor, and on the subsequent demodulation and filtering at the output.

Also: Pulse Circuits, Frequency Modulation, RC Oscillators, Modulators, Electronically Controlled Filters.
principles, the optical amplifier is about 1,000 times more sensitive than a conventional TV camera.

Westinghouse and RCA have both worked on light transducers, according to ARDC.

Waveguides Form Ship-Radar Lens

Details of Britain's giant shipborne Type 984 radar-computer system for detecting targets and directing fire were revealed by Fleet Admiral Mountbatten at the summer meeting of the British Institute of Radio Engineers in London.

Though cost of the 984 was not given, Mountbatten did make a comparison of the cost of electronic equipment in ships of the 1938 era and those of today:

<table>
<thead>
<tr>
<th>Type</th>
<th>1938</th>
<th>1968</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frigate</td>
<td>$1,200</td>
<td>$336,000</td>
</tr>
<tr>
<td>Destroyer</td>
<td>$56,000</td>
<td>$1,240,000</td>
</tr>
<tr>
<td>Aircraft</td>
<td></td>
<td>$32,000</td>
</tr>
<tr>
<td>Carrier</td>
<td></td>
<td>over $2,800,000</td>
</tr>
</tbody>
</table>

Now in operation on Britain's aircraft carrier H.M.S. Victorious, eve part of the 984 is a revolving aircraft carrier H.M.S. Victorious, A surface part of the 984 is a revolving airframe radar lens.*

Though cost of the 984 was not given, Mountbatten did make a comparison of the cost of electronic equipment in ships of the 1938 era and those of today:

- **FINANCIAL ROUNDUP**
  - Acoustica stock was recently traded in over-the-counter markets at about $10. General Ultrasonics will be operated as an Acoustica subsidiary under present management. The combined firm now employs 250 and expects to increase this number to 400 by end of 1958. The merger combines Acoustica's marketing and production facilities in the ultrasonic field with GU's research and development abilities.
  - Victoreen Instrument, Cleveland, Ohio, authorizes redemption on August 20 of $100,000 face amount of company's $700,000 of outstanding 6-percent convertible debentures, due Nov. 15, 1967. The merged firm combines Acoustica's marketing and production facilities in the ultrasonic field with GU's research and development abilities.
  - Hupp Corporation, Cleveland, Ohio, sells its electronics division which produced quartz crystals, cadmium sulide cells and electronic switching devices at plants located at Forest Park, Ill., and Carlisle, Pa. "Profit potentials did not justify the capital expenditures necessary to expand to the level necessary for profitable operations," explains Don H. Gearhart, president of Hupp. The newly incorporated Piezo Crystal Company of Carlisle, Pa., purchased the Carlisle factory. As this issue went to press, no information was available on the acquisition of the Forest Park plant.
  - Advance Industries, Cambridge, Mass., purchases all outstanding stock of Electrolyzing Corp. of Rhode Island and its six subsidiary and affiliated companies for cash and other considerations. The acquired firm and its corporate family is engaged in special process treating of metals and ceramics, and bonding of ceramics to plastics. The missile-aircraft industry is an important customer. Advance Industries manufactures ultrasonic equipment, electronic and electrical automation controls and computer equipment.

Audio Will Star At British Show


Audio equipment will have a hall to itself, with some 45 firms demonstrating their gear in soundproof rooms. Exhibits and demonstrations will include microphones, speakers, amplifiers, phonograph components, disk and tape recorders. Audio gear accounts for 20 percent of Britain's radio exports.
Electron Tube News—from SYLVANIA

Pioneering new concepts—Everywhere in electronics

IN BASIC TUBE DESIGN...

Stacked mount in glass bulb offers practical answers to industry's current needs

Sylvania's stacked mount structure is now available to design engineers because of a new glass envelope design that facilitates mass production of the tubes. Complete electrical, mechanical and environmental tests show that the new tube is capable of meeting the highest requirements of today's operational equipment. Its unique stacked construction offers an inherent ruggedness and reliability for superior vacuum tube performance. Actual test data comparing the stacked structure with conventional structures indicates as much as a 2 to 1 improvement in vibrational output at 6 times the G level.

The new stacked tube has already excited tremendous military interest. Eventually an entire line will be available for military and industrial applications.

Widespread interest in Sylvania's exclusive Framelok design fosters new type development

Accelerated development of new Framelok tube types is underway at Sylvania as a result of fast-growing acceptance of the revolutionary design shown for the first time at the 1958 IRE Convention.

Design engineers are already analyzing new circuit requirements in terms of the Framelok design. New application possibilities ranging from television to audio are developing rapidly.

Behind this widespread acceptance are these basic reasons why designers prefer the Framelok design over conventional types:

- Greater uniformity of electrical characteristics in tube after tube
- Greater stability of electrical characteristics during tube life
- Less change in electrical characteristics due to element temperatures at high dissipation levels
- Better control of cutoff
- Lower knee voltage—more uniform control of knee
- Less chance for shorts, microphonism and noise
- Better plate-to-screen current ratio
- Higher screen grid dissipation
- Less arcing.

Send for your free copy of Sylvania's new Framelok Grid Booklet, including a grid sample, for full information on the electrical and mechanical characteristics of the Framelok design.

Entertainment receiving tubes are subjected to military-type inspection procedures

These two mounts may look alike to the untrained eye . . . but trained inspection personnel can spot defects in one (left) that could cause future trouble. All Sylvania entertainment tube types must pass this visual mount inspection procedure based on that used for military types. As a result, equipment manufacturers enjoy fewer line rejects, lower manufacturing costs.

Double triode, type 7244, and single triode, type 7245
Life tests on subminiatures are increased to insure maximum reliability

Sylvania increases the life assurance on its premium subminiature tube line by increasing its life test program from 500 to 1,000 hours. The increase establishes additional positive proof of the high reliability and excellent performance of the subminiature tube line.

Sylvania writes new Gold Brand Specs for commercial and industrial applications

To meet your needs for reliable tubes in commercial and industrial equipment, Sylvania has written new specifications which tailor military standards to commercial, and industrial requirements. Some of the typical controls specified for Gold Brand tubes include Multiple Life Tests ranging from 500 to 1,000 hours, Impact Shock Tests of up to 500 G, Fatigue Tests, Vibration Tests, Glass Strain Tests and Variable Control Tests.

The following are the 12 Gold Brand types on which full specifications are available:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>407A</td>
<td>Medium-Mu double triode (9-pin miniature)</td>
</tr>
<tr>
<td>408A</td>
<td>Sharp-cutoff pentode (7-pin miniature)</td>
</tr>
<tr>
<td>5725</td>
<td>Dual-control pentode (7-pin miniature)</td>
</tr>
<tr>
<td>5726</td>
<td>Double diode (7-pin miniature)</td>
</tr>
<tr>
<td>5728</td>
<td>High-Mu Double Triode</td>
</tr>
<tr>
<td>6788</td>
<td>Sharp cutoff audio-frequency pentode</td>
</tr>
<tr>
<td>6946A</td>
<td>Medium-Mu Double Triode</td>
</tr>
<tr>
<td>6947</td>
<td>Medium-Mu Triode</td>
</tr>
<tr>
<td>6948</td>
<td>Semi-Remote cutoff RF Pentode</td>
</tr>
<tr>
<td>6949</td>
<td>High-Mu Double Triode (9-pin miniature)</td>
</tr>
<tr>
<td>694A</td>
<td>Sharp cutoff RF Pentode</td>
</tr>
<tr>
<td>6945</td>
<td>Audio-Frequency Beam Pentode</td>
</tr>
<tr>
<td>6814</td>
<td>Medium-Mu double triode (9-pin miniature)</td>
</tr>
<tr>
<td>5654</td>
<td>Sharp-cutoff pentode (7-pin miniature)</td>
</tr>
<tr>
<td>5670</td>
<td>Double diode (7-pin miniature)</td>
</tr>
<tr>
<td>5814A</td>
<td>Medium-Mu double triode (9-pin miniature)</td>
</tr>
<tr>
<td>6005</td>
<td>Beam Pentode (7-pin miniature)</td>
</tr>
</tbody>
</table>

Gold Brand Premium Guided Missile types withstand severe durability tests

Every tube type in Sylvania's Gold Brand Guided Missile line meets environmental testing more severe than that required in many advanced military specs. Each type is subjected to severe vibrational fatigue tests at sweep frequencies from 30 cps to 3000 cps at 10 G's for 6 hours in several standard positions.

All Gold Brand Sylvania subminiature tubes undergo the White Noise Test. The tubes are subjected to a white noise vibrational spectrum covering the frequency band of 100 to 5000 cps, the rms G-level is 2-3 G's per octave with peak G-level of 15 G's. The tubes are tested for both rms and peak vibrational output and limits are established on each.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6946</td>
<td>Medium-Mu Triode</td>
</tr>
<tr>
<td>6947</td>
<td>Medium-Mu Double Triode</td>
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<tr>
<td>6948</td>
<td>High-Mu Double Triode</td>
</tr>
<tr>
<td>6788</td>
<td>Sharp cutoff audio-frequency pentode</td>
</tr>
<tr>
<td>6943</td>
<td>Sharp cutoff RF Pentode</td>
</tr>
<tr>
<td>6944</td>
<td>Semi-Remote cutoff RF Pentode</td>
</tr>
<tr>
<td>6945</td>
<td>Audio-Frequency Beam Pentode</td>
</tr>
</tbody>
</table>

Gold Brand subminiature Type 6814 meets rugged requirements of airborne computers

Prime example of a Gold Brand subminiature ideally suited for airborne computer use is type 6814. Fully proven in current operational equipments the tube features controlled sharp cutoff and zero bias plate current for good switching action. It exhibits exceptional freedom from development of cathode interface throughout life.

The 100% Production DC shorts test as well as a standard AC shorts test on type 6814 minimizes the possibility of flicker shorts—assuring greater reliability in this tube's many applications, particularly in switching and triggering circuits. In addition, it withstands a minimum 1000-hour life test.

You can get the complete engineering story on Sylvania's Gold Brand Lines in the new 33-page Gold Brand booklet.
IN NEW TUBE TYPES...

Five new types are added to the receiving tube line

Type 12DV8—Designed for 12-volt auto radios, this 9-pin miniature double-diode, space charge grid tetrode can be used as a combined detector, AVC rectifier and transistor driver. The tetrode section has the advantage of low Rp for better transistor matching.

Type 12EG6—This tube is designed primarily for use in 12-volt auto radios as an RF amplifier. It is a 7-pin miniature dual control Heptode with a unipotential cathode. AVC voltage can be applied to two control grids reducing back biasing of the AVC line with large RF signals.

Type 12DZ6—This miniature pentode has a remote cutoff to give a Gm of 50 umhos at a bias of 10 to 12 volts for improved AGC characteristics in hybrid radio receivers. The plate resistance of 15,000 ohms, coupled with a Gm of 3600 umhos, insures high performance in weak signal areas.

Type 12D07—This 9-pin miniature double diode-tetrode can be used as a transistor driver in addition to functioning as a detector and AVC rectifier in hybrid auto receivers. In this multipurpose, low-cost tube, power output distortion is controlled to a maximum of 5%.

Type 12DV7—A double diode-triode for use in 12-volt hybrid auto radios. With a 12-volt plate supply the triode features a plate current of 750 ua, a mu of 15 and a Gm of 1000 umhos. The diodes feature a separate cathode connection for maximum flexibility in detector and AVC circuits.

IN NEW TRANSPARENT PHOSPHOR TUBES...

Experimental five-inch evaporated phosphor CRTs offered for applications research and development

Steady progress is being made in the development of evaporated (transparent) phosphor cathode-ray tubes at Sylvania. Now 5-inch and other small tubes are being produced and are available for experimental purposes.

High industry interest in evaporated (transparent) phosphor tube is centered around the major benefits the tubes offer over conventional CRT's. Among the more important characteristics are:

- Higher resolution—Transparent screens are capable of higher resolution than conventional settled screens because the phosphor crystals are smaller by many orders of magnitude. Video displays with sharper definition are possible.
- Improved contrast in high ambient light conditions—Transparent phosphors permit outside light to pass through the “screen” cutting reflection to a minimum. This characteristic is highly important where scopes must operate in high ambient light.
- Minimum Screen Noise—Because evaporated phosphor crystals are much smaller than those in conventional coatings, screen noise, the interplay of light reflections on the crystal faces, is reduced. The result is sharpest possible definition.

- More Uniform Light Output—The phosphor coating on evaporated screen CRT’s is some 10 times as thin as standard coatings. This smooth screen coating contributes to far greater uniformity in light output.
- Less Screen Burn—Transparent phosphor tubes offer better resistance to screen burning because the crystals are closer to the glass faceplate. This allows better heat dissipation and cooler operation.

Since all of these advantages are not available in a single evaporated phosphor tube design, it is necessary to specify which characteristics are most important for the intended application. Send full information on your particular application when you request experimental samples. Write to Sylvania direct or call your Sylvania representative.
In Industrial Television...

Special CRT is specifically designed for industrial TV monitor use

Now, higher fidelity in industrial television is possible with new cathode-ray tube, type 8FP4. It gives added definition and resolution to industrial television performance.

Type 8FP4 is an 8" rectangular all-glass, magnetic focusing tube with an ion trap and 90° magnetic deflection.

New test picture tube speeds receiver production line testing

A new 8" 110° test picture tube, type 8YP4, is specifically designed for television receiver and picture tube testing. Its small size, light weight and convenient shape make it the ideal production line test tube.

The 8YP4 is equipped with a conventional base and a convenient adaptor for conversion to a rigid pin base. It has built-in automatic electrostatic self-focusing making external focus connections or adjustments unnecessary. It employs a 6.3 volt, 600 ma heater that will also operate in 450 ma series heater strings.

In Industrial and Military C-R Tubes

New high-precision scope tubes, types 5ADP, 5ABP, and 5AQP, were developed for photography, radar and specialized uses

Sylvania again expands its line of special-purpose industrial and military cathode-ray tubes with a series of high-precision types designed for specialized uses. These tubes incorporate a high-precision electron gun made to ultra-fine tolerances. Sharp clean scope presentations result for high-precision photography.

The new tubes, types 5ADP, 5ABP, and 5AQP, are available in screen phosphors ranging from P1 to P11.

In Television Picture Tubes...

Sylvania combines the advantages of 110° deflection and 450 ma heater in three new picture tubes

Sylvania, trend setter in electron-tube design, has developed new 110° picture tubes incorporating the 450 ma 6.3 volt heater. The new tubes, types 17CTP4, 21DHP4 and 24AQP4, combine the space savings of 110° tubes with the power and cost advantages of 450 ma heaters. The low power heater not only reduces heat with total set power savings of approximately 18 watts but permits use of a lower wattage, less expensive series resistor. The end result is a line of picture tubes that meet the needs of new portable and console TV receiver designs.

SYLVANIA

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY

Please send the following information on the items checked below:

ENGINEERING DATA SHEETS

Receiving Tubes

- 7244
- 7245
- 12DV8
- 12EG6
- 12DZ6
- 12DU7
- 12DV7
- 8FP4
- 8YP4
- 8FP4
- 17CTP4
- 21DHP4
- 24AQP4
- Sylvania Framelok Grid Booklet
- Sylvania Gold Brand Booklet
- Additional explanation, and application requirement form for Sylvania transparent phosphor CRTs

Name

Address

Company
Modernize Now
for Growth and Profits

A Special Report from McGraw-Hill
to America's Business Executives

THE EDITORS of all McGraw-Hill publications are now devoting their full energies to documenting what needs to be done now to assure success in the 1960s for:

1. Individual companies in the key areas of business and industry these publications serve
2. The business community as a whole
3. The nation—in its fateful economic competition with the Soviet Union. The U. S. State Department has characterized this economic challenge as “the most dangerous of all” confronting us.

These editorial features will concentrate on what can be done now by modernization and improvement of plant and equipment to raise productivity and insure profitable growth ahead. They will appear early this fall in our 34 business and technical magazines, to assist industry in planning for the future.

We believe this special editorial undertaking by all of our publications, working as a team, will prove another landmark in our continuing efforts to speed America on the road to full economic recovery and sustained economic growth.

Donald O. McGraw
PRESIDENT
and the U. S. is her best customer.

New stereophonic records and a studio for stereophonic tape recording will be shown.

There will be 160 exhibitors in all, of which 56 are radio and tv setmakers. More of the following will be in evidence this year: portable and transportable tv receivers; tv sets equipped to receive vhf/fm sound broadcasting; receivers using transistors and printed circuits. Some emphasis will be given to export models.

Manufacturers of tubes, components, test and measuring gear are exhibiting, and the Royal Navy, Royal Air Force and the General Post Office will show some of their applications of electronics.

Wescon Offers Timely Panels

LOS ANGELES—Wescon wants to learn your viewpoint next week. With increased emphasis on panel discussions, greater audience participation is solicited in technical sessions at the Ambassador Hotel here. The convention starts Tuesday, ends Friday.

Invited panelists for reliability sessions include civilian experts on Thor and Atlas, and a military representative from ARDC. Office of Assistant Secretary of Defense is furnishing the moderator and discussion will center around contract implications of reliability requirements for military electronics.

Panelists will point out why reliability must encompass far more than just manufacturing phase. They'll discuss significance of recently rewritten military specs, and the type of system companies need to cope with new requirements.

Cosponsored by IRE, medical electronics, and telemetering and remote control professional groups, another panel will explore measurement problems created by man's impending conquest of space.

To date, the medical profession and allied biophysical and physiological scientists have solved most of their own measurement problems. Now, they'll have to rely largely on telemetering equipment and personnel. Existing gear is not adequate for all jobs, and panelists hope that a delineation of problems will result in development of necessary equipments and techniques.

Radio to Run Traffic in N. Y.

Traffic control authorities in New York recently announced a plan which may mean expenditures as high as $200,000 a year solely for radio equipment to control traffic signal lights. The plan calls for an installation program that will continue indefinitely until all major thoroughfares in greater New York are provided with radio control equipment.

First phase expenditure of $190,000 is now before the city board of estimate for approval. Sum would be used for regulating a six-mile portion of a major roadway in the Queens County section of the city. Completion of the installation is expected by next summer.

Here's how the system will work: A transmitter will be constructed in each of the five boroughs. The stations will initiate signals governing operation of the traffic lights in accordance with 18 "programs" prepared to cover a variety of traffic situations. These will be derived from prepared punch cards and broadcast in the 952 to 960-mc band.

Each traffic light in the system will contain a receiver which will respond to signals intended for it. New York's director of intersection control told Electronics this probably will be done by a three-pulse system. The first two pulses will govern geographic location by street and intersection. The third pulse will cause the light to display the required signal.

Economies possible with the radio control system make traffic experts feel there's hope of approval for expenditures. Present networks to control traffic lights, which average about 10 to the mile, cost New York about $50,000 a mile. Radio system costs about $15,000 a mile.

MEETINGS AHEAD

Aug. 19-22: Western Electronic Show and Convention, WESCON, IRE, WCEMA, Pan Pacific Auditorium, Ambassador Hotel, L. A.


Sept. 12-13: Communications Conf., IRE, Sheraton Montrose Hotel, Cedar Rapids, Iowa.


Sept. 18-19: National Assoc. of Broadcasters Fall Conf., Buena Vista Hotel, Biloxi, Miss.


Sept. 24-25: Industrial Electronics, Seventh Annual Conf., IRE, AIEE, Rackham Memorial, Detroit, Mich.

Sept. 29-Oct. 3: Audio Engineering Society, 10th Annual Conv., Hotel New Yorker, N. Y. C.


Oct. 6-8: Symposium on Extended Range and Space Communications, IRE and George Washington Univ., Linsner Auditorium, Wash., D. C.

Oct. 8-10: IRE Canadian Convention and Exposition, Electronics and Nucleartronics, Exhibition Park, Toronto, Canada.


If you can use custom quality at commercial prices

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4-stage service

HUDSON precision quality metal components are produced by cost-reducing mass production methods. The HUDSON production department is equipped with batteries of standard and special presses ranging up to 300 tons. HUDSON performs a wide range of operations to meet your needs.

1 COMPLETE SERVICE ON MU METAL FABRICATION

HUDSON is now able to supply MU Metal closures in all standard sizes and shapes. Stock supply assures prompt delivery. Consult HUDSON on all your electrical alloy requirements.

2 SPECIAL FACILITIES FOR TRANSISTOR CLOSURES

HUDSON'S newly installed 10 station automatic presses speed production on your transistor caps. Closures for transistors, diodes and other miniature components to specifications.

3 MIL-T-27A CLOSURES FROM AF TO OA

Cases and covers now offered by HUDSON from types AF to OA inclusive. Immediate shipment from large stock supplies. Cover assembles to MIL-T specifications also available.

4 STANDARD PRECISION DRAWN INSTRUMENT CASES

Standardized cases include over 1400 different sizes, with both inside and outside covers, in six standard metals. Hudson offers the engineer a range of closures unequalled in the industry.

HUDSON service is complete... includes sheet metal fabrication, spot welding, heliarc welding and silver soldering. HUDSON designers and production engineers will be happy to help work out your problems.

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Telephone—Market 3-7584 Teletype—NK 1066

Expert Fabrication in Steel, Stainless Steel, Aluminum, Brass, Copper and MU Metal
Precision Metal Components for Electronics, Nucleonics, Avionics and Rocketry

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Where there must be no slipups
there will be no slipups
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Looking for reliability? CAMBION guarantees its components unconditionally — in any quantity from one to millions. CAMBION quality control includes material certification, step-by-step inspection in production, and finally rigid inspection of finished product. There is reliability for you.

For samples, specifications, and prices, write to Sales Engineering Department, Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast stocks maintained by E. V. Roberts & Associates, 5068 West Washington Blvd., Los Angeles 16 and 1560 Laurel Street, San Carlos, Calif.

See CAMBION Guaranteed Components on Display at Booth 1139, 1958 Wescon Show, Pan Pacific Auditorium, Los Angeles, August 19 through 22.
Ten families of Cambion quality components – guaranteed unconditionally in any quantity

CAMBION QUALITY SHIELDED COIL FORMS

CAMBION QUALITY CAPACITORS

CAMBION QUALITY WOUND COILS
IN STANDARD VALUES
Precision-wound on slug-tuned ceramic coil forms, with silicone Fibreglas collars and mounting hardware. Available in bulk or in kit form (illustrated).

CAMBION QUALITY DIODE CLIPS
Seven different types, including rivet and spring-loaded units primarily for holding fragile pigtails leads from .005" to .085" in diameter. Also, one-, three-, and five-cell battery clips and miniature plugs and jacks.

CAMBION QUALITY TERMINAL BOARDS

CAMBION QUALITY PERMA-TORQ® COIL FORMS
Constant-tensioning devices for tuning cores of standard Cambion ceramic coil forms. Keeps coils tuned as set despite shock, vibration.

CAMBION QUALITY INSULATED TERMINALS
Wide variety of stand-off and feed-through models in Teflon and ceramic. Extremely resistant to shock, vibration, moisture and temperature. Solder terminals hold even after prolonged soldering operations.

CAMBION QUALITY PRINTED CIRCUIT COIL FORMS
Phenolic and ceramic types. Can be soldered after mounting. Available as forms alone or wound as specified. Two- to six-terminal models.
This letter moved an engineer ahead 5 years

Two years ago a man took 10 minutes to write this letter. Today he enjoys the responsibility and professional standing in the Autonetics Division of North American that might have taken 5 years to achieve elsewhere.

COMPUTERS AT AUTONETICS—A FIELD OF OPPORTUNITY

At Autonetics we have concentrated on developing original techniques in transistor circuitry, miniaturization, and quantity manufacture of precision components. For only with these new arts is it possible to create computers so small, rugged, reliable—yet so big in performance—that they can meet the demands of the space age or the increasingly complex problems of industry.

Our engineers have designed and built both analog and digital computers—for inertial navigation, bombing-navigation, armament control, flight control and data processing equipment. Out of this experience, Autonetics built the first transistorized digital computer of true general purpose capacity.

Today at Autonetics there's a respected combination of scientists, engineers, and production men constantly forging ahead into vital new technologies. Every state of the art is represented, from preliminary conception right through manufacturing. Facilities are the finest—and it's just a short jaunt to mountains, beaches or desert.

You owe it to yourself to consider how far you can advance by entering this exceptionally promising field right now. Here are the opportunities:

LOGICAL DESIGN • SMALL COMPUTER PROGRAMMING • SYSTEMS DESIGN, DEVELOPMENT AND TEST • TRANSISTOR CIRCUITRY • MAGNETIC MEMORY • SYSTEMS INTEGRATION • FIELD SERVICE ENGINEERING.

Write your letter today. Please include a resume of your qualifications. Decide now to investigate your opportunities at Autonetics. Reply will be prompt, factual, confidential.

Write  B. H. Benning, Manager, Employment Services.
9150 E. Imperial Highway, Downey, California

Autonetics
A DIVISION OF NORTH AMERICAN AVIATION, INC.

NERVE CENTER OF THE NEW INDUSTRIAL ERA

CIRCLE 17 READERS SERVICE CARD
At the zero second everything must function without failure. ANDREW HELIAX cable is used in postassembly and preflight checkouts of missile radio frequency systems. The cable forms a closed circuit over which interrogation and response signals are transmitted between checkout equipment and airborne radio frequency packages. The HELIAX cable runs from a mobile trailer to connecting points on the missile.

The ruggedness of HELIAX makes it well suited to this challenging task, where its low VSWR, low RF leakage and low attenuation give accurate measurement of systems performance. Flexibility permits the cable to be taken down, recoiled and subsequently reused many times.

If you require similar characteristics in a cable, consider the special advantages of HELIAX.

HELIAX is normally supplied as an assembly, complete with end fittings factory attached, reducing installation labor and improving quality.

Complete uniformity throughout its entire length gives HELIAX superior electrical characteristics.

HELIAX is always less difficult, less costly to install, easier to handle.

HELIAX is available in 7/8" size (Type H0) and 1½" size (Type H1).

VISIT OUR WESCON BOOTH NO. 1215
Read directly
1 μma
and
1 μv
with 10 times previous accuracy!
Drift less than ± 2 μv; noise less than 0.2 μv!

New -hp- 425A Microvolt-Ammeter
now makes these difficult measurements quickly and easily!

ENGINEERING
Minute dc potentials, difference voltages, nulls
Resistances from milliohms to 10 megohms*
Use with Esterline-Angus, other recorders

PHYSICS, CHEMISTRY
Grid, photomultiplier currents
Ionization levels in vacuum
Thermocouple potentials
Voltaic currents in chemicals

MEDICINE, BIOLOGY
Voltages in living cells
Nerve voltages
Voltages in plants, seeds

*with external dc source.

hp is announcing more than 30

CIRCLE 18 READERS SERVICE CARD
August 15, 1958 — ELECTRONICS engineering edition
The all-new -hp- 425A Microvolt-Ammeter will provide engineers, physicists, chemists and physiological scientists with one compact, direct-reading instrument measuring minute voltages and currents with speed, simplicity and 10 times the sensitivity of the complex equipment arrays previously required.

Very careful engineering, including heavy filtering against ac signals and substitution of a unique photoelectric chopper for the conventional mechanical vibrator, has resulted in performance heretofore unobtainable. The long-term drift of the 425A is less than 2μV and internal noise is less than 0.2 μV.

Conservative electrically, Model 425A includes every conceivable assurance of safety, accuracy and dependability. For example, momentary overloads of 1,000 volts cause no damage; and the new pickup probe is specially designed to minimize thermocouple and triboelectric effects. The meter provides constant polarity indication.

The new -hp- 425A also may be used to measure a wide range of resistances. Milliohms may be measured by using a battery and series resistor as a constant current source. Higher resistances may be measured with higher voltages; a 100 volt supply allows the 425A to measure accurately up to 10 megohms.

Call your -hp- representative now for demonstration on your bench; or, write for details.

HEWLETT-PACKARD COMPANY
4882A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
Cable “HEWPACK” • DAvenport 5-4451
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

SPECIFICATIONS

MICROVOLT-AMMETER
Voltage Range: Positive and negative voltages from 10 μV full scale to 1 V full scale in an eleven step, 1, 3, 10 sequence.
Current Range: Positive and negative currents from 10 pA full scale to 3 mA full scale in an eighteen step, 1, 3, 10 sequence.
Input Impedance: Voltage Ranges: 1 megohm ±5%. Current Ranges: Depends on range, 1 megohm to 0.33 ohm.
Accuracy: Within ±3% of full scale.
AMPLIFIER
Frequency Range: dc to 0.2 cps.
Gain: 100,000 maximum.
Output: 0 to 1 V for full scale reading, adjustable.
Output Impedance: 10 ohms, shunted by 1000 ohm potentiometer.
Noise: Less than 0.2 μV rms referred to input.
Drift: After 15 minute warm-up, less than ±2 μV per hour referred to the input.
Power: 115 V ±10%, 230 ±20%, 60 cps, 40 watts.
Dimensions: Cabinet Mount: 7½" wide, 11⅞" high, 14" deep.
Weight: Net 20 lbs.
Price: $500.00.
hp- 425AR (rack mount) $505.00.
hp- 425A (cabinet) $500.00.

Data subject to change without notice. Prices f.o.b. factory.

basic new instruments in 1958

ELECTRONICS engineering edition — August 15, 1958
CIRCLE 19 READERS SERVICE CARD 25
Fairchild silicon transistors

Milli-micro-second switching speeds and high current too

Where applications require transistor performance beyond previously accepted high limits, Fairchild Silicon Transistors offer an exceptional three-way combination:

1) 50 milli-micro-second typical rise time — permits faster switching rates in computing devices. Total switching time is typically 0.2 microseconds.

2) 1 watt dissipation at 100°C. — Saturation resistance is 10 ohms maximum. Resulting high-current capability provides opportunities to increase equipment performance while reducing circuit complexity.

3) Silicon temperature performance — Maximum junction temperature of 175°C. gives low leakage and more safety factor at any lower temperature.

These characteristics are the outcome of the solid-state diffusion technique used at Fairchild. Other important accomplishments of this process are excellent reliability and a high order of electrical uniformity throughout large production runs.

The accomplishment of a research-production team Singleness of purpose did it. Fairchild assembled a uniquely experienced team of research scientists and production engineers whose objective was to bring the advanced solid-state diffusion process under close control.

They succeeded in putting laboratory-quality silicon transistors into quantity manufacture with firm product specifications exceeding anything previously offered.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Specification</th>
<th>Rating</th>
<th>Characteristics</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCE</td>
<td>Collector to Emitter voltage (25°C)</td>
<td>40v</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC</td>
<td>Total dissipation Case temp. 25°C Case temp. 100°C</td>
<td>2 watts 1 watt</td>
<td>2N696 — 15 to 30 2N697 — 30 min.</td>
<td>Ic=150ma VCE=10v</td>
</tr>
<tr>
<td>hFE</td>
<td>D.C. current gain</td>
<td>6n typical, 10n max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCS</td>
<td>Collector saturation resistance</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

For full information and specifications, write Dept. A-8

The unretouched scope face below shows the time comparison of input (positive) and output (negative) pulses in a non-saturating mode. Time base is 20 microseconds per large division on the scope face. Maximum collector current is 50 ma.

844 CHARLESTON ROAD • PALO ALTO, CALIFORNIA
VISIT US AT BOOTH 1632 AT THE WESCON SHOW
NEW HERMETICALLY SEALED HIPERMAG CORE

PERMITS ENCAPSULATING, IMPREGNATING, OTHER PROCESSING

...WITH NO CHANGE IN MAGNETIC VALUES

Newest development in cores for magnetic amplifier applications
is the Westinghouse Polyclad hermetically sealed Hipermag
core.* Polyclad insulation is applied over a new specially de-
dsigned aluminum box housing the core. This hermetically seals
the core and allows encapsulating, casting or impregnating—
without altering magnetic properties... Eliminates magnetic
amplifier rejects caused by changed magnetic values.

Tested for all environmental conditions, Polyclad insulation is
suitable for high temperatures, protects against humidity and
high-voltage stress, provides high insulation strength, with
breakdown values up to 3000 volts.

Polyclad coating eliminates the need for core taping; makes
possible reduced insulation cost. Rounded corners prevent
shorting wire to core, allow winding directly on the core.

These cores are supplied in special sizes or in standard AIEE
sizes, in one-, two-, or four-mil oriented nickel-iron alloy
Hipernik® V and in one- or two-mil 4-79 Permalloy. Complete
listing in Westinghouse publication 44-720.

Hermetically sealed Hipermag cores are available in production
lots with normal delivery. All Hipermag cores are tested
—by Roberts constant-current, flux reset technique, or to
your specifications.

For more information about Polyclad hermetically sealed
Hipermag cores and other Hipersil® or Hipermag cores, call
your Westinghouse representative... or write Westinghouse
Electric Corporation, P.O. Box 231, Greenville, Pennsylvania.

*Patent applied for

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It's excellent for the daylight conditions often encountered in the field and at production test stations. The brilliant trace, provided by 10-KV accelerating potential on a new Tektronix 3-inch cathode-ray tube, is easily readable in bright areas, even at low sweep-repetition rates. And its DC-to-10 MC vertical response easily takes care of most of today's complex field applications.

The Type 317 is an excellent laboratory oscilloscope, too. Ask your Tektronix Field Engineer or Representative to arrange a demonstration in your most demanding applications.

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... means lightning fast in-flight reprogramming of airborne electrical/electronic circuitry... obsoletes fixed circuit connectors and other systems requiring hours or days to rewire... and offers these unusual features:

- removable patchboards to permit complete reprogramming in seconds
- 3 3/4 pounds to minimize weight... miniaturized to conserve space
- rugged shock and vibration-resistant construction with high strength aluminum alloy
- shock-resistant seating of patchcord plugs in removable board
- AMP's patented wiping action that pre-cleans contacts for top electrical performance
- 240 contacts for greatest versatility in circuit combinations or program arrangements

For more information on this new airborne wiring technique, AMP's Patchcord System Catalog is available on request.
Unique combination of performance, size and price

OVER 1000 TIMES AS SENSITIVE as galvanometer recorders... and Varian's null-balance potentiometer needs no power from the source being measured. Rugged, stable mechanism allows ink or inkless recording — easy-to-read rectilinear chart — source impedances of up to 100,000 ohms.

LESS THAN HALF AS WIDE as a standard 19-inch rack. Two Varian G-11A's mount side by side on a rack panel 10% inches high. Or as a portable, the G-11A is an easy-to-handle 15 pounds. The G-10 sits on less than one square foot; its horizontal chart is handy for jotting notes.

MORE VERSATILE AND ADAPTABLE than any similar recorder — adjustable zero, adjustable span (from 9 to 100 mv on the G-11A), multiple chart speeds (up to four on the G-11A), and plug-in input chassis for different recording requirements.

PRICES THAT BEGIN AT $340 for the G-10 and $450 or the G-11A. Because unneeded performance costs money, Varian has intentionally designed for 1% limit of error and 1-second balancing time. Thus, Varian provides needed ruggedness, dependability and operating features at moderate cost.

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VARIAN associates

INSTRUMENT DIVISION

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AlSiMag Alumina Ceramics open new fields for designers . . . permit designing to higher temperatures, higher frequencies, greater strengths.

Designers are generally familiar with the plus values of AlSiMag technical ceramics for standard industry applications. However, recent developments—particularly in new, high-strength, high-temperature AlSiMag Aluminas—have greatly enlarged their range of usefulness.

Do you need a material with such versatile characteristics as shown on this page? AlSiMag technical ceramics have helped many designers solve problems . . . may help solve yours. Send blueprint with complete operating details for our recommendations.

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another NEW Mallory Tantalum 150°C service . . . miniature size

From Mallory, another industry first . . . miniature high temperature tantalum capacitors capable of operation up to 150°C. Identified as the M2 line, these capacitors feature glass-to-metal hermetic seals, preventing any loss of electrolyte. They will withstand 2000-cycle vibration in accordance with MIL-C-3965B. The extremely rugged design, which enables their use under severe environmental conditions, and small size, only 0.5" long x 0.287" body diameter, 0.484" flange diameter, make them particularly useful in missile and aircraft electronic systems.

The M2 series is the latest addition to Mallory’s complete line of tantalum capacitors, which gives designers coverage in tantalum of capacities from .22 to 1300 mfd., voltages from 3 to 630, and temperatures from 85 to 200°C. The following ratings are available in the M2 line:

<table>
<thead>
<tr>
<th>Type</th>
<th>Mfd.</th>
<th>Working Voltage—DC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>85°C</td>
</tr>
<tr>
<td>M2-11</td>
<td>11</td>
<td>90</td>
</tr>
<tr>
<td>M2-15</td>
<td>15</td>
<td>75</td>
</tr>
<tr>
<td>M2-20</td>
<td>20</td>
<td>60</td>
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<td>M2-25</td>
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<td>50</td>
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<td>M2-70</td>
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<td>15</td>
</tr>
<tr>
<td>M2-100</td>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>M2-140</td>
<td>140</td>
<td>6</td>
</tr>
</tbody>
</table>

Ask the man from Mallory for more data and application engineering assistance—or write, today.

Expect more... get more from

Serving Industry with These Products:
Electromechanical — Resistors • Switches • Timing Devices • Vibrators
Electrochemical — Capacitors • Mercury and Zinc-Carbon Batteries
Metallurgical — Contacts • Special Metals • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.
More horsepower per pound—it’s yours with 155°C Anatherm

First polyester high temperature enamel magnet wire available in complete range of sizes—round, square, rectangular.

Of course you don’t fry eggs on them, but motors are being run hotter today. These higher operating temperatures can put you on a hot spot with your customers—if motors fail.

Solution: Anaconda Anatherm Magnet Wire. Anatherm is a new polyester film-coated wire—fully tested for use at “hottest spot” temperatures up to 155°C. With this new higher level of thermal stability, Anaconda Anatherm is the first film-coated wire to meet the newly adopted 155°C (AIEE Class F) rating!

Greater thermal stability—plus excellent abrasion-resistance, chemical stability and dielectric strength—make Anatherm ideally suited for a variety of applications. It’s especially practical where maximum performance and reliability are required from smaller equipment operating at higher temperatures.

As a polyester magnet wire, Anatherm can be used equally successfully at any hottest-spot temperature from 105°C to 155°C. Available in standard film-thickness of round wires, sizes 8 to 46, inclusive, and in a full range of sizes of square and rectangular wires. For more information, see the Man from Anaconda. See “Anaconda” in your phone book—in most principal cities—or write: Anaconda Wire & Cable Co., 25 Broadway, N. Y. 4, N. Y.

ASK THE MAN FROM ANACONDA ABOUT ANATHERM MAGNET WIRE

For you. Anatherm can mean smaller electrical equipment...higher operating temperatures. See details on reverse side—

ANALAC 105°C (AIEE Class A)
VITROTEX 130°C (AIEE Class B)
PLAIN ENAMEL 105°C (AIEE Class A)
NYFORM 105°C (AIEE Class A)
EPOZY 130°C (AIEE Class B)
IMPORTANT FACTS FOR YOUR WORK...

...about Anatherm 155°C (AIEE Class F) Magnet Wire

When proper advantage is taken of Anaconda Anatherm’s higher 155°C characteristics, electrical equipment can be improved in these ways:

RAISES LIMITING OPERATING TEMPERATURES. Anatherm raises limiting operating temperatures to 155°C. This high heat resistance means extra protection... longer equipment life... wider range of applications.

REDUCES FRAME SIZE. Anatherm gives more horsepower from the same space or the same horsepower from a smaller motor. Costs are cut for you, and your customers benefit from smaller over-all components.

INCREASES HORSEPOWER RATINGS. Anatherm is the best of the polyesters. Its high heat resistance means higher permissible operating temperatures, greater horsepower rating.

UPGRADING. Anatherm helps upgrade standard equipment. Gives added heat insurance through thermal stability. Particularly suited for overloads.

COMPATIBILITY. With polyesters, importance must be placed upon a completely compatible system. Varnish manufacturers have recently developed polyester varnishes which allow a compatible polyester magnet wire system. A number of varnishes other than polyester are compatible with Anatherm, but consultation with varnish suppliers before use is recommended.

TECHNICAL PROPERTIES

MECHANICAL PROPERTIES

Anatherm has unusually high abrasion-resistance. This characteristic allows it to be wound on both conventional and automatic winding equipment. Anatherm offers excellent flexibility and adherence properties. It meets NEMA snap test requirements and exhibits excellent adherence to the conductor.

ELECTRICAL PROPERTIES

Anatherm maintains its dielectric strength under prolonged heating at high temperatures. It consistently exceeds dielectric strength requirements for NEMA dielectric twist test.

CHEMICAL PROPERTIES

Anatherm will resist toluol, VM & P Naphtha, Ethyl Alcohol and 5% Sulphuric Acid. Anatherm is a polyester and exhibits the best characteristics of this class of chemical compound. However, all polyesters must be used with certain precautions where moisture and or enclosed systems are concerned. Similar precautions must be taken where chlorine-base supporting insulations, such as neoprene and polyvinyl chloride, are present. Polyesters should not be used in applications subject to exposure to concentrated alkalies.

THERMAL PROPERTIES

Anatherm is offered as a 155°C (AIEE Class F) magnet wire based on AIEE #57 and #510 test methods. These tests, performed by Anaconda engineers, show Anatherm as being capable of a 30,000-hour life at 157°C in an unvarnished state and the same life at 175°C when treated with a silicone or polyester type varnish. Thus Anatherm, when suitably varnished, has reserve stability even above the 155°C rating at which it is being offered. The thermoplastic flow temperature for Anatherm, based on MIL-W-583A, is very high (250°C). Anatherm also shows outstanding retention of flexibility after aging. Wire can be heated 168 hours at 175°C and then wound on three times its own diameter without cracking. Its heat-shock characteristics are exceptionally good for a polyester wire: Anatherm will withstand a 1x mandrel wrap at 155°C for one hour.

Valuable Anatherm Magnet Wire Handbook—yours for the asking!

Latest information... full technical data.
New Bendix®

BACKWARD-
OSCILLATOR
for extremely high frequencies

WAVE TUBE

An exclusive Bendix Red Bank product, the Type TE-67 Backward-Wave Oscillator Tube generates microwave energy at extremely high frequencies never before available.

This new tube provides a wide range of usable frequencies for applications in: advanced types of multichannel telephone and television systems, high definition short-range radar, highly directive communications, microwave spectroscopy and other fields where low power, voltage-tuned millimeter wave-length radio frequency energy is required. As the backward-wave tube is voltage tuned, frequency is automatically changed by varying the voltage input. No mechanical tuning adjustment is required.

For more detailed information on the tubes described here, write to: RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

ELECTRICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
<td>49kmc-59kmc</td>
</tr>
<tr>
<td>Anode Voltage</td>
<td>1000-3000 volts</td>
</tr>
<tr>
<td>Power Output</td>
<td>5mw average</td>
</tr>
<tr>
<td>Beam Current</td>
<td>5ma</td>
</tr>
<tr>
<td>Magnetic Field</td>
<td>1300 gauss (minimum)</td>
</tr>
<tr>
<td>Heater Voltage</td>
<td>6.3±10%</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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</thead>
<tbody>
<tr>
<td>Output Flange</td>
<td>Special adapter to RG-98/U</td>
</tr>
<tr>
<td>Maximum Diameter</td>
<td>0.625”</td>
</tr>
<tr>
<td>Length</td>
<td>8”</td>
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<tr>
<td>Mounting Position</td>
<td>Any</td>
</tr>
<tr>
<td>Weight</td>
<td>5 oz.*</td>
</tr>
</tbody>
</table>

*Without magnet (tube only). Magnets are available.

Additional tubes are under development to extend the frequency range to 75 kmc.

The traveling-wave amplifier tube, also available from Bendix Red Bank, is designed for operation in the 4.0 to 8.0 kmc frequency range with approximately 40 db gain and 200 milliwatts output power. The tube utilizes a helical slow-wave structure with coupled helix attenuator section. The mechanical design minimizes the effects of vibration upon the tube operation.
glass-base laminates?

**C-D-F DILECTO®**

is the answer!

Teflon®, silicone, epoxy, melamine, and phenolic glass-fabric laminates. Polyester glass-mat laminates.

You can improve design, speed production, and save money by specifying one of the many C-D-F Dilecto grades. Whatever your application for these laminates — with fine- or medium-weave glass-cloth base — you'll find a better answer to your problem at C-D-F. (Melamine can also be made with glass-mat base.) And C-D-F offers modern machining and fabrication facilities to deliver production quantities of finished Dilecto parts to your specifications.

See our catalog in Sweet's Product Design File, where the phone number of your nearby C-D-F sales engineer is listed. For free trial samples of glass-base Dilecto, or of any other C-D-F plastics, mica, or fibre product, send us your print or your problem! Write for your free copy of C-D-F Technical Bulletin 64.

**SPEED AUTOMATIC PRODUCTION** of printed circuits with warp-resistant C-D-F metal-clad Teflon® and epoxy laminates. Other advantages: high bond strength of copper to laminate, superior blister-resistance in solder immersion.

**HIGH VOLTAGE (1800v.) RF ISOLATION** is achieved by miniature C-D-F Dilecto gears in an aircraft receiver-transmitter switch. They also had to exhibit dimensional stability through a wide temperature range, resistance to fungus growth and thermal shock.

**PRECISE MACHINING AND FABRICATION** are standard benefits of Dilecto laminated plastics. These silicone glass-base parts (coil mountings, aircraft terminal board) were sawed, drilled, punched, and milled in production quantities by C-D-F and customer.

**PROPERTIES OF SOME TYPICAL C-D-F DILECTO GLASS-BASE GRADES**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Equivalent NEMA or ASTM grade</th>
<th>Flexural Strength Lengthwise (PSI)</th>
<th>Dissipation Factor at 1kHz Cond. A</th>
<th>Dielectric Strength Parallel Step x step</th>
<th>Insulation Resistance Cond. C96/55/90</th>
<th>Arc Resistance (seconds)</th>
<th>Maximum Operating Temp. (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GB-112T</td>
<td>None</td>
<td>14,000</td>
<td>0.0015</td>
<td>65</td>
<td>100,000</td>
<td>180+</td>
<td>250</td>
</tr>
<tr>
<td>GB-125</td>
<td>G-7</td>
<td>28,000</td>
<td>0.002</td>
<td>60</td>
<td>100,000</td>
<td>180+</td>
<td>200</td>
</tr>
<tr>
<td>GB-28E</td>
<td>G-10</td>
<td>70,000</td>
<td>0.019</td>
<td>65</td>
<td>75,000</td>
<td>130</td>
<td>150</td>
</tr>
<tr>
<td>GB-28EFR</td>
<td>G-10</td>
<td>68,000</td>
<td>0.010</td>
<td>65</td>
<td>100,000</td>
<td>180</td>
<td>150</td>
</tr>
<tr>
<td>GB-28M</td>
<td>G-5</td>
<td>50,000</td>
<td>0.014</td>
<td>50</td>
<td>100</td>
<td>185</td>
<td>135</td>
</tr>
<tr>
<td>GB-261D</td>
<td>G-1 and G-2</td>
<td>22,000</td>
<td>0.020</td>
<td>55</td>
<td>10,000</td>
<td>5</td>
<td>150</td>
</tr>
<tr>
<td>GM-PE</td>
<td>GPO-1</td>
<td>35,000</td>
<td>0.020</td>
<td>70</td>
<td>200</td>
<td>130</td>
<td>150</td>
</tr>
</tbody>
</table>

These are typical grades for typical applications. To meet special requirements, C-D-F makes many other Dilecto grades, one of which may serve your purpose better than any of these listed here. Consult the C-D-F Technical Department for expert assistance with your design problem involving laminated plastics products.

**CONTINENTAL-DIAMOND FIBRE**

A SUBSIDIARY OF THE Buehl COMPANY • NEWARK 16, DELAWARE
New Select-Your-Range Triplett Unimeters

New Select-Your-Range Triplett Unimeters can be combined with any of Dial-Component units for a wide variety of meter ranges—you can even create your own with available dial blanks by following simple instructions furnished.

Basic movement accounts for the greater meter cost—you can have a much more flexible inventory by stocking the minimum number of basic meter movements and a large variety and maximum quantity of inexpensive Dial-Components.

Unimeter features are: self-shielded Bar-Ring movements; AC and DC linear scales; extreme accuracy; dustproof construction; error proof assembly; instant conversion; standard mounting.

Complete details see your Electronic Parts Distributor, or write.

Triplett Unimeters
Decrease Inventory Cost...Increase Flexibility

TT ELECTRICAL INSTRUMENT COMPANY
BLUFFTON, OHIO

Tree Stowcard Kits, too. Kit A (makes 8 ranges), Kit B (makes 12 ranges), Kit C (makes 23 ranges).
HUMPHREY FREE GyROS MAY BE POWERED BY D-C, 400-CYCLE A-C OR 1500-CYCLE INVERTER

New interchangeable motors for Humphrey free gyros now make it possible to select a gyro to operate on d-c, conventional 400-cycle a-c or 1500-cycle a-c power. Use of the small, high-speed wheel increases stability and reduces drift rate about one-half. High-speed motors may be operated on transistorized 1500-cycle power supplies, using readily available 6 or 28-volt d-c input.

Production gyros are offered with a variety of pickoff configurations, including potentiometer, synchro and switch type. Humphrey free gyros are available with a manual push-button cage, electrical uncage or with fully remote electrical cage and uncage with indicating or inter-lock switches. Whatever your position or angle sensing requirements, Humphrey has a free gyro that can do the job. Call or write today.
INSTRUMENTATION—In instrumentation, such as this geophysical measuring equipment, where miniaturization and resistance to environmental conditions are important, TFE resins are unsurpassed. They are unaffected by penetrating oils, heat, shock, vibration or resoldering; thermal and dielectric properties permit miniaturization, resulting in substantial space and weight saving.

ELECTRONIC BUSINESS MACHINES—Non-flammability, safe emergency overloading, and solder resistance are three important reasons why TFE resins are used in machines such as this data-processing equipment. Servicing of wiring panels can be done quickly, with a minimum of downtime, because TFE resins are unaffected by soldering temperatures.

PROCESS CONTROL EQUIPMENT—Process controls, instrumentation, and other industrial electronic equipment can be more reliable and more easily serviced at reduced costs with TFE resins. They have zero moisture absorption, are non-flammable, and are chemically inert. Neither patching temperatures nor soldering iron heat will damage TFE resins.

OUTDOOR EQUIPMENT—TFE resins are ideal for outdoor or underground wiring applications. They have unmatched insulation resistance, and are completely unaffected by exposure to salt water, sunlight, or other extremes of weather. Oil, gasoline, and other solvents have no effect on TFE resins, and they remain flexible in extremes of heat or cold.

For top performance in electronic circuitry specify wire and cable insulated with TEFLOM TFE-fluorocarbon resins

Achieve utmost reliability and safety for your wiring. Reduce assembly and inspection costs. Cut weight and space requirements. These are a few of the advantages being realized by the use of wire and cable insulated with TFE resins.

TFE resins are almost ideal dielectrics, because they combine outstanding electrical and mechanical properties. They do not age, are non-flammable, have great flex life, maintain superior tear resistance, and display excellent dielectric properties.

Best of all, you can enjoy sales and cost advantages by using wire protected by TEFLOM TFE-fluorocarbon resins.

Look up your local supplier in the Yellow Pages (under “Plastics—Du Pont”) . . . or for technical information write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 178, Du Pont Building, Wilmington 98, Delaware.

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec.

Write for the “HOTTEST STORY IN WIRE INSULATION.” It gives you the facts that can help make your design, your product, your installation—a winner.

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.
pass tough, new ALTITUDE-MOISTURE RESISTANCE TEST
salt water immersion, 65,000 feet altitude

Designers and manufacturers of aircraft and missiles, as well as the military, have long recognized the need for a connector altitude-moisture test which would accurately simulate actual performance conditions. Such a test has been developed by manufacturers and the military and applied as standard procedure on the 67 Series MINNIE connectors in the AMPHENOL Laboratories. It consists of the following:

A plastic tank is filled with distilled water and salt added to obtain a solution of 1.050 specific gravity. Marker dye is added for tracing leakage paths. The connectors are given a dry insulation resistance (IR) reading with a 500 volt megohm bridge. All coupling rings are then securely hand-tightened and grommet clamps rechecked for tightness. The connectors are then completely submerged in the salt solution so that all cable bundle ends are out of the solution. The ends of the cable bundle from one side of each connector are taped. The tank and connectors are placed in an altitude chamber and another IR reading is made.

The pressure inside the chamber is then reduced to 0.82 inch of mercury (80,000 feet altitude) and held for one minute, then increased to approximately 2 inches of mercury (65,000 feet altitude). After maintaining 2 inches of mercury for ½ hour, the chamber is returned to room ambient pressure for ¾ hour. This is considered one complete cycle. Connectors are subjected to a total of 10 cycles.

At the conclusion of the tenth cycle, connectors remain completely submerged in the salt solution container at room-temperature and pressure for an over-week-end soak (65 hours). Final insulation resistance reading is then taken. Immediately after last IR measurement, specific gravity of salt solution is taken.

The "E"-type construction of AMPHENOL 67 Series MINNIE connectors was originally designed to meet the moisture resistance requirements of MIL-C-5015C, Paragraph 4.5.21. Since the development of the new and far more stringent altitude-moisture test, MINNIE's construction design has been modified and all AMPHENOL MINNIE "E"-type connectors pass this test.

Following the altitude-moisture resistance test, insulation resistance measurements (in megohms) on production MINNIE "E" connectors were as follows:

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Contact to Contact</th>
<th>Contact to Shell</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (Initial)</td>
<td>6000</td>
<td>7000</td>
</tr>
<tr>
<td>1</td>
<td>7500</td>
<td>4000</td>
</tr>
<tr>
<td>2</td>
<td>5500</td>
<td>3200</td>
</tr>
<tr>
<td>3</td>
<td>5500</td>
<td>3000</td>
</tr>
<tr>
<td>4 (overnight 17 hour soak)</td>
<td>3000</td>
<td>1100</td>
</tr>
<tr>
<td>5</td>
<td>2800</td>
<td>1100</td>
</tr>
<tr>
<td>6</td>
<td>3000</td>
<td>1100</td>
</tr>
<tr>
<td>7</td>
<td>3000</td>
<td>1100</td>
</tr>
<tr>
<td>8</td>
<td>3000</td>
<td>1100</td>
</tr>
<tr>
<td>9</td>
<td>3000</td>
<td>1050</td>
</tr>
<tr>
<td>10</td>
<td>3000</td>
<td>1050</td>
</tr>
<tr>
<td>11 (overnight 17 hour soak)</td>
<td>2800</td>
<td>1000</td>
</tr>
<tr>
<td>12 (weekend 65 hour soak)</td>
<td>3000</td>
<td>1050</td>
</tr>
</tbody>
</table>

AMPHENOL MINNIE "E" connectors not only meet but surpass the requirements of this tough new test. 100 megohms is the minimum insulation resistance required by MIL-C-5015C after moisture; MINNIE's minimum insulation resistance after immersion and altitude cycling is 1000 megohms.

67 Series MINNIE "E" Connectors

DESCRIPTION Miniature, multi-contact electrical connectors of the quick-disconnect bayonet lock type. Available as Plugs, Cable and Panel Receptacles, and Single Hole Mounting Receptacles. Shell design classes include:

- CLASS E—Environmentally resistant—individual wire seal
- CLASS F—For potting
- CLASS H—Hermetically sealed
- CLASS J—For jacketed cable
- CLASS C—Standard cable clamp

There are five shell sizes, and 17 insert arrangements—ranging from 3 contacts in the smallest to 48 contacts in the largest.

PART NUMBERING Descriptive part numbering of MINNIE connectors follows that used with AN (MS) connectors.

NOMINAL CURRENT RATING #20 contact is rated at 7.5 amperes and #16 contact at 17.0 amperes.

OPERATING TEMPERATURE -67°F. (-55°C.) to +257°F. (+125°C.).
HOODED SOCKET CONTACTS

Both #16 and #20 socket (female) contacts of AMPHENOL MINNIE connectors are resistant to test prod damage. The entering end of the socket has a one-piece hood that excludes the entrance of a pin 0.005" larger than the diameter of the mating pin. AMPHENOL Specification 340-43-2108, paragraph 4.5.14, gives this test to be used to determine resistance to test prod damage:

"A test prod of hardened steel having a diameter equal to a nominal mating pin shall be inserted into each socket contact to (a) .200 inch; (b) .255 inch; and (c) .310 inch depth. At each of these depths, measured from the face of the insert, a bending moment of 2 inch lbs. ±10 percent shall be applied to the 16 size contact prod and a bending moment of 0.8 inch lbs. ±10 percent shall be applied to the 20 size contact prod about the inserted ends of the prod. The connector shall be rotated in one direction through 360 degrees in order that a uniform force is applied to the inside surface of the socket contact. This test shall be performed with the socket contacts in the inserts and the contacts locked, if necessary, to prevent rotation in the inserts during the test."

After withdrawal of the fixture at the completion of the above procedure, the force needed to engage or separate the socket contact shall not exceed the following values:

<table>
<thead>
<tr>
<th>Contact</th>
<th>Max. Force Ounces</th>
<th>Min. Force Ounces</th>
</tr>
</thead>
<tbody>
<tr>
<td>#20</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>#16</td>
<td>26</td>
<td>3</td>
</tr>
</tbody>
</table>

FEATURES OF AMPHENOL MINNIE CONNECTORS

1. Environmentally sealed with unitized back end grommet. (Also available with provision for potting.) Grommet seal (type "E") meets altitude-moisture resistance requirements. Either grommet seal or potted seal meets moisture resistance requirements of MIL-C-5015C, Paragraph 4.5.21.

2. Spring-loaded coupling ring provides a positive locking action in the bayonet slot, and a constant compensating force which eliminates the effects of resilient face seal compression set.

3. Stainless steel bayonet slots and pins reduce wear and frictional characteristics and eliminate wear encountered with "hard-coat" and similar surface treatments of softer base metals. The three pin bayonet coupling minimizes the rocking action of the mated plug and receptacle.

4. Flattened incline angle of bayonet slots reduces mating force requirement.


6. Unitized grommet seal; clamp and grommet form a single unit for ease of assembly and maintenance.

7. Face seal gasket with individual barriers to isolate each contact.

8. Hard insert dielectric (plus resilient face seal) positively retains contacts with no possibility of contacts being pushed out of the insert.

9. A visual full engagement indicator is included in the design to insure the user that he has fully engaged the connectors. The indicator is an orange line around the receptacle shell.

- Insulation resistance of "E" type following altitude-moisture resistance test is a minimum 1000 megohms. MIL-C-5015C minimum following type "E" test is 100 megohms.
- When using mated sealed connectors, no derating for altitude is necessary at 70,000 feet.
- Test voltage 1,500 volts RMS 70,000 feet on sealed connectors.
- Vibration per Method 204 of MIL-Std-202A. 10 to 2,000 cps at 20 g's.
- Temperature cycling range per MIL-C-5015C, Paragraph 4.5.3 increased to 257°F. maximum and -67°F. minimum.

VOLTAGE RATING

<table>
<thead>
<tr>
<th></th>
<th>Rating</th>
<th>Mechanical Spacing (Nominal)</th>
<th>Flashover V-Rms</th>
<th>Test V-Rms</th>
<th>Recommended Working Voltage DC</th>
<th>AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea level (unsealed)</td>
<td>A</td>
<td>.034</td>
<td>2,000</td>
<td>1,500</td>
<td>700 500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>.046</td>
<td>2,300</td>
<td>1,800</td>
<td>840 600</td>
<td></td>
</tr>
<tr>
<td>Sea level (sealed)</td>
<td>A</td>
<td>.034</td>
<td>2,500</td>
<td>2,000</td>
<td>700 500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>.046</td>
<td>3,000</td>
<td>2,500</td>
<td>840 600</td>
<td></td>
</tr>
<tr>
<td>70,000 ft. (unsealed)</td>
<td>A</td>
<td>.034</td>
<td>500</td>
<td>375</td>
<td>175 125</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>.046</td>
<td>600</td>
<td>450</td>
<td>210 250</td>
<td></td>
</tr>
<tr>
<td>70,000 ft. (sealed)</td>
<td>A</td>
<td>.034</td>
<td>2,500</td>
<td>1,500</td>
<td>700 500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>.046</td>
<td>3,000</td>
<td>1,800</td>
<td>840 600</td>
<td></td>
</tr>
</tbody>
</table>

Send for your copy of the MINNIE catalog to obtain complete information.

AMPHENOL ELECTRONICS CORPORATION
1830 S. 54th Ave., Chicago 50, Illinois
ALL NEW!

Veeder-Root
Panel-Mounted High Speed
Electrical Counters

...with
electric resetting
in 1/10th
of a second

These new Series 1591 Electrical Counters fill the gap between standard and electronic counters for industrial, data processing, or laboratory and scientific uses. They’re designed for accuracy and long life at very high speeds (rated at 3000 counts per minute, with extended test-runs up to 6000 cpm).

And they have the unmatched convenience of instant push-button resetting, either mechanically right on the machine . . . or electrically from a distance. Panel-groups of these counters can be placed right in your office . . . and one button can reset an entire panel. Counters feature large figures, small size, low-wattage coils for continuous duty and other V-R vantage points on which patents are pending.

These new and different counters are the latest evidence that Veeder-Root design and development always keep pace with modern counting requirements. Write for specifications and prices.

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INcorporated
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New York • Los Angeles • San Francisco • Montreal
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Eimac Klystrons Going Strong
after 25,000 Hours in Pole Vault Tropo-Scatter Service

After 25,137 hours on the air, and still in perfect operating condition, this Eimac 3K50,000LF UHF klystron has been acquired through the cooperation of the U.S. Air Force and Canadian Marconi, Ltd. This klystron was one of the original tubes installed in Project Pole Vault, the first tropo-scatter communications line ever established. The tube is just one of a number of Eimac klystrons that have exceeded 25,000 hours of reliable on-the-air time in this system. Eimac klystrons are used as final amplifiers in the Pole Vault 10 kilowatt transmitters that handle multiple-channel voice and teletype communications. Experience with this first system in our early warning defense network confirmed klystron-powered tropospheric scatter as an outstandingly dependable system of long distance communication.

The exceptional performance of these tubes under the difficult logistical and environmental conditions of the far north is indicative of the reliability and conservative rating of performance-proved Eimac external-cavity klystrons. Eimac amplifier klystrons are now being used extensively for tropo-scatter communications throughout the United States, Canada and other regions of the world. Eimac klystrons for communications and pulse applications are now available covering frequencies from VHF to SHF and to multi-megawatt output powers.

For further information, write for a copy of the 24-page booklet “Klystron Facts Case Five.”

EITEL-McCULLOUGH, INC.
SAN BRUNO - CALIFORNIA
Eimac First for reliable tropo-scatter klystrons

Products Designed and Manufactured by Eimac

Negative Grid Tubes
Reflex and Amplifier Klystrons
Ceramic Receiving Tubes

Vacuum Tube Accessories
Vacuum Switches
Vacuum Pumps
For Safe, Dependable Electrical Protection

... Standardize on BUSS Fuses!

To make sure of proper operation under all service conditions . . . 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.

This careful testing is your assurance BUSS fuses will provide equipment with maximum protection against damage due to electrical faults.

Just as important, BUSS fuses will not give a false alarm by blowing needlessly. Shutdowns due to faulty fuses blowing without cause are eliminated.

By specifying dependable BUSS fuses, you help safeguard the good name of your equipment for quality and reliability.

Complete Line—There is a complete line of BUSS fuses in sizes from 1/500 ampere up . . . plus a companion line of fuse clips, blocks and holders.

If your protection problem is unusual . . . . . . let the BUSS fuse engineers work with you and save you engineering time. If possible, they will suggest a fuse already available in local wholesalers’ stock, so that your device can be easily serviced.

Before your final design is crystallized, be sure to get the latest 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
TUNING FORK RESONATORS

the ultimate in precision audio frequency control

UNDER

SHOCK and VIBRATION

MODEL SMJ
accuracies to ±.01%, −55°C to +85°C
frequencies from 400 to 2,000 cps.

MODEL SMG
accuracies to ±.001%, zero°C to +75°C
frequencies from 960 to 2,000 cps.

SHOCK: 15 G's 11 milliseconds

VIBRATION: while operating,
.5" displacement to 7.5 cps, 1.5 G's from 7.5 to 22 cps, .06" displacement 22 to 80 cps, 20 G's from 80 to 2,000 cps.

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In direct recording systems
ONLY—brush GIVES YOU
writing method.

When you need precise, permanently visible measurements of electrical or physical phenomena, make your logical choice of equipment from the newest Brush designs in ultralinear recording systems. For your specific application, now choose...

The writing method! Because different problems demand different writing methods, Brush gives you your choice...ink...electric...thermal writing.

The trace presentation! Brush offers curvilinear and rectilinear readout. Both methods produce ultralinear traces—clear...sharp...easy to read.

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transmissions permit instantaneous switching on the spot or by remote control.

New functionally designed control panels are clean, legible, easy to understand. All components are readily accessible for fast inspection and simple adjustment.

The most comprehensive operating manuals in the industry are included with every Brush product.

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Now...new efficiency for TV power supplies with dependable diodes of Du Pont Hyperpure Silicon

More efficient power supplies...savings in space and weight...important reasons why TV manufacturers are replacing conventional rectifying systems with silicon diodes. Today, several types of silicon diodes and rectifiers are readily available for TV circuits. TV manufacturers have tested silicon rectifiers and report no noticeable change in output voltage under continuous load conditions over long periods of time. Silicon components can operate in ambient from -65° to 150° C. They maintain excellent electrical stability and resist aging.

Silicon components have high shock and vibration limits. They are up to 99% efficient in units operated at 60 cps and require little maintenance. Silicon cells permit a rectification ratio as high as 10 million to 1—almost negligible reverse conductance. Silicon bridges are available with ratings from 1 to 1,000 amperes and more than 600 volts rms.

Note to device manufacturers: You can produce silicon transistors, rectifiers and diodes of the highest quality with Du Pont Hyperpure Silicon. It's now available in three grades for maximum efficiency and ease of use...with a purity range of 3 to 11 atoms of boron per billion. Technical information on crystal growing is available from Du Pont...pioneer producer of semiconductor-grade silicon.

NEW BOOKLET ON DU PONT HYPERPURE SILICON

You’ll find our new, illustrated booklet about Hyperpure Silicon helpful and interesting—it describes the manufacture, properties and uses of Du Pont Hyperpure Silicon. Just drop us a card for your copy. E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Silicon Development Group, Wilmington 98, Delaware. (This offer limited to United States and Canada.)

PIGMENTS DEPARTMENT

DU PONT
HYPERPURE SILICON

BETTER THINGS FOR BETTER LIVING
THROUGH CHEMISTRY
Cobble Bros.' controls were designed around Clare Relays

"The most important reason Clare Mercury-Wetted-Contact Relays were chosen as the basic components for this control is their reliability."

Assurance of billions of trouble-free operations caused engineers of Cobble Bros. Machinery Co. to design their electrical control system around Clare HG relays.

There are 120 Clare HG Relays in controls of the Cobble Yardage Tufting Machine shown. They receive impulses from 120 electrical contact fingers as they "read" the pattern. The relays operate electro-mechanical clutches to translate these impulses into intricate carpet designs.

Reliability means freedom from costly maintenance. If, like Cobble Bros.' engineers, you want only the best for your design, let us tell you ALL about Clare Mercury-Wetted-Contact Relays. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable address: CLARELAY.

CLARE RELAYS
FIRST in the industrial field

Yarn control of the Cobble Bros.' Tufting Machine is through electrical contact fingers which transmit impulses to 120 CLARE RELAYS each controlling two electro-magnetic clutches.

That's why

COBBLE BROS.' controls were designed around Clare Relays

Each relay is housed with a transistor in this modular type unit. The module is then plugged into the control system.

Send for Clare Bulletins 120 and 122
Quick-Opening Fasteners

Selecting Small Fastenings for Metal Closures

"Use captive fasteners wherever feasible... Avoid the use of loose washers and loose nuts... Fasteners on equipment covers should be operable either with no tools or with standard hand tools."

(John D. Folley, Jr. & James W. Altman, Research Scientists, American Institute for Research)

Spring Loading Holds Panels in Compression

Quarter-Turn Fastener

Lion Fasteners open and close with a ¼ turn, hold sheets tightly under the compression of a rugged spring. Quickly operated and fully retained in the outer panel, they are approved under U. S. Government military specifications. Stud and receptacle float for easy alignment and simplified hole preparation. Flush, oval, wing, knurled, ring, and key head styles available.

Sizes—No. 2, No. 5, and High Strength for extra heavy duty.

Adjustable to any grip length or panel thickness, the pawl is fixed in place by a single set screw. The fastener's brightly finished knob is set off by a plated washer. Also furnished with screwdriver operated flush head.

Spring Tension Latch

For fastening slide-out drawers and hinged panels the Southco Arrowhead Latch is recommended. It locks or opens with a quarter turn yet occupies less than ½" inside space.

Doors are held under spring tension—a push against the arrowhead knob relaxes this tension, allows operation with fingertip ease. Drill a single hole for installation—no fastening to the door is necessary. No striker plate is needed.

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Write in confidence to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 6-W, Culver City, California.

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Electronics engineering edition — August 15, 1958
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ELECTRONICS engineering edition — August 15, 1958

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- **P** — Power supply.

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FROM BEYOND THE SKY
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In the field of communications, two extraordinary events have occurred within a short span of time. One was the linking of Europe to America by the submarine telephone cable. The other was the sending of radio signals from U. S. satellites in outer space.

Both achievements depended on developments from Bell Telephone Laboratories. The cable was made possible by development of long-life electron tube amplifiers able to withstand crushing pressure on the ocean floor. The satellites derive their radio voices from transistors—products of basic research in semiconductor physics.

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Magnetic Gage Locates Encased Metal Parts

Magnetic-field pickup accurately locates the exact position of a ferromagnetic barrier encapsulated in a shaped-charge container. Principle is used to determine whether or not encased metal piece is off center, tilted or both. High-explosive charge containing barrier is used in oil-well blasting.

By PAUL SEAWARD, Poulter Laboratories, Stanford Research Institute, Menlo Park, California

Accurately locating the exact position of a ferromagnetic object, solidly embedded in a casing, is accomplished by spinning the casing in a magnetic field and picking up small variations in the flux pattern of the encapsulated metal. Using this principle, it is possible to determine whether such an encased object is in its proper position, is off center, tilted or both.

The magnetic concentricity gage was developed to determine the exact location of a piece of steel which is encapsulated in a high-explosive charge used for oil-well blasting. In this application, it is essential to check the exact placement of the steel piece after the explosive charge has been loaded, for this curved steel barrier plays a key role in controlling the magnitude and direction of the high-velocity jet of metal discharged when the charge is detonated.

A photo shows the main unit of the gage. The meter, amplifier, and power supply are located in a special box attached to the outside of a building.

The shaped charge is held against the brass drive spindle by a brass idler shaft. Equally spaced numbers on the periphery of an aluminum indexing wheel, fastened to the brass idler shaft, are used with a flashtube circuit to indicate the direction of maximum eccentricity of the barrier. When the
FIG. 2—Flashtube trigger circuit uses a thyratron and not only gives a measure of the amount of eccentricity but also fires a flashtube once each revolution to give an indication of the position of maximum eccentricity. The sensitive pickup coil probe consists of 22,000 turns of No. 36 enameled wire wound on a bobbin. The core is made from a 1/2-in. stack of 0.014-in. silicon iron laminations 1/4-in. wide by 34-in. long. The 1-in. probe point width was achieved by shearing the ends of the laminations to the desired shape before they were inserted into the coil bobbin. The whole assembly is vacuum-varnished for rigidity. A rigid mounting is fabricated from hardwood pieces and heavy aluminum pillars, so that relative motion between pickup probe, rotating steel barrier and magnetic field is due only to the eccentricity of the barrier. A permanent magnet, made from two pole-pieces of a magnetron magnet, provides the magnetic field.

Measurements of the voltage, generated in the pickup coil by test pieces of known eccentricity, showed that the coil voltage was directly proportional to both the barrier offset and the barrier rotational speed. At 30 rps, approximately 6 millivolts per thousandth-in. offset was generated in the coil. This voltage is read on a vacuum-tube voltmeter.

The flashtube trigger circuit, Fig. 2, uses a 2D21 thyratron switch to discharge a capacitor across the primary of a high-voltage pulse transformer whenever the thyratron is fired. The high-voltage pulse from the pulse transformer is applied to the trigger electrode of the flash-tube. The R-C time constant of the charging resistor and energy storage capacitor was chosen to fire the 2D21 reliably to a maximum rate of 60 times a second.

A three-stage amplifier with clipper circuits meets the requirements of the flashtube trigger and satisfies the desired accuracy of position-indication. The phase shift through the amplifier is constant, within a few degrees, over 10 to 100 cps, the range of input frequencies used.

The amplifier output voltages and, therefore, the eccentricity magnitude reading are independent of variations in the barrier rotational speed over a reasonably wide range such as 10 to 100 rps.

A plot of pickup coil voltage measurements versus the barrier rotational speed indicated that the coil voltage increased 6 db for each octave increase in rotational speed. The amplifier-clipper circuit was designed so that output voltage decreases 6 db per octave from 5 to 120 cps. Thus the amplifier output voltage reading for a barrier of given offset remains constant regardless of variations in the air-motor speed.

The amplifier provides output voltage as a linear function of input signal voltage from 0 to 70 millivolts rms. This results in straight-line calibration graphs that are easy to read and interpret.

FIG. 2—Flashtube trigger circuit uses a thyratron switch to discharge a capacitor across high-voltage pulse transformer primary

August 15, 1958 — ELECTRONICS engineering edition
To reduce noise pickup or generation in the input stage, a low-noise dual triode, 12AY7, is used for the first two stages with a special shock resistant tube socket. Also a tube shield with an NEL-type insert reduces the tube operating temperature. The shield is grounded to the chassis. The input stage uses deposited-carbon resistors and is well shielded. Desired frequency response is obtained by a negative feedback system wherein the voltage developed across the cathode resistor of the third amplifier stage is coupled back to the cathode of the first amplifier. As the feedback capacitor is located in a low-voltage low-impedance path, its voltage rating can be relatively low and the stray capacitance is eliminated.

Spurious firing due to bumping or jarring the gage is eliminated by incorporating a 6BN6 gated-beam tube controlled by an integrating network with a long time constant. A portion of the output voltage from the linear amplifier is amplified in the 6C4 voltage amplifier, rectified and turns on the gated-amplifier after a suitable signal persists for several seconds.

The feedback amplifier output voltage goes directly to the vacuum-tube voltmeter where the rms voltage reading is used—in conjunction with a set of graphs—to indicate magnitude of barrier eccentricity, see Fig. 3. This same output voltage is clipped and fed into the 6BN6 gated-amplifier. Clipping prevents overdriving the 6BN6, and assists in the squaring process that follows. Output of the 6BN6 is clipped by a 6AL5 and fed into a high-mu triode whose output is a square wave of fast rise time relative to the period of the wave. The rise time is approximately 40 \( \mu \) sec.

The negative portion of the square wave is clipped off and the positive excursion limited to about 30 v by another 6AL5. The resulting waveform is then differentiated and triggers the 2D21 thyatron.

The small box mounted on top of the steel box to the left of the gage frame in the photo contains a switch and a three-position attenuator. The switch is normally connected to the connector marked MONITOR on the main chassis and turns off the flashtube portion of the circuit by grounding the grid of the high-mu triode amplifier. This increases flashtube life by minimizing unnecessary firing. The three-position attenuator reduces the wide range of coil voltages (5 to 700 millivolts) to the range that falls within the input capabilities of the linear amplifier. Thus accuracy of the instrument is enhanced by spreading the total range of barrier offset readings (0.001 to 0.125 in.) over three graphs instead of one, as shown in Fig. 3.

Bias control in the cathode circuit of the 6BN6, marked SYMMETRY, adjusts the symmetry of the two halves of the square wave output from the 6BN6. Proper setting of the SYMMETRY control determines the accuracy of the indication of position of maximum eccentricity. To set this control, a signal of approximately 40 to 50 millivolts rms is fed into the feedback amplifier input from a signal generator. A cro connected to MONITOR displays the square-wave output. Also, the symmetry control is set to the position that makes each half of the square wave cover an equal time interval.

The shaped charge and gage were developed in a research effort conducted for Jet Research Center, Inc., Arlington, Texas.
Line Current Controls

Low-power oscillator provides both unmodulated and 60-cps modulated signals for carrier-current transmission to control receiver in TV set. Unmodulated carrier of required duration controls channel selection while modulated carrier controls sound level. System operates on one of four nonadjacent frequencies to avoid interaction between nearby systems.

By J. R. BANKER and C. H. WOOD, Jr.*

Television-Radio Division, Westinghouse Electric Corp., Metuchen, N. J.

Use of carrier current enables remote control of channel selection and sound level in TV receivers. The control system to be described comprises a small handheld low-powered transmitter and a companion receiving unit mounted adjacent to the tuner in the set.

Transmitter

The complete remote-control transmitter is shown in Fig. 1. A straightforward Hartley oscillator circuit is used.

An unmodulated carrier of the required duration is used for channel selection while 60-cps modulation of that carrier is used for sound control. Modulation is readily accomplished by switching the oscillator plate circuit from the dc side of the rectifier to the a-c. The self-indicating control switch provides nonambiguous operation; movement of the switch from center is momentary in the direction for channel selection, while a latching position for the sound function is provided when moving the lever in the other direction.

Interference between neighboring transmitters and receivers is eliminated through the use of four individual frequencies—52.5, 57.5, 67.5 and 73.5 kc. Either of two nonadjacent carrier frequencies may be selected by an easily accessible switch. The remaining two frequencies require repositioning of the coil core.

By making the switchable carrier frequencies nonadjacent, there is no possibility of interaction between two units. Coupling to the power line is by a nonresonant low-impedance secondary, with C, acting as a blocking capacitor. Auto-transformer T, supplies filament power and the selenium rectifier in a half-wave circuit supplies d-c, filtered by C, for the unmodulated signal.

Requirements of the FCC regarding radiation above 450 kc have been fulfilled by controlling the harmonic output of the transmitter by four methods. Power output has been limited to 12 mw in the unmodulated case, a low-pass filter comprising R, and C, is used. Resistor R, also limits the power output and by carefully choosing the feedback ratio by the position of the tap on the coil power is also limited.

Receiver

The receiver shown in Fig. 2 can be considered as two separate receivers, one capable of detecting an unmodulated carrier while remaining insensitive to a modulated one, the other detecting both modulated and unmodulated carriers.

The section sensitive only to an unmodulated carrier energizes a relay for channel selection, while the section sensitive to both signals energizes the sound muting relay. By making the sound muting section sensitive to both signals, the audio level is automatically lowered simultaneously with channel selection, thus avoiding bursts of sound.

Several characteristics of the receiver are functions of its source impedance. Though the impedance of the power line at a given frequency may be represented by a single resistance and reactance, this value is difficult to determine. Furthermore, the value continually changes as equipment and appliances are switched on or off.

For a given line under average conditions, it is convenient to speak of the equivalent line impedance, that single resistance value which when shunted across the output of the transmitter reduces the output voltage to the same value as does the a-c line. Values from 10 to 50 ohms have been measured, although it is possible that it may be as high as 200 ohms. Since this variation causes a corresponding change of the Q of the receiver tuned circuit which in turn results in wide variations in receiver selectivity, it is essential that the receiver always see the lowest source impedance. The TV receiver with which this system is used employs a 0.15-µf.
Remote Tv Receiver

![Remote Tv Receiver Circuit Diagram](image)

FIG. 2—One part of receiver detects only unmodulated carrier while other part detects both modulated and unmodulated signals.

FIG. 3—Receiver selectivity as a function of line impedance.

line bypass capacitor to reduce sweep harmonic radiation. This holds the line impedance at the a-c terminals of the receiver fairly constant at 10 ohms regardless of actual impedance variations.

**Circuit Features**

The input of the remote-control receiver has a single series-tuned circuit connected across the a-c line. The impedance of this circuit appears as 41 ohms. This is a deliberate mismatch to the 10-ohm line to secure the desired selectivity. The effect of controlled line impedance on the selectivity of the receiver is shown in Fig. 3.

Four individually-tuned frequencies are selectable by switching additional capacitors across that for the highest frequency. To achieve the desired accuracy, two-percent mica tuning capacitors are used.

A threshold control at the input of the first r-f amplifier allows the receiver sensitivity to be adjusted to meet individual requirements. Due to Miller effect, the input of the first stage is not extremely high in impedance and has considerable capacitance. Resistor R (Fig. 2) prevents a change of Q and detuning of the resonant circuit with variation in the threshold control. The second function of this resistor is to clip noise pulses appearing with the signal.

For the channel-switching function, V₁ is a two-stage carrier-frequency amplifier, the second stage also acting as a limiter. The unmodulated carrier in passing through peak rectifier V₅ produces a positive d-c voltage. Channel-relay stage V₅ is biased near cutoff. The output of V₅, is directly coupled to the grid of V₄, increasing the plate current to operate the relay. The modulated carrier used for sound control is similarly rectified by V₅, and increases the plate current of V₄.

Because the modulated carrier has a duty cycle of only 35 percent and the maximum signal from the plate of V₄, is limited, it is never sufficient to operate the channel relay. Thus there is no undesirable cross-function operation. Capacitor C across the channel relay coil removes the 60-cps component which would otherwise appear and cause buzzing of the relay for sound muting operation.

**Muting**

For muting control, V₅ acts as a grid-leak detector rectifying the modulated carrier and providing amplification at 60 cps. This signal is direct-coupled through a low-pass filter to the grid of V₄, which provides additional 60-cps amplification to effect the large grid swing required by sound-relay stage V₄. This stage is biased near cutoff, as is channel-relay stage V₄. Its plate current increases on the average by the large 60-cps signal on its grid. Resistor R₅ reduces the tendency to clamp and thus bias the grid negatively. Capacitor C across the relay removes the 60-cps component.

With no input signal the back contact of the channel relay is closed, grounding the grid return R of sound-relay stage V₄. Whenever the channel relay operates, a positive d-c voltage is applied to the grid of V₄ to close the sound relay.

**Noise Considerations**

It is imperative that the receiver be insensitive to noise, since both regular and random noises exist on the line at all times. Regular noise, resulting principally from fluorescent lighting, may measure 10 millivolts p-p. Random noise may be of the order of 500 millivolts p-p. Since the receiver sensitivity is approximately 30 millivolts, some means of discriminating against noise is necessary to prevent the relays from responding and causing dropouts in the sound or undesired switching of channels.

Excellent noise immunity results from clipping noise pulses at the input of the first stage and using short time constants between subsequent stages. The limiting action of the second stage also contributes to noise immunity. The resulting signal-to-noise ratio is approximately 30 db.

The use of carrier current has solved several problems. The availability of a-c voltage makes it possible to incorporate a power supply in the transmitter. The receiver unit is also self-powered. The tuner in the tv receiver is programmed mechanically to stop only at the channels actually transmitting.
Electronic Control Times

Increased reliability and reduction of downtime in production result when thyratrons are used in place of relays for controlling high-speed resistance welding. Typical electronic control described in this article provides fail-safe operation, reduces transients by correct adjustment of the ignitron firing angle, and affords accurate repetition and calibration of the timing cycle.

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HIGH-SPEED resistance welding requires four exact timing functions. The period necessary to bring the electrodes together and build up pressure is called squeeze time. This begins when a solenoid is energized to allow air to enter a cylinder and force the electrodes together. When sufficient pressure is built up, weld time begins, and current flows through the weld transformer. In cases of warping metal or poor jigging, hold time is used to keep the electrodes together while the molten metal is congealing. The electrodes then open, and in fast-repeat operation, the period required to move them to a new location is called off time.

If a relay is used for controlling the weld current flow, there will be an inrush of about 30 amp and the relay will tend to bounce several times before establishing a firm contact, each bounce causing severe transient strain across the solenoid valve coil. The combination of opening and closing the valve in high-speed operations may account for several million transients each day. The present trend is to use electron tubes for control functions in resistance welders. Maintenance on

FIG. 1—Schematic of a typical control for a high-speed resistance welding gun. Fuses and overload protection circuits are not shown. This circuit affords either single-shot operation or continuous recyling of the timing functions.
High-Speed Welding Cycle

Protracted delays caused by maintenance problems in any of the high-speed resistance welding stations in a production line, such as in this automotive plant, can be costly. All-electronic controls have reduced downtime by as much as 90 percent because of their innate reliability. In this installation, all the control units are mounted on a catwalk overhead for ease of maintenance.

controls has thereby been reduced as much as 90 percent. This is significant on high-speed production lines, as down time is one of the highest operational costs.

Requirements

The requirements of a high-speed resistance welding control are: fail-safe operation of the timing circuit, fully electronic operation of both solenoid valve and weld-current control, transient reduction by 90-deg firing of the first half-cycle of welding current, highly accurate repetition and calibration, and high-speed operation of over 600 spots/min.

Fail-safe operation is accomplished by using positive voltage on the grid of the timing thyatron. Without this feature, the control might freeze the gun to the work on a high-speed production line and cause downtime.

Weld Current

To keep transients to a minimum, the weld current should be initiated at about 90 deg on the voltage wave for the first half-cycle only, and current flow should be terminated at the completion of a half-cycle opposite in polarity to the starting wave. When electron tubes are used to accomplish this critical timing, the firing angle and termination point will remain consistent after millions of operations. Furthermore, the fuses or other overload protection devices may be selected without having to compensate for high transients.

An example of a typical fully-electronic control of high-speed resistance welding guns is shown in Fig. 1. Relays may be used as safety cutoff devices, but all operations are dependent on electronic timing.

The solenoid valve is actuated by a pair of 3-amp thyatrons $V_s$ and $V_v$, which will handle 40-amp inrush current. The tubes in this portion of the circuit eliminate the electrical strain imposed on the valve coil when relays are used. The same type 3-amp thyatrons $V_s$ and $V_v$ are used to control the weld current through the ignitrons and give accurate control for the 90-deg firing. Five smaller type-2050 tubes are used for the electronic sequencing and timing control.

All assemblies are held in place with quick-change fasteners and are electrically interconnected by plug-in connectors. Ignitrons are available using manual pressure
connections instead of bolts, and the water connections are changed with pressure-lock connectors.

**Operation**

With the timer at rest, but with power applied, capacitor C is charged by conduction of V., C is charged through rectifier D, C is charged through D, C is charged through D, and C is charged through D.

Valve-firing tubes V, and V, are each held nonconducting with about 60-v bias on their grids, while the weld-control tubes V, and V, are held blocked in the same manner. One pulse can be used to fire both V, and V, by using the inductive kick from T. Thus the positive pulses from V, will control both the positive and negative half-cycles to give full-wave control of the valve. This is shown graphically in Fig. 2. The same type of control is used to energize the weld transformer for full waves of current. When phase shift is necessary, a trailing tube is added and a phase-shift circuit controls T.

There is a negative bias of about 30 v on the grid of V, developed through R3. At rest, the top of capacitor C, is about 100-v positive. This voltage is applied to the grid through R3. When initiating switch S, is closed, V, conducts, energizing the solenoid valve by causing conduction in V, and V, with T, energized, the voltage drop across its primary is rectified by D, to charge C,.

The charge on C, puts a negative voltage on the grid of V, sufficient to block this tube. Capacitor C, then discharges through R, for the squeeze time. When the voltage across C, drops to about 1 v, tube V, fires and energizes T, This also effectively shorts the positive pulses across the line, and rectifiers D, and D, stop charging their capacitors. The plate supply for V, is derived from the secondary of T, This tube now conducts because the high positive voltage from C, overcomes the negative bias from C, With T, energized, pulses are fed back through D, to keep C, charged. Positive pulses are also fed to the grid of V, to overcome the negative bias, and the resulting conduction energizes the weld tubes.

Weld time starts when V, conducts, halting the charging of C, through rectifier D, When C, discharges through R, to a potential of about 29 v, the negative bias from C, blocks V, thus ending the weld time by removing the positive pulses from the grid of V, With its charging source removed, C, drains through R, for the hold time. When the positive charge of C, drops to about 29 v, the negative voltage on C, blocks V, to end the hold time.

With S, in the REPEAT position, blocking of V, deenergizes T, and removes the source of charging current for C, This capacitor discharges through R, for the off time. With the bias drained down, V, conducts and charges C, The negative voltage at the top of C, blocks V, and this immediately allows positive-pulse conduction through D, to recharge WELD capacitor C, and HOLD capacitor C, through D, With the initiating switch held closed, charging of C, puts a positive voltage on the grid of V, causing it to fire and start another sequence.

For single-shot operation S, is placed in the SINGLE position. Closing S, charges C, through D, stopping the operation at the end of hold time as long as S, is closed.

Capacitor C, accomplishes the 90-deg firing. At the start of the first weld pulse C, is completely discharged and takes 90 deg of the sine-wave pulse to charge fully. For this period no energy is fed to the grid of V, After the capacitor is charged, however, the remainder of the half-wave pulse gets through to V, overcoming the bias and causing the tube to fire at the 90-deg angle.

Now C, is charged fully on the first pulse and offers no shorting effect for the duration of the weld time. At the end of weld time C, is discharged through R, to be effective for the first pulse of the next weld-time period.

**Construction**

To conserve space, grain-oriented core transformers are used. These small transformers perform as well as the stacked-iron type, but they must be energized and deenergized at the correct points on the voltage wave to prevent saturation.

By using special plug-in phase shift units incorporating a trailing tube, either heat control, slope control, or current regulation can be used with the timer to accurately control current at the weld zone.

Calibration accuracy is essential for high-speed controls because of the possible necessity of fast interchange of panels during production. If the calibration accuracy of all controls is the same, replacement panels will give consistent operation without further adjustment. Because weld time is the most important function controlled by the unit, tap switches are generally used instead of potentiometers.

Both the valve solenoid and weld transformer must be in phase with the timer supply to be effective.
Transistors Reduce Relay Servo Size

Relay servo system simulates on-off control device by using step-function potentiometer to provide on-off characteristic of the null detector. Easily adjusted damping is applied through differential relay contacts to eliminate oscillations; fast response to small angle displacements assures close following.

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DESIRE FOR COMPACT and efficient servo devices has grown with the postwar expansion of servo applications. Originally great efforts were expended on the design of linear components, but currently servo systems using less expensive nonlinear components are in demand.

This article describes a transistorized relay servo system which illustrates the simplicity possible in design of the nonlinear type.

Positional Units
Nonlinearities existing in the servo system shown in Fig. 1A are approximated by linear transfer characteristics. When the servo device is used as a positional system, the block $K_G(j\omega)$ represents an electronic amplifier, a motor and a gear train. Except for errors resulting from nonlinearities such as static friction and backlash, the positional error is zero. A high-gain amplifier provides desirable performance, and compensating networks prevent oscillation.

The relay-type system shown in Fig. 1B has a full on or off voltage applied to the servo motor. In this system, a high degree of nonlinearity exists between the input error and the drive force applied to the servo motor.

Relay-type servo systems have
the error signal available in both magnitude and sign, or in sign only. Block V of Fig. 1B, the nonlinearity in the system, may be in one or more places including the error detector system.

**Stabilization**

Oscillation cycles whose amplitude and frequency depend on the parameters of the system exist in the relay servo. Damping devices that increase the natural frequency of oscillation to the point where the amplitude of the cycle is negligibly small stabilize the relay servo. These devices anticipate the point of correspondence between the input and the output shaft and apply a breaking torque to the motor prior to this point. By introducing a small dead zone into the system, continuous hunting is eliminated.

Reduction in size and weight of relay servo systems is achieved with efficient and compact relays which control power output in watts with microwatts of input. Use of nonlinear servo systems is mandatory where the available null detector is nonlinear outside of a narrow region at the null position. Since the system is insensitive to variations in gain, the gain parameter may vary over wide limits without affecting response characteristics.

**Description of Equipment**

The transistorized relay servo system shown in Fig. 2 has a step-function potentiometer with the characteristics shown in Fig. 3. The potentiometer simulates the on-off characteristic of the null detector. The dead center or null position of the servo system corresponds to the center of the linear range of the potentiometer.

The potentiometer has 360 deg of mechanical rotation and 357 deg of electrical contact. During a 3-deg segment of the potentiometer rotation, a linear variation from zero to full output is obtained. The R-C time lag from the potentiometer to the base of the transistors simulates the time constant of the actual mechanical and motor system. Time constant variation produces undamped oscillations at the frequency of the actual system.

To equalize the sensitivity of the npn and pnp transistors, the series base resistors of the npn transistor are halved and the value of the capacitor associated with the smaller resistor doubled to compensate for the unequal time constant.

**Compatible Performance**

Transistors and relays are extremely compatible for on-off servo applications. Current drain for operation of the system shown in Fig. 2 is about 14 ma at 25 v. Since 10 ma is required as bleeder current for a center-tapped supply, actually only 4 ma at 25 v is required by the relay servo system.

The transistors are connected across a split 25-v power supply. Connection of the arm of the potentiometer to the positive side of the supply causes 4 ma to flow in transistor Q1. Except for reverse collector current, there is no current in Q2.

With the potentiometer arm connected to the negative supply, 4 ma flows through the other coil of the
differential relay and actuates the relay in the opposite direction. Since relay-system contacts are connected to the control winding of a reversible, shaded-pole motor, closing either set of contacts drives the motor toward the central position of the potentiometer. When there is no current in either coil, the relay is in its neutral position and the motor is not excited.

**Damping**

For a step displacement of the motor shaft, the slider voltage of the step-function potentiometer is shown in Fig. 4A where damping is not used. The voltage waveform illustrates the oscillatory nature of the output shaft position. The amplitude of the displacement corresponds to several deg on each side of the null position.

When base current is supplied to the off transistor as the relay closes, 2 ma of collector current, sufficient to return the relay to its neutral position, is produced in that transistor. By adjusting the value of the capacitance in the base circuit the amount of damping is changed for the desired response.

The slider voltage obtained for three step displacements of the output shaft is shown in Fig. 4B. Potentiometer noise produces the variation of the correction voltage appearing at the top of the waveform.

The damping voltage shown in Fig. 4C and applied to the base of the off transistor decelerates the motor by tripping the relay off. This feedback voltage decays exponentially. Feedback prevents the motor from running at top speed and over-shooting after it reaches the null position.

**Position and Velocity**

A sketch of the position and velocity of the output shaft superimposed on the phase-plane plot is shown for the damped and undamped cases in Fig. 5. The curve for the undamped case corresponds to one set of initial conditions. A family of such curves is obtained for various initial shaft displacements or initial shaft velocities. In the undamped case the phase-plane plot consists of parabolic segments when the motor's self-damping is small. When damping forces on the motor are neglected, the equation of motor torque and acceleration is

\[ T = I \left( d^2 \theta / dt^2 \right) \]  \hspace{1cm} (1)

where \( T \) is motor torque for full excitation, \( I \) is rotational inertia and \( d^2 \theta / dt^2 \) is acceleration. Then

\[ \omega_n(t) = (T/2I) t + C_1 \]  \hspace{1cm} (2)

where \( \omega_n \) is output shaft angular velocity and constant \( C_1 \) is shaft angular velocity at \( t = 0 \). Furthermore,

\[ \theta_n(t) = (T/2I) t^2 + C_1 t + C_2 \]  \hspace{1cm} (3)

where constant \( C_2 \) is the angular shaft position at \( t = 0 \).

**System Advantages**

Base-current damping does not give optimum system speed response but has the valuable features of simplicity and ease of adjustment. The degree of damping is adjusted by varying the time constant of the base feedback voltage. Essentially, impulse excitation of the motor control winding restores the shaft to the null position with the spacing of the impulses determined by the feedback time constant. Figure 6 shows the excitation time as controlled by the relay time constant, and the braking time by the feedback time constant.

With this system, the shaft is returned to the null position with a low energy storage assuring small amplitude of the stable oscillation. By introducing a dead zone and a center-position relay into the system, the oscillation is reduced to zero. Where a velocity input must be followed, base-current damping is desired, since the speed of response is fast for small displacement angles.

The system also has high damping. For small angles, operation approaches that indicated by Eq. 4 and 5. The maximum average velocity followed by the system is reduced by the impulse excitation, but within the velocity follow-up limits, satisfactory performance is obtained.

**References**


Logical Design of SAGE

Speed and clarity of information are prime requisites of any effective radar system such as SAGE. The monitor described accomplishes these objectives and eliminates other unnecessary data simultaneously. Logical design of the equipment and detailed circuitry show how its done

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Visual display of selected long-range radar inputs to the SAGE computer is provided by equipment known as the long-range radar input monitor control. The equipment consists of one large unit containing digital and analog portions and four display consoles. The types of display presented are shown and described in Fig. 1.

The monitor operator can select any one of 15 radar sites and any one of 14 types of messages. The messages identify the type of target; that is, ships, land masses, enemy aircraft and commercial aircraft. Desired selections are passed over to the digital portion of the equipment for comparison with incoming data. If the incoming site identity and message-label codes match a desired selection, a display of range $R$ and azimuth data $\theta$ is made.

Input to the monitor consists of two successive digital words fed in parallel form and separated from each other in time by 10 $\mu$s. First word contains a radar site identification and message-label code; the second contains target range and azimuth data. Other information is contained in the words also but is not used by the monitor.

Logic for the word discriminator is shown in Fig. 2. Simultaneous reference to the timing chart in Fig. 3 is helpful.

A drum demand (DD) pulse from the drum control circuitry in the SAGE computer is received 6.5 $\mu$s before the first word (point A, Fig. 3). No DD pulse precedes the second word, thereby allowing determination of which word of the message has been received. At the same time the DD pulse is received, an OD-3 clock pulse arrives. The OD-3 pulse is delayed 1.5 $\mu$s (point B, Fig. 3). After the 1.5-$\mu$s delay of OD-3, it strobes the first gate in the output line of the flip-flop. The second gate is not affected because its suppressor grid is at $-30 \, \text{v}$. The resultant pulse sets a type-C flip-flop and goes through the register reset unit to reset all the storage registers.

After five more $\mu$s, the first word arrives (point C, Fig. 3) and is stored in the registers. Simultaneously, a data available (DA)

* Now with Link Aviation Inc., Binghamton, N. Y.
FIG. 3 - Timing chart for monitor. Clock pulses are spaced 2.5 µsec apart and cycle is repeated every 10 µsec. Data available (DA) pulse arrives with both first and second words.

Table I - Register Complementing for Correct Quadrant Representation

<table>
<thead>
<tr>
<th>Quadrant</th>
<th>20 Bit</th>
<th>21 Bit</th>
<th>Complement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sin Register</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2⁻¹</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>1</td>
<td>2⁻¹, 2⁻²</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0</td>
<td>2⁻¹</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2⁻¹, 2⁻²</td>
</tr>
</tbody>
</table>

The DA pulse arrives and sets a type-C flip-flop. In the next five µsec, information stored in the site and message-label registers is compared with the word requested at the consoles to decide whether or not to display the second word.

The next time an OD-3 pulse is received and delayed (point D, Fig. 3), gates 1 and 2 are strobed. Output from gate 1 resets the storage registers through the register reset unit. Output from gate 2 resets the DA flip-flop and strobes gate 4. The output pulse from gate 4 resets the two flip-flops and strobes the selector output gate to start the display timer if a selection has been made. There is no output pulse from gate 3 since its suppressor grid is at -30 v.

The DA pulse associated with the second word and the second word arrive five µsec after the second OD-3 delayed pulse (point E, Fig. 3). The second word is stored in the registers while the DA pulse sets a type-C flip-flop. At this time, the condition of the flip-flops storing the two most significant bits of the azimuth information is sampled to determine which quadrant the message represents. The register complementer then has outputs available to complement the storage registers. This action is necessary to insure that the output levels will represent the required quadrant correctly.

The next OD-3 delayed pulse (point F, Fig. 3) strobes gates 1 and 2. There is no output from gate 1 since its suppressor is at -30 v. Pulse output from gate 2 resets the DA flip-flop and strobes gates 3 and 4. There is no output from gate 4 since its suppressor is at -30 v.

FIG. 4 - Logical design of register complementer

Since its suppressor is at -30 v. Output from gate 3 strobes four gates in the register complementer allowing the necessary complementing to be accomplished.

The next OD-3 pulse has no further effect since the two gates which it strobes have their suppressors at -30 v. The operational sequence is not started again until another DD pulse is received. If the received message is not selected for display, the next DD pulse starts the sequence again.

If the message is selected for display, a display-started (DS) pulse is supplied to the common equipment where further DD pulses are inhibited until the display period ends.

At the end of the display period, a display-ended (DE) pulse is generated which resets the storage registers. The DE pulse is supplied to the common equipment also and de-inhibits the DD pulses. Timing and control of the DS and DE pulses are functions of the display timer. It will not be described in detail because of space limitations.

Storage Registers

Three flip-flop storage registers are provided in the digital portion to store the received information bits. These are: a site and message-label storage; range storage; and azimuth storage.

FIG. 5 - Effects of register complementing
then discarded. Assume, however, that the azimuth information started at 0 deg and increased successively to 360 deg. Then, the summed output of the azimuth storage register through all four quadrants would appear, without register complementing circuitry, as the flip-flop output before complementing as shown in Fig. 5. The register complementer complements both the sin- and cos-storage registers to produce a triangularly shaped output approximating either the sin or cos of the azimuth angle stored in the registers. Result of this complementing is indicated by the remaining two lines in Fig. 5.

Table I shows that condition of the two most significant bits (2n° and 2n°) of the sin-storage register is unique for each quadrant. Other columns of the table indicate which bits of the sin and cos registers must be complemented so that output levels correctly represent the quadrant.

In the first quadrant there are zeros on the lines for the 2n° and 2n° sin set sides and ones on the lines for the reset sides referring to Fig. 4. As a result, only AND circuit 1 has an output. When this level is gated through gate 1, an output pulse is obtained from OR circuits 1 and 2 which complement all of the cos register and the 2n° sin flip-flop after passing through the appropriate driver circuitry.

In the second quadrant, zeros appear on the lines from the 2n° sin set side and the 2n° sin reset side. Ones appear on the other two lines so that only AND circuit 2 has an output. When this output level is gated through gate 2, an output pulse is obtained from OR circuits 2 and 3. These pulses pass through the driver circuitry and complement all of the cos register and the 2n° through 2n° sin flip-flops.

In the third quadrant, there are ones on the lines from the 2n° sin set side and the 2n° sin reset side while the other two lines have zeros on them. In this case, only AND circuit 4 has an output which is gated through gate 4 at the correct time. An output pulse is then obtained from OR circuits 3 and 4. These pulses pass through the driver circuitry and complement all of the sin registers except for the 2n° sin bit which remains uncomplemented.

In the fourth quadrant, ones appear on the lines from the 2n° and 2n° sin set sides while zeros appear on the lines from the reset sides. Consequently, an output is obtained from AND circuit 3 which is gated through gate 3 at the correct time. An output pulse is then obtained from OR circuits 1 and 4. These pulses pass through the driver circuitry and complement the 2n° and 2n° sin bits.

Display Selection

Either a particular type of message from a specified radar site or all messages from a specified radar set can be displayed. In the first case, words in the storage registers are compared with words requested at the consoles in the site-identity and single-message-label selectors. In the second case, site-identity and multiple-message-label selectors are used. To avoid switching circuitry, single- and multiple-message-label selectors are fed in parallel. Output of each is combined in an OR circuit. To cause a display, an output must be obtained from the site selector and from one of the message-label selectors. Selection circuitry is built in quadruplicate, one set for each console.

Site-Identity Selector

Logic for the site-identity selector is shown in Fig. 6. A typical binary word (1 0 1 0) has been chosen. Any other word could be compared in a similar fashion. The
word from the console uses the opposite level notation of the word from the registers. That is, binary one is \(+10\text{ v}\) and binary zero is \(-30\text{ v}\) from the registers. But binary one is \(-30\text{ v}\) and binary zero is \(+10\text{ v}\) from the console selection switches. Under these conditions and with the particular binary word chosen as an example, OR circuits 1 to 4 have a \(+10\text{ v}\) output and AND circuits 1 to 4 have a \(-30\text{ v}\) output. As a result, AND circuit 5 has a \(+10\text{ v}\) output and OR circuit 5 has a \(-30\text{ v}\) output. The inverter

If an output is obtained from the multiple-message-label selector it is fed back to OR circuit 6 in the single-message-label selector. This level \(+10\text{ v}\) passes through the inverter and applies \(-30\text{ v}\) to the output and circuit. This action blocks any output from the single-message-label selector and serves to interlock the two message-label selectors as a safety feature.

**Multiple-Message-Label Selector**

Logic of the multiple-message-label selector is shown in Fig. 8. This mode of operation can be selected at the console. Assume that the word requested by the consoles is \(0,0,0,0\). With the opposite voltage-level representation still being used, the levels are all \(+10\text{ v}\). With the circuitry shown, an output will be obtained for all message labels representing odd binary numbers except 17 (1 0 0 0 1) and 19 (1 0 0 1 1). These last two numbers are used for height finder information and have no significance for the monitor.

If the conditions for message-label selection (Fig. 8) are examined closely, the following conditions are evident: \(A\) must always be a one \(+10\text{ v}\); \(B\) may be either a one or a zero \(-30\text{ v}\) or \(+10\text{ v}\); \(C\) is a zero whenever both \(B\) and \(D\) are zeros; \(D\) may be a one or a zero; and \(E\) is always a one. In Boolean notation, output of the circuit must be:

\[(A) \cdot (B + D + C) \cdot (E)\]

The notation on Fig. 8 indicates the manner in which this function is obtained with the circuitry shown.

Output of the multiple-message-label selector is fed to OR circuit 6, Fig. 7, to perform the interlocking function. Output is fed also to the OR circuit in Fig. 6 so that an intensification trigger pulse which starts the timing count in the display timer.

Assume that the word in the storage register had been 1 0 1 1 and the word requested by the consoles was still 1 0 1 0. Then, a \(+10\text{ v}\) output would have been obtained from AND circuit 4. After passing through OR circuit 5, this output would have been inverted. The resultant \(-30\text{ v}\) level would have blocked AND circuit 6. Any mismatch in the words will result in the output being blocked in a similar fashion.

**Single-Message-Label Selector**

Logic of the single-message-label selector is shown in Fig. 7. Selection of a single message label is performed in exactly the same manner as in the site-identity selector. Output of the site-identity selector is fed to the OR circuit shown in Fig. 6.

FIG. 2-Multiple-message-label selection logic

changes the \(-30\text{ v}\) output from OR circuit 5 to \(+10\text{ v}\) and feeds it to AND circuit 6. This circuit now has two of the three necessary inputs. If either of the message-label selectors has a \(+10\text{ v}\) output, the third input requirement will be filled and AND circuit 6 will have a \(+10\text{ v}\) output. This output is gated out to become the intensification trigger pulse which starts the timing count in the display timer.

The binary decoder in the analog portion of the equipment, Fig. 9, performs a digital-to-analog conversion. Three decoders are used in the monitor—one each in the sin \(\theta\), cos \(\theta\), and range channels. Output of any one of the decoder units is a d-c level proportional to the digital data appearing at the input of the binary decoder unit.

Five basic circuits are used to perform the conversion. These are: two voltage reference sources, a constant-current source, a current-switching tube, and a resistive ladder network.

**Decoder Circuity**

Figure 10 shows the circuitry for two of the 11 decoder stages. These two stages correspond to the two most significant bits of digital data presented to the decoder units. The decoder output voltage varies from \(+100\text{ v}\) (no digital input) to \(+150\text{ v}\) (all digital inputs present).

Part of the resistive ladder, \(R_s\), is shown at the top of Fig. 10. The ladder weights and sums the digital input so that the analog voltage output is propor-
ational to the input word. Summing takes place since there is one output terminal for the entire ladder network.

To understand the weighting function, assume that the right-hand halves of current-switching tubes $V_1$ and $V_2$ are conducting. Each tube draws the same current through the ladder. The ladder characteristics, however, are such that the drop associated with $V_1$ has only half the effect on the output voltage as the drop associated with $V_2$. The same effect exists in every section of the ladder so that the individual stages correctly represent the binary weighting of the digital input.

Tube sections $V_a$ and $V_b$ provide a constant-current source during the time that $V_1$ and $V_2$ draw current through the ladder network. Reference voltage 2 is supplied to the grids of $V_1$, to stabilize the operation. Calibration potentiometers are used in the cathodes of $V_1$, both for initial calibration and to correct for any long-term component drift. Constant-current sources described are used in the four most significant stages of the decoder. For the other seven stages, a regulated voltage reference is the only necessary control.

In $V_1$, and $V_2$, digital data are applied to the left-hand grids. When a digital zero is supplied to a decoder-stage input, it is desirable to have that stage draw current through the ladder network. Result of this mode of operation is that the output voltage will be low ($+100$ v) with all inputs zero ($-30$ v) and high ($+150$ v) with all inputs ones ($+10$ v). To obtain this mode, the right-hand grids of $V_1$, and $V_2$, are held constant at a regulated negative voltage (reference voltage 1).

When a zero is applied to any stage, the left side of that current-switching tube is cut off. The right side draws current through the ladder network, dropping the output voltage.

When a one is applied to the stage, the left side of the current-switching tube conducts, the right side is cut off. Output voltage rises according to the weight of that stage. Current drawn by the left side of the current-switching tubes is bypassed around the resistor ladder network.

**Buffer Unit**

Two voltage regulators and three operational amplifiers comprise the buffer unit. Each has its own level-shifting network, as shown in Fig. 11.

One amplifier and level-shifting network is used in each of the three signal channels ($\sin \theta$, $\cos \theta$ and range).

Pure resistive coupling is used between the level-shifting network and the operational amplifier. Despite the signal attenuation present, this type of coupling is used to preserve the accurate signal level from the decoder output. Signal levels are shifted so that the sin and cos channels will have a range from $-25$ to $+25$ v as the azimuth increases from 0 to 360 deg. Also, it is necessary that the range channel vary from 0 to $+80$ v as the range increases from 0 to maximum. Level-shifting precision is maintained by 0.1-percent resistors. The resistive network is used also to provide the necessary fixed, high-resistance load for the decoders.

**Operational Amplifiers**

Primary function of the operational amplifier is to provide a source capable of driving the varying input impedance of the sin-cos approximators. Gain lost in the level-shifting network is also made up in this stage. In the range channel, restoring the lost gain is the only function of that operational amplifier.

Operational amplifiers were selected because of the high precision obtainable. The amplifier has an open-loop gain in excess of 3,000 and a maximum theoretical error of 0.03 percent. The amplifier is actually operated at a net gain of only slightly greater than unity. Use of high-precision resistors in the negative feedback from the gain-setting network assures stability of the selected net gain regardless of any variation of tube parameters.

Several types of operational amplifiers are used. A schematic of a typical one is shown in Fig. 12. A differential-amplifier stage minimizes effects of tube drift. A pentode second stage with positive feedback and a cathode-follower output stage are used also. Regulated voltages are used in the input.
stage to minimize effect of any supply ripple at the output of the amplifier.

Output of the range buffer is fed directly to each of the analog multipliers. Sin and cos buffer outputs are fed to the sin sin -cos approximator and the cos sin -cos approximator.

Sin-Cos Approximator

The sin-cos approximator converts the first approximation of sin \( \theta \) and cos \( \theta \) to an accurate approximation of these functions. Conversion is accomplished by use of two diode function generators—one for positive signals, the other for negative signals. Circuitry is shown in Fig. 13.

Two voltage regulators are also associated with this circuit. Each supplies one of the reference voltages indicated.

Assume that information is entering the digital portion in the form of constantly increasing values of the azimuth angle \( \theta \). For any constant range, this information is displayed as a circle on the console. The first approximation of \( \theta \) enters the sin-cos approximator as a triangular wave. It should be stated here that each cycle of the triangular wave consists of 4096 separate messages to the digital portion, one for each additional azimuth bit. The triangular wave is shaped to a sin (or cos) wave by the biased diodes. The diodes approximate the sin wave with a series of linear functions. The number of diodes used determines the accuracy of the approximation (one percent in the monitor). Diode-connected triodes were used.

Two analog multipliers are used in the monitor to convert the decoder range \( R \) and azimuth \( \theta \) information into \( x \) and \( y \) coordinates. Specifically, one multiplier multiplies \( R \) by sin \( \theta \) to obtain \( x \). The other multiplies \( R \) by cos \( \theta \) to obtain \( y \).

The \( R \) data are obtained from the range-buffer amplifier and the sin and cos data are from the two sin-cos approximators. Multiplier outputs are fed to the distribution power amplifiers.

Polar coordinates used in the monitor are opposite to the \( x = R \cos \theta \) and \( y = R \sin \theta \) seen generally in mathematics. If the usual coordinates were used, zero azimuth (at maximum range) would be displayed at the right side of the crt. Spots displayed at increasing azimuth angles would then appear in successive counter-clockwise positions. By changing the coordinates, zero azimuth or north (at maximum range) appears at the top of the crt. Increasing azimuth angles cause the spots to appear in successive clockwise positions.

Analog Multiplier

The analog voltage multiplier uses several operational amplifiers and associated network circuitry in a variation of the quarter-squared technique of multiplying two voltages. This technique uses the equation

\[
xy = \frac{1}{4} [(x + y)^2 - (x - y)^2]
\]

Squares of the sum and difference terms are formed accurately and synthetically without use of squaring devices. Operational amplifiers find the difference term and divide by four. The only satisfactory explanation of the multiplier operation is mathematical but will not be dealt with here.

Distribution Power Amplifier

The distribution power amplifier is an operational amplifier with an output capable of supplying high current with low output impedance. The output signal drives the deflection amplifiers in the consoles. A schematic of the distribution power amplifier is shown in Fig. 14. Regulators stabilize the internal voltages and several compensating networks maintain short rise and fall times. A large amount of negative feedback reduces the high open-loop gain to a closed-loop gain approaching unit. This stabilizes the selector net gain for tube parameter variations.

This equipment was developed by Bendix Radio on a subcontract under the auspices of IBM, Lincoln Laboratory and the USAF.
Transistor Unit Monitors

Continuous indication of blood pressure, with better than 3-percent full-scale accuracy, is obtained by using variable-reactance pressure transducer mounted in 5-cc syringe. Transistorized excitation supply amplifier and power-supply circuits permit packaging entire instrument in 8 by 10 by 10 inch unit.

By O. Z. ROY and J. R. CHARBONNEAU
Electromedical Project, National Research Council, Ottawa, Canada

RELIABLE AND ACCURATE methods of continuously measuring a patient's blood pressure during an operation have been provided for many years by commercial instruments. However, because operating room space is at such a premium it was felt that many of the bulky commercial models could be replaced by a transistorized monitor.

The instrument to be described has three ranges, 0 to 75, 0 to 150 and 0 to 300 mm of Hg; the mean blood pressure is indicated on a panel meter, while an additional output permits continuous recording of systolic and diastolic pressure variations. The complete instrument measures 8 by 10 by 10 in. and has a full-scale accuracy of better than 3 percent.

Basic Principles

By definition the maximum intrarterial pressure during contraction of the heart, or the systole phase, is called systolic and the minimum pressure between relaxation and the start of the next heart contraction is called diastolic. The mean pressure is usually given as half the sum of the values for the systolic and diastolic pressures. A pressure introduced at the transducer effects an electrical relationship which is exactly proportional to the applied pressure.

The transducer, which is activated by a needle inserted directly into a patient's artery, is a commercially available variable-reactance unit that replaces the plunger.

FIG. 1—Accuracy and repeatability of readings obtained with this circuit are limited only by characteristics of transducer used.
Blood Pressure

in a 5-cc syringe. This assembly facilitates sterilization by solution or autoclaving. To prevent blood clotting, a three-way stopcock is used between the needle and the syringe for the introduction of anticoagulant solution.

Circuit

The transducer is excited by a low-distortion sine wave produced by the oscillator shown in Fig. 1. This circuit is the counterpart of the vacuum-tube Wien-bridge oscillator. Positive and negative feedback circuits generate a 5-kc, 1-v rms signal.

Frequency of oscillation is determined by the bridge circuit \((R_c, R, C_1, C_2)\) in the negative-feedback loop. The amplitude of oscillation is stabilized by the lamp filament resistance in the positive feedback circuit. Power output stage \(Q_2\) couples the oscillator to the low-impedance transducer bridge circuit.

With the bridge parameters shown and proper balancing procedure, the null potential can be made as low as 0.1 mv. The null point, although not absolute zero, is low enough to be negligible and serves as a reference for the output readings.

The signal from the bridge is fed through a range switch into a three-stage 5-ke amplifier comprising \(Q_1, Q_2\), and \(Q_3\); bandwidth and gain are shown in Fig. 2. Provision of sufficient negative feedback throughout the amplifier allows variations between transistors and provides good thermal stability.

The amplified pressure signal is rectified by \(D_1\) and applied to the bases of \(Q_1\) and \(Q_2\). A microammeter is connected between the collectors. Silicon transistors are used because of their greater stability with temperature variations.

To obtain a true mean-pressure indication on the meter, the ripple voltage produced by the systolic and diastolic pressure variations is fed in phase to both sides of the differential amplifier through a large capacitor and thus does not affect the meter reading. However, a pen-recorder output is incorporated to obtain a record of systolic/diastolic pressure changes.

The constant-voltage transistor-regulated power supply produces \(-12 v\) at the load with better than 1-percent regulation for line variations of \(\pm 10\) percent, and better than 5-percent regulation variations from zero to 100 ma.

Calibration

The instrument is calibrated by applying a known pressure on the transducer through a cuff manometer. With the range switch on the 0 to 75 mm range and a static pressure of 75 mm of Hg set by the cuff manometer, a full-scale reading is obtained by adjusting the current flowing into the base of \(Q_2\) with the calibration potentiometer. Typical calibration curves for the instrument are shown in Fig. 3.

Accuracy and repeatability of readings are determined chiefly by the transducer used. With a Crescent type MPQ6 (0 to 300 mm Hg) transducer in the circuit, an accuracy of better than 3-percent full scale was obtained. The overall base-line drift, after a warmup period of two hours is less than 1 percent of the full-scale reading per hour.
Active Bandpass Filter

There are many applications for a small, adjustable audio bandpass filter having sharp cut-off characteristics. The filter described here is adaptable for sound analysis and can be designed with fractional octave steps. Sharp cut-off slopes, wide dynamic range and low noise make it valuable for a variety of measurements in the audio field.

By making the filter active, all inductances could be eliminated, reducing size, weight, distortion and hum pickup while extending dynamic range. To obtain sharp corners and high cutoff slopes with a minimum of complication, both high-pass and low-pass sections of the filter were designed to achieve 7th-order Butterworth (maximally-flat) characteristics, giving cutoff slopes of 42 db/octave.

In a 7th-order filter of the type considered, seven elements must be varied simultaneously to alter the cutoff frequency. Because it is difficult to achieve accurate tracking of seven ganged elements, it was decided to change the cutoff frequency by switching the elements in discrete steps. Each decade is divided into eleven intervals, equally spaced on a logarithmic frequency scale. Thus, the ratio between two successive cutoff frequencies is $10^{\frac{1}{10}} = 1.23285$.

The absolute value of the input-output voltage transfer ratio, $S(j\omega)$, of a 7th-order low-pass Butterworth filter having unity transfer ratio in the pass region may be written as $|S(j\omega)| = \left| 1 + \frac{1}{\omega^2} \right|^\frac{1}{2}$, where the cutoff radial frequency $\omega_c$ has been normalized to unity for convenience. As shown elsewhere,

Table I—Low-Pass Frequency-Determining Resistor Values

<table>
<thead>
<tr>
<th>$f$ (cps)</th>
<th>$d = 1.952$</th>
<th>$d = 1.247$</th>
<th>$d = 0.445$</th>
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<tr>
<td>20</td>
<td>$R_1 = 795.82$</td>
<td>$R_2 = 48.41$</td>
<td>$R_3 = 110.98$</td>
</tr>
<tr>
<td>24.66</td>
<td>$R_1 = 64.3$</td>
<td>$R_2 = 262.6$</td>
<td>$R_3 = 69.29$</td>
</tr>
<tr>
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<td>$R_1 = 52.33$</td>
<td>$R_2 = 30.62$</td>
<td>$R_3 = 11.06$</td>
</tr>
<tr>
<td>37.78</td>
<td>$R_1 = 127.15$</td>
<td>$R_2 = 217.5$</td>
<td>$R_3 = 15.99$</td>
</tr>
<tr>
<td>46.24</td>
<td>$R_1 = 211.66$</td>
<td>$R_2 = 321.5$</td>
<td>$R_3 = 217.02$</td>
</tr>
<tr>
<td>57.11</td>
<td>$R_1 = 229.81$</td>
<td>$R_2 = 321.5$</td>
<td>$R_3 = 321.5$</td>
</tr>
</tbody>
</table>

Table II—High-Pass Frequency-Determining Resistor Values

<table>
<thead>
<tr>
<th>$f$ (cps)</th>
<th>$d = 1.802$</th>
<th>$d = 1.247$</th>
<th>$d = 0.445$</th>
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<tr>
<td>16</td>
<td>$R_1 = 162.23$</td>
<td>$R_2 = 98.11$</td>
<td>$R_3 = 70.23$</td>
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<tr>
<td>20</td>
<td>$R_1 = 795.82$</td>
<td>$R_2 = 48.41$</td>
<td>$R_3 = 110.98$</td>
</tr>
<tr>
<td>24.66</td>
<td>$R_1 = 64.3$</td>
<td>$R_2 = 262.6$</td>
<td>$R_3 = 69.29$</td>
</tr>
<tr>
<td>30</td>
<td>$R_1 = 52.33$</td>
<td>$R_2 = 30.62$</td>
<td>$R_3 = 11.06$</td>
</tr>
<tr>
<td>37.78</td>
<td>$R_1 = 127.15$</td>
<td>$R_2 = 217.5$</td>
<td>$R_3 = 15.99$</td>
</tr>
<tr>
<td>46.24</td>
<td>$R_1 = 211.66$</td>
<td>$R_2 = 321.5$</td>
<td>$R_3 = 217.02$</td>
</tr>
<tr>
<td>57.11</td>
<td>$R_1 = 229.81$</td>
<td>$R_2 = 321.5$</td>
<td>$R_3 = 321.5$</td>
</tr>
</tbody>
</table>
Use of active elements results in a lightweight, adjustable R-C audio filter having Butterworth attenuation characteristics and 42 db/octave cutoff slopes. Filter supplies more than 50 volts rms output with low distortion and has dynamic range exceeding 100 db. Second-order harmonic distortion is considerably reduced by operating tube heaters at low voltage.

By J. ROSS MACDONALD Texas Instruments Incorporated, Dallas, Texas

Has Sharp Cutoff

The transfer ratio itself may be written in terms of the complex frequency variable \( p \) (equal to \( \sigma + j\omega \), where \( \sigma \) is a small constant) as

\[
S(p) = \left( (p + 1)(p + d_1 p + 1)(p + d_2 p + 1) \right)^n,
\]

with \( d_n = 2 \cos \left( \frac{n \pi}{7} \right) \) for \( n = 1, 2, 3 \). These values of \( d_n \) (1.802, 1.247, and 0.445) cause the complex-conjugate poles of \( S(p) \) to lie equally spaced on the left half of a unit-radius circle in the \( p \) plane with center at \( p = 0 \). There is also a pole at \( p = -1 \). This distribution of poles results in Butterworth, or maximally flat, response. For high-pass response, there is a 7th-order zero at \( p = 0 \) in addition.

One of the easiest ways of realizing the above form of \( S(p) \) is to use a separate circuit to achieve each term in parentheses in the expression for \( S(p) \). These circuits must, of course, be isolated from each other. The term \( (p + 1)^n \) is produced merely by a single R-C time constant. The other terms may be realized in a variety of ways.

Results of previous work\(^1\) lead to the simple feedback circuits of Fig. 2. The active elements with voltage-transfer ratios of \( K \) should, ideally, have infinite input and zero output impedances. They then give perfect isolation between stages. For practical purposes, cathode followers may be used as long as the required \( K \) is less than unity.

Equations relating the \( d \)'s, \( K \)'s, and frequency-determining resistor and capacitor values have been given and are discussed in connection with the detailed circuit design of the present filter elsewhere.\(^2\) Tables I and II show the calculated frequency-determining resistor values. Resistor values were selected to within 2 or 3 percent of nominal and the capacitor values to within 1 percent, Table III.

Table III—Active-Element Transfer Ratios, \( K \), and Frequency-Determining Capacitor (\( \mu F \)) for the Lowest Decade

<table>
<thead>
<tr>
<th>( d )</th>
<th>( K )</th>
<th>( C_L )</th>
<th>( C_H )</th>
<th>( C_L )</th>
<th>( C_H )</th>
<th>( C_L )</th>
<th>( C_H )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \ldots )</td>
<td>0.97</td>
<td>0.97</td>
<td>0.01</td>
<td>0.01</td>
<td>( \ldots )</td>
<td>( \ldots )</td>
<td>( \ldots )</td>
</tr>
<tr>
<td>1.802</td>
<td>0.97</td>
<td>0.97</td>
<td>( \ldots )</td>
<td>( \ldots )</td>
<td>0.015</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>2.147</td>
<td>0.97</td>
<td>0.97</td>
<td>( \ldots )</td>
<td>( \ldots )</td>
<td>0.03</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>0.445</td>
<td>1.333</td>
<td>1.380</td>
<td>( \ldots )</td>
<td>( \ldots )</td>
<td>0.05</td>
<td>0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

FIG. 2—Elemental frequency-determining circuits with feedback

Figure 3 shows the circuit of the filter with switches for changing resistor and capacitor values omitted. The switches shown allow the low-pass and the high-pass sections to be used in series, either section separately, or neither section. The low-pass section is entirely direct coupled and could be employed separately as a direct-coupled filter.

Augmented cathode followers
Variables have low output impedances and voltage transfer ratios which may be made greater than unity are used. The filter was actually designed with all cathode follower's equal to 0.97 and with the low- and high-pass acf's having K's of 1.33 and 1.3, respectively.

**Cathode Followers**

The 12BZ7 cathode followers used were found to be superior to 12AT7's in having an input-output voltage transfer ratio nearer unity and a lower output impedance. The factor K varied from 0.98 with an added output load of 115,000 ohms to 0.96 with an added load of 15,000 ohms. Because switching of the frequency-determining resistors puts a varying load on the cathode-follower circuits, it is desirable to pick the impedance level such that the change from minimum to maximum load alters K as little as possible since the d factors which determine filter response depend on the K's. On the other hand, with too high an impedance level, the effect of stray capacitances will become important at high frequencies. The impedance level has been selected so that all cathode-follower K's lie between about 0.982 and 0.97. Frequency-determining resistance values then lie between 1.1 meghm and 32,000 ohms. The actual small variations of K with load have been found to exert negligible effect on the filter characteristics. The output impedances of the two acf's used are so low that variable loading has no measurable effect on their K values. Values of K greater than unity are achieved here by tapping down the feedback line on the output cathode resistor. Distortion is low in the acf circuits and, like cathode followers, they produce no phase inversion.

In the cathode follower circuits, the input shields are driven by the output. Since the output is in phase with and almost equal to the input, this technique reduces the effect of stray capacitance to ground and of capacitance between shield and input appreciably. The minimum input resistance of the filter is about 80,000 ohms. It could be made much greater by using a separate input isolation stage. The output resistance is about 350 ohms. By placing an acf last, it could be reduced to about 5 ohms; it was felt more desirable, however, to use the low acf output resistance to drive frequency-selective elements instead of the output.

**Performance**

Before measurement of filter performance, the two acf K-values were adjusted to give the closest approximation to maximally flat or Butterworth response in the neighborhood of all of the cutoff frequencies. Although the many frequency-determining resistance values were selected to within only two or three percent tolerance, it was found that all cutoff regions approximated ideal Butterworth response to within ±1 db and that many were much closer than that to ideal. Only when several of the resistance tolerances were off in the same direction did as much as a 1 db deviation above or below ideal response occur. In the majority of the cases, resistance deviations in opposite directions cancelled out.

The input-output voltage transfer ratio of the low-pass section was found to be 1.33 while that of the high-pass section was 1.26, making the voltage amplification ratio of both sections in series 1.68. These results apply for all positions of the low-pass section but are slightly altered for the f × 100 position of the high-pass section. There, the high-pass voltage transfer ratio is reduced by 4 db compared to the f × 1 and f × 10 positions. This reduction is independent of cutoff position (resistance values) and arises from unavoidable stray capacitance to ground. The effect could have been reduced or eliminated entirely by making all high-pass capacitance values ten times larger and all resistance values ten times smaller. This reduction in impedance level would have caused appreciable change in cathode follower K's with cutoff position, however, because of the increased loading and would have necessitated replacement of these cathode followers by acf's if no change of high-pass voltage transfer ratio and corner shape with cut-off position were required.

The impedance level is similarly high in the low-pass section, but voltage amplification reduction in the f × 100 position can be eliminated since the important stray capacitance is there in parallel with the frequency-determining capaci-
capacitances in the $f \times 100$ positions. By using variable trimmers to their correct values, including stray capacitance effects, to yield Butterworth response.

**Phase and Amplitude**

Typical amplitude and phase characteristics for two different settings of the filter are shown in Fig. 4. Because of unavoidable harmonic distortion in the oscillator used, the high-pass amplitude characteristic with high-pass cutoff frequency $f_{h1} = 1,070$ cps, low-pass cutoff $f_{l1} = 20,000$ cps had to be measured with a wave analyzer. The low-pass characteristic could be measured with either the wave analyzer or a wide-band a-c voltmeter. Phase was measured with a phasemeter. The intrinsic noise output of the filter set for maximum bandpass in the low-pass characteristic is less than 100 µv rms measured (500 Hz-20,000 Hz).

The upper dashed phase curve of Fig. 4 is associated with the low-pass amplitude curve. It approaches a high-frequency limiting value of 560 deg, while the lower phase curve approaches a value of -560 deg. These phase shifts are appreciable. Others have shown' that tremendous phase shifts are required to cause audible effects.

It has already been mentioned that when $f_{l1}$ and $f_{h1}$ are set equal, the resulting characteristic is an inverted V with 42 db/octave side slopes. When the high- and low-pass cut-offs are separated by one step, the top of the characteristic is more rounded and is about 1.2 db under the normal transmission of the filter. With two or more steps between high- and low-pass settings, the top of the band-pass characteristic is not reduced compared with the normal transmission and it shows a definite flat portion with three or more steps.

The dynamic range of the filter is great. Because of the use of cathode followers and acf circuits, it will handle an output of more than 50 v rms without appreciable distortion. The total dynamic range therefore exceeds 110 db. Having no inductors, the filter is not susceptible to hum pickup from magnetic fields.

Figure 5 shows the measured intermodulation distortion of the filter for two different heater voltages applied to all tubes. The effect of heater voltage in reducing distortion is clarified in Fig. 6. These measurements show that the third harmonic distortion is virtually independent of heater voltage (or current) until such low voltages are reached that cathode emission drops rapidly. Similarly, the fundamental component is independent of heater-voltage until this level is reached. On the other hand, the second harmonic goes virtually to zero just before the point is reached where the emission drops quickly.

Since the second harmonic is the major harmonic component at the lower output voltages, Figs 5 and 6 show that the intermodulation distortion is also appreciably reduced at the lower outputs by reducing the heater voltage to the region where second-harmonic distortion is negligible. This conclusion is also borne out by the different slopes of the two curves of Fig. 5. The low distortion values shown in Figs. 5 and 6 also depend on proper selection of the positive and negative supply voltages.

Second-harmonic cancellation of the above form arises from a dependence of the input-output transfer characteristics of the various tubes of the filter on cathode temperature. At a certain temperature, the curves of these characteristics are apparently just right to yield a combined characteristic with no second-order harmonic-generating components over quite a wide dynamic range. Since the specifications of the filter are improved by operation with 3.5-3.8 volts on the heaters, it is run at that level.

**REFERENCES**

Amplifier Delay Charts

Curves presented here permit rapid determination of time delay through various types of amplifiers when only desired bandwidth is known. Most desirable amplifier type for a given design can be found directly from a universal chart especially applicable to computers and radar.


Small time delays present in vacuum tube amplifiers determine the correct temporal relationship between two or more signals. This delay time is composed of two parts—actual transit time in tubes and components and delay resulting from phase shift through the circuit.

Since transit time delays are insignificant, this discussion deals only with phase shift effects. Basic equation used is

\[ T = t_{\text{out}} - t_{\text{in}} = \frac{d\phi}{d\omega} \]

where \( T \) is time delay, \( t_{\text{out}} \) is time out of network, \( t_{\text{in}} \) is time into network, \( \phi \) is phase shift through network and \( \omega \) is any frequency.

FIG. 1—Time delay curves for networks. Time delay characteristics produced in ordinary R-L-C networks are important design factors. Many applications use linear delay dispersion plotted above.

FIG. 2—Time delay curves for video amplifiers. Video amplifiers can be common R-C amplifiers or compensated types which provide bandwidth improvement and faster rise times. Time delay curves for various degrees of shunt compensation are plotted in (A). For the uncompensated case, the time delay variation across the bandwidth is 50 percent while for 0.25 shunt compensation the variation is only 41 percent. Shunt compensation greater than 0.25 produces larger and more positive time delays. Time delay curves for cascaded shunt compensated stages plotted in (B) show the relationship between time delay variation, overall bandwidth and number of stages. Delay variation across the band decreases with increasing numbers of stages because of bandwidth splitting. Time delay for a number of stages can be determined readily from curves with only knowledge of overall bandwidth and number of stages.
FIG. 3—Time delay curves for synchronously tuned bandpass amplifiers. Time delay through single-tuned i-f amplifiers containing n stages is plotted in (A). This chart is normalized to the bandwidth of a single stage to show flattening of time delay variation across overall bandwidth when number of stages is increased. Time delay distortion of a broadband signal is smallest when a large number of cascaded stages is used. For example, variation across the band for a single stage is 50 percent while for three stages is only 19 percent. In narrow-band i-f strip design, therefore, it is not advantageous to make one stage the bandwidth determining stage unless the associated time delay distortion can be tolerated. Time delay variation as a function of overall bandwidth is plotted in (B). Only overall bandwidth and number of stages must be known to determine the overall time delay. In a strip having stages of unequal bandwidths, overall delay can be calculated by adding delays for each bandwidth.

FIG. 4—Time delay curves for stagger-tuned amplifiers. Stagger-tuned amplifiers are used when large bandwidths are required. The product of overall bandwidth and mean stage gain for a flat, staggered n-uple is the same as the gain bandwidth product for a single tuned circuit. Main advantage of this circuit is that the bandwidth shrinkage of m cascaded flat staggered n-uples is much smaller than the shrinkage which occurs in n cascaded simple-tuned circuits. Time delay curves for a flat, staggered n-uple designed from tabulated values are shown in (A). The only cases which have less than the synchronously tuned delay are the flat staggered pair and the flat staggered triple. Time delay for m flat, staggered triples and pairs as functions of overall bandwidth are shown in (B) and (C). Overstaggered n-uples are sometimes used where even wider bandwidths for a given gain are required and slight dips in the bandpass can be tolerated. An overstaggered n-uple can be designed from the flat-staggered n-uple design table in (A) by leaving the individual resonant frequencies unaltered and narrowing the individual bandpasses by the same ratio. Overall bandpass will be virtually unaltered, but gain will increase proportionately. Time delay curves for over-staggered pairs and triples with one and three db dips are overall delay can be be calculated by adding delays for each bandwidth.
Amplifier Delay Charts (continued from p 89)

FIG. 5—Time delay curves for double-tuned circuits. Main advantages of transformer coupled tuned circuits over single-tuned circuits are the higher gain-bandwidth product, the steeper skirt selectivity and the lower bandwidth shrinkage with cascaded stages. Improvement in gain-bandwidth product depends on the Q ratio of primary and secondary windings and varies from $\sqrt{2}$ with equal primary and secondary Q's to 2 with one of the Q's infinite, that is, one side loaded. For a given bandwidth, selectivity curve is constant with variation of Q ratio.

Time delay curves for transitional double-tuned circuits are plotted in (A). For a single stage, only 20 percent time delay variation exists over the 3 db bandwidth as compared with 50 percent for a single-tuned stage. For three stages, however, the single-tuned delay variation is down to 19 percent while the variation in the double-tuned case is decreased to only 22 percent. High bandwidth shrinkage rate tends to flatten the delay variation across the 3 db bandwidth of a number of single-tuned amplifiers. Delay characteristics change for nontransitional couplings. Time delay curves for various degrees of coupling are plotted in (B). Quantity $\beta$ is normalized to that obtained with transitional coupling

FIG. 6—Time delay curves for stagger damping. A plan for broadening the bandwidth of a number of cascaded double-tuned circuits is called stagger damping. It consists of cascaded undercoupled and overcoupled circuits. A properly designed, flat, stagger-damped n-ple has a product of overall bandwidth and mean stage gain equal to that of a one-side, loaded double-tuned circuit. Curves were based on data shown in design table

FIG. 7—Universal time delay curves. When signals are in the form of voltage pulses, amplifier delay time can be important. Pulse delay time, as defined here, is the time difference between the input and output leading edges measured at the point which is 50 percent of the peak pulse amplitude. Correlation of delay time with overall bandwidth and number of stages is accomplished in the universal amplifier delay curves at right. If the amplifier type, the number of stages, and the overall bandwidth are known, the amplifier delay time can be found directly. For example: an eight-stage synchronously tuned amplifier having an overall bandwidth of one mc produces a delay time of 0.755 $\mu$sec, while a shunt compensated video amplifier of the same overall bandwidth and number of stages has a delay of 0.48 $\mu$sec. The curves apply only for cascaded stages or n-ple with equal bandwidth. If unequal bandwidths are used, the overall bandwidth is the sum of the delays at each bandwidth as determined separately from the universal curve. Assume that an amplifier of known time delay is required with a gain of 80 db, a bandwidth of four mc and cascaded 6554 tubes. The 100-db, 80-mc circuit with the shortest delay turns out to be the seven-stage R-C amplifier while a three-stage, stagger-damped triple gives the longest delay.

---

**Table:**

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<th>Amplifier</th>
<th>Stages</th>
<th>Gain (db)</th>
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<td>Stagger-damped</td>
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<td>83</td>
<td>1.23</td>
<td>0.318</td>
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---

*August 15, 1958 — ELECTRONICS engineering edition*
NEW CINCH
HINGE CONNECTORS

PLUG AND SOCKET
SHOWING CONTACT
ARRANGEMENT

The top section of the lock fits into a slot in the top of the cap forming a perfect lock which cannot be accidentally opened, as shown below. Lifting up top section releases same prior to unlocking.

The plug and socket units of the "H" Series are easily engaged with normal pressure and the lock holds them securely together. Releasing the lock the units separate by the spring action of the contacts. A simple locking device insures positive contact. Wiping contact action keeps contacts clean at all times. Either the plug or socket body fit into the cap. Cable entrance hole can be placed at the one end, or in the top, or both. Cover is finished in black wrinkle and the cable clamps are cadmium plated. Contact tails will take either conventional solder wiring or AMP "78" series Taper Tab receptacles.

The plug or socket bodies can be ordered from the code numbers listed. The one that is attached to the chassis should have the lock attached. If an insulating liner is required in the cover, suffix L should be added to the Code Number.

The cap is ordered according to the number of contacts required. Then the letter L designating the liner. The letter giving hole size follows. Then the letter indicating the location of the hole; either T for top, or E for end, and if a cable clamp is required, the letter C is added.

For example, if a 50 contact unit is required with cover, having a ¾" hole in the top with a cable clamp and liner, the code would be 24540-181C. The chassis socket would be 24492 and the plug for the cap 24504.

The Cinch "H" Series is made in 20 to 100 contacts, in multiples of 10 contacts.

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Electrons at Work

Radiometer Studies Atmosphere

Radio astronomy techniques were used to measure atmospheric absorption, refraction and scintillation at 4,700 mc (C band). The sun served as the source of r-f energy. The measurements were made with a comparison-type radiometer using traveling-wave tubes in a trf receiver, instead of a superheterodyne circuit.

The three-stage traveling-wave amplifier used in the system, shown in Fig. 1, has a center frequency of 4,700 mc. An 800-mc bandwidth filter and a detector follow the trf sections.

A 30-cps mechanical chopper switches between the antenna and the 300-degree K black-body matched-load signal. A 16-db noise tube and suitable precision attenuator are used to check system operation and furnish temperature calibration for signals.

Output from the filter and synchronous detector is fed through the integrator unit to a recording milliammeter with a 0.5-sec time constant.

The basic advantage of the traveling-wave tube radiometer lies in its wide band. The wider band increases sensitivity of this system, since minimum detectable signal is inversely proportional to the square root of bandwidth. Therefore, the sensitivity of this unit is five times that of the 10-mc superheterodyne (actually, an effective 20 mc in this receiver, since both sidebands are used in the superheterodyne).

In initial equipment tests in 1955, this system was found necessary because, without the comparison feature, long-term drift was considerable. In the tests made with the traveling-wave tube radiometer, a peak-to-peak noise power fluctuation of the equipment corresponded to temperature changes of about one degree K for a response time of 4 sec. This compares with about 5 degrees K for a superheterodyne radiometer having the same noise figure and response time. When the gain stabilization feature (signal chopper and synchronous detector) are deactivated, long-term drift becomes severe, but the system maintains its short-term sensitivity.

Results of the refraction experiments indicate that average refraction is the same in the microwave region as in the optical region. However, results indicate that during a particular day, there might be considerable fluctuation about this average.

Amplitude scintillations detected with the antenna at a low angle are always present and can be of large amplitude with longer periods prevailing. At higher angles, the fluctuations are probably solar in origin and are of short period and small amplitude. While the origin of the scintillations is probably meteorological, no correlation of scintillation amplitude at low angles and commonly measured meteorological parameters was noted.

The absorption measurements yield a value of 0.00348 db/km.

This material was abstracted from “Absorption, Refraction and Scintillation Measurements at 4,700 Me with a Traveling-Wave Tube Radiometer” by John P. Castelli, Jules Arons, Carl Perioli and Joseph Casey of the Air Force Cambridge Research Center.

Auto Tachometer Uses Transistor

By James Cowan
Radson Engineering Corp., Macon, Ill.

Design of an accurate electronic tachometer for automobiles involves several factors. Primary considerations include final size, ease of installation and, since the field is quite competitive, retail price.

In the transistorized tachometer described here, the vehicle battery was to be used, rather than a separate source of power. This created a problem, in that voltage in automobile electrical systems varies as much as ±5 volts, because of motor speed and voltage-regulator setting.

A constant supply voltage was obtained in the tachometer shown in Fig. 1 by using a zener diode, $D_1$, from the transistor collector to ground. This is an inexpensive yet effective way of eliminating an internal voltage source, such as is used in several other types of automobile tachometers.

The ignition waveform is used as a means of triggering the circuit. This waveform is rectified by diode...
TUNG-SOL POWER TRANSISTORS IMPROVED
THREE WAYS BY:

NEW
Cold-Weld SEAL

Tung-Sol's new true cold-weld seal represents a major advance in transistor technology. An exclusive Tung-Sol development, cold-weld sealing increases TO-3 outline package efficiency and brings designers a threefold bonus in over-all transistor performance.

Improved thermal qualities. The cold-weld process produces a hermetic, copper-to-copper seal and makes possible a 100% copper transistor with thermal properties superior to previous high power types.

Improved reliability. Cold-weld encapsulation eliminates heat damage, "splash", and heat-caused moisture that can impair transistor performance.

Improved efficient life. Even through temperature fluctuations that cause "breathing", the cold-weld seal stays vacuum-tight, moisture-proof—result of actual integration of the copper molecules during sealing.

Tung-Sol power switches with the new cold-weld seal withstand the most rigid combination of tests given any transistor—the 100 psi "bomb" immersion test and the critically sensitive Mass Spectrometer leak test. Further, they meet all military environmental requirements. For full data on the improved Tung-Sol types to fill any transistor need, contact: Semiconductor Division, Tung-Sol Electric Inc., Newark 4, New Jersey.

TUNG-SOL POWER TRANSISTORS IMPROVED SPECIFICATIONS

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<th>Type</th>
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Collector Dissipation @ 25°C*...50 Watts
Collector Dissipation @ 55°C...25 Watts
Thermal Resistance...1.2° C/Watt Max.
ICBO @ VCB = -25V T = 25°C...0.5 Ma Max.
ICBO @ VCB = -25V T = 85°C...7.5 Ma Max.
Storage Temperature...-55 to +100°C

Mounting base temperature
Shot Counter Uses Strobotron

By RONALD L. IVES Palo Alto, Calif.

DURING TESTING of some new ballistic equipment, need arose for a portable, self-contained, self-powered shot and blast counter. The unit was required to be roughly directional, sensitive only to loud noises and made only of standard, easily obtained parts. A low-cost sensor was also desirable, because of the probability of destruction during tests.

These objectives were attained by using a cheap p-m speaker as a pickup, a single stage of amplification using a 1U4, a 1D21 strobotron counter actuator and an electromagnetic counter. The circuit is shown in Fig. 1.

Tests show that the cone of admittance of the p-m speaker has an included angle of about 60 degrees, with sensitivity falling off rapidly outside this zone.

Pulses produced when a shock wave hits the speaker are stepped up in voltage by a small line-to-grid transformer. In the secondary circuit, positive pulses are dumped by a germanium diode, and negative pulses go to the grid of the 1U4 amplifier. Although the circuit will work with either speaker polarity, best operation is secured if the first shock wave produces a negative pulse on the 1U4 grid.

The positive pulse triggers transistor Q1, charging capacitor C1 through the meter. Pulse repetition rate determines the amount of current through the meter. Capacitor C1 discharges through diode D2.

The meter is calibrated in revolutions per minute, and final adjustment is made by resistor R5. The meter covers the range from zero to 6,000 rpm.

The entire tachometer is housed in a single unit. A printed circuit is used to save space and to speed assembly.

Only two electrical connections are required to install the tachometer, which has been designed for 8-cylinder automobiles having 12-volt ignition systems.

FIG. 1-Simple tachometer circuit uses zener diode to compensate variations in vehicle 12-volt system

The positive pulse triggers transistor Q1, charging capacitor C1 through the meter. Pulse repetition rate determines the amount of current through the meter. Capacitor C1 discharges through diode D2.

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The waveform produced by automobiles made by different manufacturers varies because of differences in point and spark-plug gap setting. Rapid acceleration also alters the waveform. Because of these differences and the large number of transients in these waveforms, resistors R1 and R3 and capacitor C3 are used in the transistor base circuit to filter the waveform.

The positive pulse triggers transistor Q1, charging capacitor C1 through the meter. Pulse repetition rate determines the amount of current through the meter. Capacitor C1 discharges through diode D2.

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Compact printed-circuit package makes single-unit auto tachometer possible

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We have developed a radical new finish for aluminum boxes for tape wound cores. Your production department will glow with delight, for we guarantee this finish to withstand 1,000 volts (at 60 cycles) without taping!

GVB, for Guaranteed Voltage Breakdown (limits), is what we call this new finish. It is perfectly matched to our aluminum core boxes, for it will withstand temperatures from -70°F to 450°F. Potting techniques need not change, for GVB-finish lives happily with standard potting compounds.

By eliminating the need for taping the core box, you also eliminate a time consuming production step. By combining GVB-finish with our aluminum core box, we assure you a core capable of being vacuum impregnated down to 20 mm. of mercury.

And they are Performance-Guaranteed! Like all tape wound cores from Magnetics, Inc., aluminum-boxed or phenolic-boxed, you buy them with performance guaranteed to published limits. The maximum and minimum limits are for $B_m$, $B_{m1}$, $B_{m2}$, $H_1$, and gain. This data is published for one, two, four and six mil Orthonol® and Hy Mu 80 tape cores.

GVB-finished cores are ready for you now. So are the published limits for all Magnetics, Inc. tape wound cores. Write today for more GVB details, and for your copy of the guaranteed performance limits: Dept. E-51, Magnetics, Inc., Butler, Pennsylvania.
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TOROIDAL
WINDER
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faster production at lower cost
speeds up to 2000 turns per minute
4-digit, 2- or 7-position predetermined
turns counting

The entirely NEW electronic system of the TW 300 provides unmatched features in a toroidal winder...proximity pick-up for use with any size wire without physical contact...100% accurate turns counting...controlled slow-start, slow-stop driving motor...automatic segmental winding with perfect repeatability...progressive winding of segments or continuous coils in either direction.

The TW 300, designed for easy servicing and maintenance, cuts production time and operator fatigue to the bone. Flexibility in production of new coil types with superior electrical characteristics is unlimited because of the new control system with automatic winding features. This machine is a significant advance toward complete automation of toroidal winding.

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COMPANY, INCORPORATED
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Semiconductors Provide Analog Voltage Source

By E. R. JAMES Design Engineer, Motorola, Inc., Riverside, Calif.

VARIABLE power supplies are one of the most frequently used pieces of laboratory equipment.

Although many power supplies are available on the market, their size and cost often limit their applications. Some lack precision control of the voltage output. Batteries also have disadvantages such as poor regulation and short life.

The power supply described overcomes many of the disadvantages of commercial supplies and batteries. It is compact, has low drift and ripple, is easily calibrated.

Although this supply was de-
VERSATILITY and adaptability are prime reasons why designers have made the MH a P&B best seller. This relay series, for example, does yeoman duty in such diverse applications as jet aircraft, street lighting equipment, computers and missile ground controls.

When multiple switching is required...when size, weight, long life and reliability are critical...our MH relay can usually fill the bill. It's RIGHT for countless jobs, often at countable savings.

Let us send you complete information about this miniature telephone-type relay and the variations we've evolved for special applications. Write or call today.
Miniature Hermetically Sealed Relays

The reliability of this relay under severe conditions of vibration and shock has been field-proven in many applications. It is another example of how R-B-M's production maturity and complete facilities can eliminate many of your engineering problems.

Operating Benefits

- 125°C operating ambient
- Temp. Range: 22700 BHSM type, -55° to +85°C
- 22800 BHSM HT type, -65° to +125°C
- Coil Upto: Sensitivity 0.2 W, min. per pole (30v.d.c.) Max. coil dissipation 3.75 W
- Contacts—Max. 4-pdt 3 Amp. at 32 V.D.C. or 115 V.A.C. (non-inductive)
- Special contacts available for low level or dry circuit applications
- Approx. weight - 3.25 oz.

Consult your local RBM Product Application Engineer or write for Bulletin BHSM-1.
FIG. 1—Silicon transistor in precision voltage source isolates control potentiometer from output current

design as an analog voltage source for computer circuits, it may be used in many other applications. In addition, modifications requiring less costly parts are possible where performance is not so critical.

Circuit Description

The circuit may be considered in two discrete parts—voltage supply and control element. The complete circuit is shown in Fig. 1. The voltage supply is a bridge rectifier with r-c filtering that reduces ripple sufficiently for a low-voltage, low-current device. Zener diodes provide good regulation.

The control unit uses a transistor in the grounded-collector configuration. This arrangement serves a twofold purpose. It improves linearity of the control potentiometer by lessening loading effects, and it isolates the output current from the precision potentiometer. The latter feature protects the potentiometer from accidental burnout from excessive current drain.

Output impedance of the emitter follower for the voltage range considered is

\[ r_o = r_s + \frac{R_o}{1 - \alpha_{eb}} \]

In the present application, \( r_s \) is about 30 ohms, which makes \( R_o \gg r_s \). Therefore, the above expression can be simplified to

\[ r_o = r_s + R_o (1 - \alpha_{eb}) \]

Before evaluating this expression, it is necessary to determine \( r_s \) as a function of voltage out.

\[ r_s = \frac{dV_{be}}{dI_o} = \frac{kT/q}{I_o} = 0.020 \frac{V}{mA} \]

Since \( \alpha_{eb} \) is 0.96 for the transistor used in the circuit, output impedance expressed in measurable quantities is

\[ r_o = \frac{260}{V_{out}} + 0.04 R_o \]

A plot of this expression is shown in Fig. 2.

From the graph (Fig. 2), it can be seen that the impedance varies from 400 to 800 ohms in the 10-volt setting and from about 200 to 800 ohms in the 20-volt setting. However, restricting the use of the 20-volt setting for voltages from 10 to 20 volts, the impedance of the source can be considered as 600 ohms nominally.

Accurate calibration is provided by a ten-turn 0.1-percent potentiometer with a ten-turn dial. A calibration curve is shown in Fig. 3. After four hours, a similar curve was within 0.2 percent of the original calibration. A drift curve is shown in Fig. 4. After one hour, the drift rate is 5 millivolts per hour. Ripple is less than 5 mv.

Circuit Variations

The voltage source discussed was designed to meet a special need—that of a highly accurate, stable source. Because of this, a silicon transistor and two zener diodes were used to maintain stability over a wide voltage range. If maximum stability were not the major factor, a considerable reduction in cost could be effected by using a
The world's toughest referee

...a count of one and the tape is OUT!

The machine above is a unique testing instrument, designed by Audio Devices engineers and installed at the Audiotape plant in Glenbrook, Conn. This Automatic Defect Counter records and plays back every inch of the EP Audiotape under test.

Type EP is the extra precision magnetic recording tape for applications in computing, automation, telemetering and seismography. If the tape fails to record a single test pulse out of the millions put on a single reel, the entire reel is rejected. There are no ifs, ands or buts.

This is one of many special quality-control operations to which type EP Audiotape is subjected. The extra attention begins at the raw material stage where the master rolls of base materials are critically examined for uniformity of gauge, freedom from stretch, and cleanliness. The oxide and binder components are selected for fineness of dispersion and magnetic properties—then combined and fed through a micronic filter and metered on the selected foil in Audio's special dust-free precision coating machines. The coated master rolls are then selected for freedom from imperfections and proceed through the slitting operation. Each ribbon is wiped after slitting to remove all traces of dust, run through the defect counter, rejects discarded, and the defect-free tape packed in hermetically sealed metal cans or plastic cases.

The defect counter does its job so well that type EP Audiotape is guaranteed to be defect-free! For more information write for free Bulletin T112A. Write Dept. TE, Audio Devices, Inc., 444 Madison Avenue, New York 22, N. Y.

FIG. 3—Plot shows output voltages for potentiometer settings on both voltage ranges

FIG. 4—Drift rate was 5 mv/hr after one hour

simple zener diode (eliminating the switching circuit) and a germanium transistor. The transistor must have a power dissipation sufficiently great to handle the load current at maximum voltage.

Another variation is possible that would materially reduce cost. This is a variable voltage supply with specified current rating. In this application, the ten-turn potentiometer may be replaced by a standard 2-watt potentiometer. The transistor could be a low-cost power transistor. For currents in excess of 20 ma, the resistor in series with the zener diode will have to be chosen so that at maximum current drain, there would be sufficient current through the zener to keep it in its regulatory region. Chokes in the filter circuit would be adjustable at higher currents to decrease d-c resistance.
High Speed Switching

**with reliable T/I silicon transistors**

New improved T1 2N337 and 2N338 specifications provide greater design flexibility for your switching circuits... nuclear counters... pre-amplifiers... RF amplifiers... 455 KC IF amplifiers... and many other high frequency applications.

You get high gain at low current levels with T1 diffused silicon transistors. High alpha cutoff... 10 mc min for 2N337, 20 mc min for 2N338... and extremely low collector capacitance assure optimum performance in your switching and high frequency amplifier applications.

**design characteristics at 25° C ambient** (except where advanced temperatures are indicated)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2N337</th>
<th>2N338</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector Cutoff Current</td>
<td>100 mA</td>
<td>50 mA</td>
</tr>
<tr>
<td>Breakdown Voltage</td>
<td>20 V</td>
<td>20 V</td>
</tr>
<tr>
<td>Breakdown Voltage</td>
<td>500 V</td>
<td>500 V</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>10 kΩ</td>
<td>10 kΩ</td>
</tr>
<tr>
<td>Output Admittance</td>
<td>100 Ω</td>
<td>100 Ω</td>
</tr>
<tr>
<td>Feedback Voltage Ratio</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Current Transfer Ratio</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>DC Beta</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Frequency Cutoff</td>
<td>100 kHz</td>
<td>100 kHz</td>
</tr>
<tr>
<td>Collector Capacitance*</td>
<td>10 pF</td>
<td>10 pF</td>
</tr>
<tr>
<td>Saturation Resistance</td>
<td>100 Ω</td>
<td>100 Ω</td>
</tr>
<tr>
<td>Rise time</td>
<td>10 ns</td>
<td>10 ns</td>
</tr>
<tr>
<td>Fall time</td>
<td>20 ns</td>
<td>20 ns</td>
</tr>
<tr>
<td>New Improved Specifications for 2N337 and 2N338</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BVCEO</td>
<td>40 V max</td>
<td>45 V max</td>
</tr>
<tr>
<td>RCEO</td>
<td>300 kΩ max</td>
<td>150 kΩ max</td>
</tr>
<tr>
<td>hfe</td>
<td>90 α max</td>
<td>80 α max</td>
</tr>
</tbody>
</table>

Consider T1's guaranteed specifications when you select semiconductor devices for your next transistor circuit.

---

[Diagram and specification table are not transcribed into the text.]

Texas Instruments Incorporated
Semiconductor-Components Division
Post Office Box 312
Dallas, Texas

World's Largest Semiconductor Plant
COMPONENT DESIGN

Small UHF Ferrite Unit Shifts Phase 360 Deg

Small physical size of phase shifter is evident here

FERRITE DEVICES capable of 360-deg phase shift in the uhf region are sometimes too lossy and bulky to be practical. But a unit developed by Electronic Communications, Inc., Timonium, Md., is only 61-in. long and less than one in. square in cross-section. The 360-deg phase shift is accomplished with about one db of loss.

Basic to the design of the shifter is a folded Stripline structure as shown in Fig. 1. Each of five layers of Stripline is loaded with two 0.40 by 0.05 by 6 in. strips of TT-414 ferrite (Trans-Tech, Inc.), one on each side of the center conductor. The ferrite is a magnesium-manganese-aluminum combination with a saturation magnetization of 600 oersteds and a Curie temperature of about 100 C. To provide continuity between layers, the center conductor is folded. Total length of ferrite through which the wave must travel is 32.2 in.

The phase shifter requires a longitudinal magnetic field of enough intensity to place the operating region above resonance. For the unit fabricated, this is supplied by a 12-in. long, 1.1-in. diam solenoid into which the phase shifter fits easily.

Operating Characteristics

Original range of interest for the unit was 200 to 600 mc but characteristics were actually investigated from two to 2,000 mc. Figure 2 shows results obtained at 200, 400, 600 and 800 mc. Table I gives pertinent characteristics at each of these four different frequencies.

The phase shifter is a reciprocal device and can be used in both transmitting and receiving systems.

Miniature Motor Has Simple Stator

A BOBBIN-WOUND COIL and a simplified stator designed by Dynamic Instrument, Westbury, N. Y. permit servo motor sizes as small as 0.3 in. diameter. Simplicity of the coil and stator construction should give a production cost less than half that of ordinary motors.

The small size is possible because of the low magnetizing power needed to produce a suitable electromagnetic field. Regardless of how many poles there are in the motor, and disregarding stray leakage flux, all of the magnetic field lines per phase link all of the turns per phase.

The motor reaches full speed of 1,460 rpm in 0.004 sec and can be provided with a variety of shaft extensions, power and voltage ratings. It can be wound for class-H (to 400 F ambient), for transistor operation, as well as other varieties to suit special customer needs. Push-pull and high voltage types (used for direct coupling to a driver

Table I—Phase-Shifter Characteristics at Different Frequencies

<table>
<thead>
<tr>
<th>Frequency in mc</th>
<th>Insertion loss in db</th>
<th>Differential phase shift in deg</th>
<th>Magnetic-field change in oersteds</th>
<th>Max vswr over field range</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>1.6</td>
<td>360</td>
<td>220-1,500</td>
<td>1.8</td>
</tr>
<tr>
<td>400</td>
<td>1.1</td>
<td>360</td>
<td>130-1,250</td>
<td>1.45</td>
</tr>
<tr>
<td>600</td>
<td>1.1</td>
<td>360</td>
<td>635-1,625</td>
<td>1.5</td>
</tr>
<tr>
<td>800</td>
<td>1.4</td>
<td>360</td>
<td>730-1,630</td>
<td>1.5</td>
</tr>
</tbody>
</table>
MINIATURIZED COMPONENTS

DESIGNED FOR APPLICATION miniaturized components developed for use in our own equipment such as the 90901 Oscilloscope, are now available for separate sale. Many of these parts are similar, in most details except size, to their equivalents in our standard component parts group. In certain devices where complete miniaturization is not paramount, a combination of standard and miniature components may possibly be used to advantage. For convenience, we have also listed on this page the extremely small sized coil forms from our standard catalog.

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A001</td>
<td>Bar knob for 3/4&quot; shaft. 1/2&quot; high by 3/4&quot; long.</td>
</tr>
<tr>
<td>A006</td>
<td>Fluted black plastic knob with brass insert for 1/4&quot; shaft. 3/4&quot; high by 3/4&quot; diameter.</td>
</tr>
<tr>
<td>A007</td>
<td>3/4&quot; black plastic dial knob with brass insert for 1/4&quot; shaft. 3/4&quot; diameter dial. 3/4&quot; high.</td>
</tr>
<tr>
<td>A012</td>
<td>Right angle drive for 1/4&quot; shafts. Single hole mounting.</td>
</tr>
<tr>
<td>A014</td>
<td>1/2&quot; bar dial for 1/4&quot; shaft. 3/4&quot; high. 180° or 280° dials for clockwise or counter-clockwise rotation.</td>
</tr>
<tr>
<td>A015</td>
<td>1&quot; fluted knob dial for 3/4&quot; shaft. 3/4&quot; high. Same dial plates as no. A014.</td>
</tr>
<tr>
<td>A017</td>
<td>13/4&quot; diameter fluted black plastic knob for 1/4&quot; shaft.</td>
</tr>
<tr>
<td>A018</td>
<td>Knob, same as no. A007 except for style.</td>
</tr>
<tr>
<td>A019</td>
<td>Knob, same as no. A007, but without dial.</td>
</tr>
<tr>
<td>A025</td>
<td>Miniature metal index for miniature dials.</td>
</tr>
<tr>
<td>A030</td>
<td>Miniature dial lock.</td>
</tr>
<tr>
<td>A031</td>
<td>Miniature metal index for miniature dials.</td>
</tr>
<tr>
<td>A035</td>
<td>Miniature dial lock.</td>
</tr>
<tr>
<td>A036</td>
<td>Shaft lock for 1/4&quot; diameter shaft. 1/4&quot;-32 UNF. Nibble plated brass.</td>
</tr>
<tr>
<td>A037</td>
<td>Shaft lock with knurled locking nut.</td>
</tr>
</tbody>
</table>
amplifier, eliminating the need for an output transformer) are also available to impedance ratings impossible in more conventional type units. Ratings of 115 v in diameters down to a fraction of an inch eliminate the step-down transformers and large capacitors usually found in low voltage miniature motors. For example, a 26 v motor employing a 2-μf tuning capacitor would require only 0.1-μf capacitor at 115 v. Where required, dielectric strengths of 2,000 v can be provided. Dielectric strengths of 1,250 v between phases to and the frames are standard, even in very small frame sizes, where previously they could be achieved only with difficulty and often with a large percentage of rejections in production.

Special Tube Fins Offset Calefaction


Currently under study by the FCC is the advisability of allowing certain so-called clear-channel a-m stations to exceed the 50-kw broadcast power limit. New powers proposed are 500 kw minimum and 750 kw maximum. With higher powers, tube cooling will be more of a problem. One technique first reported in Electronics’ makes use of novel fin design to take advantage of fundamental heat-transfer principles.

Figure 1 shows the relation between heat flow per unit area and temperature of a small metallic surface immersed in still water. Zones C and D are known as the calefaction region. In a household analogy, calefaction is illustrated by a drop of water on a hot stove where the steam prevents effective heat transfer of the liquid.

With a larger area, such as the cylindrical anode of a conventional water-cooled tube, steam produces an insulating layer which reduces contact of the anode with the water. The anode’s melting point can then

To Eliminate Noise—Add Some

Electronic earphone contains miniature microphone which generates noise signals opposite in phase to loud unwanted noises. When two sound waves meet in earcup, most of total noise energy is dissipated. Developed by U. S. Army Signal Research and Development Lab, Ft. Monmouth together with RCA, the earphone works with a special electronic inverter and amplifier unit.

To arrange for a personal interview, or for a prompt report on these or other current openings, return coupon to:

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Supervisor, Engineering Personnel
CHANCE VOUGHT AIRCRAFT,
Dallas, Texas

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interested in the opening for ....................................
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Address ....................................
City.............. State..............
in'ge·nu'i·ty: designing a 12-ton missile
to fit inside an atomic sub

Chance Vought's *Regulus II* missile is twice as long as a city bus. It is crammed with delicate instruments, armed with a nuclear warhead. Yet Vought engineers designed *Regulus II* to serve safely, efficiently aboard the Navy's newest nuclear-driven submarines.

They shock-proofed the missile against underwater blasts. They conditioned it for polar ice, or equatorial heat. They made it—like Vought's smaller Fleet veteran, *Regulus I*—a dependable weapon, accurate from conventional or nuclear subs, from surface ships or highly maneuverable, mobile shore launchers.

Aboard its special, globe-girdling sub, *Regulus II* will move invisibly any distance to its launching point. There it can begin a supersonic, long-range strike in minutes. Or it may lurk unseen for months as a patient and ready deterrent.

A chilling prospect for would-be aggressors, this example of Vought ingenuity.

Scientists and engineers: pioneer with Vought in new missile, manned aircraft, and electronics programs. For details on select openings write to: C. A. Besio, Supervisor, Engineering Personnel, Dept. R-8.
PRINTED CIRCUIT TRIMMERS

This new subminiature trimmer is designed for printed circuit assembly.

SLIM and TRIM, they fit neatly with diodes and transistors.

Constructed of high-temperature-resistant plastic, with a 37 turn lead-screw adjustment for fine trimming, the TPC trimmer is a masterpiece of miniaturization. Virtually hermetic sealed, this newest addition to the TIC line is moisture proof. Power rating is 1 watt at 70°C, derated to 0 at 225°C. Pretinned leads accommodate hot-tin dipping techniques. Lead separations are in multiples of 0.1" in accordance with standard printed circuit separations.

FEATURES:

- Reliability and performance in operations up to 225°C.
- Resistance Ranges from 100 to 30,000 ohms.

Environmental testing has proven these rugged, compact trimmers meet or exceed the military specifications required for airborne and missile applications.

Bulletins with full details available upon request.

TECHNOLOGY INSTRUMENT CORPORATION

569 Main St., Acton, Mass.  P.O. Box 3941, No. Hollywood, Calif.
COLonial 3-7711  POplar 5-8620

FIG. 2—Teeth of power tube are designed as shown

be at point S, Fig. 1, or about 200 w/in.².

By designing the teeth or fins of the power tube as shown in Fig. 2, permanent contact with the liquid by the tips of the fins is insured and temperature can be kept below 110°C (point L, Fig. 1). With teeth of good thermal conductivity it is physically impossible for two adjacent points of the surface to be at 125°C (Point M, Fig. 1) and 1,100°C (point Q).

Figure 3 is a sketch of a Vaportron with vertical fins. Tubes have also been made with horizontal fins. A third version uses a tooth-type construction combining vertical and horizontal fin concepts.

In operation, the tube is set in a
WESTON'S BROAD LINE OF RUGGEDIZED INSTRUMENTS WILL TAKE THEM EASILY IN STRIDE

New design concepts, new materials and new production techniques . . . these are the ingredients of Weston's '58 line of Ruggedized Instruments. Now, more than ever, they insure dependable, accurate service under extremes of shock, vibration, temperature, humidity and general abuse.

Mechanisms are mounted on metal decks. The decks and terminals are then molded into a specially compounded, shock-resistant rubber. This results in a well-insulated, leak-proof, and virtually break-proof seal. Damage from impact to jewels and pivots is eliminated through spring-backed mounting. Tough plastic windows make the use of zero correctors practical. The entire mechanism is housed in a rigid steel case which provides excellent shielding against external magnetic fields. The instruments may be mounted interchangeably on either magnetic or non-magnetic panels without loss of accuracy.

Consult your local Weston representative for complete details . . . or write for Catalog A-38. Address: Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.
NEW RECTANGULAR C-R Tube

...4½" x 5½", gives raster area of a 7" round tube. Bezel adapters for all standard cameras.

INDIVIDUAL INTENSITY & FOCUS CONTROLS

... for both channels.

HIGH SENSITIVITY

... to 200 microvolts/centimeter on both channels.

IDENTICAL VERTICAL AMPLIFIERS

... with differential inputs.

HORIZONTAL DISPLAY

Selects: Calibrated Sweep.

Expanded Sweep.

Calibrated Sweep on Channel A and Expanded Sweep on Channel B.

NEW ETC HIGH SENSITIVITY

2-Channel Oscilloscope

MOST SCOPE/DOLLAR

Priced scarcely higher than professional single-channel scopes, the ETC K-260 brings true 2-channel oscilloscope versatility to industrial and scientific work at lowest cost. Heart of the K-260 is a unique rectangular cathode ray tube that gives the raster area of a 7" round tube—but in less space and with more convenient viewing qualities.

Write today for complete specifications.

MODEL K-260

OUTSTANDING VALUE

only $785 f.o.b. Philadelphia

PERFORMANCE HIGHLIGHTS

IDENTICAL VERTICAL AMPLIFIERS

Sensitivity: 200µv/cm, dc-coupled.

Bandwidth: dc to 500 kc.

Differential Input Attenuation: to 100 millivolts per centimeter.

HORIZONTAL AMPLIFIER

Selector: Calibrated sweep, expanded sweep (up to 5 times), or calibrated sweep on Ch. A with expanded sweep on Ch. B.

Response: dc to 200 kc, ±3db.

LINEAR SWEEP — 3% accuracy

Calibrated: 100 msec/cm to 1 µsec/cm.

Uncalibrated: 1 sec/cm to 2 µsec/cm.

Linearity: 5%

INTERNAL CALIBRATOR

1,000 cps square wave at 0.2 mv to 10 volts in 12 steps.

tank. Steam rises through a short insulating pipe to a condenser and returns as water to a storage tank. No water pump is required.

The technique described has been proved in more than a million hours of operation.

REFERENCE


Turret Mounting Servo Components

Rotating servo components assembled in miniature turret packages require less volume and are better suited to vibration and shock than many conventional rotating component packages which line up the components end-to-end. The turret concept developed by Mechatrol, a division of Servomechanisms, Inc., Westbury, N. Y. also permits more flexible use of servo components. A single servo motor can be used to drive more than one component, each at the same or different gear ratios. The output shaft is designed for easy connection to other components or sub-assemblies.

Adding Components

The illustration shows a typical turret package containing a size 11 motor-tachometer, gearhead and potentiometer.
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ABC electronics ABP
A McGRAW-HILL PUBLICATION
330 W. 42nd St., New York 36, N. Y.
Copper Is Temporary Base for Inlaid Circuits

INLAID CIRCUITS, electrical conductors flush with the surface of the surrounding dielectric, are particularly useful with sliding contacts. Main applications are miniature tap switches, commutators, coding discs, cross-over switches and computer parts.

Method of producing inlaid circuits, developed by Glass Products Co., Santa Barbara, Calif., differs substantially from a technique reported here October 1, 1957. The process is basically chemical and does not require finish machining. Nodules which grow on plated silver provide the mechanical bond between the conductor and the insulating base material.

Oversized artwork master furnished by customers or prepared by Glass Products is photographed by a reducing camera onto glass. This is used to print multiple images of the circuit, in actual size, on glass plates. Plates, usually 12 by 17 inches, may contain up to 200 prints of smaller circuits, such as commutators.

Next, the following production steps are followed, as shown in the diagram:

1. A sheet of 0.005 inch copper the size of the plate is treated with light-sensitive resist, generally containing potassium dichromate. The sheet is exposed in a vacuum frame using the plate as a negative. The exposed areas of the resist are set and the unexposed areas washed in a warm water bath.

2. The bare copper pattern is electroplated with various metals. Metals and plating thicknesses depend on circuit requirements. A common combination is a 0.00003 inch layer of rhodium followed by a 0.002 inch layer of nickel. The rhodium provides a smooth, corrosion-resistant final surface. Occasionally, a flash of gold is first deposited as a lubricating surface for the contact to slide on. The heavier layer of nickel gives the circuit a hard body.

3. A layer of silver, 0.002 inch thick, goes on top. Irregular nodules on the silver grip the backing plate of plastic or metal used for the circuit board.

4. The plated copper sheet is

DESIGN TRENDS: Padless Printed Wiring Board

Conventional printed wiring boards use a pad around component lead holes to ensure a strong solder fillet. Photo shows a conventional board flanked by miniaturized versions. 1/5th the size, developed by Photocircuits Corp., Glen Cove, N. Y. Size reduction is achieved by eliminating space required for the pads. Holes are plated through so that solder joints are made primarily inside the holes. The firm reports that experimental boards, with 40 mil holes, 40 mil conductors and 40 mil spacing between holes, passed temperature, vibration and shock tests of MIL-E-5272. Pull strength of connections is 20 pounds in 40 mil G10 board and 12 pounds in 1/32 inch XXP. Close registration between printing and hole fabrication operations is required.
Here for the first time is a 1500 volt rectifier proven in service at 150°C Case. Current levels up to 400 ma are handled by the TM155... the latest to join Transitron’s expanding family of high voltage silicon rectifiers. And now this entire high voltage series is priced more attractively than ever!

Features

- No derating at high temperature
- High power handling ability
- Small size
- Hermetically sealed

For still higher voltages at currents to 175 ma, Transitron makes rectifier assemblies in cartridges and in the convenient “2 W” axial lead package.

Hermetically sealed in the standard 7/8” hex package, these units are resistant to shock, vibration and environment changes. The new higher ratings make them useful in high voltage power supplies for magnetrons, klystrons, electronic precipitators and other applications requiring 600 volt output or higher.

Send for our rectifier brochure, TE-1351.
ALL NEW!

See these AIRPAX items at the Wescon show
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LOW NOISE CHOPPERS
Series 2300 for 400 CPS
Series 2400 for 60 CPS

DATA LOGGING AMPLIFIER
Three stage low null drift stabilized magnetic amplifier

TACH-PAK
Permits tachometry with an accuracy at 0.1%

PREAC
A single stage magnetic computer amplifier having exceptionally high gain

AIRPAX continues to lead the way!
Airpax Engineers have developed the above items as well as many others which represent the latest advances in components designed for use in commercial and military fields.

immersed in hot lye bath to remove remaining resist.

(5) The sheet is placed, plated side up, on a stainless steel plate for rigidity during pressing. A thin sheet of adhesive and a sheet of dielectric material are applied, followed by backing material. Phenolic, melamine, epoxy, or combination of these, are used as dielectrics. When a phenolic laminate is used, uncured sheets of phenolic paper are laid against the silver without adhesive. When melamine is desired, it is used uncured as the adhesive and becomes the dielectric when cured. Phenolic laminates, mylar, aluminum and many other metals have been used as circuit backing.

Sandwiches of 90 commutators each are prepared for insertion in hydraulic press

The sandwich is subjected to approximately 1,400 psi at a temperature of 305F in a hydraulic press. This forces dielectric into fillets formed by plated material and copper sheet so that the dielectric assumes the same plane as the material first plated.

(6) The processed sandwich is bathed in ferric chloride until all the copper is removed, leaving the plated conductors flush with the dielectric surface. If the rhodium layer is very thin, there is a chance it may be porous enough to allow the acid to reach the nickel. In that case, chromic acid is used since it will dissolve copper but not nickel nor rhodium. Acid will not become trapped in the dielectric (which could cause electrical leakage) due to the smooth surface given by the copper sheet.

Finally, the circuits are sawed apart and cleaned.

When an ultra-smooth surface
After pressing, copper plating base is etched away in tank finish is required, the sheet copper is not used. A layer of copper 0.0002 inch thick is chemically reduced on optically polished glass. After masking, plating and pressing, the glass plate is pulled off and the copper etched away.

Strong cross-over connections may be made by laying up additional layers of resist and conducting material over the plated circuit at the sandwich stage. The cross-overs will be under the circuit after the copper sheet is etched away. The resist pattern is applied with a silk screen.

**Micrometers Change Cut and Strip Setup**

**Fast Setup** changes through use of micrometer-type adjustments features a high-speed wire cutter and stripper made by Eubanks Engineering Co., Pasadena, Calif.

Standard models handle solid or stranded wire from 32 AWG to 3/16 inch OD. Cutting lengths are 1 inch to 300 feet. Strip lengths are 1/8 to 1 inch, to maximum strip combinations of 1 by 3/8 inch.

Operator adjusts wire travel speed. Installation at Beckman Instruments includes a Reeves induction heating unit.

---

**Beyond the call of duty**

To assure top quality in every Varian Tube, each must pass three separate and exhaustive series of tests before it passes final inspection. First, all electrical characteristics are checked. Next, the tube is tested under severe vibration environment to be sure that it is particle free. After a holding period all electrical characteristics are rechecked. Only then, when every parameter has exceeded specifications, has the tube met Varian's high measure of perfection.

This is typical of the care involved in the manufacture of Varian tubes... and one of the reasons why they are considered the standard of the industry. Over 100 of these tubes are described and illustrated in our latest catalog. Write for your copy today.
NOW...Mil-Spec* miniature precision, 125°C

POTS

at mass production prices...

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ORDER TYPE E TODAY AND SAVE UP TO 50%!

E = Excellence + Economy, you'll soon agree, when you get a quotation on Waters Type E Precision Potentiometers from your nearby distributor. He has them in stock... ready for fast delivery at prices that pass along to you the benefits of Waters' unique mass-production techniques. Nowhere else can you match the prices you pay for potentiometers with the following features:

HIGH-PRICED FEATURES AT NEW LOW COST

*ENVIRONMENTAL SPECIFICATIONS
MIL-E-5272A and MIL-R-19

*LIFE EXPECTANCY
MIL-R-19 where applicable

BODY AND COVER
Anodized aluminum, precision machined, for high dissipation rating (2 to 4 watts)

BUSHINGS
Corrosion resistant alloy, precision bored, choice of plain or split in all sizes (except RTS 1/4)

TERMINALS
Turret type, gold flashed over silver plate for ease of wiring

ELECTRICAL CONNECTIONS
All important internal connections welded, other connections high-temperature soldered.

WINDING AND SLIP RING CONTACTS
Precious metal

TEMPERATURE COEFFICIENT OF WIRE
0.00002 parts per °C

EQUIVALENT NOISE RESISTANCE
140 ohms, maximum

DIELECTRIC STRENGTH
1000 volts DC for one minute at sea level

NEW BULLETIN "E" gives complete details about standard mechanical and electrical specifications, dimensions and part numbers of these high precision, low-cost potentiometers. Get your copy right away from your nearest Waters distributor or write direct to Waters at Wayland.

Wire travel speed may be varied from zero to 150 feet a minute. Machine may be set to cut a single wire. Or it will cut and strip 1 inch pieces at 8,600 per hour, 50 inch pieces at 1,970 an hour, and so on.

Blade position determines strip lengths and micrometers adjust cutting depth

Wire length is measured as the wire passes under a measuring wheel. Length is predetermined by a micrometer which controls a ratio unit. Settings are given by a chart on the cabinet.

Strip lengths are changed by shifting positions of cutting blades in a slotted block. Cutting depth is set to within 0.001 inch by micrometers mounted above and below the cutting heads. Compressed air is used to operate the cut and strip mechanism and control wire feed. Construction is modular so assemblies may be separately serviced.

Tape Programs
Board Driller

TAPE-PROGRAMMED drill press positioning table has been modified to drill 45 to 60 holes a minute in printed wiring boards. Positioning accuracy is 0.001 inch, sufficient for automatic component insertion.

According to Jones & Lamson Machine Co., Springfield, Vt., the cycle may be set at fully automatic or jogged through 1 hole at a time. Cycle may be interrupted at any point for manual operation.

If more than 1 size hole is re-
quired, table may be programmed to drill 1 size hole in all boards of a batch and recycle after drill change. Or, it will automatically inter-rupt cycle and call for drill changes on each board.

Table travel is 12 inches front to back and 20 inches side to side. Travel speed from hole to hole is 150 inches a minute.

Positioning table is set up under twin drilling heads. More than 2 heads may be used.

Tape preparation time averages 5 minutes a hole. Hole locations are reduced to offset dimensions from a starting point. Sequence of operation is chosen and listed. A hand-operated punch is used to punch directions into 4-inch Mylar tape.

Light, Inert Filler
Tiny, hollow ceramic spheres made by Hastings Plastics, Inc., Santa Monica, Calif., may be used as radome and potting compound filler. Chemically inert, dimensionally stable, they may be mixed with liquid epoxy, polyester or phenolic resin. Average particle density ranges from 0.4 to 0.65 gm/cc and moisture absorption after 72 hours at 180°F in saturated atmosphere is less than 0.01 per cent.

If you need slug tuned coil forms that stand rough treatment and meet military specifications, it will pay you to look into Waters Ribbed Ceramic Coil Forms. Their silicone-impregnated ceramic conforms to JAN-1-10 Grade L5 or better. Their ribbed construction permits coil leads to be brought under windings to lugs. No loose leads. Also permits highest “Q”. Unique construction includes a new permanent tension device. No loose parts.

Like well-known Waters Phenolic Coil Forms, these new numbers come with standard bushing or retractable type. The latter allows core to enter bushing to give more effective winding area. All numbers are designed to be stacked or have bushings on each end for double tuning.

BULLETIN (ED) covers all details about Waters Ribbed Ceramic and Phenolic Coil Forms for frequency ranges from Audio to 250 M.C. and above. Get your copy from your nearby Waters distributor or write direct to Waters at Wayland.

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COIL FORMS

gives you a wider choice...

by Waters

RIBBED CERAMIC HIGH-"Q" COIL FORMS
NOW AVAILABLE FROM STOCK!

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NEW PRODUCTS

Spotlighting New Switches

Westinghouse Electric Corp.
contactless limit switch

Meletron Corp.
progressive shorting type

The Daven Co.
snap-action switch

The Capitol Machine Co.
multiposition device

Haydon Switch, Inc.
molded terminal units

The 5300 series precision switch now being manufactured by Haydon Switch, Inc., Waterbury 20, Conn., (305) is available with a full range of operating forces, from 2 to 20 oz. Terminals, molded into the plastic cover, cannot wobble or be loosened under rough usage.

SWITCHES, in their extremely wide varieties, represent a sizable portion of the components business. Manufacturers are constantly striving for new highs in controlled accuracy and reliability.

Meletron Corp., 950 N. Highland Ave., Los Angeles 38, Calif., (300) announces the Melematic, a new snap action switch suitable for use where the operating force is specific. It has a resin plastic housing and extruded terminals to prevent stripping of threads.

In production at Hydraulic Research and Mfg. Co., 2835 N. Naomi St., Burbank, Calif., (301) is the new 90,000 series pressure switch with intermediate mechanical snap action that insures trigger switching of the electrical switch element. The unit is qualified and available in pressure settings from 5 to 4,000 psi.

The Capitol Machine Co., 36 Balmforth Ave., Danbury, Conn., (302) has introduced the Series 1A series of switches designed for minimum space required behind the panel and use of a No. 327 lamp. Each position has an individual lamp assembly.

A new progressive shorting type switch has been developed by The Daven Co., Livingston, N. J., (303). It shorts out every other position on the switch but the one in use. It is particularly useful in the metering of a single position or for the gathering of pertinent information on it. Switches are available as 20, 24 and 32 pole units.

Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 22, Pa., (304) now has available proximity limit switches designed for operating life to be independent of switching operations performed. Electrical output is 24 V d-c at 0.335 ampere.

For more information use READER SERVICE Card

One-Piece Headers
varied designs

Glasseal Products Co., Inc., 1111 E. Elizabeth Ave., Linden, N. J., has developed a new type of square and rectangular header. The completely sealed header eliminates the usual subassembly operations for electronic manufacturers who use square or rectangular cans to package their units. The new designs are available in nearly every standard size and include moat, square flange, and insert type construction. Circle 306 on Reader Service Card.

(Continued on page 118)
Type 404-R, standard relay rack mounting, 10 1/16" high, 16 1/4" cabinet width, 17 9/16" deep.

**HIGH REPETITION RATE PULSE GENERATORS**

**DU MONT**

404-R
(Rack-mounted)

404
(Bench model)

Leading edge of a typical pulse connected directly to the deflection plates of a cathode-ray tube. Sweep rate is 0.01 usec/scale division.

QUICK FACTS

- Repetition rate up to 100,000 pps, down to single, manually triggered pulse.
- Maximum jitter between trigger and pulse 0.002 usec, or 0.04% of delay.
- Rise or fall time of pulse, 0.02 usec maximum.
- Continuously variable pulse width from 0.05 to 100 usec.

- Output of 50 volts into a 50 ohm load, positive or negative polarity.
- Calibrated attenuator offers 59.5 db attenuation in 0.5 db steps with no pulse degradation.
- Internal pulse delay from -2 to +125 usec with respect to trigger output.
- May be externally triggered.

Price: 404-R...$69000
404......67500
f.o.b. E. Paterson, N. J., U.S.A.

The Du Mont Type 404 bench model Pulse Generator and the Type 404-R rack-mounting version are electronically identical, and equal in performance. They are physically different only to satisfy their operational use.

Hard tube circuitry in these pulse generators eliminates jitter, overshoot and ringing inherent in conventional hydrogen-thyratron designs. Repetition rates of 100,000 pps down to single, manually triggered pulses, plus fast rise time (0.02 usec) and continuously variable pulse widths from 0.05 to 100 usec combine to give these pulse generators outstanding versatility.

**DU MONT INSTRUMENT DIVISION**

ALLEN B. DU MONT LABORATORIES, INC.
CLIFTON, N. J., U.S.A.

Make a point to see the new DuMont 401-A low-frequency oscilloscope. Among its many features are identical X & Y amplifiers.

Visit Du Mont at the Wescon Show—Booths 1433 and 1434

ELECTRONICS engineering edition — August 15, 1958
Continuous performance under extreme environmental conditions is yours with Deutsch 27-contact miniature connectors. These environmental performers exhibit thrilling qualities:

- Available for immediate delivery
- Durable for 500 cycles of engagement
- Seal before and after contact
- Unaffected by altitude pressure variations
- Operate from -67°F to 250°F
- Meet or exceed requirements of MIL-C-5015

Shimmy and shake these rugged connectors. They're vibration-dampened and withstand physical shocks up to 100 G's. The exclusive Deutsch ball-lock coupling ring ensures a positive lock without twisting or turning, without lock-wiring or coupling nut. Just push in to connect—pull back to disconnect.

To take a peek at the inside information on Deutsch 27-contact miniature connectors...as well as the 3, 7, 12, 19, 37 and 61 contact members of this environmental troupe...write for data file 8B. Or see them all at WESCON (Booth 949-950).

Decade Delay Lines
lumped-constant

Epsco Components, 108 Cummings St., Boston, Mass., has developed a new lumped-constant decade delay line featuring high impedance output. The following inputs are available: 500 ohms, 1,000 ohms and 2,000 ohms. Variable from 0 to 11 μsec, in increments of 0.1 μsec, with rise times of 0.25 μsec. Units are provided with coaxial input and output connectors. These delay lines are reported to be ideal for research and laboratory personnel, for work in systems' breadboarding and for general testing. Circle 307 on Reader Service Card.

D-C Millivoltmeter
differential input

Millivac Instruments, P.O. Box 997, Schenectady, N. Y. The MV-37A differential input d-c millivoltmeter has a high common mode rejection ratio (1,000:1), not only on its sensitive direct ranges but also on its insensitive range where the input signal is being attenuated. Attenuator errors be-
tween the two input channels are eliminated by a switching relay which inserts the same input attenuator alternately in either channel. The instrument is expected to find extensive application for computer servicing. Circle 308 on Reader Service Card.

**Portable Voltmeter**

battery-powered

ALTO SCIENTIFIC CO., INC., 855 Commercial St., Palo Alto, Calif., announces model D-62 battery-powered portable d-c/a-c voltmeter. It can measure a-c and d-c with a maximum sensitivity of 1 mv full scale. Voltage range of the d-c unit is 1 mv to 100 v; of the a-c, 1 mv to 300 v. The D-62 has a d-c accuracy of ±2 percent, and an a-c accuracy of ±5 percent. Frequency range of the a-c unit is 5 cps to 200 kc. Input resistance is 10 megohms a-c and d-c. Approximate battery life is 40 hr for the chopper and 130 hr for the voltmeter power source. Circle 309 on Reader Service Card.

**Chopper connector mounted**

The Bristol Co., Waterbury 20, Conn. Miniature hermetically-sealed Syncroverter switches are now being packaged for the latest

---

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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Also describes Heathkit ham gear and hi-fi equipment in kit form. 100 interesting and profitable "do-it-yourself" projects.
NEW SIMPLICITY OF OPERATION

Bendix-Pacific FM/FM Receiving Stations have achieved a new high in operational simplicity. Comparator type circuitry, highly stable components and automatic calibration techniques eliminate all controls except channel selection and calibration switches. With Bendix-Pacific stations, high accuracy data can be obtained in a shorter time than ever before.

Bendix-Pacific Receiving Station Systems represent the most advanced state of the art. Two types are available: The TGRS-100 Receiving Station is designed for either real-time reception and demodulation of signals from FM/FM Telemetry Transmitting Systems or demodulation of tape recorded data. The TGRS-600 Receiving Station is designed primarily for precision conversion of tape recorded information from FM to analog.

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Bendix-Pacific maintains a complete staff of instrumentation personnel to assist you in the solution of your data problems.

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DIVISION OF BENDIX AVIATION CORPORATION
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Canadian Distributors: Computing Devices of Canada, Ottawa 4, Ontario

Export Division: Bendix International, 205 E. 42nd Street, New York 17, New York

modular-type equipment. These choppers functionally mate with the Cannon K02-16-10SN receptacle and retain the nonresonant performance of the previous models of the same devices. Units are designed to operate at extremes of altitude, temperature, shock, vibration, and acoustic noise encountered in the various military airborne equipment requirements. Circle 310 on Reader Service Card.

Phototube with u-v response

RADIO CORP. OF AMERICA, Harrison, N. J. The 7200 is a 9-stage multiplier phototube designed especially for the detection and measurement of ultraviolet radiation, and for other applications involving low-level radiation sources. It employs an envelope consisting of a fused-silica section and a graded-seal section. The fused-silica section transmits radiant energy in the u-v region down to and below 2,000 angstroms. Spectral response of the 7200 covers the range from about 1,800 to 6,000 angstroms. The tube has high sensitivity to blue-rich light and negligible sensitivity to red radiation. Circle 311 on Reader Service Card.

Digital Timer

ERIE RESISTOR CORP., 644 W. 12th St., Erie, Pa. Model 2400 is a miniature four-decade digital timer.
having a time resolution of 1 milli-second and a maximum indicated time interval of 9.999 sec. Glow transfer tubes are used as decade counters and indicators. Pulses derived from a 1,000 cps tuning fork are fed to a gated amplifier which is controlled by miniature “start” and “stop” thyratrons. The thyratron gate control circuitry reduces the normal requirement of ten triodes to a total of two miniature gas-filled tetrodes. Overall dimensions of the timer are 6 in. by 7 in. by 4\(\frac{1}{2}\) in. Model 2400 is designed to meet specification MIL-T-945A. Circle 312 on Reader Service Card.

**TWT Amplifiers**

**S-band units**

**Hughes Products**, International Airport Station, Los Angeles 45, Calif. The MAS-1A is an S-band periodically focused twt amplifier with power outputs of 1 kw over a frequency band of 2,000 to 4,000 mc. Peak power outputs are obtained with duty cycles up to 0.005 when operated with 1 w drive. The tube has a gain of 30 to 33 db, giving an excess of 1 kw over most the band. The type of p-m focusing field employed eliminates the solenoid, solenoid power supplies, and solenoid heat dissipation. Circle 313 on Reader Service Card.

**Repeater Servo**

**modular design**

**Waldorf Instrument Co., Huntington Station, L. I., N. Y.,** has developed a complete miniature plug-in potentiometer servo repeater system. The model W 1902 is a self-contained servo measuring

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**HELIPOT’s newest potentiometer**... the single-turn.

1-1/16” A.I.A. diameter, all-metal series 5200... fends off 2,000 cps at 30G’s, repels 10 cycles NAS 710, procedure III humidity, rides out 50G’s shock and 100G’s acceleration.

We’re tough, too... on the 5200’s mechanical tolerances. Register face, diameter and shaft runouts are all held to 0.001” max... spring-loaded shaft eliminates endplay.

All this with linearity to ± 0.15% ... power rating of 3 watts at 100°C (derating to zero at 150°)... 250 to 100,000 ohms standard resistance range... and certified test data to prove our every claim.

What a pot for airborne applications ... at a down-to-earth price! Write for data file A 82 for the proven facts.
The Aximax 2 vane axial fan is designed for tightly packed "black boxes" aboard aircraft or missiles where maximum cooling is mandatory with a minimum of space and weight loss due to the fan. Air delivery of 60 cfm free air is attained from a fan 2" in diameter by 1.5" in axial length. Weight is 4.5 ounces. Variation in driving motors include constant speed 20,000 rpm, 10,000 rpm as well as variable speed Altivar versions. The latter vary their speed inversely with density thereby approaching constant cooling with a minimum of power drain and noise. Power requirements vary from 400 cps for the standard unit to 1600 cps for special designs, 1 or 3 phase, sinusoidal or square wave. The Aximax 2 meets MIL-E-5400B and other individual missile specifications. Write today for complete technical information to -

ROTRON mfg. co., inc.
WOODSTOCK, NEW YORK
In Canada: The Hoover Co., Ltd., Hamilton, Ont.

Variable Toroid encapsulated
Burnell & Co., Inc., 10 Pelham Parkway, Pelham, N. Y., has announced a subminiature encapsulated variable toroid equivalent in electrical specs to the types AT-11 and AT-12 Adjustoroids. Developed especially for printed circuit and similar light weight applications, this variable toroid is completely hermetically sealed as there is no physical contact between the adjusting screw and the toroid itself. Stepless adjustment of inductance over a 10 percent range is provided and torque adjustment is such as to preclude possible strain on p-e mounting. Circle 315 on Reader Service Card.

Phase Detector
1 percent accurate
Ad-Yu Electronics Lab., Inc., 249 Terrace Ave., Passaic, N. J. Type 205B phase detector is designed for phase measurement from 15 mc up to 500 mc, with an
error of 0.05 deg or 1 percent of the dial reading. It is suitable for measuring performance characteristics of radar amplifiers, r-f cables, or other transmission networks where constant time delay for all frequency components is important for faithful transmission of signals. Essentially, the instrument consists of a continuously variable coaxial delay line, two step variable coaxial delay lines and a vector sum amplifier with separate amplitude adjustment. Circle 316 on Reader Service Card.

**Pulse Transformer**

gap-firing

LEVINTHAL ELECTRONIC PRODUCTS, Inc., 760 Stanford Industrial Park, Palo Alto, Calif. A new gap-firing pulse transformer is recommended for application in crowbar protective circuits to 100 kv. It is rated for a secondary peak voltage of 135 kv, a maximum pulse width of 0.5 μsec, and a maximum duty of 0.002. The turns ratio is 1 to 15, step-up polarity-inverting. Circle 317 on Reader Service Card.

**Magnetic Coils**

high temperature

PRECISION, INC., 730 Lyndale Ave. North, Minneapolis, Minn., has developed a group of high temperature magnetic coils designed for critical applications under exacting conditions of humidity, temperature, shock and vibration. Units are available in sizes ranging from ½ in. to 2½ in. diameter and are built to specification. Moisture

---

**VSWR and RF WATTMETERS**

25 MCS TO 3000 MCS

These rugged, compact units accurately measure and indicate the RF power and VSWR of coaxial transmission lines. Each type combines a frequency insensitive bidirectional coupler and complete indicator circuit in one small case. Accuracy of power measurement is ± 5% of full scale.

<table>
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<tr>
<th>Model No.</th>
<th>Frequency Range (Mcs)</th>
<th>Power Range (Watts)</th>
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<td>712N</td>
<td>25—1000</td>
<td>0-2.5; 5; 10 in 3 scales</td>
<td>N*</td>
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<td>723N</td>
<td>1000—3000</td>
<td>0-12 in one scale</td>
<td>N†</td>
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</table>

* Also available with UHF, BNC and Type C connectors
† Also available with BNC and Type C connectors

For more information please write for 68-page catalog No. 12 or see Electronics Buyers' Guide or Electronic Engineers Master.
Since 1942 the Bird Electronic Corporation has met the challenge of a constantly growing electronic industry. Today, enlarged engineering facilities demonstrate our intention to maintain leadership in our field. A wide range of coaxial line instruments and accessories are being designed to meet a variety of specifications; and new applications are continuously being sought.

In addition to experience and established leadership, Bird has the physical facilities to produce and dependably deliver coaxial line instruments and accessories meeting your highly exacting requirements.

VISIT BOOTHS 1529 & 1530 AT WESCON SHOW

**Electronics**

---

absorption is negligible under conditions of high humidity. Unit will withstand temperatures up to 350 °F for 100 hr and show no evidence of shorted turns in subsequent tests. Circle 318 on Reader Service Card.

**Stretch Cable**

**silicone type**

Stretch Wire Corp., P. O. Box 893, New Rochelle, N. Y. The new silicone stretch cable can be easily extended 200 percent and retracted to its original relaxed size. The cable is durable, highly resistant to abrasion and wear, as well as oil or chemical attack. Dielectric strength is 550 v per mil. It can be used where extremes of temperature have to be met. The brittle point is less than -150 °F and +375 °F. Tensile strength is 1,500 lb per sq in. Terminations are in spades, clips, jacks or connectors as required. Circle 319 on Reader Service Card.

**Rare Earth Ferrite**

for microwave use

Microwave Chemicals Laboratory, Inc., 282 Seventh Ave., New York 1, N. Y., is now producing YIG, yttrium-iron garnet. It has extremely low loss characteristics and is said to have a lower noise factor than ferrites currently available. YIG has a ferrimagnetic
resonance line-width of 55 oersteds at 9,000 mc and 30 oersteds at 3,000 mc. Saturation magnetization is also very low. Applications include isolators, rotators, and paramagnetic amplifiers. Company’s present commercial production of YIG can be had in either rectangular or cylindrical shapes. Circle 320 on Reader Service Card.

Thyratron
new lug base

NATIONAL ELECTRONICS, INC., Geneva, Ill. A new 2.5 ampere d-c thyratron (NL-710L) is an argon-mercury vapor type with the new lug base. The spade terminals of the lug base make positive contact and eliminate socket heating and associated troubles. Ratings are: filament volts, 2.5; filament current, 9 amperes; anode current, 2.5 amperes d-c; peak anode current, 30 amperes; and peak inverse and forward volts, 1,500. Circle 321 on Reader Service Card.

Volmeter-Amplifier
10 µv to 1,000 v

BOONTON ELECTRONICS CORP., 738 Speedwell Ave., Morris Plains, N. J. Model 98-A differential d-c voltmeter-amplifier is designed to

ERIE Ceramicon Trimmers have an enviable reputation for the qualities that are most needed for satisfactory performance. They are dependably true to specifications. They have remarkable stability under the most exacting conditions. They have a capacity change that is practically uniform throughout the full range.

The unique connecting strap on Ceramicon Base Trimmers eliminates the possibility of intermittent contact between the adjusting shaft and the silver pattern. Fired silver electrodes are applied to top of base and rotor, so that capacity is smoothly changed by varying the area of overlap.

ERIE Ceramicon Trimmers and Custom Trimmer Assemblies are available in a wide variety of temperature compensating characteristics and exceed the electrical requirements for MIL-C81A.

These Erie Trimmers are widely used in electronic instruments, test equipment, and military applications. The smaller size basic ERIE 557 Trimmer offers exceptional advantage in miniaturized custom designed assemblies.

Complete description of all ERIE Standard Trimmers is included in Catalog 314-1 . . . Write for it.
HONEST JOHN artillery rocket depends on G-E electric heating blanket (inset) to bring missile to uniform operating temperature before launching.

HONEST JOHN FIRING SHOWS HOW . . .

**General Electric Specialty Heating Maintains Propellant Temperature**

Successful launch—and flight—of the Honest John depends upon exact propellant temperature at the moment of firing. A General Electric heating and insulating blanket—which shrouds missile from nose to nozzle—provides and maintains that temperature!

Proper operation of many types of land and airborne equipment, especially at low temperatures, often depends on controlled heat in the right places at the right time. Experienced G-E heating engineers, backed by complete facilities, have already solved thermal conditioning problems on applications ranging from complete missiles and airborne systems to tiny test instruments.

**LET US ANALYZE YOUR HEATING PROBLEM.** Whether you need a custom-made prototype, or quantity production, investigate G-E "one stop" service for specialty heating products tailored to your specific needs.

**FOR MORE INFORMATION** contact your General Electric Aviation and Defense Industries Sales Office or send coupon.

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**DECIMAL COUNTER transistorized**

**NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa., announces an all transistorized decimal counter on a single plug-in card.** The unit will provide a four line 1-2-4-8 output code, with 4 ma drive available directly from each of these lines, to do useful work in recording operations. It is designed to operate from negative pulses of approximately 2 v amplitude and 1 to 2 μsec in duration, and at operating speeds from 0 to 150 kc. All inputs and outputs are provided through a single 18 tab p-c connector. Circle 323 on Reader Service Card.

**ALLOYS high temperature**

**TECHALLOY Co., Inc., Rahns, Pa., has developed super alloys for a variety of high temperature applications, in wire, rod and strip form.** They are available in cold-drawn wire and rod in sizes from ½ in. to 0.002 in. diameters and in thin strip, 0.040 in. to 0.005 in. in...
Power Supplies
transistorized

POWER DESIGNS, INC., 89-25 130th St., Richmond Hill 18, N. Y. Model 1515 is one of a family of portable transistorized power supplies protected by Robotec, a transistorized electronic circuit producing simultaneous current and voltage cutoff upon external short circuit. The circuit operates in 30 μsec reducing line input power to a negligible value holding the power supply cut off until manually reset. The power supply is also prevented from being turned on if the output terminals are short circuited. Range of the unit is 1-15 v d-c, 0-1.5 amperes. Regulation is better than 15 mv or 0.05 percent; response time, less than 50 μsec. Circle 325 on Reader Service Card.

Radar Picture Tube
high resolution

WESTINGHOUSE ELECTRONIC TUBE DIVISION, P. 0. Box 284, Elmira, N. Y., has available a high resolution radar picture tube (WX3751) for use in radar and other military and industrial systems. It produces...
CONQUEST OF SPACE

There are some who find fulfillment in boundless outer space. And more power to them!

But those of us who still have our feet on the ground also find real challenges in less expansive surroundings.

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Magnetic Components Department
Section 6120
Waltham 54, Massachusetts

V-R Power Supply
transistorized

KEPCO LABORATORIES, INC., 131-38 Sanford Ave., Flushing 55, N.Y. Model SC-36-0.5 compact supply delivers 0-36 v, 0-0.5 ampere. Regulation for line or load is less than 0.1 percent or 0.003 v, whichever is greater. Ripple is less than 1 mv. Recovery time is less than 50 μ sec. Stability for 8 hours is less than 0.1 percent or 0.003 v, whichever is greater. Operating temperature range is 50 C maximum. Temperature coefficient is less than 0.05 percent per deg C. Output impedance is less than 0.04 ohm. Circle 327 on Reader Service Card.

Altitude Chamber
walk-in type

AMERICAN RESEARCH CORP., Farmington, Conn. Although this walk-in altitude chamber has a free test space of 10 ft by 12 ft by 12 ft deep, it is completely pre-tested at the factory before delivery. Thorough performance checking is necessary there because the chamber must reduce pressure to a simulated altitude of 100,000 ft in seven minutes. Temperature range...
Using
Thermistors
Edited by
FENWAL ELECTRONICS
THERMISTOR PROBE ASSEMBLIES
Fenwal Electronics' new thermistor probe assemblies enormously simplify an engineer's design and development problems. Developed and built by Fenwal to your specifications, each assembly is a ready-to-use, easy-to-handle unit incorporating all the qualities that make Fenwal Electronics' thermistors outstanding — sensitivity, stability, reliability, fast response, light weight, and small size.

Three examples of complete thermistor probe assemblies Fenwal Electronics has designed and built to customers' specifications.

Fenwal Electronics develops and builds complete assemblies to various configurations and temperature ranges for specific applications. Probes can be completely interchangeable, and have identical resistance-temperature characteristics.

Engineers: Fenwal Electronics now has a thermistor kit No. G200, which includes 12 different individually packaged thermistors, each with complete data, for development work. $19.95 f.o.b. Framingham.

Write FENWAL ELECTRONICS, INC., 27 Mellen Street, Framingham, Mass., for Bulletin EM-13, describing nine of the many thermistor probe assemblies Fenwal Electronics can build for you. Or write for the Fenwal Electronics catalog (EMC-2).

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400 cycle
DEVR
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distortion
regulates
voltage

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It cuts man-hour loss in design and manufacture of aircraft and missile electronic systems where line fluctuations or distortion cause inaccuracies . . . increases servo and computer stability and accuracy . . . is invaluable for standards and other laboratories where highest instrument accuracy is essential. By eliminating surges, it increases equipment life.

Price: $1875 f.o.b., Carlstadt, N. J. Also in 60 cps model. Write today for complete facts.

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Here's good news to all crystal cutters, germanium, quartz, silicon, barium titanate, etc! Felker DI-MET metal bonded diamond blades are exceedingly thin, greatly reducing amount of expensive crystal lost in the cut! Special blades are supplied for either wafering or dicing insuring maximum efficiency and savings of material! Fast cutting, smooth finishes, long blade life, utmost reliability . . . you get them all in Felker DI-MET . . . originators of the first commercial diamond abrasive cut-off blades!

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CIRCLE 94 READERS SERVICE CARD

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ELECTRONICS engineering edition — August 15, 1958
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Thermal Relay
for missile use

HUGHES PRODUCTS, International Airport Station, Los Angeles 45, Calif., announces a one-time operating, single-pole thermal relay, with a faultless hermetic seal. Small size, positive operation, and convenience of location adjacent to desired components are advantages claimed. Three steps occur within the relay when an electric signal is triggered: (1) Firing effects the release of constrained contact. (2) Contact closes upon a fixed contact point. (3) Switch circuit becomes permanently closed. Circle 329 on Reader Service Card.

Transistors
germanium type

GENERAL ELECTRIC Co., Syracuse, N. Y., announces a line of four new pnp medium-speed switching transistors having less than a 20 percent change in VBE and Ic after 4,000 hours storage at 100 C. JETEC type-designated 2N394, 2N395, 2N396 and 2N397 they are designed for use in digital computers and other switching applications where highly stable components are required for maximum overall equipment reliability. Bulletin ECG-293 contains characteristic curves and complete ratings. Circle 330 on Reader Service Card.
sending a bill?

It'll get there quicker if you give your postal delivery zone number with your address.

The Post Office has divided 106 cities into postal delivery zones to speed mail delivery. Be sure to include zone number when writing to these cities; be sure to include your zone number in your return address —after the city, before the state.
A few typical applications of Taylor Vulcanized Fibre

Welders' Helmets  Golf Club Face Inserts  Carrying Cases

Track Insulation  Motor Insulation  Abrasive Discs

Switch Parts  Sliding Door Guides  Shuttles and Bobbin Heads

Vulcanized Fibre
Is Versatile

The applications of Taylor Vulcanized Fibre are many in number. This is because of its many unusual characteristics. It is a hard, dense material with excellent physical, mechanical and electrical properties. It is tough and resilient; has high resistance to impact, abrasion, wear, organic solvents, oils and gasoline; it can be machined, stamped, punched and formed; it is attractive in appearance, light in weight.

Taylor Vulcanized Fibre is available in a number of different grades, in sheets, rolls and turned rods. Undoubtedly you have an application where the unique properties of vulcanized fibre can be put to work in your product. A Taylor application engineer will be glad to discuss requirements with you and recommend the best grade to fit them. Get the benefit of his advice by contacting TAYLOR FIBRE Co., Norristown 40, Pa.

Literature of

MATERIALS


COMPONENTS


Capacitors. Vitramon, Inc., P. O. Box 544, Bridgeport 1, Conn. A four-page brochure illustrates and describes the company's complete line of capacitors. It shows how the manufacturing process of bonding the vitreous enamel dielectric to fine-silver electrodes results in superior performance. Circle 333 on Reader Service Card.

Electrolytic Capacitors. Illinois Condenser Co., 1616 N. Throop St., Chicago 22, Ill. A four-page catalog gives complete data on the type SMT subminiature tubular electrolytic capacitors including voltage range and temperature ranges. Listed in simple chart form, the information is easy to use for reference. Circle 334 on Reader Service Card.

Semiconductor Products. Texas Instruments, Inc., P. O. Box 312, Dallas, Tex. A new six-page folder gives complete technical specifications for a wide line of semiconductor products. Included are silicon and germanium transistors, silicon diodes and rectifiers, precision film resistors, solid tantalum
the Week

capacitors. Sensor silicon resistors, and diffused base germanium transistors. Circle 335 on Reader Service Card.

EQUIPMENT


Power Units. Sytron Co., Lexington Ave., Homer City, Pa., has published a new selenium rectifier a-c to d-c power unit catalog. Complete data and specifications are contained in the profusely illustrated 10-page booklet. Circle 338 on Reader Service Card.

Tubeless D-C Power Supply. Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn., has available a technical data sheet describing their model MA28-125 tubeless d-c power supply. The unit discussed has an output of 0-125 amperes over a regulated voltage range continuously variable from 18 to 36 v d-c. Circle 339 on Reader Service Card.

FACILITIES

Resistor Testing. Mcpeco, Inc., Morristown, N.J., is offering an illustrated 30-page brochure, entitled "Factual Resistor Reliability," which describes in detail the nondestructive conditioning and testing procedures used on the company's line of high reliability precision resistors. Circle 340 on Reader Service Card.

FOR SCIENCE and INDUSTRY

Electro-Pulse

PRECISION PULSE GENERATORS

- 10 CPS to 100 KC
- Calibrated Duration and Delay
- Block Unitized Construction

FAST RISE TIME

...LOW IMPEDANCE

An extremely versatile instrument for the generation of accurately controlled test pulses—also provides gate pulses, neg. triangles, and five sync. pulses in each cycle. Ideally suited for: Computer Development. Radar Test...Fuse and Relay Research...Pulse Modulation...Transient Response Studies...General Pulse Circuit Development.

- 10 CPS to 100 KC Rep. Rate • 0 to 10,000 
- .1 to 1,000 
- 80 V Amplitude (open circuit) • 93 Ohms Internal Impedance • .02 Rise Time
- Twin Pulse or Advanced Pulse Connection

Write for Complete Data: Our Bulletin 2120A-I


Model 1310A LONG TIME DELAY GENERATOR

Representatives in Major Cities

Electro-Pulse, Inc.
11861 Teale Street, Culver City, California
Telephones: Exmont 8-6764 and Texas 0-8006
Ling Acquires Sixth Firm

Acquisition of United Electronics Co. of Newark, N. J., makes the sixth wholly owned subsidiary taken on by Ling Electronics, Inc., Culver City, Calif., in the past two years.

Announced purchase price was $750,000 paid in cash and 65,000 shares of common stock of Ling. In return, Ling acquired all of United's common stock.

Top management of two firms gathered following completion of the transaction are (above, l to r): James J. Ling, chairman, Ling board of directors; John R. Beers, United vice-president in charge of research and engineering; Charles A. Rice, president of United, and Cameron G. Pierce, president of Ling.

United Electronics is a 23-year-old company involved in design of high-energy, special-purpose thermionic tubes and fixed and variable ceramic vacuum capacitors. Its proprietary products are used in radar, physiotherapy, radio frequency power, radio transmission and ultrasonic instrumentation applications.

Ling Electronics is a pioneer in the design and manufacturing of high-power, electronically driven systems for random, complex and sine wave vibration testing. These systems include high-power vibration generators, systems consoles and other specialized equipment necessary to duplicate in laboratory testing the intense vibrations encountered by jet aircraft, missiles and rockets in flight.

Maryland Firm Expands

To provide additional space for its manufacturing activity, Aircraft Armaments, Inc., Cockeysville, Md., has leased a newly constructed building in Towson. Designated as Annex F, the new building is the sixth annex acquired by the organization since moving into its main plant in September 1954.

Brauer Joins Fansteel

Howard H. Brauer has joined Fansteel Metallurgical Corp. as staff assistant to Glen Ramsey, v-p and general manager of the company's rectifier-capacitor division. His principal activities are systems and procedures in accounting, production controls, scheduling and marketing, particularly the mechanization of these procedures with punched cards.

Brauer comes to Fansteel after 10 years at Bell & Howell Co. as chief electronics engineer.

U. S. Edcor Moves To Phoenix

The entire administrative and manufacturing facility of U. S. Electronics Development Corp. recently moved from Glendale, Calif., to Phoenix, Ariz. The new 35,000 sq ft plant is devoted entirely to the research engineering and production of electronic capacitors for commercial, industrial and military use.

General Devices Names Director

Walter C. Johnson (pictured, left) chief consultant of General Devices, Inc., Princeton, N. J., is appointed a director of the company, as announced by its president, John Brinster (right). General Devices specializes in multichannel instrumentation devices, creating, engineering and manufacturing components and systems for scientific, military and industrial uses.

Collins Division Reorganizes

The Texas Division of Collins Radio Co. has consolidated research, development, sales and manufacturing activities to concen-
MASER

The Maser is a microwave amplifier utilizing energy stored in a molecular or atomic system. Emission of energy is stimulated by the input signal. Masers operate at liquid helium temperatures and have low noise levels, approaching zero db.

Recently, a university research laboratory† used LINDE single crystal synthetic ruby (Al₂O₃ with Cr₂O₃ additive) in a three-level solid state Maser. The ruby crystal was placed in the Maser's tuned cavity and a magnetic field of 4200 gauss was applied. To bring electrons from a ground state into a permissible higher energy level, a pumping frequency of 24 kMc was used and the Maser amplified signals at 9.3 kMc.

LINDE supplies other crystals, including rutile, spinel, and sapphire (Al₂O₃). Sapphire is used in infrared optical systems, windows for higher power microwave tubes, spacers and supports in vacuum tubes, radiation pipes. It has strength at elevated temperatures, melts at 2040°C., is hard, inert, nonporous, and can be sealed to metals and glasses. Sapphire is available in the shape of domes, windows to 4½ inches in diameter, rods and special configurations.

For more information, write Crystal Products Department, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.


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COME TO BOOTH 228
See this new de-soldering technique demonstrated ...also newest tips for soldering subminiature components.

Write for complete details and new catalog
Unar Electric Tools, Inc.
4101 Redwood Avenue, Los Angeles 66, California

For Fast, SAFE, Easy Printed Circuit Repair

5 assorted tips for every de-soldering operation

DE-SOLDERING KIT
#270 Popular lightweight pencil handle with 5 assorted tips for every de-soldering operation. Slotted tip that melts solder and straightens bent or folded tube tabs. Bar tip for straight line de-soldering. 3 different size cup tips that de-solder tube tabs and center pin in one simple operation. In goldtone metal case. List $5.95 each.

Navy Presents High Award
The Navy Certificate of Merit, one of its highest honors, was recently awarded the Cooke Engineering Co., Alexandria, Va. Nelson M. Cooke (pictured, right), company president, accepted the award from Rear Admiral A. G. Mumma, acting for the Secretary of the Navy. Specifically, the award was granted for the successful accomplishment of the emergency "turnkey" project of effecting the systems design, planning, provisioning, installing, "checking-out", and turning over to the Navy an extensive radio communications facility at Londonderry, Northern Ireland. The entire project was completed in six months.

Hull Elected EIA President
At its recent 34th Annual Convention in Chicago, the Electronic Industries Association elected David R. Hull president. A vice president of defense programs of the Raytheon Mfg. Co., Waltham, Mass., Hull succeeds W. R. C. Baker, who retired last
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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SYNONYMOUS

WIDEBAND FLUTTER METERS

Features
A very sensitive broadband instrument for laboratory use in the precise measurement of small amounts of flutter with components up to 5000 cps. Most frequently used in telemetering and data reduction systems.

Specifications
Carrier Frequency - 14,500 cps, crystal controlled
Bandwidth - D.C. to 5000 cps
Bandwidth Selection - Full range above, 0.5 to 30 cps, 30 to 300 cps, 300 to 5000 cps.
Scale Ranges - 0.2%, 0.6%, and 2.0% full scale
Drift Meter - ± 0.005% per minute
Display - 3-inch flat-face oscilloscope for flutter analysis

Price: $965.00 rack mounted, $1000.00 In cabinet

CIRCLE 205 READERS SERVICE CARD
NEWS ABOUT BENDIX SHAFT ENCODERS

Photo-Electric Sensor Types Added to Line

The Bendix® "Supermarket" for precision components has long served your analog-digital converter needs with miniature, brush slip-ring shaft encoders featuring extremely high resolution. Now, with the addition of new photo-electric sensor types, the Bendix shaft encoder line makes Bendix extra quality available for even broader applications.

With these new photo-electric sensor units, you enjoy the important advantages of higher operating speeds, lower operating torque requirements, longer life, and finer resolution in relation to physical size.

BENDIX OFFERS WIDE CHOICE TO FIT YOUR EXACT SHAFT ENCODER NEEDS

<table>
<thead>
<tr>
<th>TYPE NO.</th>
<th>GS-7-A1</th>
<th>GS-8-A1</th>
<th>GS-5-A1</th>
<th>GS-3-A1</th>
<th>GS-4-A1</th>
<th>GS-4-A1</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTPUT</td>
<td>9 DIGIT GRAY</td>
<td>13 DIGIT GRAY</td>
<td>8 DIGIT GRAY</td>
<td>9 DIGIT BINARY</td>
<td>7 DIGIT BINARY</td>
<td>13 DIGIT GRAY</td>
</tr>
<tr>
<td>STYLE</td>
<td>PHOTO ELETTRIC</td>
<td>DOUBLE BRUSH</td>
<td>BRUSH</td>
<td>BRUSH</td>
<td>DOUBLE BRUSH</td>
<td>BRUSH</td>
</tr>
<tr>
<td>RESOLUTION</td>
<td>1 PART IN 512</td>
<td>1 PART IN 8192</td>
<td>1 PART IN 256</td>
<td>1 PART IN 188</td>
<td>1 PART IN 128</td>
<td>1 PART IN 8192</td>
</tr>
<tr>
<td>MILLI-AMPS/DIGIT</td>
<td>.075 (MAX.)</td>
<td>10 (MAX.)</td>
<td>10 (MAX.)</td>
<td>15 (MAX.)</td>
<td>10 (MAX.)</td>
<td>10 (MAX.)</td>
</tr>
<tr>
<td>CONT. SPEED (RPM)</td>
<td>HIGH SPEED</td>
<td>150 (MAX.)</td>
<td>150 (MAX.)</td>
<td>150 (MAX.)</td>
<td>150 (MAX.)</td>
<td>50 (MAX.)</td>
</tr>
<tr>
<td>OPERATING TORQUE</td>
<td>.05 OZ- IN. (MAX.)</td>
<td>.50 OZ-IN. (MAX.)</td>
<td>.20 OZ- IN. (MAX.)</td>
<td>.27 OZ-IN. (MAX.)</td>
<td>.31 OZ-IN. (MAX.)</td>
<td>.40 OZ-IN. (MAX.)</td>
</tr>
<tr>
<td>CASE DIAMETER</td>
<td>1.191 INCH</td>
<td>1.411 INCH</td>
<td>.937 INCH</td>
<td>.937 INCH</td>
<td>.937 INCH</td>
<td>2.50 INCH</td>
</tr>
</tbody>
</table>

*RPM DETERMINED BY APPLICATION

Eclipse-Pioneer Division

Teterboro, N. J.

*You Can't Beat the Bendix Supermarket.

year as vice president of General Electric Co. and this year concluded his second term as EIA president.

Scal Appointed General Mgr.

ROBERT SCAL (picture), vice president and chief engineer of R/S Electronics Corp., Palo Alto, Calif., a subsidiary of Regan Industries, Inc., has been named to assume the duties of general manager of the subsidiary.

R/S Electronics manufactures electronic equipment for military and industrial uses, including a full line of i-f amplifiers for missile, radar, and aircraft installation.

Scal joined the Regan subsidiary in 1954 as chief engineer, after serving for seven years as chief of the Radar Miniaturization Unit of the Electronics Div., National Bureau of Standards.

FEC Transfers Myron Bakst

APPOINTMENT of Myron Bakst as project manager for the White Alice integrated civilian-military communications system in Alaska has been announced by F. H. Lannah, president of Federal Electric Corp., Paramus, N. J.

FEC, service subsidiary of IT&T Corp., operates and maintains the system under a contract with the Air Force.

Bakst was transferred to the system from the Distant Early Warning (DEW) Line, also operated
THE BEST IN
STATION RECEIVERS

Aerocom's Model 77 single-channel H.F. crystal-controlled receiver was
designed and built to meet your needs.

A high-performance, rack-mounted, rugged
receiver, designed for reception of A1, F1
or A3 signals. Frequency range is from
2 MCS to 24 MCS, using permanently
mounted R.F. coils which are selected by
rotary switch. (No plug-in coils). Can be
operated continuously in any climate from
hot and humid to very cold. Crystal band-
pass filter used in L.F. amplifier. 6 KC width
normally supplied for A3 and 1.8 KC width
normally supplied for FSK.

Two Model 77 receivers can be used in
a space-diversity system by using Aerocom's
Model DRC diversity combining unit.

follow your career under ideal conditions at
LIBRASCOPE

Computer—Controls—Components
Design—Development—Manufacturing

You can be assured of ideal working conditions at well located Librascope. Why?
Because of the physical plant: air-conditioned, ultra-modern, the location: at the
edge of the foothills; near Los Angeles, Hollywood and the pleasant residential family
areas of Burbank, Glendale, Pasadena.

A company with highest professional and technical standards. If you are an M.E. or
E.E., mathematician or physicist, interested in Analog or Digital Computers • Logical
Design • Instrumentation • Servo Mechanisms • Electro-mechanical • Systems •
Transistor Applications • Controls for commercial and Military Equipment, you're
invited to investigate the opportunities at Librascope which has just held its 20th
Anniversary—a sound, stable organization growing with automation. Write Glen
Seltzer, Employment Manager.

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INCORPORATED
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Miami 33, Florida

LIBRASCOPE uses
the engineering
project team
method.

Write today for this
interesting booklet
about Librascope.
M-1 Toss Bomb System

When the prime contractor for the M-1 Toss Bomb System required a highly reliable miniature accelerometer for the bombing computer used in U.S.A.F. Tactical Bombers, Fairchild was called in. Fairchild’s Sales and Customer Engineering Group working closely with the Contractor’s Engineers developed the TA-100 pictured below.

For Angle of attack correction...

Fairchild Accelerometers

Fairchild Features — Fairchild Linear Accelerometers are miniature in size, light weight, and have high sensitivity and resolution.

Three basic designs are offered. The TA-100 is an economical pendulous accelerometer with torsion bar suspension and pot pick-off. The TA-200 is an axial design with coil spring restraint and pot pick-off. The TA-400 is a floated pendulous accelerometer using a torsion bar with jewel bearing suspension and an a.c. type pick-off.

Other Outstanding Features
1. Potentiometer or AC pick-offs
2. Linear or non-linear pot outputs
3. Low cross-talk
4. Low temperature error
5. High sensitivity

Typical Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>TA-100 (low natural frequency)</th>
<th>TA-200 (low cross-talk)</th>
<th>TA-400 (low cross-talk &amp; high accuracy)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>potentiometer ±1 to ±100g</td>
<td>potentiometer ±1 to ±100g</td>
<td>A.C. reluctance ±1/2 to ±10g</td>
</tr>
<tr>
<td></td>
<td>5-50 cps</td>
<td>7-50 cps</td>
<td>8-80 cps</td>
</tr>
<tr>
<td></td>
<td>.7 @ 25°C</td>
<td>.7 @ 25°C</td>
<td>.7 @ 25°C</td>
</tr>
<tr>
<td></td>
<td>1.5%</td>
<td>1.5%</td>
<td>better than 1%</td>
</tr>
</tbody>
</table>

The TA-100 and TA-200 can be supplied with A.C. type or Fairchild’s Nobl-Ohm infinite resolution Film Pot pick-offs on special order.

For information write to Dept. 21-E

Camden Firm Elects V-P

In Camden, N. J., Magnetic Metals Co., manufacturers of electromagnetic core products for the transformer industry, has elected Donald O. Schwemsen (picture) vice-president. With the company since 1956, his new duties will include both engineering and managerial responsibilities.

Organize New Company

1 siL. Adams-Russell Co., Inc., Cambridge, Mass., was recently formed by Gerald J. Adams, Lindsay Russell and Oliver H. Straus. Adams has been a project manager and group head at Hycon Eastern, Inc. of Cambridge for the last three years. For the preceding eight years he was senior engineer at Alford Consulting Engineers of Boston.

Russell was formerly a project engineer at Hycon Eastern, and was also a project engineer at Alford Consulting Engineers from 1951 to 1956.

Straus was also at Hycon Eastern, Inc. as a vice president. Prior to
Announcing...

Modine transistor coolers

Standardized for immediate shipment
in module and strip form

These compact, lightweight aluminum units prevent thermal runaway in electronic circuits... hold transistor junction temperature safely within design limits. Heat is conducted through the base mounting plate and is dissipated by cooling air passing through the fins.

Modine Bulletin ID-158 contains performance data and application information on these efficient coolers. For full details on standard and custom-built models, write Electronic Cooling Dept., Modine Manufacturing Co., 1602 DeKoven Avenue, Racine, Wisconsin.
Looking for the right resistor?

Call Speer for a complete line
of fixed composition resistors, phenolic coil forms

For detailed information on specifications, characteristics and applications ask for this catalog of Speer Electronic Components. Automation Soldering your concern? Be sure to send for Speer's Bulletin on this subject.

Plant Briefs

Synco Corp. of Oxford, Mich., manufacturer of power tools, has expanded into the field of capacitors and LC coils with the building of a new plant in Hicksville, Ohio.

Aerolab Development Co., Pasadena, Calif., recently acquired a new building with 15,000 sq ft of floor space adjacent to its main plant. New facilities will be used for design and manufacture of high altitude research missiles.

Electronics Corp. of America, Cambridge, Mass., has established an affiliate in Rio Piedras, Puerto Rico. New firm, Electronics Corp. Pan America, will manufacture industrial electronic controls for the transportation industry.

News of Reps

Four newly appointed reps will handle electronic test equipment for Teletronics Laboratory, Inc., Westbury, N. Y. Reps and their territories are:

Broger Instrument Sales Co. for New England; W. K. Geist Co. for southern California, Arizona and New Mexico; George F. Landfear Enterprises for New Jersey and metropolitan New York; and Ohio Instrument Co. for Ohio, Kentucky, West Virginia and western Pennsylvania.


Impressive cost savings and greater reliability are inherent in the use of the new Ney molded contact assemblies. For use with printed commutators, potentiometer windings, slip ring assemblies and printed rotary switches, these assemblies are available in a standard line now being manufactured by Ney, or can be designed to customer specifications.

Seven prime advantages are (1) a complete single or multiple brush assembly ready to use, (2) no welding or soldering, (3) reduction of adjustment during assembly into unit, (4) insured uniformity of desired gram pressure, (5) reduced inspection costs, (6) time tested Ney alloys for reliability, (7) will withstand extremes in operating environments.

SEND FOR LITERATURE

The J. M. Ney Company
P.O. Box 990, Dept. E, Hartford 1, Conn.
CIRCLE 217 READERS SERVICE CARD

August 15, 1958 – ELECTRONICS engineering edition
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For your laboratory, incoming inspection, or in-line test positions—or wherever accurate and reliable measurements must be made quickly—you need a HYCON Digital Volt-Ohmometer.

READABLE 1/2" digits, in line, with illuminated decimal point and polarity indicator for fast (2 second average) readout without interpolation error.

RUGGED AND RELIABLE with no delicate components—designed for continuous operation, and to withstand shock and vibration without loss of accuracy.

Complete Data in Bulletin 645

Model 645AR 0.1% accurate, DC and Ohms $875.00
Model 615AR 0.5% accurate, DC and Ohms $485.00
Both instruments are 1% accurate on AC from 10 to 1000 volts; 2% accurate below 10 volts.

Order from your HYCON representative, or from:

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370 South Fair Oak, Pasadena, California

HYCON ELECTRONICS, INC.
360 South Fair Oak, Pasadena, California

Why do it Yourself?

It Pays to Standardize on Jeffers R.F. Choke Coils

You can save time, labor, and money by stocking the wide range of Jeffers R.F. choke coils just as you do resistors, capacitors, and other similar components. You can forget tedious, expensive hand assembly from miscellaneous forms, wires, and coatings by using standardized Jeffers coils, completely assembled for use.

Jeffers coils are well made, using insulated copper wire windings... husky molded jackets. All windings are soldered to leads... shorted end turns are completely eliminated.

Put these advantages to work in your circuits! Jeffers Electronics offers you... ready for delivery... a complete line of R.F. choke coils with a complete range of inductance values. Write today for our specification sheets.

Jeffers Electronics offers you... ready for delivery... a complete line of R.F. choke coils with a complete range of inductance values. Write today for our specification sheets.

Olive Can Company

Speer Products for the Electronics Industry

Speer Resistor, Speer Carbon Products, International Graphite & Electrode

Jeffers Electronics

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Olive Can Company

Originators of Low Cost, High Voltage housings for the TV Industry

CIRCLE 219 READERS SERVICE CARD

ELECTRONICS Engineering edition – August 15, 1958
NEW BOOKS

Electronic Designers' Handbook

By R. W. LANDEE, D. C. DAVIS, AND A. P. ALBRECHT.


The authors of this addition to McGraw-Hill's handbook series have directed their efforts to students and practicing engineers in the electronic field.

The book is divided into 23 sections and in size, format and general content is very similar to F. E. Terman's "Radio Engineers' Handbook." The first seven sections of the new handbook cover the subjects of general design, data, vacuum tubes and transistors, voltage amplifiers, power amplifiers, modulation, oscillators and receivers. The new material covers transistors, design problems arising from the need for circuits to handle pulses, suppressed-carrier and single-sideband transmission, backward-wave and phase-shift oscillator circuits and the more sophisticated band-pass circuits involving flat-staggered tuning.

Noise—In the section on receivers, the discussion of noise is more extensive than that found in many textbooks. In this same section there is also an excellent discussion on tube and crystal mixers together with illustrative examples to bring out the important points.

The following five sections on multivibrators, variable delay circuits, trigger circuits, sawtooth generators, limiters and clamps, point up the tremendous growth in pulse and digital techniques.

Of the sections on inductively coupled circuits, transformers and chokes, power supplies, filters, attenuators and equalizers, the section on transformers and chokes is notable in that it presents a comparatively complete treatment of the design of low-power iron-core transformers and chokes. The section on filters presents graphical performance data for constant-k and m-derived filter sections having dissipation.

Principles of feedback and com-
Meet the industry's top efficiency team...

Augat's complete line of Component Cradles and Clips

Here's positive, lasting protection against external shock and vibration. Augat cradles are especially designed to clamp sub-miniature and miniature tubes, transistors, resistors, capacitors, diodes, crystals, etc.

They assure longer life of tubes and transistors by reducing temperature through conduction.

SEE US AT WESCON IN BOOTH 2748

Write today for additional information and samples.

AUGAT BROS. INC.
31 PERRY AVENUE • ATTLEBORO, MASS.

CIRCLE 225 READERS SERVICE CARD

Electrical Coil Windings

For 40 years... specializing in all types of coils to customers' specifications. Design or engineering assistance available on request.

COTO-COIL CO., INC.
SINCE 1917
65 Pavilion Avenue Providence 5, Rhode Island

CIRCLE 226 READERS SERVICE CARD

For Those Who Demand Service!

COSMIC ELECTROLYTIC & PAPER TUBULAR

"35 YEARS OF PROVEN DEPENDABILITY"

COSMIC CONDENSER CO.
853 Whittier St., Bronx, N. Y.

PHONE Ludlow 9-3380

CIRCLE 227 READERS SERVICE CARD

KURMAN RELAYS

SUB-MINIATURE SENSITIVE RELAY
Series 1

POWER RELAY
Series 26

POWERFUL SENSITIVE RELAY
Series 300

MIDGET SENSITIVE RELAY
Series 23

TELEPHONE RELAY
Series A

Immediate Delivery from Franchised Distributors

SEND FOR COMPLETE CATALOG

Kurman Relays... hermetically sealed, dust covered and open... meet military specifications... interchangeable with other leading makes.

KURMAN ELECTRIC CO.
Division of NORBUTE CORPORATION
Dept. E, 191 Newel St., Brooklyn 22, N. Y.

EVERgreen 3-8000

EXPORT: TERMINAL RADIO INTL.
135 LIBERTY ST. N. Y. C.

CIRCLE 228 READERS SERVICE CARD
EAGLE
TIME DELAY RELAY
WITH COMPACTNESS — PLUS
"MIL-SPEC" 2000 cps VIBRATION TESTS

SPECIFICATIONS (General)
a. Operates during 5 to 2000 cps, 10G vibration.
b. Operates —55° to +125° C.
c. Withstands 30G 11ms shock.
d. Weight 9 oz.
e. Hermetically sealed.
f. D.C. operating coil.
g. Timing not affected by voltage variations.
h. 3% accuracy under normal test conditions.

This relay employs a new type escapement principle. It offers utmost reliability under severe environmental conditions through its rugged design and self-starting characteristics.

Write for complete descriptive Bulletin 820. Address Dept. E-858.

THUMBNAIl REVIEWS
Streamlined Lens-Radomes. (PB 131041). By A. F. Kay, OTS, U. S. Dept. of Commerce, Washington, D.C., 1956, 49 p., $1.25. Design technique for variable-refractive-index lenses combined with a computer and servomechanism techniques are discussed in two excellent sections which total nearly 10 percent of the book, again illustrating the dramatic expansion of the horizons of the electronic designer over the short span of a decade and a half.

The sections on transmission lines and antennas illustrate the growing use of the Smith chart and the increasing emphasis on the microwave frequencies.

Network Theory. The two final sections on waveform analysis and network analysis include fundamentals of statistical and probability theory, graphical methods as an aid in the determination of inverse Laplace transforms, the analysis of complex waveforms and what amounts to a short course in network theory.

The usual mathematical tables are missing but should be of no concern to the average user who probably has the necessary tables duplicated many times even if his technical library is a modest one.

Designs Illustrated. In the preface the authors have stated that it has been their opinion that handbooks often have limited value since the presentation is frequently so concise that the material presented has little value unless the reader has had previous experience with the subject. Consequently an attempt has been made to overcome this limitation by making the text as lucid as possible and by including design examples which illustrate the application of the material to specific design problems.

It is the opinion of this reviewer that the authors have successfully met their goal and have contributed a very useful tool for the electronic designer. This book deserves a place on every reference shelf.

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Send for leaflet B124/C.

And More Symbols

Comments about the conflict between symbols for transistor and gated rectifier (June 20, p 158 and Aug. 1, p 159) raise a question of great concern to the circuit designer, since circuit diagrams must be clearly understood in order to fulfill their purpose.

The rapid pace of progress in this field leaves the engineer short of symbols, short of standards, and short of breath in keeping up with the advance of technology.

The fountainhead of information in this matter is made up of the Institute of Radio Engineers, American Institute of Electrical Engineers, American Standards Association, and the office of standardization of the Department of Defense. All these groups have cooperated to prepare the military standards known as "Mil Specs." The military standard for graphical symbols is MIL-STD-15A. It is mandatory for all government contracts.

This standard shows this symbol for a tetrode transistor and this for a pentode transistor.

Obviously the gated rectifier symbols used by ELECTRONICS, as well as that proposed by Messrs. Frenzel and Gutzwiller (Comment, June 20) infringe on the ones already approved by MIL-STD-15A for special transistors.

Mil specs have not caught up yet with the gated rectifier, and no official symbol is available now for this device.

Whatever modification is made to the standard rectifier symbol in order to represent a control gate terminal, it should not be made to resemble a transistor. A transistor is a current amplifier, a rectifier is not, and their symbols should re-
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August 15, 1958 - ELECTRONICS engineering edition

flect the wide difference.

My suggestion is a symbol along these lines:

\[
\begin{align*}
\uparrow \quad \uparrow \\
P \quad N
\end{align*}
\]

that is, the standard rectifier symbol extended to include the standard for a terminal, which is a small circle, the P or N to signify the kind of gate terminal.

John J. Rivera
Federal Telecommunication Laboratories
Belleville, N. J.

Reader Rivera's letter came into our office before we had a chance to print the reasoned and definitive discussion of the problem by S. K. Ghandhi of IRE's semiconductor symbol group (Comment, Aug. 1, p 159). Reader Ghandhi made clear in his letter the philosophy of IRE in setting up symbol standards:

"Symbol structure must be a logical extension of a well-accepted symbol and must be capable of extension to new devices as the state of the art progresses. A symbol should not be based on theory of operation... theories have a habit of being improved continuously... A symbol should indicate the physical properties where possible without complication."

The symbols suggested by Mr. Rivera in the last paragraph of his letter seem to be based more on theory than on physical properties.

An Error in Authorship

My name appeared as one of the co-authors of the article "New Intermetallics Offer Wide Infrared Response" (July 4, p 48). Since I did not actually make any contribution to this article, I would appreciate a notice deleting my name as author.

Thank you very much for rectifying this error.

Alan J. Strauss
Chicago Midway Laboratories
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Reader Strauss' valuable work in intermetallics apparently got in our way.
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