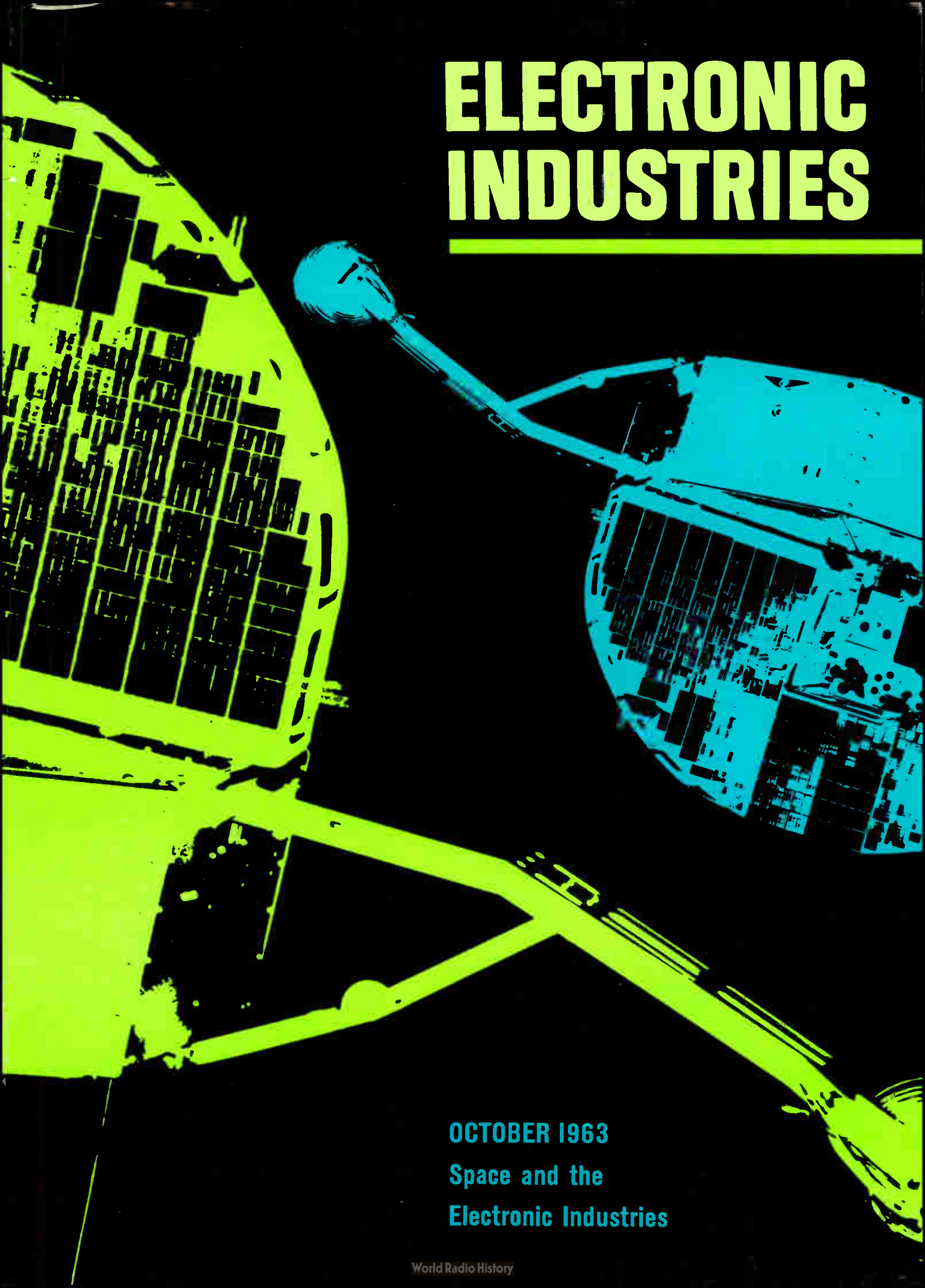


ELECTRONIC INDUSTRIES



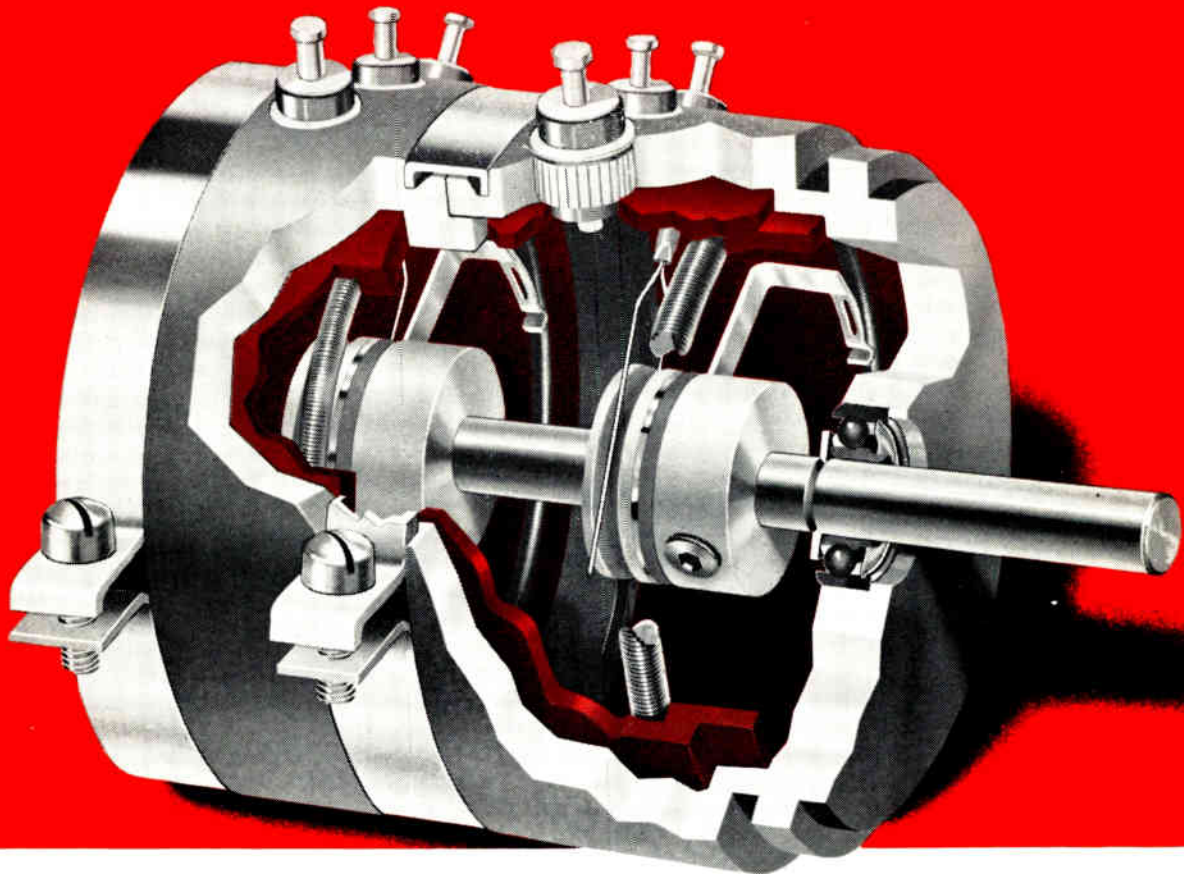
OCTOBER 1963

Space and the
Electronic Industries

DALE

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Your Assurance of RELIABILITY



Dale enters the precision potentiometer field with insight gained through long experience in producing precision wirewound resistors and precision wirewound trimmers. This experience has provided Dale with advanced technology in winding the smallest diameter resistance wires as well as superiority in producing resistance devices with improved metallurgical and performance characteristics. To this insight and experience has been added Dale's stringently controlled methods of manufacture — methods which have reached new levels of achievement as a result of the Dale high reliability **MINUTEMAN** component development program. Now, the Dale reputation for products with inherent stability can be your assurance of the highest quality in precision potentiometers. Send us your requirements. Dale will make a precision potentiometer to meet them. Write for Dale Precision Potentiometer Catalog E.

SPECIFICATIONS

• Meet requirements of MIL-R-12934B and NAS-710 • Eight physical sizes $\frac{7}{8}$ " to 3" diameter • Electrical angles and functions can be supplied to specification • Special mechanical configurations, single and ganged units available.

CHECK THESE FEATURES

- 1. LINER-HOUSING** construction combines the excellent dielectric strength and high temperature properties of molded diallyl pthalate with the structural strength and stability of a precision-machined anodized aluminum housing.
- 2. WELDED TERMINATIONS** provide greater tapping accuracy and mechanical strength. Terminations are gold plated to aid soldering and welding. Resistant to moisture and oxidation.
- 3. MANDREL INSULATION** assures excellent load life characteristics through use of high-temperature materials.
- 4. MOLDED HUB** of diallyl pthalate has excellent dielectric strength and high temperature characteristics. Contains precision instrument bearings.
- 5. CONTACTS** on wiper and collector assemblies are of noble or precious metals throughout.
- 6. CLAMP BANDS** are recessed within housing and do not increase diameter of unit.

DALE**DALE ELECTRONICS, INC.**

1304 28th Avenue, Columbus, Nebraska

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Also Made and Sold by Dale Electronics Canada, Ltd., Toronto, Ontario, Canada

Circle 98 on Inquiry Card



SHELBY A. McMILLION,
Publisher
BERNARD F. OSBAHR,
Editor

ELECTRONIC INDUSTRIES

AMERICAN INDUSTRIES ARE OUR CHALLENGE

THE SEARCH TO EXPAND ELECTRONIC MARKETS outside the electronic industries is now taking a realistic turn. Last month, at EIA's Fall Conference, in New York, its Industrial Electronics Division was authorized and financed to explore electronic applications in other industries. Such marketing research is long overdue.

During the past twenty years the meteoric growth of the electronic industries has been chiefly due to defense spending. Now we have a backlog of electronic capability and capacity which had given rise to a Department of Defense buyer's market. This situation limits the future growth pattern of the defense-aerospace electronic business. To bolster the growth curve, we now must break into new high ground by putting our defense-funded technology to work creating new markets. Our best immediate prospects may be developed right in our economy's own backyard—the U.S. industrial complex.

Don't look for a panacea or fast profits in these new areas. This industrial market is highly competitive. R & D is not financed by the customers. Profits are not assured and losses are possible. But it is not subject to burdensome government regulations nor to renegotiation! And your proprietary

products can be legally protected.

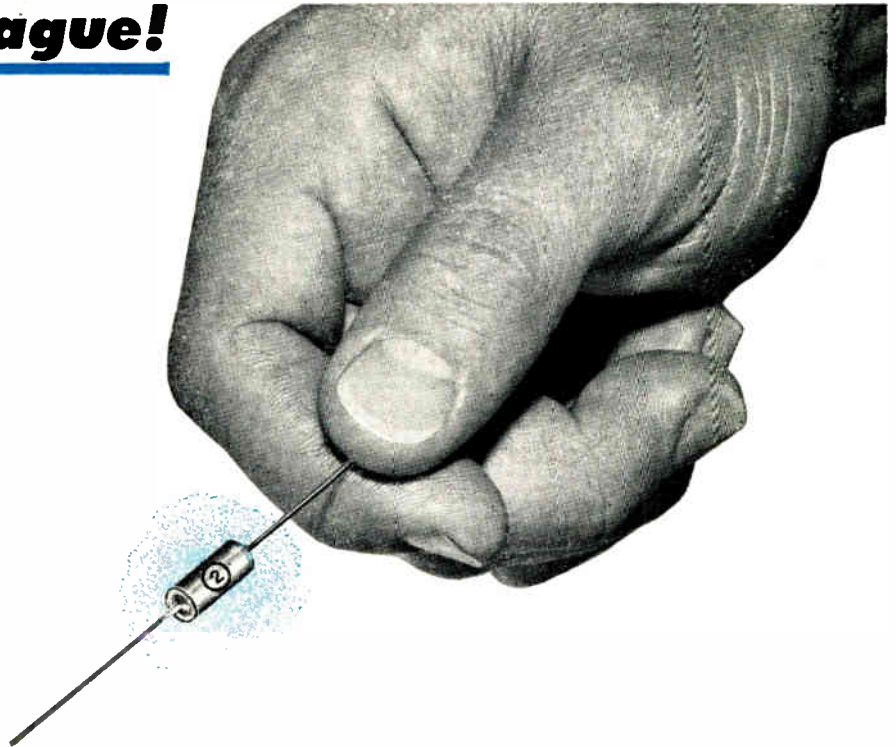
Today's gross national product totals approximately \$580 billion. The National Planning Association in Washington, D. C., foresees a GNP of about \$700 billion by 1970. This is up some \$150 billion. The electronic industries should be a prime mover to help achieve this industrial growth. We now have many obsolete plants whose operations could be modernized and automated electronically.

One of the big problems we face is that we have yet to resolve the technical communications between the electronic industries and their potential industrial customer. Engineers must learn how other industries work and how electronic technologies can best be applied to maximize industrial profits. This job is difficult, and challenging, but not insurmountable.

Since your future as an engineer may depend upon how soon industrial markets are developed, we support EIA's new effort and we solicit your suggestions as to how its newly funded committee can best accomplish its task. We suggest that members of other industrial engineering and management groups join with EIA in a united industrial electronic engineering-management-marketing effort.

Bernard F. Osbahr

Only from Sprague!



Improved Type 150D Solid-Electrolyte

TANTALEX® CAPACITORS

with **PERFORMANCE CHARACTERISTICS**

NEVER BEFORE POSSIBLE!

■ **DISSIPATION FACTOR CUT BY ½**—Not more than 3% at 20 VDC and up, permitting even higher a-c ripple currents!

■ **LOWER IMPEDANCE AT HIGH FREQUENCY**—With impedances in fractional ohmic values in the megacycle range, Type 150D admirably meets the stringent requirements of high-speed computers.

■ **LOWER LEAKAGE CURRENTS**—Previous limits have been dramatically reduced; in some instances by as much as a factor of three.

■ **INCREASED CAPACITANCE STABILITY**—Capacitance change with temperature is now less than ½ the previous guaranteed values. Capacitance change with life is almost insignificant.

■ **NEW HIGHER VOLTAGE RATINGS**—50, 60, 75 and 100 volt ratings are now available, with associated surge voltages higher than any presently offered in the industry.

NEW ULTRA-MINIATURE TYPE 172D

New end-seal design makes possible two tiny sizes (.085" dia. x .250" long, and .127" dia. x .375" long) for "cordwood" packaging to supplement standard-sized Type 150D ratings in case size "A".

For complete technical data on Type 150D and 172D Tantalex Capacitors, write for Engineering Bulletins 3520E and 3523, respectively, to Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

Popular ratings of Type 150D Capacitors are available for fast delivery from your Sprague Industrial Distributor

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ELECTRONIC INDUSTRIES

October 1963
Vol. 22, No. 10

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COVER: The weather on the sun is reported to Earth by Orbiting Solar Observatory-1, the new satellite developed for NASA by Ball Brothers Research Corp., Boulder, Colorado. Its basic airframe is fabricated of Alcoa aluminum. The 440-pound OSO-1 is in two sections—a rotating three-legged base, and a fan-shaped sail. The wheel-like base structure is divided into nine compartments, containing satellite control systems, and most of the complex instruments now studying the sun. The OSO-1 was launched into orbit by a Thor-Delta rocket.

Now from Sprague!

SEPT®

SILICON PLANAR EPITAXIAL TRANSISTORS 2N2217 thru 2N2222

TO-5 (P _D =.8W) TO-18 (P _D =.5W)	2N2217 2N2220	2N2218 2N2221	2N2219 2N2222
BV _{CBO}	60 V (max.)	60 V (max.)	60 V (max.)
I _{CBO} @ 50V	10nA(max.)	10nA(max.)	10nA(max.)
h _{FE} @ I _C =150 mA	20-60	40-120	100-300
V _{CE} (SAT) (@ I _C =150 mA)	.4 V	.4 V	.4 V
C _{ob} @ 10 V	8 pF	8 pF	8 pF
f _T @ V _{CE} = 20 V I _C = 20 mA	400mc(typ.)	400mc(typ.)	400mc(typ.)

Sprague N-P-N SEPT® Transistors are designed for optimum emitter perimeter-to-area ratio, providing outstanding gain uniformity from 0.1 mA to 500 mA and f_T (typ.) of 400 mc. Sprague epitaxial techniques guarantee high BV_{CEO} (30V) and low V_{CE} (SAT) (.24 V @ 150 mA).

SEPT® TRANSISTORS FILL A WIDE RANGE OF APPLICATIONS AS SWITCHES, CORE DRIVERS, AND AMPLIFIERS!

For application engineering assistance, write to Transistor Division, Sprague Electric Co., Concord, N. H. For technical data, write for Engineering Bulletins 32,000, 32,005 and 32,010A to Technical Literature Service, Sprague Electric Co., 233 Marshall St., North Adams, Mass.

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ARTICLE HIGHLIGHTS

of this issue



Survey of Vacuum Technology

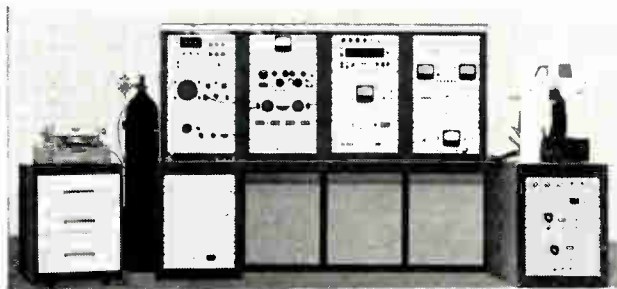
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High-vacuum environments are becoming increasingly important for space simulation and for production of high reliability electronic devices. This article will prove helpful to those who find it necessary to select and use high-vacuum equipment for electronic applications.

Electronics Growth Brings Trouble for Labor

56

When radio was young many unions were already old, though at the pinnacle of their power. The rapid growth of industrial and aerospace electronics has blown the fuse for some unions, depleted ranks in others while adding new members to a few. Labor now faces two chief dilemmas—changing skills and technology, and automation.



Improved Checkout For IR Detectors

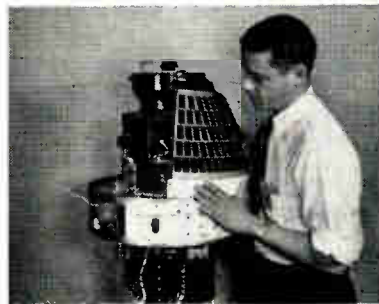
82

The key to reliability in airborne IR packages is in the design and manufacture of the detectors themselves, and in the checkout procedures used to keep them in operating condition. Because the chemical and physical nature of IR devices creates inherent problems of stability and uniformity, the test measurements play a vital role in successful systems.

Well Regulated Battery-Solar Cell Charging

88

The terminal potential of a battery is a poor measure of its state of charge. Present methods do not give charge-rate information nor do they provide a reliable continuous indication of battery charge. Here is a system which permits deep discharge and safe, controlled high charging rate along with weight reduction.



Automatic Tracking Antenna Systems

92

Ground-based antenna systems are being used for research and target acquisition, automatic tracking, command and telemetry. The basic problems lie in physical size, noise and sensitivity. These are discussed along with performance and cost aspects of the various types.



Six Tape Recorders Stacked on a Bench

Slide 6 magnetic-tape cartridges into the trim 1½-cubic-foot transport of a KRS DATA-Stact™ Portable Instrumentation Recorder. Give each cartridge double-bandwidth record/reproduce channels. Equip the transport with plug-in, interchangeable FM and Direct-type electronics. Result is a remarkable 6-in-1 recording system with up to 12 channels of data-logging capacity.

REVERSIBLE CARTRIDGES

Reliable, smooth-running KRS STACTape™ Cartridges were designed for use in DATA-Stact Recorders to meet highest instrumentation recording standards. Only in KRS STACTape Cartridges can you reverse tape direction to edit data. The housing contains up to 1,200 feet of continuous-loop ¼-inch instrumentation Mylar tape. You never touch tape during operation or storage.

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Send for the vital statistics that are found only in Instrumentation Bulletin DR-2.



Dept. E.I.
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Palo Alto, California

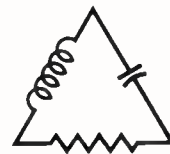
MULTI-CHOICE OPERATION

With a STACT Recorder on line, you can record and reproduce data on any number of channels singly, sequentially, or simultaneously with precise synchronous start-stop operation of the 6-cartridge stack. Backlighted pushbutton controls make operation practically foolproof. A single connector provides for remote control of all cartridges.

THE ONLY BENCH MODEL WITH S.A.*

Simple design and careful manufacture of KRS DATA-Stact Recorders assure years of faultless data-logging performance. The transport uses only two moving parts: (1) A single extended non-slip capstan, and (2) a quiet, cool-running synchronous motor. All-solid-state electronics require little maintenance. Prices range from \$2,500 to \$7,000.

* Stack-Able design



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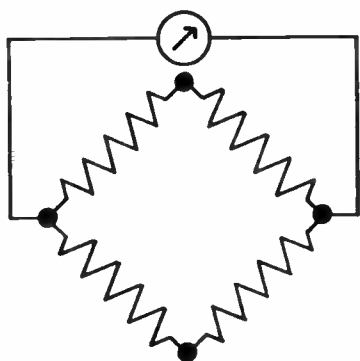
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thorization.

Two reliable techniques for finding faults on cables

TRADITIONAL



Step 1. Dispatch a field engineer to closest cable termination beyond the fault site.

Step 2. Field engineer attaches a pair of test leads to the tie point, completing a Wheatstone bridge circuit to the central station.

Step 3. Fault on cable changes resistance on one side of the bridge; an operator at the central station adjusts resistance on opposite side of circuit to balance the bridge.

Step 4. When the galvanometer reaches the zero point, the operator reads amount of resistance in ohms required to balance the bridge.

Step 5. Turning from meter to map file, he consults a table to find the gauge of cable section under test.

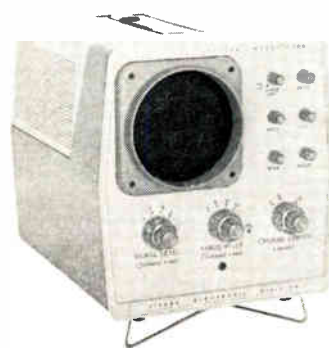
Step 6. Operator calculates resistance of that gauge cable in ohms-per-foot.

Step 7. Resistivity of cable in ohms-per-foot is divided into ohms resistance required to balance bridge circuit.

Step 8. Dividend equals distance in feet from tie point back to cable fault (without compensating for changes in ambient temperature and humidity which can affect performance of the bridge circuit).

For further information on this widely used technique of fault-finding, collar any power engineer who has had extensive experience on a test board.

MODERN



Step 1. Assign an operator to scan up to 30 miles of cable through a Sierra 370A Cable Fault Locator.

Step 2. See opens, shorts, or impedance variations the instant they occur; read distance to fault directly in feet from the pip on the scope.

For further information on this time and labor-saving technique of pinpointing cable faults, get in touch with Sierra Electronic Division of Philco. Ask for data on the Model 370A Cable Fault Locator. While you're at it, you might call in your nearest Sierra sales representative for a fault-finding demonstration.

SIERRA ELECTRONIC DIV.

OF
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A SUBSIDIARY OF *Ford Motor Company*

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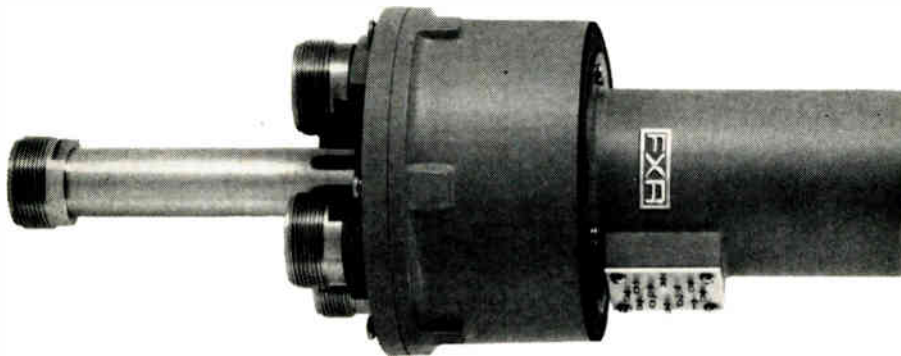
This ad is about coaxial switches:

little ones



(like this one ounce diode switch)

big ones



(like this high-power, high-voltage switch)

special ones

FXR's recent acquisition of the General Communication Company line of coaxial switches extends our switch coverage up to 10 Gc. More than 7500 switch designs, with RF power ratings from one to 8000 watts. Single-pole through 12-pole. Transfer and crossover. In a wide variety of configurations and functions.

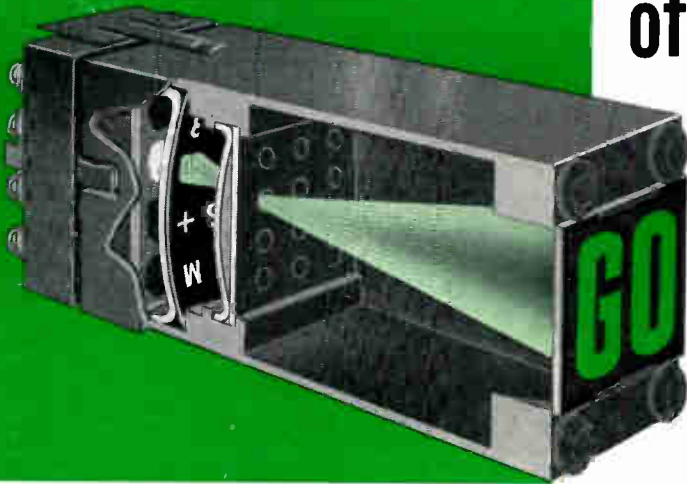
yours?

Designing your own? Maybe the world's largest coaxial switch design engineering staff can be of assistance. We've had lots of experience designing precision devices. That operate reliably in extreme environments. And meet or exceed applicable military specs.

To see what we mean, look over the details of the 850 switches in our two catalogs. By return mail from FXR, 33 E. Franklin St., Danbury, Conn. Or contact your Amphenol-Borg distributor, or call Bernie Washisko at FXR.

FXR[™] THE RF PRODUCTS AND MICROWAVE DIVISION
OF AMPHENOL-BORG ELECTRONICS CORPORATION

Improve the readability
of your display systems
with double-brilliant,
clear characters
... and color



Only IEE one-plane readouts give you such versatile displays

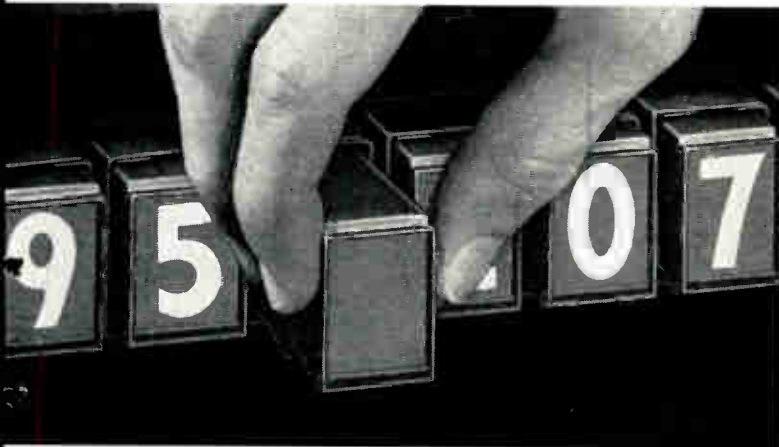
IEE rear-projection readouts provide bright, distinct characters, *all on the same plane*, to assure maximum readability of data displayed. An improved lens system in the Series 120

and 220 readouts doubles brightness without increasing cost. Typical brilliance of units with 6-volt, type 328 lamps is now 50 foot-lamberts as compared to 27 foot-lamberts for previous units. Normal lifetime is 500 hours. By reducing operating voltage to 5 volts, lamp life is extended 10 times to 5,000 hours, and brilliance is reduced only to its former adequate light level of 27 foot-lamberts. Single lamp life up to 50,000 hours can be obtained by operating 6-volt, type 349 lamps at 5 volts. Similar results are obtained in these units using 14 and 28-volt lamps.

Any message that can be photographically reproduced—numerals, letters, multi-digits, multiple words, symbols, colors—all can be displayed on IEE readouts.

Up to 12 messages can be presented individually or in combination by each readout with maximum character heights of $\frac{5}{8}$ ". Write for your copy of the IEE Readout Display Selector Guide.

Series 230 front plug-in readout assemblies are ideal for systems that require message changes. Inserts with new message displays can be changed quickly and easily. Accessibility from the front of a panel makes lamp replacement easy, allows permanent wiring and eliminates the need for flexible cabling.



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World Radio History

RADARSCOPE

Analyzing current developments and trends throughout the electronic industries that will shape tomorrow's research, manufacturing and operation



ELECTRONIC HYDROGEN-FIRE DETECTOR

Detection system for liquid hydrogen rocket fuel fires made by General Dynamics/Astronautics uses two TV cameras. Special filter in one allows only IR radiation to pass to a sensitive vidicon tube to detect invisible hydrogen fire. Second camera is for surveillance. Lab man Leonard Showalter adjusts unit.

CO-OPERATIVE RESEARCH VENTURES between electronics firms and non-competing companies in other fields were suggested by Charles B. Thornton, board chairman of Litton Industries, as a means to reduce duplication and waste. He predicted the next ten years as a period of increased sales, continued mergers and decreasing defense orientation for the electronics industry. He declared that migration of electronics technology into other fields and industries is so great that the so-called electronics industry may lose much, if not all, of its identity. He noted that recent estimates put waste among the nation's R&D activities at around 50% owing to overlap and duplication. He laid most of the blame at industry's front door. "I believe there is an opportunity for furthering our technological progress through joint research efforts between non-competing companies," he said.

SATELLITE COMMUNICATIONS CONTROL is currently being studied by RCA for the Army's satellite program. The initial control center, according to the study, will be used to schedule available communications links through all satellites in the system. RCA Chief Defense Engineer Dr. Harry J. Watters, says the system will consist of a computer and the peripheral equipment needed to provide continuous data on available links provided by satellites. Data will allow Army ground terminals to aim antennas at the nearest satellite.

INDEPENDENT ATOMIC MOTION in crystals, reported by Westinghouse scientists, may help explain behavior of solid state devices and phototransistors. The motion is a shaking—or acoustic vibration—of a few atoms at scattered places where defects occur. It was once taken for granted that all crystal parts vibrated coherently. The discovery may lead to raising present operating temperatures of lasers and masers and explain peculiar effect of neutron radiation on fused quartz.

TELEMETRY STANDARDS TESTS are being sponsored by the Aerospace Industries Association. The proposed constant bandwidth FM standards would provide more efficient use of the available frequency space. Major programs of the DOD, NASA, and AEC are approaching hardware procurement phases using equipment that is neither standard nor applicable for general use. The tests are being conducted by Data-Control Systems, Inc., of Danbury, Conn. The proposed system provides up to 22 data channels at 0 to 1 kc, for use in the 1 mc wide UHF telemetry bands, or 11 data channels for the 500 kc VHF bands.

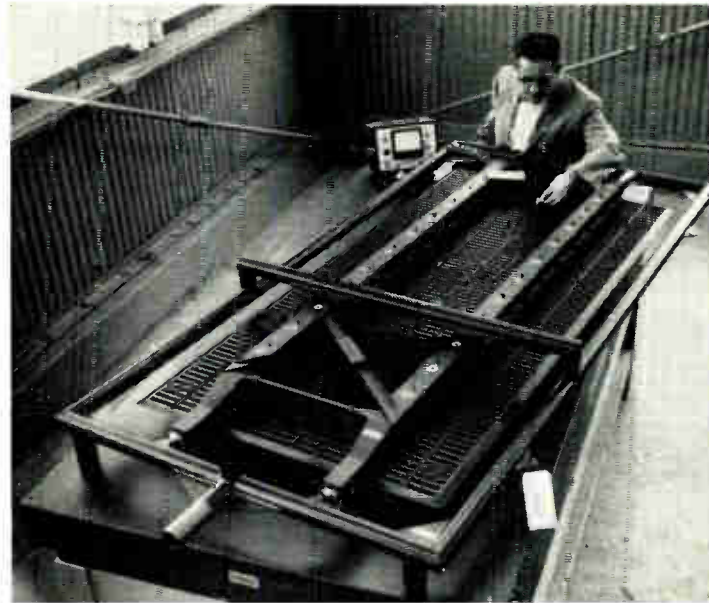
NUCLEAR POWER SUPPLY is currently under study by the Air Force and GE for possible use on manned and unmanned spacecraft. Scientists are now working on an experimental device to carry enough atomic fuel to continuously supply electrical power equivalent to the needs of one hundred average U. S. homes for more than two years, and yet be only three feet long and one foot in diameter. The device has no moving parts, and consists of a small nuclear reactor and a thermionic converter system—similar to thermionic diodes in radio—to change reactor heat into electricity. It would be used in space to power communications and life support equipment. Power output would be as high as 100,000 watts.

STRONG MAGNETIC EFFECTS of chromium tribromide on light have been seen by Bell Labs scientists, who have obtained extremely large magnetic rotations of polarized light. In doing so, they have modulated light at higher frequencies than ever before, and have seen ferromagnetic resonance and magnetostatic modes in crystals for the first time. Lab work has also produced valuable spectroscopic data on electron energy levels of chromium tribromide, giving rise to theory explaining absorption association with large magnetic rotations, which could be useful in search for compounds with similar rotation and absorption properties.

HIGH FREQUENCY TRANSISTORS are strongly recommended by NASA for equipment that will operate in space. Researchers at Langley Research Center exposed germanium and silicon units to successive energy levels from 40 to 440 mev protons. Both silicon and germanium transistors sustained more damage from the lower 40 mev radiation than from the 440 mev. Transistors having higher alpha cutoff frequency were much more resistant to higher radiation.

SOLAR TRACKER IN SPACE

Parabolic reflector petal, one of 36, installed in automatic tracking and solar collecting system designed by Electro-Optical Systems, Inc. The complete mirror, with 2000 sq. ft. reflecting surface, would be aligned with the sun by servo control and would give as much as 250 kw of thermal energy.



SOLAR PANELS FOR MARS MARINER

One of four Ryan-built solar panels, three by six feet, for NASA's Mariner Mars fly-by vehicle is examined by W. M. Cattrell, Ryan project engineer. Ryan is building structures for Cal Tech's Jet Propulsion Laboratory to capture sun's energy for power. Mariner is set for 1964 launch to Mars vicinity.

CONDITIONED-REFLEX MACHINE that can learn to recognize some 4800 previously learned visual patterns with 99.6% accuracy has been developed for the Air Force Systems Command at Wright-Patterson by Scope, Inc. Called Conflex I, the desk-top size unit includes a sensory field, discrimination cells and a memory device. It is capable of recognizing such patterns as pictorial displays, letters, numbers, geometric designs, and with a different sensor, it may be used to recognize speech, other audio and higher frequency patterns. It learns in a random fashion and its "intelligence" may be increased by adding memory units. At present, Conflex I is a research tool to develop pattern recognition techniques for aerospace use.

CREATION OF HIGH FREQUENCIES by multiple quantum transitions has been achieved at Kane Engineering Labs., of Palo Alto. Scientists achieved frequency multiplication by three (third harmonic) on the order of 80 watts output from 250 kw input. The conversion was from X-band to K-band. Through multiple quantum transitions, interaction of electromagnetic energy with a molecular system can convert power from one frequency to an odd harmonic of the basic frequency. Microwave frequencies can then be lifted to even higher frequencies. Approach may offer potential for reaching into the spectrum area between microwaves and infrared.

(More RADARSCOPE on Page 13)

time (t), pressure (psi), temperature (t)
 voltage (E), current (i), watts (w), weight
 volt amperes (va), frequency (f), stress (E)
 strain, force (F) radiat
 dis p, amplitude (A), flow (gpm)
 pH, velocity (v), acceleration (a),
 length, thickness (t) volume (V)
 angle, (w), angular acceleration (a)
 torque, (g), weight (w), ten
 shock, (I), magnetic field
 intens, (log), radiation (I)
 relative, rption (k), phase angle (θ),
 density, H, conductivity (P), im
 velocity, length (L), angl
 width, volume (V), angle (θ),
 angular, class acceleration (α), st
 torque, (g), shock (g), thick
 weight, (I), radiation (I)
 magne, (H), Distance (s), width

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Type R Dynograph® Specifications

Sensitivity Range	1 μ v/mm — 5 v/mm
Frequency Response	DC to 200 cps
Response Time	2.5 msec
Drift (shorted input)	1 μ v equiv. input/hr.
Warm-up Time	Instantaneous
Recording Amplitude	7 cm (curvilinear) 6 cm (rectilinear)
Linearity	0.5% for central 5 cm (curv.) 1.0% for central 5 cm (rect.)
Input Impedance	2.5 megohm
Input Couplers	Complete line
Number of channels	to 24
Approximate cost per channel	\$1,000

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RADARSCOPE

COLD-CATHODE TRAVELING WAVE TUBE developed by Raytheon is expected to have long life due to absence of a heater circuit. Still experimental, the tube may not be available in quantity for several years. It delivers continuous gain over its frequency range of 2 to 4 gc. Continued research on the TWT promises desirable features such as high current densities, low noise beams, instant starting and long life. Aside from the tube's cold tunnel cathode, its electron beam can be shaped and pre-focused during manufacture by use of masks while vaporized semiconducting material layers are deposited onto layers of aluminum, aluminum oxide, and gold. The beam image has been made in the form of a hollow circle for greater efficiency, reports Raytheon.

SYNCOM II AND 60-FT. ANTENNAS helped to make successful voice and teletype tests over 7,700 miles—the greater surface distance spanned between two earth points by communications satellite, says NASA. The tests linked the USNS Kingsport, anchored at Lagos, Nigeria, and Camp Roberts, Calif. Part of NASA long-range effort to explore world-wide communications, Syncom II at first beamed signals between Lagos and Lakelhurst, N. J., with a 60-ft. Sylvania parabolic antenna at Fort Dix, N. J., backing up. As the satellite moved into line with Camp Roberts, signals beamed from Africa were picked up by the other Sylvania antenna at the Roberts station. The antennas can track an orbiting body 22,300 miles out within 24/1000ths of a degree accuracy.

EDP MOTHER TONGUE IS HERE, according to the American Standards Association. Some \$3 million in man-hours over four years were spent in developing the seven-bit coded character set now the electronic benchmark for information interchange between data processing machines and computers. Credit for hurdling the barrier in the search for a nationally accepted code goes to the Business Equipment Manufacturers Association and X3 sectional committee. In the newly approved American Standard Code for Information Exchange X3.4-1963, 128 possible coded characters are prescribed—from 36 control functions and format effectors to the 64-character subset devoted to graphics. Pending further work, 28 characters remain unassigned.

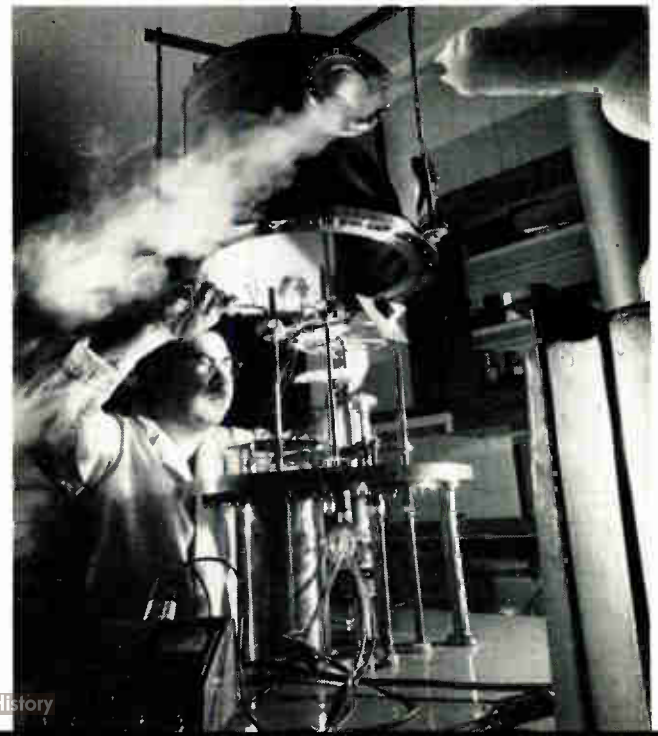
ELECTRON BURST FROM HOT TUNGSTEN, allowing extra high current, may eliminate the moments of radio silence when astronauts re-enter atmosphere. A Cornell research team has found that heating a tungsten cathode with a pulsed laser beam generates 10,000 or more amperes per square centimeter as compared with 1 to 10 amps from conventionally heated cathodes. High frequency tubes using the Cornell technique would produce thousands of watts at 100 to 200 kmc as compared to the thousandths of watts now available at a limit of 100 kmc.

FAST-FIRING LASER, with continuing operation, has been developed by Maser Optics, Inc., of Boston. According to Dr. Harry Franks, firm's president, the new ruby laser, believed to be the fastest laser devised to date, fires one pulse of light energy every second. Heretofore, the fastest rate ever reached with a continuous-operation laser was about one pulse every ten seconds. The laser was developed for high-volume metalworking applications, such as welding, metal removal and metal perforation. Power output is up to 2 joules per pulse. Input is rated at 600 joules per pulse.

(More RADARSCOPE on Page 15)

ULTRA-THIN FILM GROWER

Being readied for an experiment by senior technician Paul Raygor, this ultra-high vacuum chamber is used by Westinghouse scientists to grow films only 10 atoms thick. Films are used in research on solid-state devices. Chamber can get pressures down to one-trillionth of one atmosphere.



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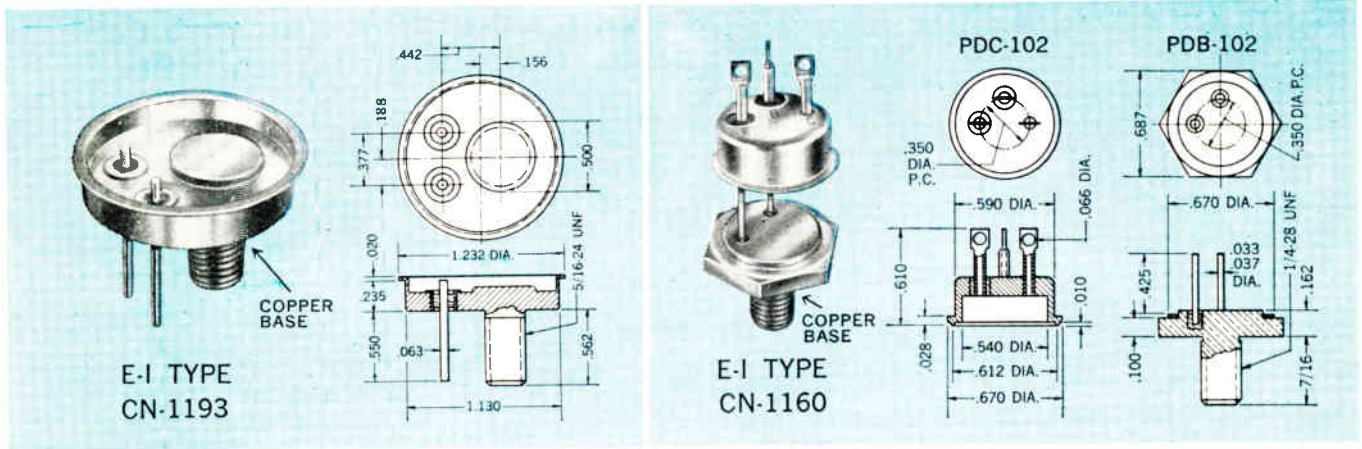
Semiconductor News - FROM ELECTRICAL INDUSTRIES

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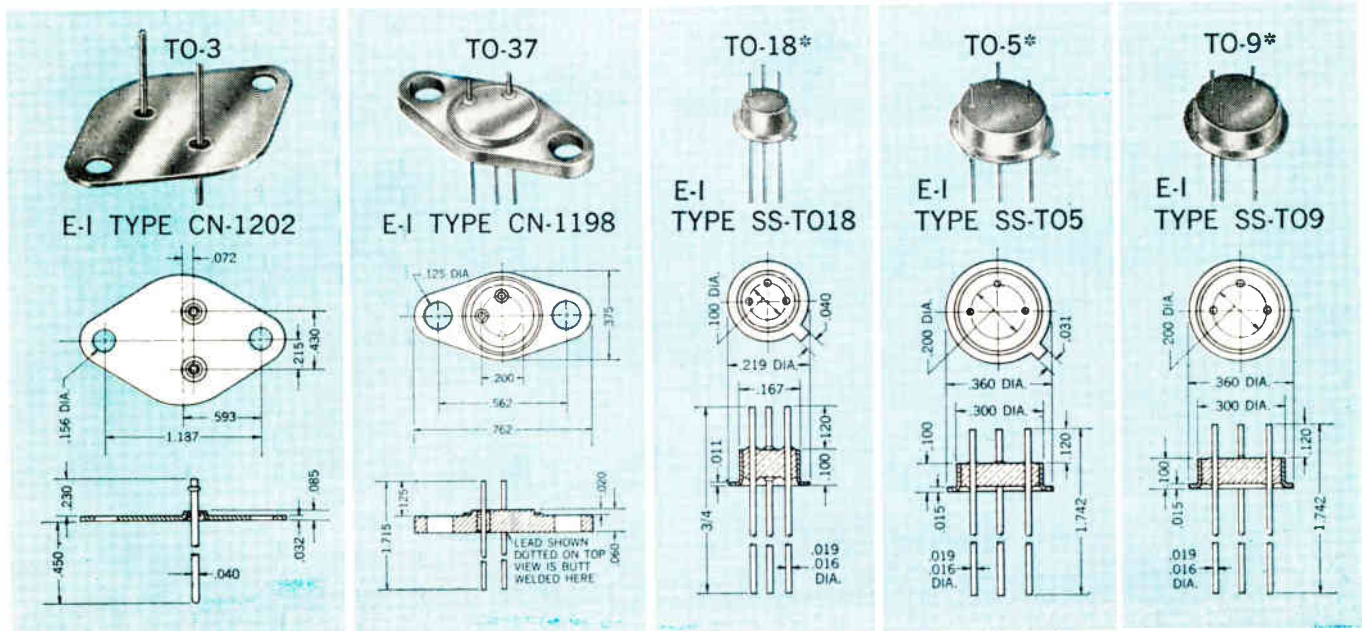
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equal or exceed government specifications. If you have a design problem involving any type of glass-to-metal hermetic sealing, ask ELECTRICAL INDUSTRIES for recommendations on your specific requirements—call or write today!

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RADARSCOPE

LOW-POWERED RADAR SYSTEM designed by General Dynamics/Electronics can do away with "hide-and-peek-games" with aircraft in close formation in any weather, day or night. Aircraft Station Keeper (ASK) radar system provides position data over a full 360° around the plane. It gives each plane using the system a pictorial display of all other craft within the flight pattern. Compact, low-powered, the system is mainly a combine of transceivers and display devices. The two units occupy only 1/4 cubic foot of space, weigh 16 lbs. and drain 50 watts. ASK fits all types of military aircraft.

SMALL SPACE INSTRUMENTS and a new approach in getting research data and basic scientific information was suggested as the field our physicists should get into by NACA's Dr. Hugh L. Dryden. In effect, Dr. Dryden said, in an address at William and Mary College, following site presentation for Virginia Associated Research Center, that too many physicists today are still satisfied with nuclear physics — big machines, small particles, small distances. Now, space science has opened avenues into space physics, a field demanding new, exotic materials, miniaturized electronic instruments and other ultra-small devices to study interstellar phenomena of vast proportions. The need is for our creative physicist to think now in terms of small devices to measure and collect the wealth of scientific information from outer space.

UNIFIED CARRIER SYSTEM for spacecraft-to-earth communications has been tested for a simulated Apollo mission for velocities of 36,000 ft/sec. by NASA and MIT's Lincoln Laboratory. A unified carrier approach is aimed at integrating ranging and communications functions, and uses phase-locked loop techniques in spacecraft to relate received and transmitted carrier coherently. Ranging is accomplished through a pseudo-noise code, demodulated at the craft and remodulated on the down-link carrier, and finally compared against transmitted code. Simultaneous lock-on of the carrier, telemetry, and code synchronization phase-locked loops have been observed in the background of noise expected during actual Apollo mission. Intensity spectrum of video modulation has been measured and compares favorably with theory.

SOUND RECOGNITION MACHINE, the Class Filter, was developed by ITT Federal Laboratories to recognize basic phonetic elements of speech, called phonemes. With training samples, the machine first "learns" the characteristics of the audible effects it is to recognize. When presented with an unknown sound later with the same characteristics as the "learned" pattern, the Class Filter will know the sound.

AGGRESSIVE RESEARCH PROGRAM for advanced aircraft design is urged by NASA's advisory panel. The panel cites a "serious threat by foreign competition to the U. S. lead in aircraft design." If the U. S. is to hold its lead, advisors note, we must conduct "hard-at-it" basic and applied research programs to permit the design of top aircraft, for military and commercial. The advisors also said that the U.S. must provide a means to allow scheduled flights to go through despite weather.

WHAT'S MY ATTITUDE, NOW?

To help astronauts answer that question during Apollo flight, Honeywell built this trainer that includes a model of Apollo command module to mimic craft's instruments. Viewers can see in 3-D actual attitude in varied flight conditions. Bernard Olson (left) and John Haaland conduct human-factors studies.

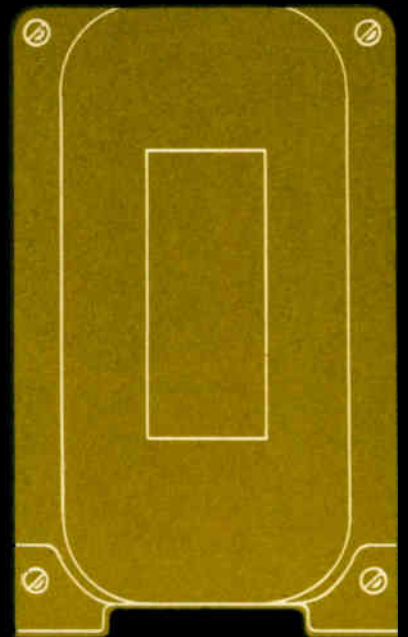




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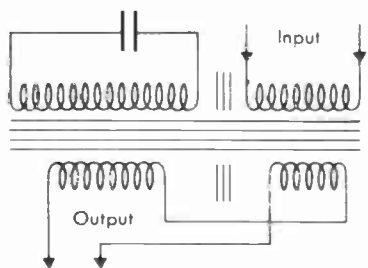
GOLDEN CV

marks Sola's 2-millionth voltage-regulating transformer

The sharp trend to transistors, advent of micro-electronics, and related developments, obviously

CV TRANSFORMER — AUTOMATIC ANSWER TO STRINGENT VOLTAGE PARAMETERS

Sola constant-voltage transformers are *naturals* for powering voltage-sensitive equipment — offer remarkable static and dynamic characteristics. Regulation is $\pm 1\%$ for primary voltage variations of $\pm 15\%$. Response time, 25 milliseconds! Primary operates *unsaturated*, as in conventional transformers; secondary runs saturated so input changes cause negligible secondary effects. Sola's even counter outright load shorts! Sinusoidal types have less than 3% rms harmonics . . . actually will improve poor input waveforms. And, there are no moving parts . . . no tubes . . . no maintenance. Ratings to 7500 va; custom designs also available in production quantities. Ask for Bulletin CV-100.



mean line-voltage fluctuations will be taking on *critical* significance. Thus the constant-voltage transformer is virtually a "black box turned to gold" . . . a *natural* for resolving tricky problems associated with input-voltage parameters.

Pictured is J. G. Sola (right) commemorating the two-millionth such unit off our line with the award of a golden Sola Transformer. Recipient is our first and still-continuing customer, Cenco Instruments Corp., producer of precision electronic instruments. Accepting for Cenco is Mr. Ralph Read, President. It was Mr. Sola's fundamental research in magnetics that produced this technological break-through in static-magnetic voltage regulation.

Significant improvements in ratings and construction inevitably followed. Yet the Sola CV's *leading original attributes* remain its leading advantages: inherent voltage regulation, maintenance-free operation, overload protection and cost savings!



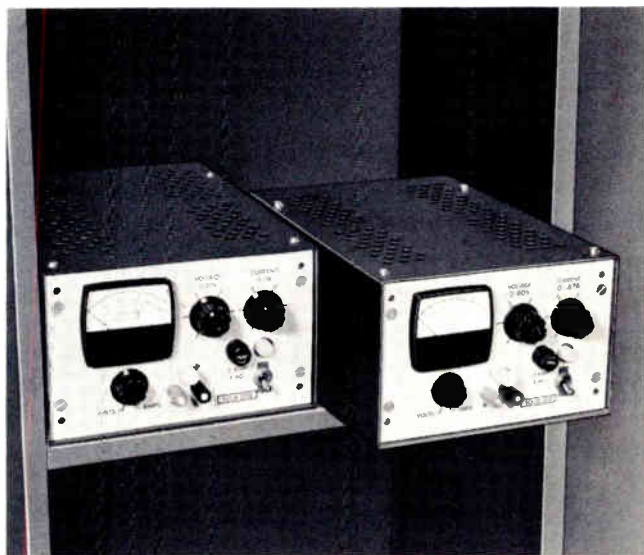
New "Solavolt" delivers regulated d-c voltage and current, adjustable to zero

Solavolt adjustable-voltage supplies have recently broadened their selection to include a variety of economical new models. The additional units feature fingertip dialing from 0 to 90 volts, adjustable over entire range without step-switching. Ratings from 2.8 to 24 amps.

Voltage regulation, provided by integral Sola CV transformer, is $\pm 1\%$ at maximum voltage, full load. Ripple, optimum for all ratings. The Sola transformer additionally affords short-circuit protection, through inherent current limiting.

New Solavolt adjustable supplies offer ideal flexibility where regulation isn't too critical. Operate from 100-130 and 200-260 volt inputs. Supplied ready for 19" rack mounting, they're a worthy complement to existing Solavolt choices (ranging to 400 v). Ask for Bulletin DC-105.

**Space saving "squeeze" play:
New QSB Adjustable-Voltage
D-C Supplies fit TWO in 19-inch
rack, side-by-side**

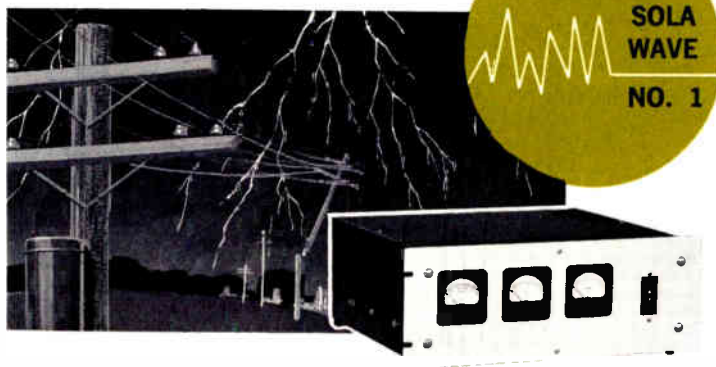


New QSB transistorized adjustable d-c supplies afford *extra compactness* and *more watts per dollar* than even our popular QSA! Provide instantly adjustable voltage and current for experimental and test purposes. Applicable to all fields of science, they're just half the width of QSA; so a pair of QSB chassis easily fits side by side in standard 19" racks.

These superlative power sources offer *remote programming* of current and voltage . . . remote voltage sensing . . . current and voltage stabilization . . . short-circuit protection . . . series and parallel operating flexibility.

Regulation $\pm 0.005\%$ for line voltage $\pm 10\%$ (0 to full load) . . . as low as 0.02% for current (0 to full load). Ripple less than 15 mv rms. Recovery time just 50 microseconds to return within regulation envelope and remain there.

QSB's operate from 115-v nominal input, 47-440 cps, without troublesome voltage overshoot at turn-on or turn-off. All solid-state circuitry. Four choices of output to 80 vdc; 0.5 to 2 amps. Like its big brother QSA, the new, compact QSB is clearly the choice for *adjustable output with extremely precise regulation*. Send for Bulletin DC-132.



**New Sola solid-state inverter
puts out 60 to 3000 watts of
stable, sinusoidal a-c for
emergency standby service**

If you manufacture 120-vac equipment that also must operate from *standby battery power*, you'll find a priceless ally in this new Sola solid-state inverter. No moving parts to cause trouble; no costly maintenance. Sola inverters offer all inherent advantages of the sinusoidal CV transformer: stable output; low harmonics; automatic current limiting and short-circuit protection.

Choice of input ratings includes 12, 28, 48 and 125 volts dc...output from 60 to 3000 va...models for 60 or 400 cycles. Accidental reversal of polarity won't harm any component other than the fuse. Enclosed chassis noiselessly convection cooled. Inverter operates with any power-factor or resistive load from zero to outright shorts. Efficiency 60 to 75% for 28-volt units, and even greater for higher voltage ratings. Output — 120 vac, $\pm 1\%$ at nominal input and full load; frequency stabilized within $\pm 0.2\%$. Write for Bulletin AC-136.

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Regulating voltage in kva ranges? Solatron pre-regulates voltage for kva-rated equipment

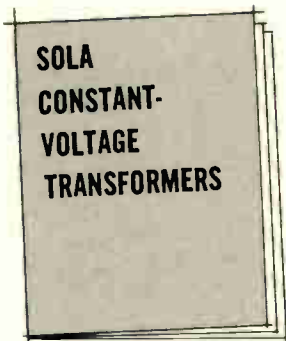
Electronic-design people find themselves increasingly confronted on one hand with big blocks of power for electrical and electronic equipment, and on the other hand, with line-voltage that won't stay within required limits. Ready to resolve this dilemma is the remarkable Solatron voltage regulator —

a new concept in solid-state regulation in ranges of 1 kva and up.

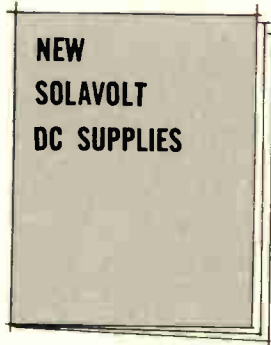
Solatron spans power demand from 1 to 100 kva, single or 3-phase! Cleans up troublesome line fluctuations; or even better, can sense your entire power-supply output, and provide the *overall* correction needed. *In less than 5 cycles.* Without tubes, servomotors, or other electromechanical elements! Got a kw-size voltage problem? Send for Sola Bulletin LVR-2000 . . . on Solatron line-voltage regulators.



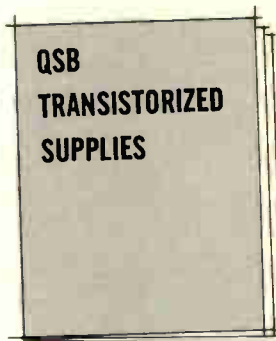
Send postcard below for details on these Sola self-regulating transformers and power supplies!



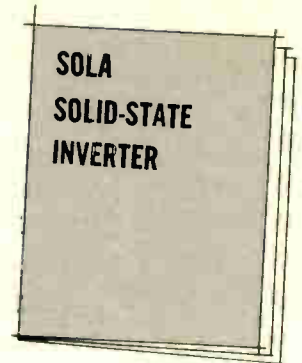
Bulletin CV-100: Handy reference to the basic line of Sola transformers, including sinusoidal and normal harmonic wave types, and filament and plate-filament models.



Bulletin DC-105: Outlines the new economical Solavolt supplies offering adjustable d-c voltage ideal wherever regulating requirements are other than extremely critical in nature.



Bulletin DC-132: Details on new Sola QSB solid-state supply providing adjustable d-c voltage, and very precise regulation from a new, extremely compact unit.



Bulletin AC-136: Shows how this new line of rugged and reliable inverters covers your needs up to 3000 va, with every inherent advantage of our Sola Transformer.

Please send me the following Sola bulletins:

- Transformer Bulletin CV-100 Inverter Bulletin AC-136
 Solavolt Bulletin DC-105 Solatron Bulletin LVR-2000
 QSB Bulletin DC-132

NAME

TITLE OR POSITION

COMPANY

ADDRESS



Bulletin LVR-2000: Packed with specifics and background on this revolutionary Sola a-c preregulator, conceived for high-power regulation needs up to 100 kva.



The new name came after we realized how many *other* changes have been made recently in our company.

Item: expansion of our markets and our plans for developing them.

Item: management's decision to intensify planning of new products and materials.

Item: a three-fold expansion of our research and development facilities, highlighting microelectronics.

Item: addition of several internationally famous scientists to our already strong research staff.

Item: modernization of all production facilities through our mechanical automation program.

Item: even greater emphasis than before on space age quality, reliability and product performance repeatability.

Reason enough to change our name to one more descriptive of the advanced thinking within our 35-year-old company, don't you agree?

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FORMERLY ERIE RESISTOR CORPORATION

WHERE IMAGINATION CREATES VALUE IN ELECTRONICS
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Circle 11 on Inquiry Card

21

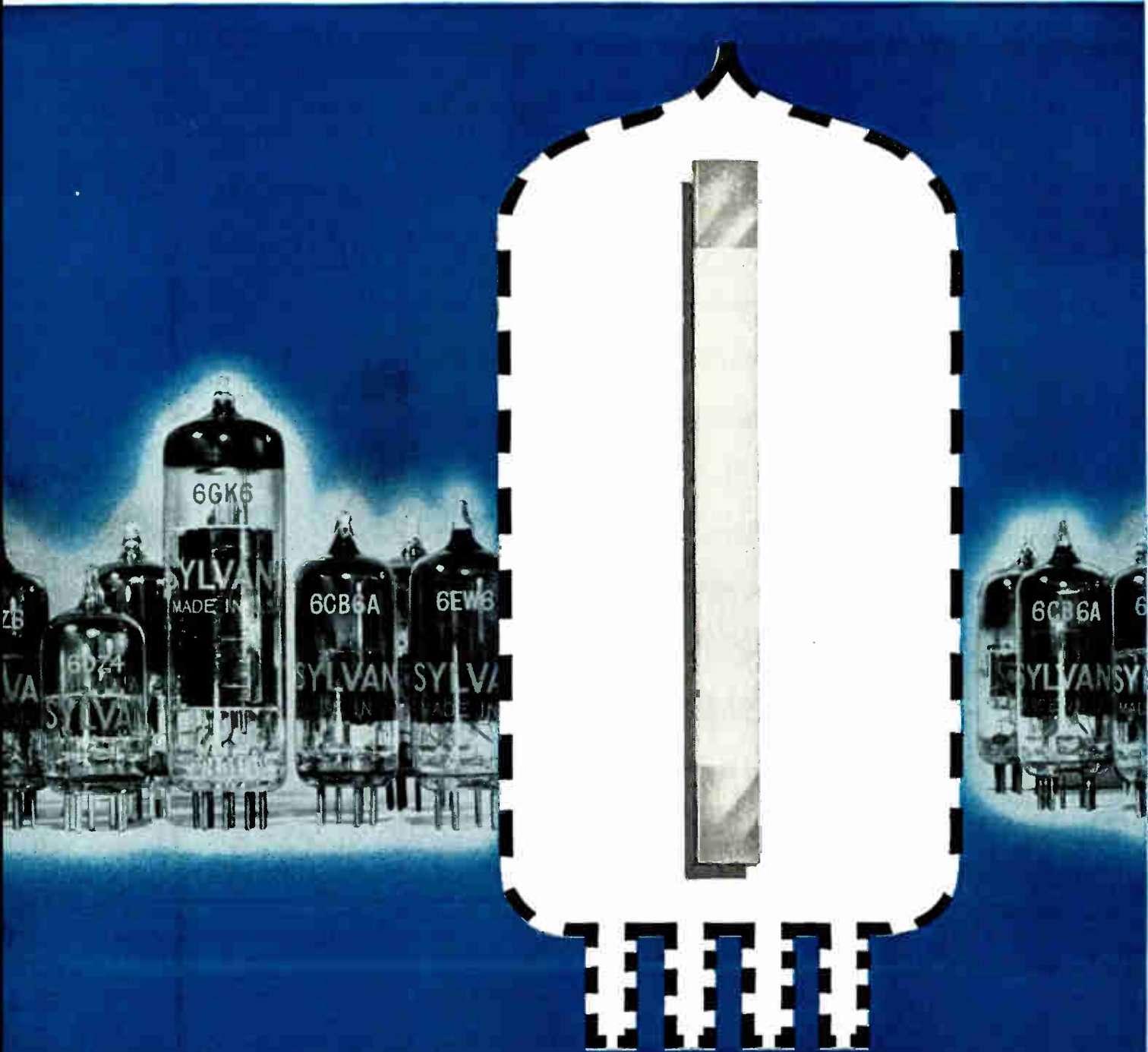
Sylvania—first with the Sarong and Bikini cathodes—now announces a new development that significantly increases the reliability of Sylvania tubes. "Life-Boost Cathode" is the name...the secret is an ultra-pure, uniform alloy made possible by Sylvania's leadership in powder metal technology.

Contrasted to conventional melted alloys, the Life-Boost powder-metal alloy is so pure and uniform, with performance so predictable, that it eliminates any need for the usual "melt approval." Alloy uniformity inhibits the formation of leakage paths, which extends tube life. It also means

better-controlled electron emission and regulated barium release throughout life—tube performance stays within specifications. Further, the new cathodes have 25% greater mechanical strength, which significantly reduces equipment failure in the field.

Precise control of alloy composition is the key. The basic pure nickel powder plus carefully controlled powdered reducing agents are thoroughly blended and immediately rolled into thin-gauge strip. Because no critical temperatures are involved, no impurities are introduced from crucibles and con-

New LIFE-BOOST* Cathode gives increased life, stability and



tainers, forging hammers or hot-rolling equipment. And the powder process permits previously impossible or hard-to-attain combinations of wanted properties, such as electrical passivity and mechanical strength at high temperature.

A planned conversion of Sylvania tubes to the Life-Boost Cathode is under way. For information on types available now, contact your Sylvania Sales Engineer, or write: Electronic Tube Division, Sylvania Electric Products Inc., Box 87, Buffalo, New York.

Sylvania Tubes uniformity



90 TYPES already have the LIFE-BOOST Cathode:

2AF4B; 3AF4B; 6AF4A, B; 2/3/6DZ4; 6GK6; 6BQ5; 6DQ5; 6/25CD6; 25DN6; 6/12/25BQ6GTB.A; 6V6; 12BZ6; 3/4/6CB6A; 4/6DE6; 6CF6; 3/6DE6; 5/6EW6; 6186; 7056; 5/6GM6; 32ET5A; 25EH5; 50B5; 6AH6WA; 6CU5; 6/12DT5; 6/12/25BK5; 6DT5; 6AU8, A; 6BH8; 7060; 8ET7; 6/8GN8; 10JY8; 6BL8; 6883A; 6080WA; 6080WB; GB-6080; 6AH6; 6BC5; 25F5; 35C5; 6AS5; 4/6BZ6; 6CB6A; 6082; 6GR7/SR-3213; 12BV7; 12BY7; 6/12DQ6B; 6J4WA; 12CA5; 12ED5; 50C5; 6BF5; 6CA5; 6ET7; 5687WA; 6AN5; 12DB5; 6K6; 6146; 6146A; 6159A; 6BL7GTA; 6/12AV5GA

Here's evidence of what it can do:

...In 6DZ4 UHF oscillator:

No failures, greatly improved stability

Test: 40 tubes operated at 130 VAC for 1500 hours in 40 TV sets (4 models, 3 manufacturers represented).

Failures: None resulting in set failure. (Statistical estimate: 1% per 1000 hours at 130 V, or about 0.3% per 1000 hours at 117 V.) Failure rate for same tube made with conventionally prepared cathode material: 13.1%.

Oscillator Grid Current: After 1500 hours at 130 V, 90% of LIFE-Boost Cathode tubes had grid current between 550 and 950 μ A. Only about 38% of the tubes with conventional cathodes remained within these limits after period of test.

...in 6GK6, used for critical vertical output: TV set manufacturer reports improved stability

Test: More than 1000 hours at 135 VAC line.

Results: No leakage problems, no slump in characteristics; tube can be used in vertical socket as well as other sockets of customer's TV set line.

Sylvania tests show significantly reduced sublimation (formation of leakage paths), and improved plate current stability under accelerated life test and heater cycling conditions with over-voltages applied.

...in RF pentodes:

Reduced grid emission, no insulation breakdown

RF pentodes BZ6, CB6, EW6 and others, when subjected to life testing, showed reduced grid emission levels after conversion to the LIFE-Boost Cathode. Insulation levels during and at the completion of life showed little or no change—an indication of improved stability—and end-point failures due to breakdown were virtually nonexistent.

CIRCLE 12 ON READER SERVICE CARD

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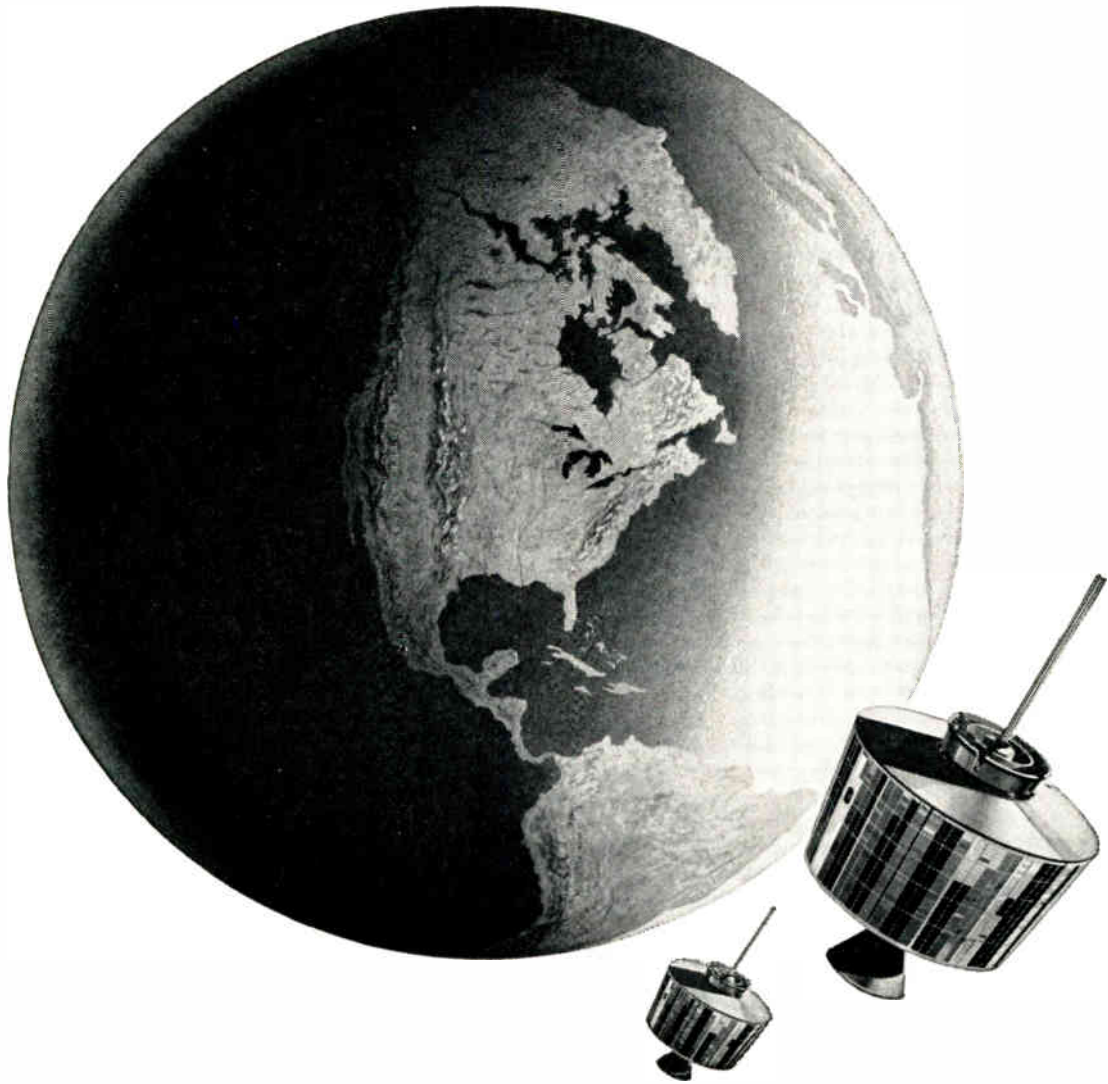
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NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS
MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES



circuit designers...is your appointment in space with Hughes?

Today, Hughes is one of the nation's most active aerospace/electronics firms. Projects include: F-111B PHOENIX Guided Missile System, TOW Anti-Tank Missile, SURVEYOR Lunar Spacecraft, SYNCOM, VATE, ARPAT, POLARIS, Hard Point Defense and others.

This vigor promises the qualified engineer or scientist more and bigger opportunities for both professional and personal growth.

Many immediate openings exist. The engineers selected for these positions will be assigned to the following design tasks: the development of high power airborne radar transmitters, the design of which involves use

of the most advanced components; the design of low noise radar receivers using parametric amplifiers; solid state masers and other advanced microwave components; radar data processing circuit design, including range and speed trackers, crystal filter circuitry and a variety of display circuits; high efficiency power supplies for airborne and space electronic systems; telemetering and command circuits for space vehicles, timing, control and display circuits for the Hughes COLIDAR (Coherent Light Detection and Ranging).

If you are interested and believe that you can contribute, make your appointment today.

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Boot and Shoe Recorder
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Commercial Car Journal
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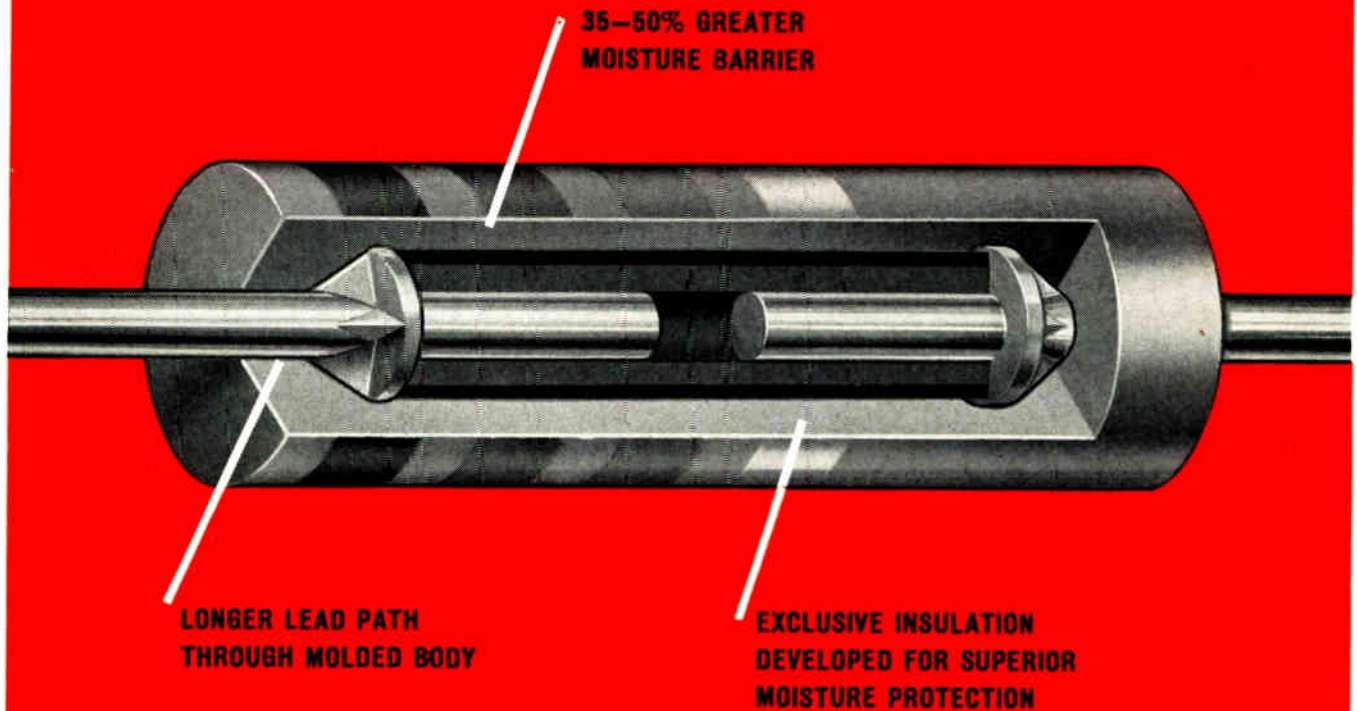
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Food Engineering
Gas
Western Gas
Hardware Age
Iron Age Metalworking
International

Jewelers' Circular-Keystone
Marine Products
Motor Age
Optical Journal
Product Design & Development
The Iron Age
The Spectator

**ELECTRONIC
INDUSTRIES**

In **FIXED COMPOSITION RESISTORS**

if it's news, expect it first from IRC



Among Fixed Composition Resistors IRC offers **GREATER MOISTURE PROTECTION**

HERE'S WHY... IRC's resistance element is a film of carbon composition thermally bonded to a glass body. This rugged, compact configuration permits 35 and 50% more molded protection around the resistance elements of RC20 and RC32 styles, respectively.

Other brands are designed around a fat carbon slug similar to a soft pencil lead. The thickness of their resistance elements requires them to restrict the volume of their molded jackets in order to stay within MIL size limits. Moisture protection is reduced proportionately.

IRC MIL-R-11 resistors are molded in a special insulation developed by IRC specifically for superior moisture, dielectric and mechanical characteristics. This exclusive material, combined with the added insulation thickness results in a resistor that is **AT LEAST TWO TIMES BETTER** under severe moisture conditions.

Specify IRC MIL-R-11 resistors for an extra measure of protection. Write for GBT bulletin. International Resistance Co., Philadelphia 8, Pa.

PERFORMANCE ADVANTAGES

IRC Type GBT's also provide

- Lower operating temperature
- Better resistance-temperature characteristics
- Superior at high frequencies
- Outstanding load life
- Ranges to 100,000 megohms
- Stronger termination
- Weldable leads



WASHINGTON TRENDS

FUNDS FOR NASA APPROVED—A record high \$5.3 billion for NASA was approved by Senate-House conferees. NASA originally asked for \$5.7 billion for the 12 months ending next June 30. The House cut this sum sharply to \$5.2 billion, but the Senate restored many cuts. Biggest single difference between the two chambers is project Apollo. The House had cut the Apollo program by \$120 million, and the Senate voted the entire \$1.2 billion asked. They split the difference and voted \$1.1 billion. As for the controversial electronics research center scheduled for the Boston area, the conferees accepted the House provision that NASA must justify the project before construction begins.

CSC TO SELL STOCK, SIGNS 3 FIRMS—Stock in Communications Satellite Corp. (CSC) will go on the board early in 1964. FCC, while nagging CSC about stock sale delays, has been threatening to stop further CSC borrowings unless half of the stock is put on sale to the public soon. CSC chairman Leo D. Welch tells FCC chairman E. William Henry to keep FCC nose out of CSC affairs. FCC authorized CSC to borrow \$600,000, with \$100,000 for operating funds and the other \$500,000 for research and design of a satellite system. Welch claims invasion of firm's managerial functions, and says he'll resist further FCC moves to inhibit his duties.—CSC has signed its first three contracts with AT&T, RCA, Hughes Aircraft for studies on multiple-access techniques for communications satellites.

FCC STUDIES SATELLITES—Federal Communications Commission wants to take a close look at the economic effects of worldwide electronic communication via space satellites. FCC is concerned that communications satellites may dilute competition among international radio and cable companies. The FCC study would show whether more competition or a series of mergers is needed among international carriers. One thing chairman E. William Henry is sure of: international telegraph carriers should be authorized immediately to handle voice transmission. These companies could then offer effective competition to the AT&T, which has a "substantial monopoly of pure voice communications."

DEMAND FOR TECHNICAL MEN GROWING

—The U. S. faces a critical shortage of scientific personnel over the next few years as demands from government and industry for technicians overrun the capacity of schools and colleges to produce them. The National Science Foundation warns, in a recent report, that two million scientists and engineers will be needed by 1970 but that colleges will likely produce only some 700,000. Demands for scientists and engineers, says NSF, have outrun general growth of the U. S. labor force.

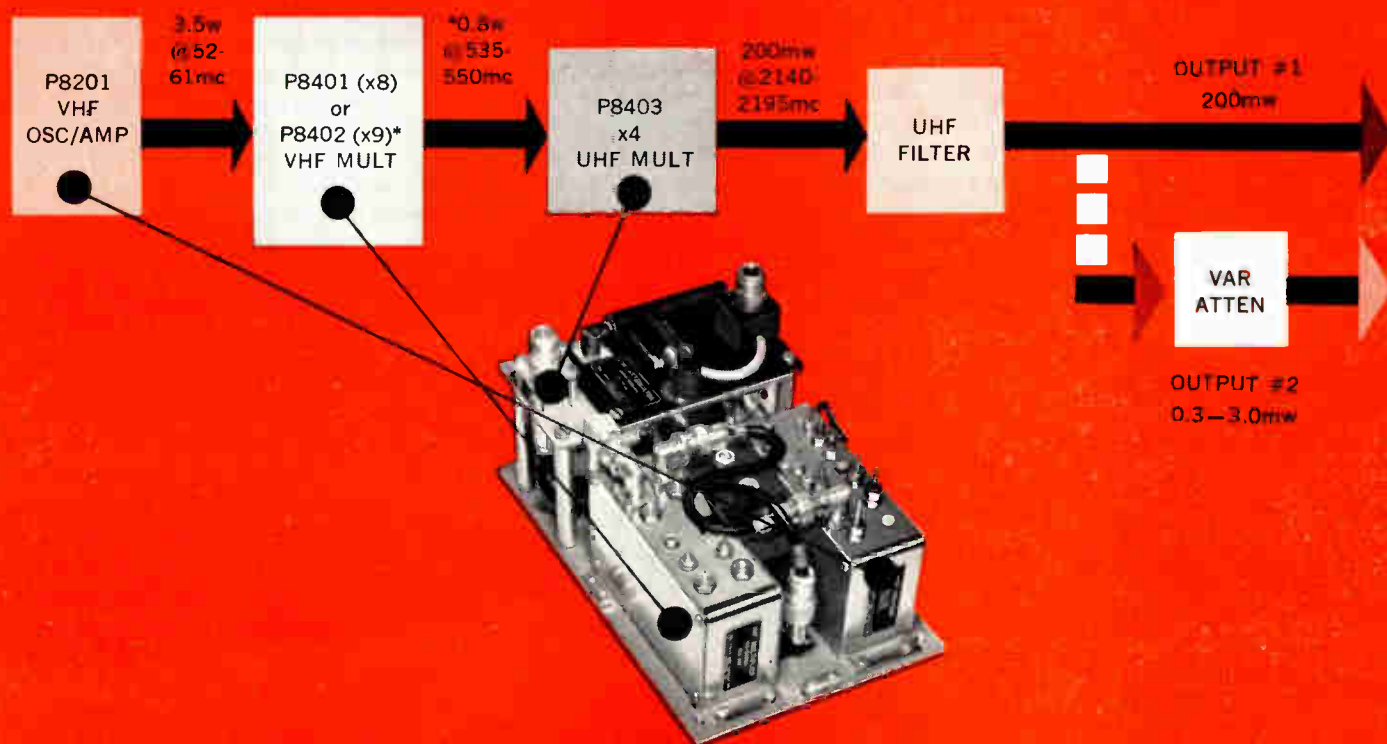
EIA ASKS TARIFF CHANGES

—Electronic products should be separate from electrical machinery in lists being readied for 1964 tariff talks, says Robert C. Sprague, chairman of EIA Electronic Imports Committee, and chief executive of Sprague Electric Co. Mr. Sprague said, "High-priced skills are required in R&D, design, and in producing new and improved electronic products. Capacitors, resistors, tubes and semiconductors, several of which may be held in the hand, and which sell for a few cents to a few dollars each, cannot be considered, for trade agreement purposes, on the same basis as an electric generator selling for several million dollars.—EIA also declared that removal of certain restrictive import regulations in other nations, including government purchasing practices and discriminatory specs, would do as much to increase exports of U. S. electronics as would lower tariffs.

ELECTRONICS EXPORTS PUSHED

—U. S. Commerce Department is urging American electronics firms interested in developing a market in Britain to submit export proposals to a special electronics trade mission by next March 1. The mission will try to promote contracts for purchase of electronic products and services. The six businessmen making up the mission will be specialists in numerical control systems, industrial process control systems, measuring and testing, ultrasonics, and advanced high-performance components for equipment, including solid state devices. They'll seek applications in the chemical manufacturing, food processing, combustion engineering, metalworking, and electronic engineering fields. Proposals for exports by U. S. firms will be summarized in a booklet to be distributed ahead of the May-June mission.

Philco S-Band Power Source



New reliability standards are inherent in the solid-state design of the new Philco P8001 S-Band Power Source. Fully engineered—it's available complete or in your choice of contained modules. The modules: a transistorized oscillator/amplifier; varactorized VHF multiplier; and varactorized UHF multiplier. New and fully engineered.



Philco C-Band Tunnel Diode Amplifier. Mount it at the antenna to cut cable loss and noise. No matter where you mount it, the new Philco P701 Tunnel Diode Amplifier will have a maximum noise figure of 4.5 db . . . plus the unusually wide bandwidth of 20% . . . and 18 db typical gain. Operable to a 3,000-hour battery life (much longer, of course, on 110 Volts AC).

Get data on Philco Power Sources and Tunnel Diode Amplifiers. Write Dept. EI1063S.

SPECIAL PRODUCTS OPERATION

PHILCO

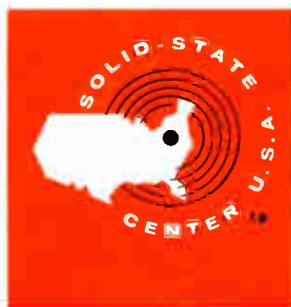
A SUBSIDIARY OF *Ford Motor Company*

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In Europe: Avenue de Beauregard 3, Fribourg, Switzerland

In Canada: Don Mills Road, Don Mills, Ontario, Canada

Circle 16 on Inquiry Card



MARKETING

Facts and Figures Round-Up

EIA STARTS BIG EFFORT TO HALT IMPORT 'THREAT'

EIA has asked its members to support a "massive effort to prevent destruction of the U.S. electronics industry by rising imports from low-wage nations."

Robert C. Sprague, chairman of the EIA Electronics Imports Committee, and chief executive of Sprague Electric Co., asked all EIA divisions to back a request for a board appropriation to carry on a "constant and intensive" program in behalf of the industry.

The program includes preparation of data on the effects of imports on jobs, sales and output of U.S. firms bearing the brunt of foreign competition.

'CHECK WITH MARKETING,' MARKETEERS TELL ENGINEERS

Engineers were offered some friendly advice from marketing men at the 1963 Defense Industry Marketing Forum of the American Management Association.

1. Don't simply engineer what you like as an engineer. Perhaps nobody wants it. Check the growing lists of guidelines—value analyses, costs analyses, allowable expenses and budgets, etc.—and check with your department head—who should have checked with market research or defense sales.

2. A top U.S. contractor surveyed R&D directors and found that five or six do not consult with marketing directors to determine market needs.

3. While engineers must develop new products, or improve old ones, the market research people find it equally important to develop new approaches, or improve old selling ways.

COMPONENTS FACTORY SHIPMENTS RISE TO NEW LEVELS

Factory sales and shipments of components by U.S. electronics firms came close to the four-billion-dollar mark in 1962.

At least three-fourths of this total was earmarked for the aerospace/defense market.

In the latest report from the Electronics Division, Business and Defense Services Administration of the Commerce Department, the total for all components is estimated at \$3.9 billion. This is a new high, more than 8% above the 1961 level.

Listed in the report, which does not include all components, are resistors, capacitors, connectors, relays, coils, power and special purpose tubes, receiving tubes, and TV tubes, plus semiconductors. The report also lists some complex items such as integrated circuit modules and plug-ins.

Total sales of electron tubes increased 1.7% over 1961 to a new level of \$875 million. A 10% increase in power and special purpose tubes more than offset declines of 1.7% in

receiving tubes and 3.5% in TV picture tube output.

Although unit shipments of semiconductors increased 35% over 1961, the value of shipments showed only a 1% increase to \$571 million. This reflects a steady decline in unit prices of many transistor and diode types.

Relay sales recorded a 10% increase to \$201 million, which reversed the slight decline in 1961. The advent of advanced types was the chief cause for this increase.

Shipments of capacitors gained 16% to \$349 million, and resistors increased 23% to nearly \$350 million.

Connectors showed a gain of 30% to \$248 million.

Quartz crystals rose 29% to \$37 million and complex components went up a big 77% to \$67 million.

MARKET MEN HIT DOD ON DOLLAR-TRIMMING WAYS

Defense and aerospace marketing officials are taking issue with Defense Sec. McNamara and the "loaded approaches" they say he used to trim \$1.1 billion from Pentagon procurement in FY 1963.

He was commended for economizing through greater use of excess inventories, switching from non-competitive to competitive procurement, shifting from cost-plus to fixed-price and incentive contracts, standardization and simplification procedures. Criticisms generally fall into two categories:

1. Price may be lower in some cases—but so may quality of product and/or service.

2. Comparison may be unfair. An example is the comparison of prototypes and production units.

NEW MARKET LOOMING FOR USED COMPUTERS

A slow groundswell seems to be in the making for used, surplus electronic computers. While there is already a growing market for electrical and mechanical office machines being bumped by computers, some of the older vintage EDP units are being replaced.

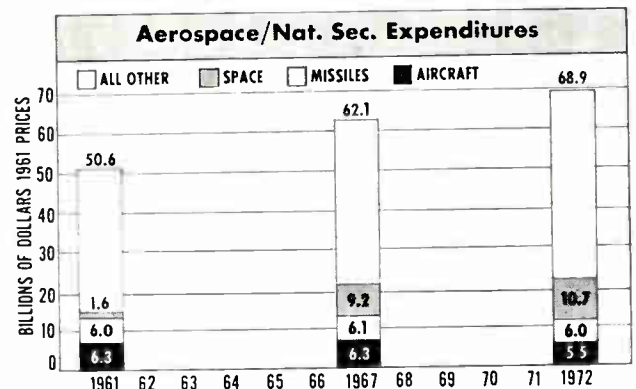
First on the auctioneer's block was Bizmac—RCA's original EDP system which was sold by the Army from its Detroit arsenal. Another surplus military computer was Univac 1103, used for some years at Elgin Air Force Base, Florida.

THE TOP TEN IN AEROSPACE/DEFENSE

Top ten U.S. contractors by net value of aerospace/defense prime contract awards for Experimental, Developmental, Test and Research work—fiscal year 1962 (7/1/61 to 6/30/62).

Company	Place of Contract Work	Approx. Dollars (Millions)
General Dynamics Corp.	San Diego, Calif.	\$508
Lockheed Aircraft Corp.	Sunnyvale, Calif.	500
Boeing Co.	Seattle, Wash.	497
North American Aviation	Los Angeles, Calif.	401
General Electric	Philadelphia, Pa.	384
Martin Marietta Corp.	Littleton, Colo.	333
Western Electric Co.	New York, N. Y.	268
Aerojet-General Corp.	Sacramento, Calif.	202
Douglas Aircraft Co.	Santa Monica, Calif.	181
Sperry Rand Corp.	Syosset, N. Y.	152

(Electronic Industries Association)



Projected costs within the security budget indicate that aerospace programs will rise from 1961's \$14 billion to more than \$22 billion by 1972. Most increases will be in space; aircraft and missiles will plateau, or fall a little. (Aerospace Management estimates \$22 billion aerospace for FY '64.)

(Lockheed-Georgia Company)

Designers of amplifiers, oscillators and frequency converters can now have the benefit of cutoff frequencies to 40 Gc, resulting from the high peak-current-to-capacitance ratios of Sylvania germanium tunnel diodes.

Uniform, stable equipment performance is aided by the tight tolerance control, low temperature coefficient and rugged construction of these units—and you have a wide choice. If one of the 120 standard types doesn't

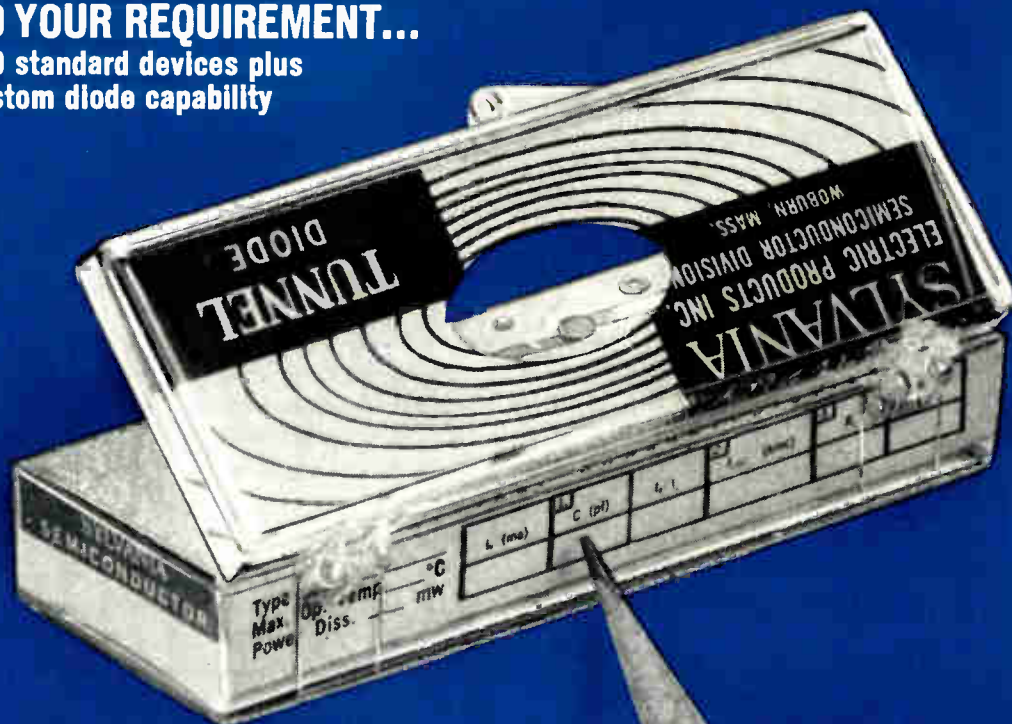
exactly fit your requirement, characteristics such as negative resistance, current-capacitance ratio and total capacitance can be tailored to your needs. Other performance benefits of these diodes are their low (1.30) noise constant, and ultra-low microphonic sensitivity.

Addition of the new, smaller package, with its low capacitance and low inductance, effectively raises self-resonant frequencies and opens many new application

Sylvania Germanium Tunnel Diodes to 100 mA, new low-capacitance

CHARACTERISTICS TO YOUR REQUIREMENT...

120 standard devices plus
custom diode capability



possibilities. To make it even more useful, Sylvania offers this new package with or without prongs. The standard package, too, is available with or without leads, bringing the package choice up to four.

Consider Sylvania for all of your germanium tunnel diode requirements in UHF, L, S, C and X bands. Contact your Sylvania sales engineer or Semiconductor Division, Sylvania Electric Products Inc., Woburn, Mass.

offer I_p from 1 mA package

CHOICE OF 4 PACKAGES



Series D5061

New, low capacitance, low inductance package. 0.72 max dia. 0.31 max length.



Series D5071

With .030 prongs.



Series D4961

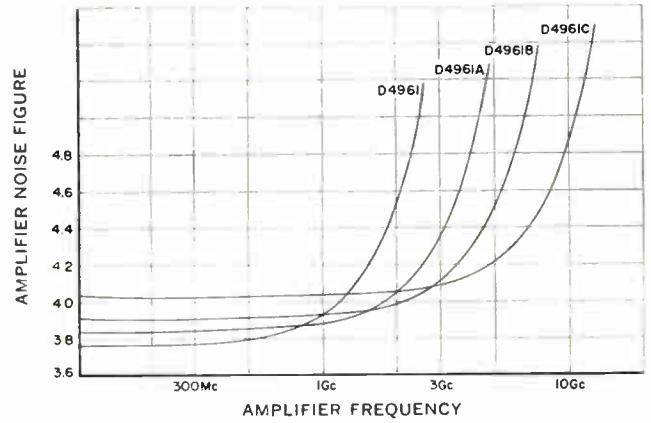
Standard. 0.124 max. dia.



Series D4971

Standard with ribbon leads.

Tunnel Diode Amplifier Noise Figure



Calculated noise figure for a diode of each type. This is a conservative figure based on type minimums. Amplifier noise figure NF is computed as:

$$NF = \frac{1 + N_s}{(1 - R_{s,r_j})^2 (1 - (f/f_{co})^2)}$$

Where N_s is the typical value 1.30 for Sylvania germanium tunnel diodes, R_s is maximum selection limit for series resistance, r_j is typical negative resistance (65 ohms), f is the amplifier frequency and f_{co} is the minimum specified cutoff frequency for the type.

Performance Summary—Typical Units

	Peak Current I_p	Typical Negative Resistance r_j	Maximum Series Resistance R_s	Minimum Cutoff Frequency f_{co}
D4961	2.0 ± .2	65	2.0	5
D4961A	2.0 ± .2	65	3.0	9
D4961B	2.0 ± .2	65	4.0	14
D4961C	2.0 ± .2	65	6.0	24
D4962	5.0 ± .5	26	1.0	4
D4962A	5.0 ± .5	26	1.5	7.5
D4962B	5.0 ± .5	26	2.5	12
D4962C	5.0 ± .5	26	3.5	20
D4963C	10 ± 1	13	2.0	18
D4964C	20 ± 2	6.5	1.5	16
D4965	50 ± 5	2.6	.25	2.5
D4965A	50 ± 5	2.6	.4	4
D4965B	50 ± 5	2.6	.8	6
D4965C	50 ± 5	2.6	1.2	11

Above characteristics are the same in D4971, D5061, D5071 series. Typical characteristics are:

Series	Package Inductance	Package Capacitance
D4961	0.25 nh	0.65 pf
D4971	0.25 nh	0.65 pf
D5061	0.15 nh	0.30 pf
D5071	0.15 nh	0.30 pf

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NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

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Guess how many Honeywell Meters in this fishbowl. Win a baby shark.

Imagine the fun of having your very own shark! Imagine the delighted laughter of neighbors when they discover it in your swimming pool! All you do is guess how many Honeywell miniature meters are in that fishbowl. Come closest, and the shark is yours for life! (Why the contest? To dramatize how many different miniature meters we make—most in the business—and just how miniature our miniatures are. Like the HS-1 Ruggedized that shrugs off vibra-

tion, is immune to dust and moisture; the MCE-1 Edge-wise; the stylish MM-1 Medalist meter; and the new, square-shaped MS-1.) Entries must be postmarked before midnight, Nov. 15, 1963. In case of tie, earliest postmark wins. People who work for Honeywell may compete but we warn them: they won't win. Send your guess to Honeywell, Precision Meter Division, Manchester, N.H.

Honeywell

While you're at it, ask for our latest catalog. Fascinating poolside reading.

Another bull's-eye in capacitor design...!



C-SERIES EXACT SIZE

PRESENTLY AVAILABLE IN 2 CASE SIZES

Case A: Diameter .146; length .370; lead diameter .020.

Case B: Diameter .196; length .505; lead diameter .025.

Case material: Dimensionally-stable, moisture-resistant, self-extinguishing epoxy with excellent dielectric properties.

Leads: Solder-coated nickel wire.

LINDE, KEMET PRODUCTS for Electronics/Aerospace

LINDE Laser/Maser Crystals, Sapphire, Rare Gases/Mixtures, Cryogenic Materials, Single-Crystal Refractory Metals, Semiconductor Silicon, Silicon Monoxide. KEMET Barium Getters and Solid Tantalum Capacitors—6 to 100V.

Write today for technical data

"KEMET"

TRADE MARK

BULLET-SHAPED

C-SERIES

(Polar Type)

SOLID TANTALUM CAPACITORS

Provide peak performance under severe shock/vibration conditions

★ Molded shape adaptable to welded module construction or conventional point-to-point wiring...also automatic insertion equipment.

★ Suitable for better-grade entertainment devices, ship-to-shore and other 2-way radio communications or similar top-quality uses.

KEMET's complete line of solid tantalum capacitors has a brand new member—the C-Series polar type—designed for highly compact circuitry!

C-Series units consist of a porous tantalum anode encapsulated in an epoxy case with a bullet-shaped end for fast polarity identification, easy capacitor orientation, and assembly in close proximity to other components.

DC leakage current is extremely low and dissipation factor is not sacrificed. Capacitance ranges from 0.1 to 56 microfarads in ± 5 , 10, and 20 per cent tolerances. Working voltages are 6, 10, 15, 20, 35, and 50. Operation is continuous over a temperature range of -55° to $+85^\circ\text{C}$.

For full information on the C-Series and other solid tantalums in KEMET's complete line—from 6 to 100 volts—write to:

"THE SPECIALIST IN SOLID TANTALUM CAPACITORS"

KEMET DEPARTMENT

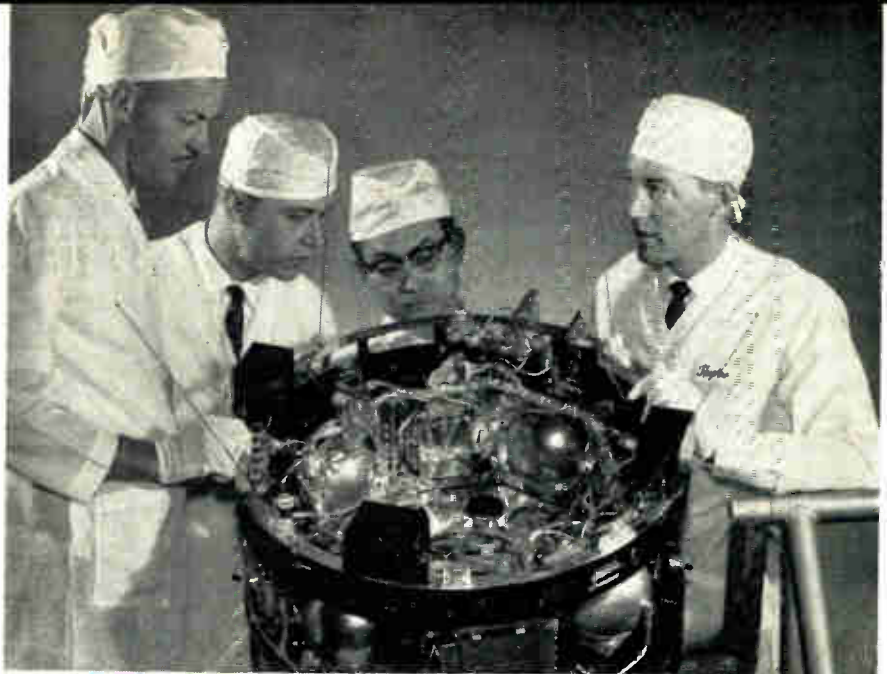
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Cleveland 7, Ohio
Telephone: 216-221-0600



LINDE DIVISION

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SNAPSHOTS... OF THE ELECTRONIC INDUSTRIES



SPACE 'SIGNALS'

Hughes Aircraft Co. Syncom engineering team consisting of (l to r) Chester Bjorgan, David Kamm, Thomas Mizote and Stanley Peterson examine the synchronous satellite which provides a 4-continent communications link-up.

CRITICAL EYE

Microelectronic circuit forms 'mirror' for critical eye of researcher at Autonetics division of North American Aviation, Inc., Anaheim, Calif. Rectangles are resistors and capacitors with lines forming connections.

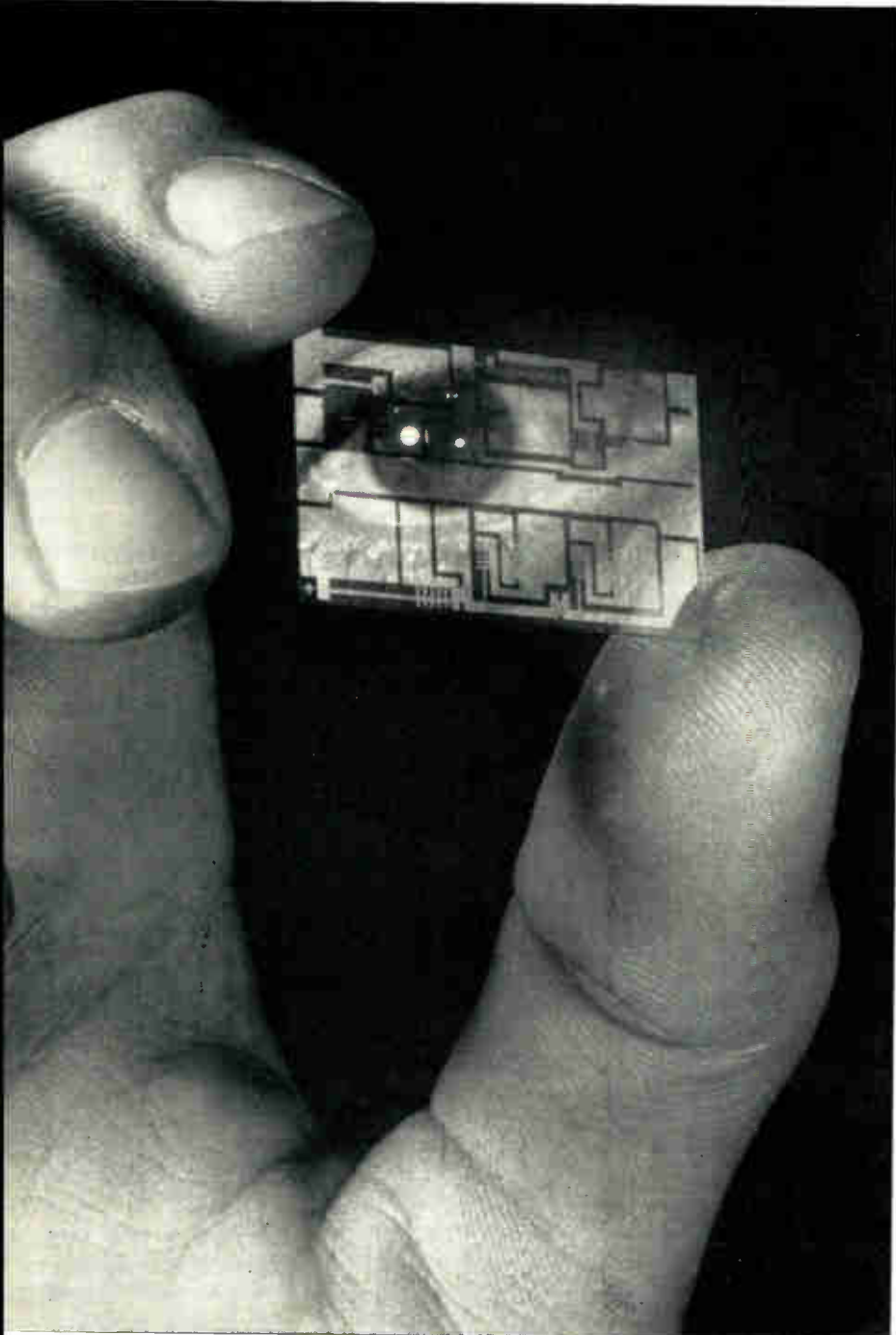


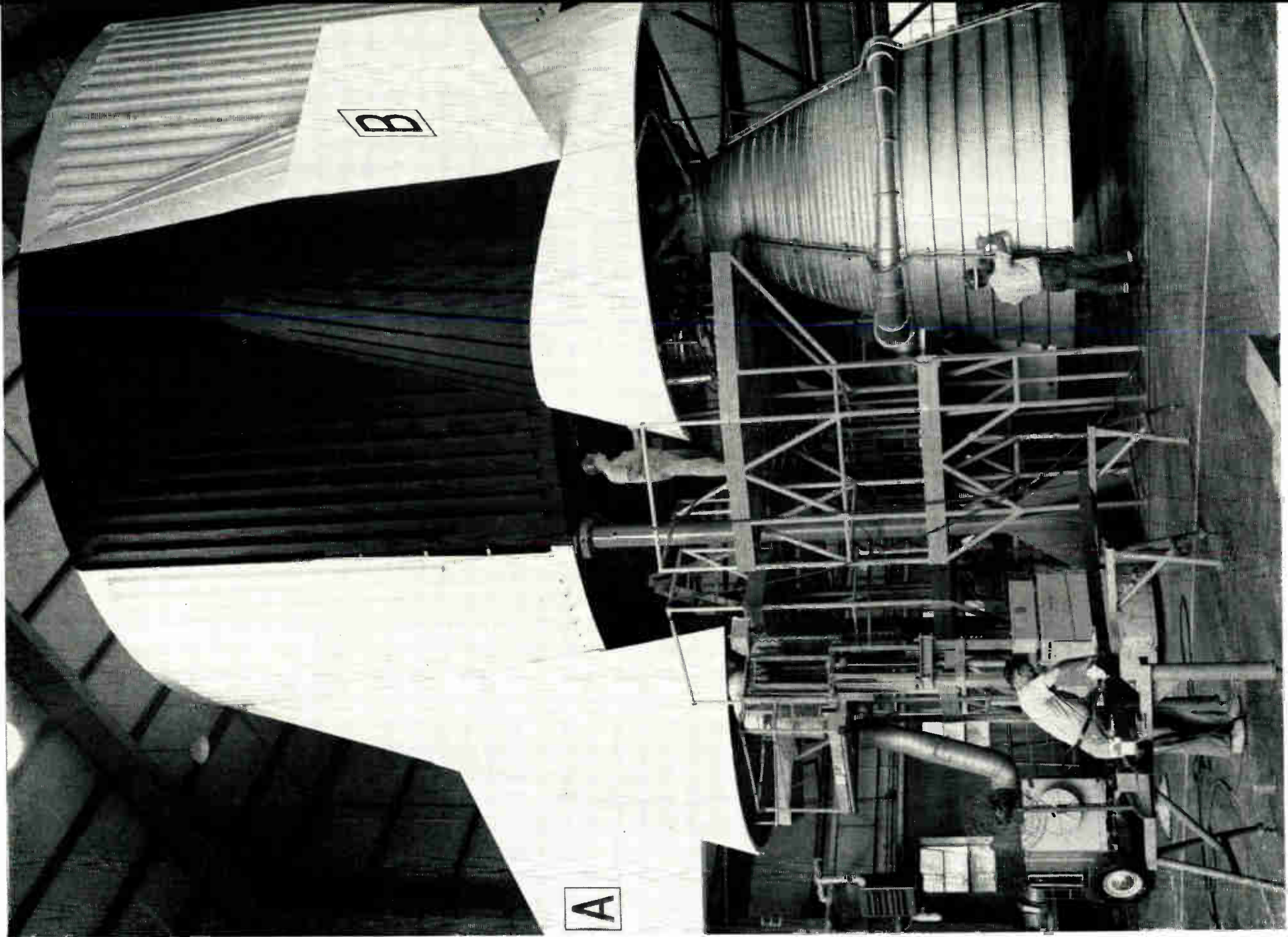
BRAIN MONITOR

Dr. Milton DeLucchi, (Major, USAF), and Dr. W. Ross Adey, UCLA brain scientist, examine components of a helmet designed to monitor brain activity in space. Helmet was developed at UCLA's Brain Research Inst.

"BUSINESS END"

Mockup (r) of the S-1C stage thrust structure of the Saturn V moon rocket nears completion at the NASA center in Huntsville, Ala. The booster, 33 ft. in dia. and 138 ft. long, will be powered by 5 engines developing 7.5 million lbs. thrust. Two mock engines are shown mounted beneath the thrust structure.

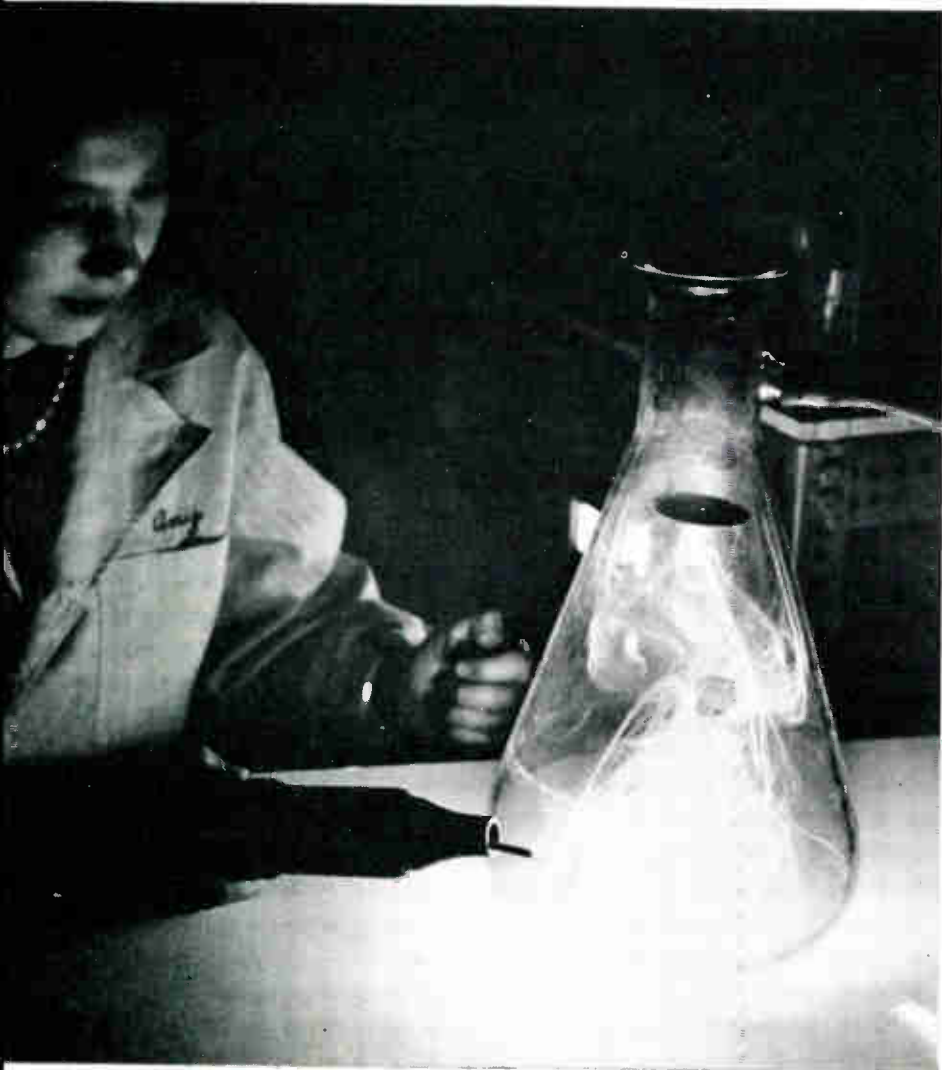
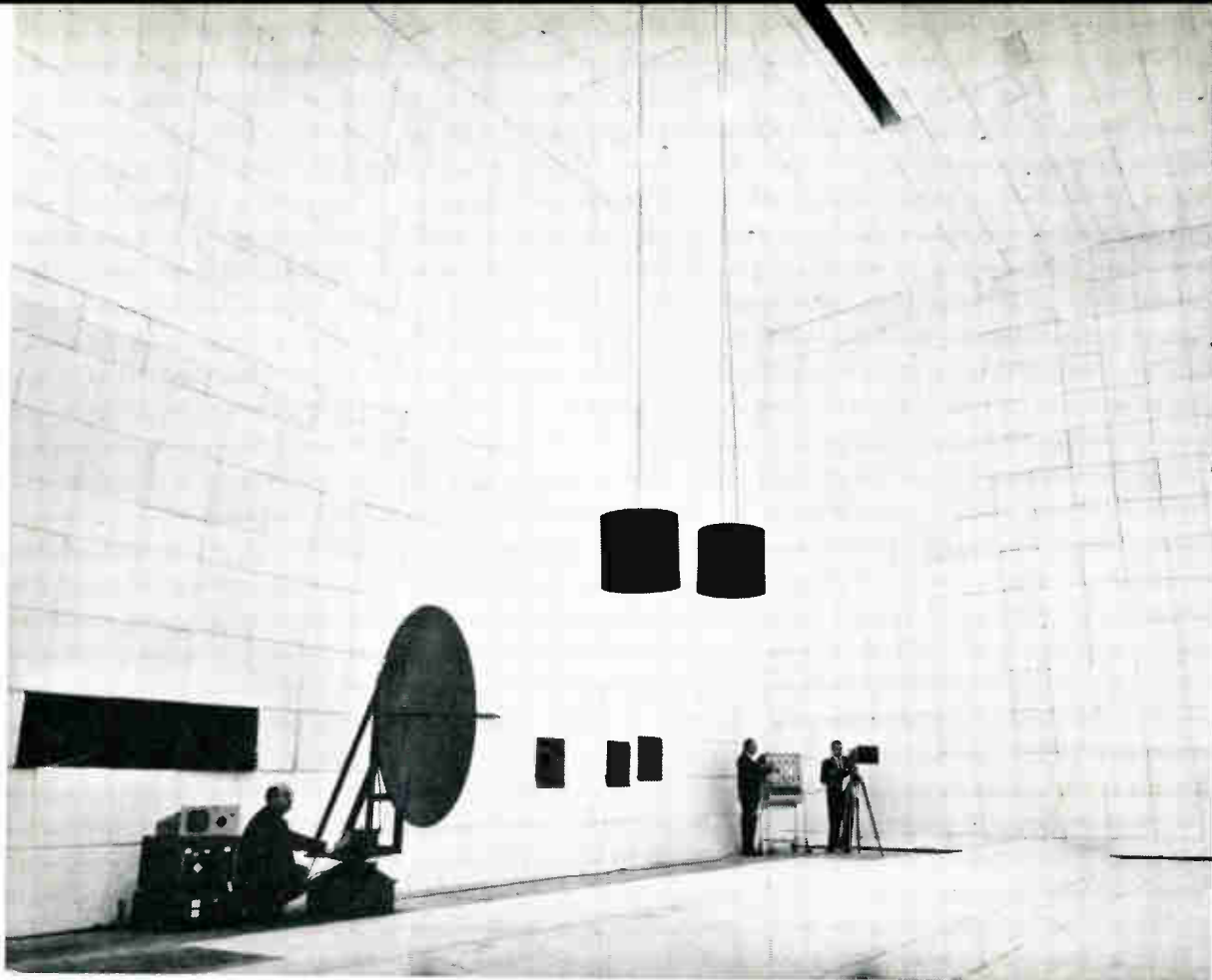




**SNAPSHOTS...
OF THE
ELECTRONIC
INDUSTRIES
(Continued)**

"QUIET"

Personnel of Lockheed Missiles & Space Co., Sunnyvale, Calif., check out performance of new anechoic chamber. Objects hanging from ceiling are hooks for overhead hoist, shrouded in anechoic material to eliminate reflections. Hoist cables are non-metallic for the same reason.



"READ OUT"

Glass fibers give off light when exposed to electron bombardment by Amy Jasinski in Owens-Illinois Glass Co.'s lab in Toledo, Ohio. Transparent glasses change to colored, but still transparent, glasses when exposed to electron beams or Ultra-Violet radiation. First use of these "O-I Silicas" may be as "read out" devices for radarscopes and computers.

SPEEDS TRAINING

Jack Glaser, Hughes Aircraft Co. Dept. Mgr., explains AN MSQ-28 Modular Trainer Facility to Captain G. A. Hermes. The trainer will speed U. S. Army air defense group training.



Report from

**BELL
LABORATORIES**



To produce these mode patterns, the normal operation of a helium-neon optical maser is perturbed by placing a pair of wire cross hairs in the cavity. These wires interact with the mode structure of the unperturbed cavity, suppressing some modes and, in certain cases, coupling others together. By changing the angle between the cross hairs, this interaction can be altered and different mode patterns, as shown, can be produced.

A STEADILY GROWING FAMILY OF OPTICAL MASERS

Scientists at Bell Telephone Laboratories are continuing extensive research programs to gain increased knowledge about optical maser (laser) action. The immediate goal of these investigations is more complete understanding of the phenomenon itself. In the long run, however, this knowledge will help us to evaluate better the communications applications.

One aspect of optical maser research is the study of the mode structures in laser cavities. The modes excited in a particular experiment can be identified by mode patterns, shown above, produced by directing the emergent beam onto a photographic plate.

Optical maser research at Bell Laboratories has resulted in a broad new field of radiation science. For instance, discovery of gas lasers also provided the first continuously operating laser. The active medium in this device is a mixture of helium and neon; its

operation depends on the excitation of neon atoms by collision with excited helium atoms. Originally, this system emitted infrared light, but recently it has been made to produce visible red and yellow light.

More recently, in another significant advance, our scientists have discovered two other new mechanisms for creating maser action in gases. One depends on the dissociation of oxygen molecules in mixtures of oxygen and neon or argon. The other takes place in pure noble gases—helium, neon, argon, krypton and xenon—and depends on a direct transfer of energy from accelerated free electrons to the gas atoms.

With these mechanisms and various gases or gas mixtures, we have achieved maser action at approximately 150 different wavelengths extending from 0.594 microns in the yellow region of the spectrum to 34.5 microns in the far infrared—and more are in prospect.



BELL TELEPHONE LABORATORIES

World center of communications research and development

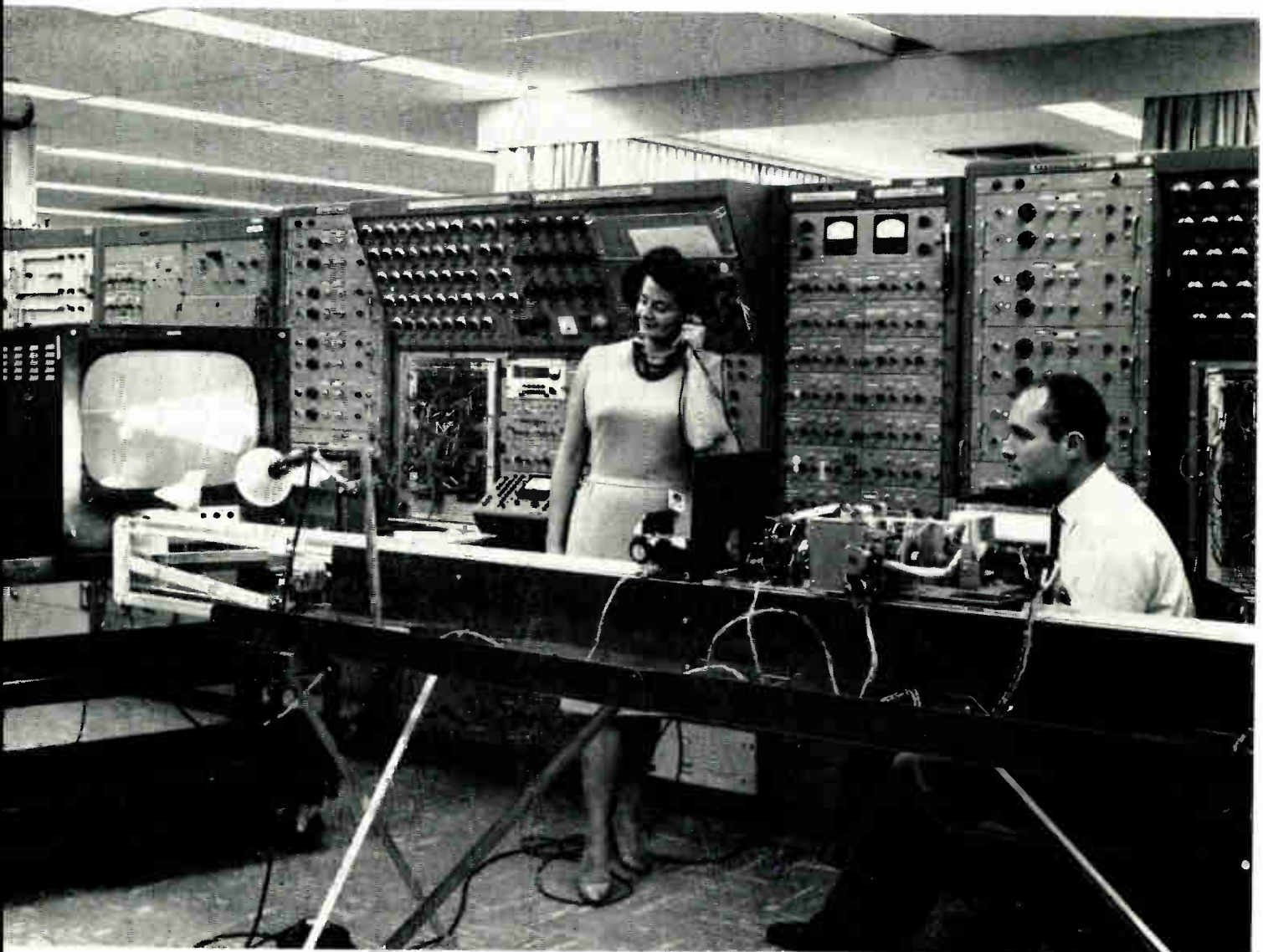
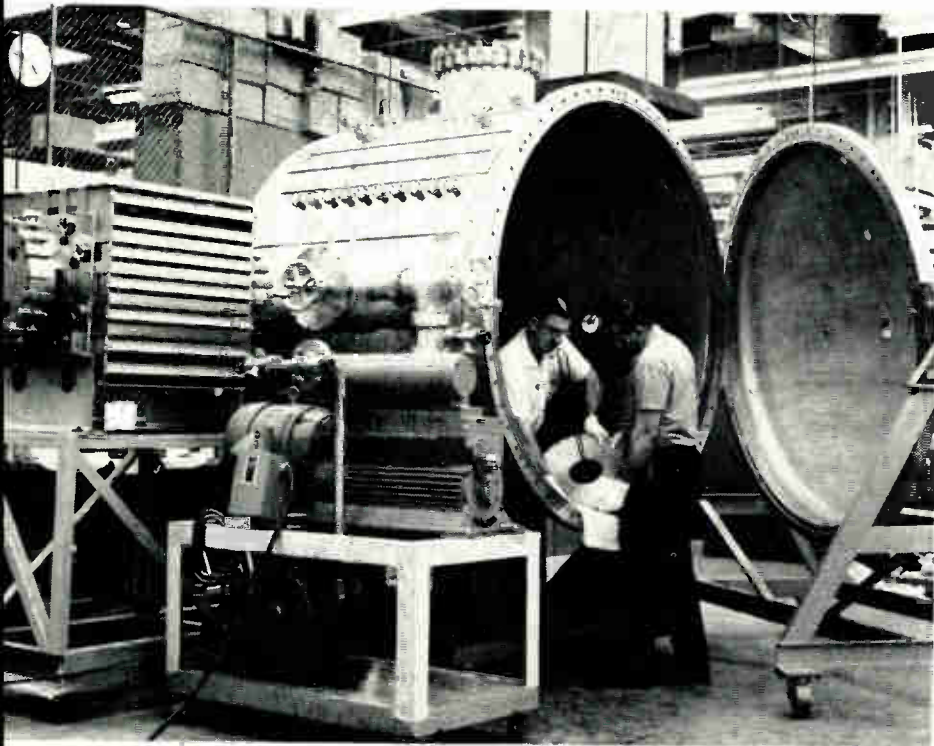
SNAPSHOTS . . . OF THE ELECTRONIC INDUSTRIES (Concluded)

PRESSURE CHAMBER

Workers prepare to make use of space simulation chamber at Varian Associates' Vacuum Applications Center, Palo Alto, Calif. Chamber is capable of pressures below 10^{-11} torr, which are normally encountered by satellites about 500 miles from the earth's surface.

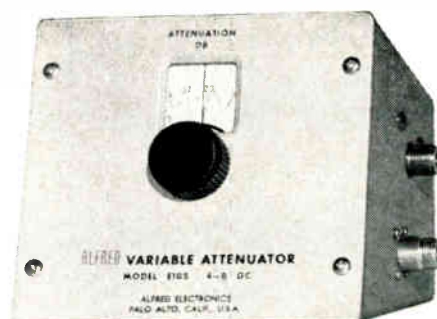
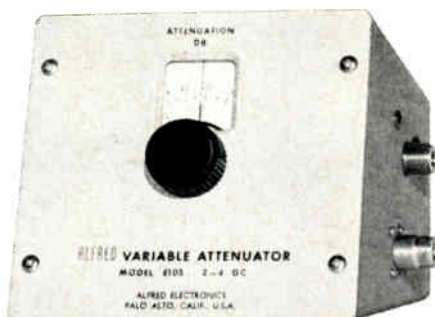
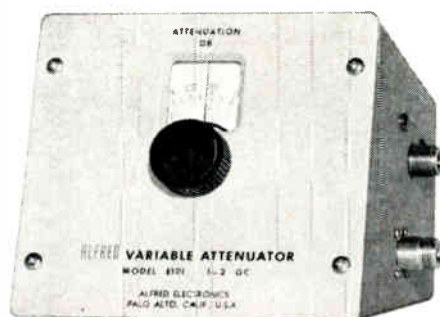
SIMULATED FLIGHT

Terry Vasques and Bart Monge watch rendezvous and docking maneuver in a simulated space flight at General Dynamics/Astronautics, San Diego, Calif. TV monitor is similar to one in the company's manned spacecraft simulator in another building. Computer provides the instruction to drive the "zoom" lens running on tracks. Miss Vasques is talking to the "astronaut" in the spacecraft simulator.



New Attenuator CAPABILITY

...from ALFRED



Coaxial, Variable
1 to 2 Gc, 2 to 4 Gc, 4 to 8 Gc

First to Combine ALL FOUR Attenuator Features!

* LOW INSERTION LOSS

An insertion loss of only 5 db at the zero db setting permits the ALFRED attenuator to be used where limited power is available.

* WIDE RANGE ATTENUATOR

Greater than 60 db continuously variable attenuation in L, S, and C bands.

* FLAT RESPONSE

Frequency sensitivity is less than $\pm 3/4$ db at minimum attenuation with external terminations having VSWR less than 1.1:1.

* EXPANDED DIAL SCALE

The 8" calibrated scale length, four times longer than is provided on other coaxial attenuators, gives fine resolution. Accuracy of calibration at mid-band is ± 0.2 db or $\pm 2\%$, whichever is greater.

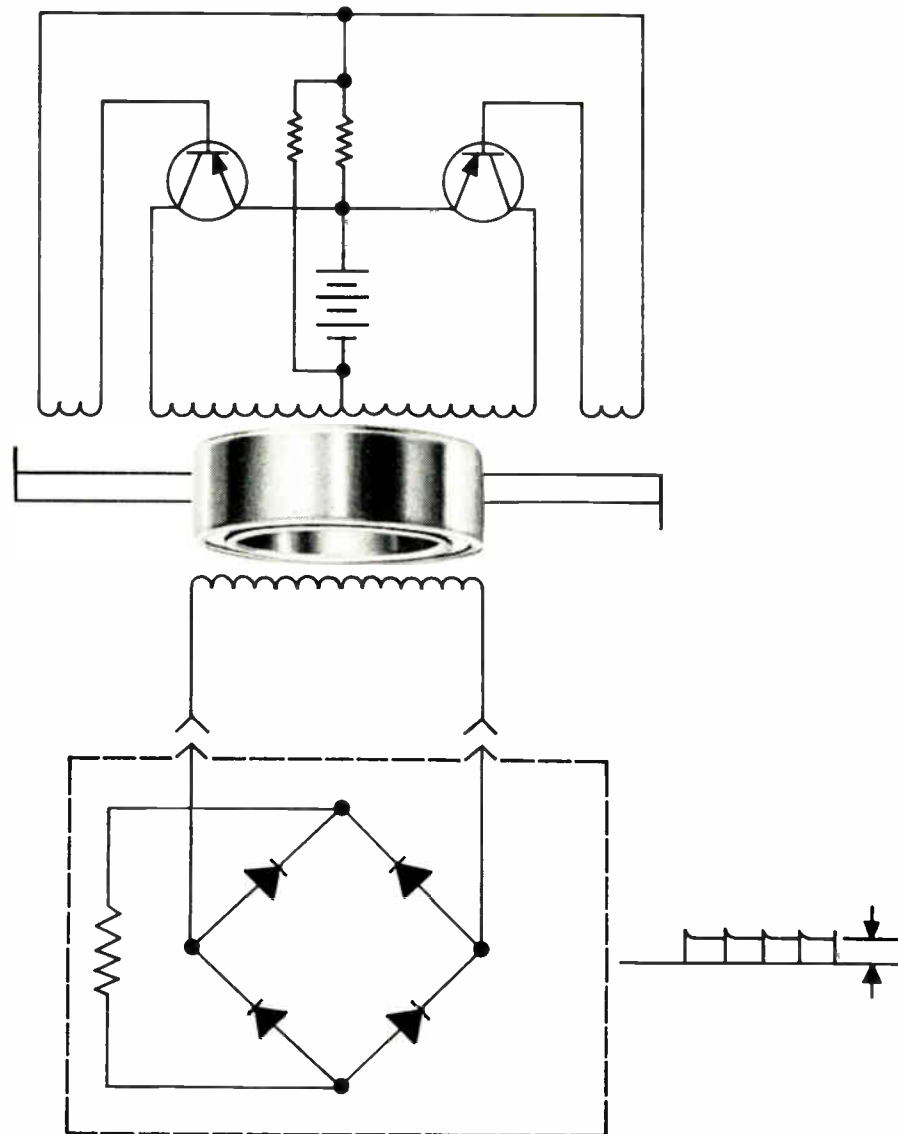
In addition, good directivity allows the instrument to be used as a directional coupler with high decoupling action or as a variable coupler for mixer applications. Maximum power rating is 100 watts.

SPECIFICATIONS

Model	E101	E103	E105
Frequency Range Gc	1 to 2	2 to 4	4 to 8
Insertion Loss (at 0 db setting)	5 db	5 db	5 db
Frequency Response (at 0 db setting)	$\pm 3/4$ db	$\pm 3/4$ db	$\pm 3/4$ db
Frequency Response (at 60 db setting)	$\pm 1 1/2$ db	$\pm 1 1/2$ db	± 2 db
Calibration accuracy at center frequency	± 0.2 db or $\pm 2\%$, whichever is greater		
Impedance	50 Ω	50 Ω	50 Ω
Connectors	Type N female		
Price	\$400	\$450	\$480

ALFRED ELECTRONICS

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How to design a static converter/inverter

Basically a magnetic coupled multivibrator, the square wave output of this static converter/inverter can be delivered as a-c directly to a load. Or, it can be rectified (full wave) to supply d-c voltages higher or lower than battery supply voltage. Ideal for highly portable equipment, the circuit has all the advantages of solid state devices. And, because transistors are the switches, replacing mechanical vibrators, potential maintenance problems are eliminated.

A Magnetics Inc. tape wound core is the *key* to perfect switching operation. The rapid change in core impedance in going from the unsaturated to saturated state forces the transistor switching. Thus, a *properly selected core* and the number of turns of wire on it become important, since this determines the operating frequency of the inverter.

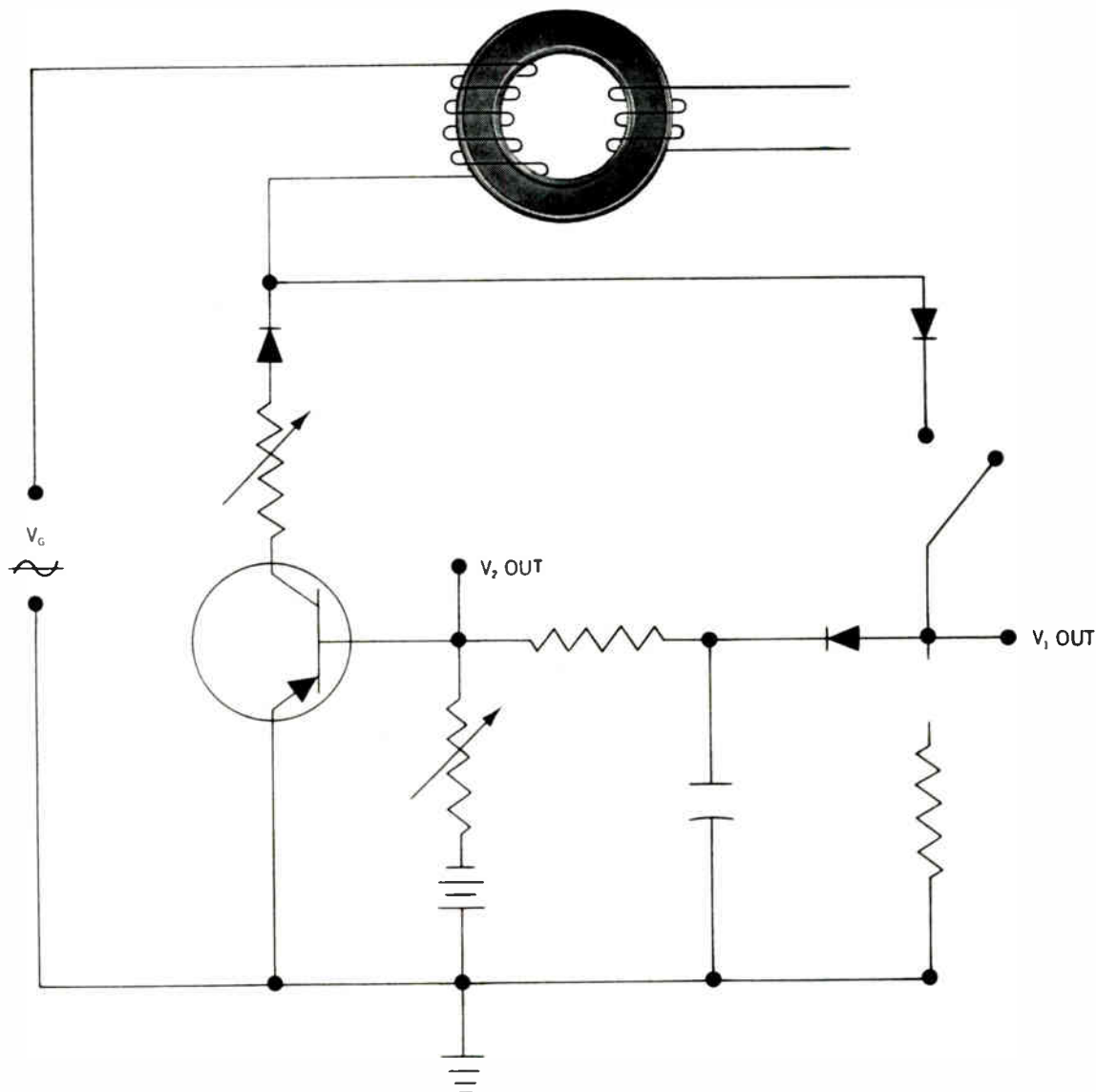
Core material is important, too. For example, Magnetics Inc. Orthonol,[®] is ideal for most power applications where

a given voltage and frequency are required. Where the design calls for a high voltage at low power levels, such as a d-c supply for photo tubes, Geiger tubes, or where high efficiencies are required under light loads, Magnetics Inc. Permalloy 80 should be selected.

Since power requirements, wire size, and frequency influence core size, Magnetics Inc. has a complete range of sizes and alloys available for complete design freedom.

To help you choose the core you need . . . and for more details on this circuit, write for bulletin "Designing d-c to d-c Converters" to Magnetics Inc., EI-2, Butler, Pa.

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HOW TO GET 2 MINUTES TIME DELAY WITH 1% ACCURACY

HERE'S AN ADVANCED DESIGN that uses alternate positive and negative volt-second signals to pulse an Orthonol[®] core to produce time delays up to 2 minutes with 1% accuracy. Key to extreme accuracy in this bi-directional trigger technique: the nearly ideal rectangular loop characteristics of Magnetics Inc.'s Orthonol[®] that permit switching sharply from the unsaturated to the saturated state.

What makes the circuit superior to mechanical devices, commonly used r-c circuits or magnetic core circuits of the past? Just this. Trigger pulses can come from any constant frequency source. The circuit is symmetrical; hence, compensating for effects of variations in temperature, voltage and frequency.

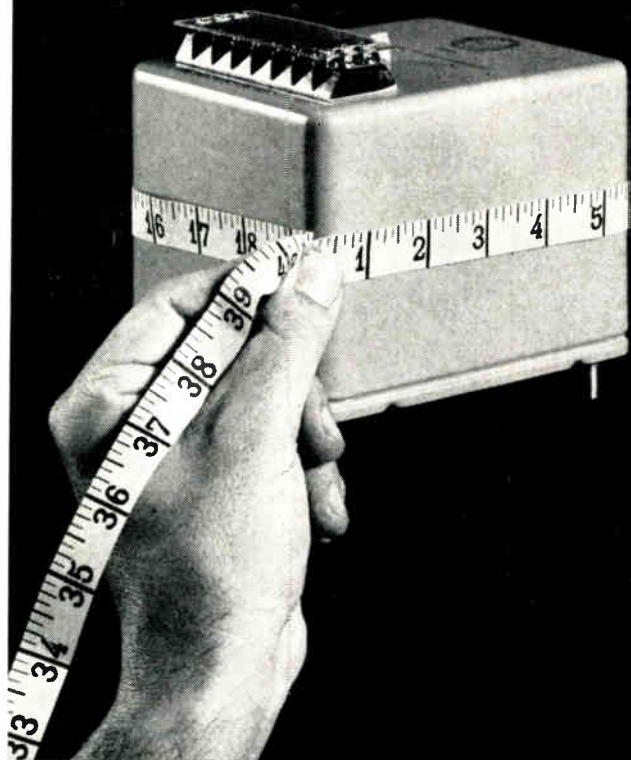
And because the circuit features solid state devices, high reliability is assured.

Useful for electronic counters and timers where accuracy and reliability are paramount, the circuit can also be applied to converting low level analog signals to frequency signals. By using the storage capacity (volt-second capacity) of the Orthonol[®] core, high sensitivity for any desired frequency range can be achieved.

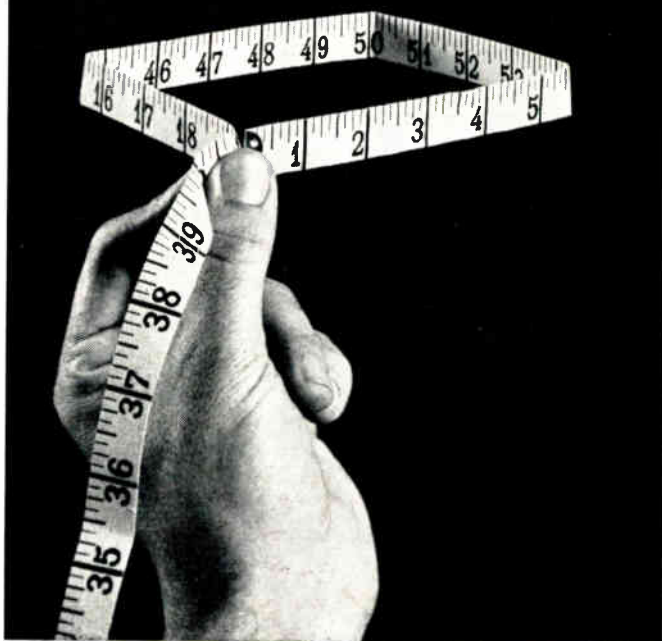
For specific information about this circuit and the Magnetics Inc. cores that make it possible, write to *Magnetics Inc., Dept. EI-1, Butler, Pa.*

MAGNETICS inc.

what doubles the output



*... without changing the
waistline?*



FC-75 does it for this solid state voltage control,
permits boost from 1000 to 2000 watts!

Only component changed is the coolant! Sealed in conventional oil coolants, the voltage control unit, above, is rated at 1000 watts. With faster-cooling 3M Brand Inert Liquid FC-75, the unit doubles its rating to 2000 watts, becomes today's smallest control of its output and type!

The device, made by Electro-Seal Corporation, was initially developed for the temperature control system of an electric oven. It can also be used as a static switch or as a continuously variable voltage control.

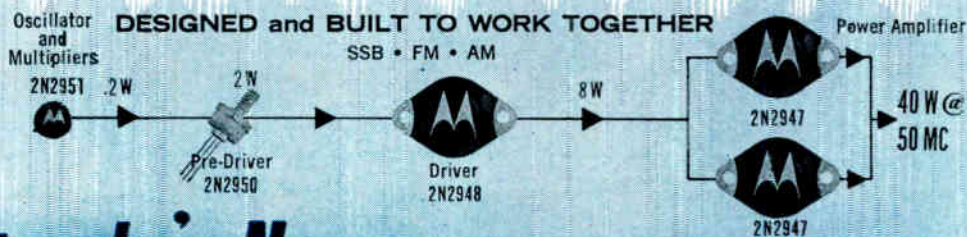
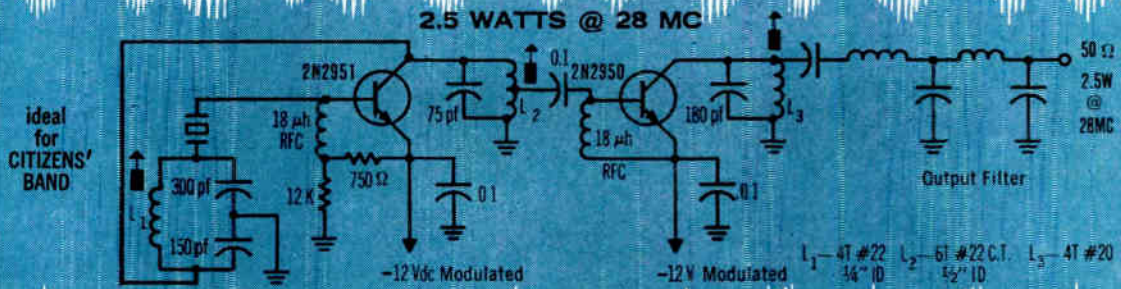
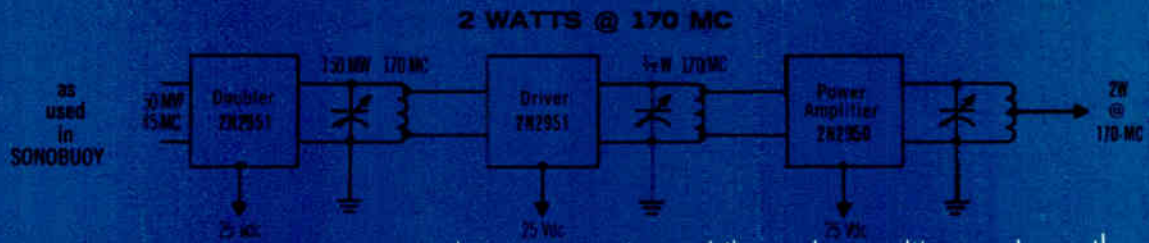
This control is just one of many dramatic examples of how FC-75 (and its companion, FC-43) helps designers "cool" space problems: Get more work out of the same space, or get

the same electronic job done in less, by speeding heat transfer. In miniaturization, for example, such units as transformers have been trimmed 4 to 1 in volume, 2 to 1 in weight.

FC-75 removes as much as 40 times more heat through boiling than oil-type coolants can by convection. Electrical strength of FC-75 remains the same, liquid or vapor, so there's no dielectric breakdown. FC-75 is chemically inert, compatible with practically all materials, seldom needs replenishment or service. It's non-explosive, non-flammable, odorless, thermally stable. For technical details on 3M Inert Liquid FC-75 and FC-43, write Chemical Division, Dept. KCQ-103 3M Company, St. Paul 19, Minnesota.

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Type	Package	Power Output in Watts (cw)	Power Gain @ Power Output (db)	Collector Efficiency (%)	Pulse Breakdown* V_{CES} (V)	V_{CB} (Vdc)	$I_{C, max}$ (A dc)	P_D 25°C Case
2N2947	TO-3	17	8.5	70	90	60	1.5	25
2N2948	TO-3	10	7	60	80	40	1.5	25
2N2950	STUD	3.5	12	50	85	60	0.75	6.0
2N2951	TO-5	0.7	7.5	40	—	60	0.50	2.0

*Minimum specification limit measured in pulse condition at 250 mA.



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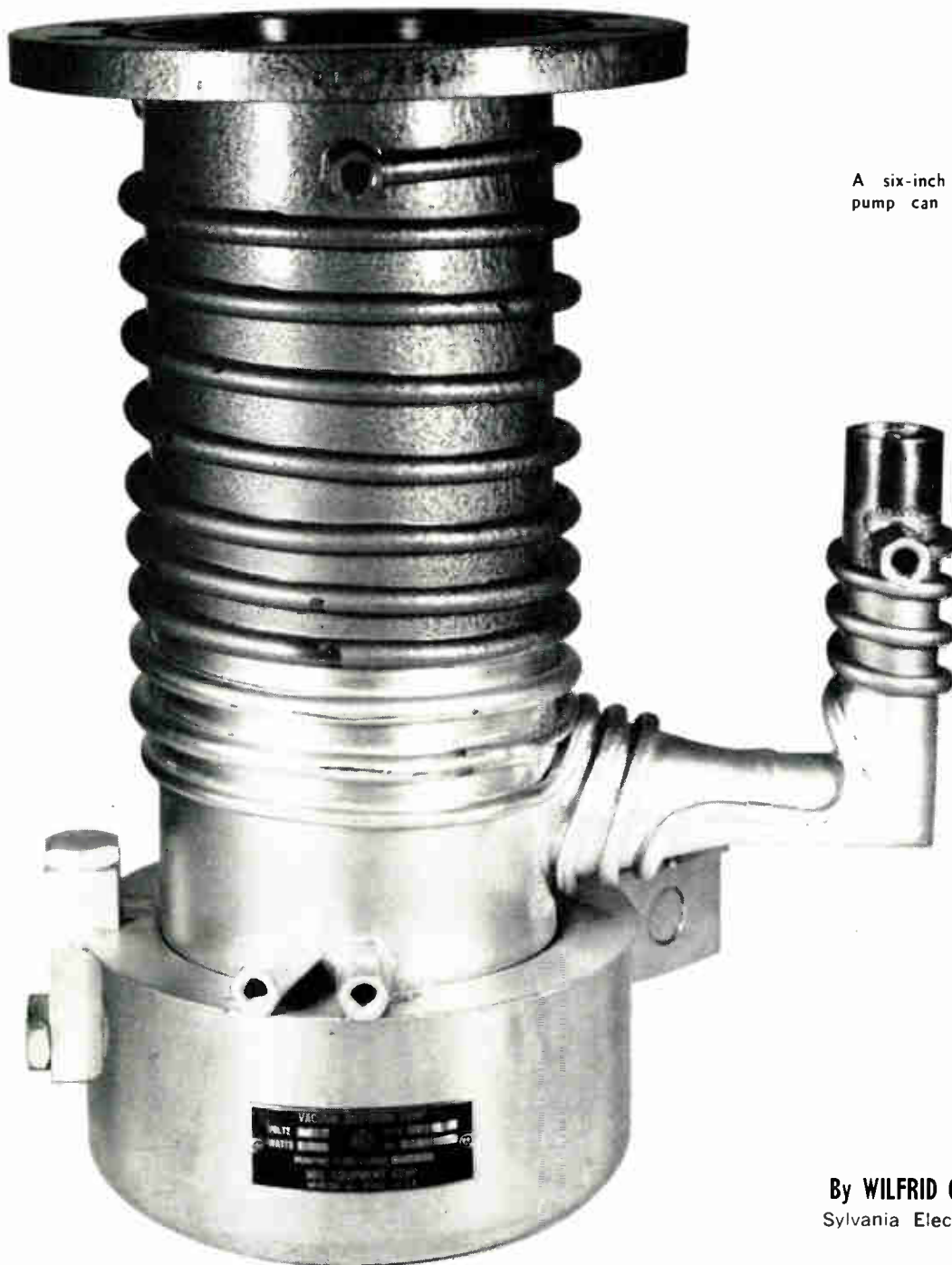
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SURVEY OF VACUUM TECHNOLOGY

High vacuum environments are becoming increasingly important for space simulation and for production of high reliability electronic devices. This article will prove helpful to those who find it necessary to select and use high-vacuum equipment for electronic applications.



A six-inch oil-diffusion vacuum pump can pump large volumes.



By **WILFRID G. MATHESON, P.E.**
Sylvania Electric Products, Inc.
60 Boston St.
Salem, Mass.

ADVANCED ELECTRONIC TECHNOLOGY often depends on increasingly high vacuum environments. How such environments may be achieved, how one copes with impurities introduced by the equipment, how long it takes to reach vacuum, and the cost of achieving vacuum are of increasing interest to electronic engineers. Yet, few of us have much training or experience in high-vacuum technology. This article, therefore, is tutorial in nature. It is designed to serve as background and reference material for those who find it necessary to select and use high-vacuum equipment for electronic applications.

The design of highly sophisticated vacuum systems, often needed for space simulation or for high reliability electronic device processing, is not for the novice. There are companies which specialize in high-vacuum systems design that should normally be consulted where more than "rough pumping" systems are needed.

Details of ultra-high vacuum equipment, such as ion and cryogenic pumps, are covered in another article in this issue beginning on page 102.

* * *

Vacuum is correctly defined as a state which exists in a completely sealed space from which all gases and vapors have been removed. Since no method of producing an absolute vacuum has yet been devised, progress toward that goal must be described in terms of "degree" of vacuum attained. Pressure attained is limited by the materials chosen to enclose such a space, nature of the gases and vapors to be removed, and methods of pumping used.

Degree of vacuum bears a definite relation to atmospheric pressure. (At sea-level this pressure is about 760 mm. of mercury).¹ The list below serves to show the relationship existing between the degree of vacuum and the pressure.

Condition	Pressure Range
Low Vacuum	760 to 25 Torr
Medium Vacuum	25 to 1.0 Torr
Fine Vacuum	1.0 to 1.0×10^{-3} Torr
High Vacuum	1.0×10^{-3} to 1.0×10^{-6} Torr
Very High Vacuum	1.0×10^{-6} to 1.0×10^{-9} Torr
Ultra High Vacuum	1.0×10^{-9} and below Torr

Behavior of gases and vapors becomes more involved as conditions of pressure and temperature change. Ideal gases obey Boyle's law as well as Charles' Law, but non-condensable gases and vapors do not. Generally speaking, in any range of vacuum being used, one is confronted with a complex of gases and vapors.

1. In recent years, the term "Torr" has been generally accepted as the international standard term equivalent to a column of mercury 1.0 mm. high. ("Torr" is in honor of Evangelista Torricelli, who invented the barometer in 1643.)

In a cubic centimeter of gas, at normal atmospheric pressure (760 Torr), there are about 2.7×10^{19} molecules. If we reduce the pressure to 1.0×10^{-7} Torr, we would have about 2.7×10^9 molecules.

Molecules of air, under standard conditions, collide with each other after travelling an average distance of 9.5×10^{-6} cm. Average distance that a particle travels between successive collisions is called the Mean Free Path. At a pressure of 1.0×10^{-7} Torr, this increases to 14.0 meters. At ultra low pressures, such as in outer space, the molecules are very far apart, so that the average distance one must travel to collide with another is measured in hundreds of meters.

In the years between 1920 and 1940 much fundamental knowledge concerning vacuum physics was accumulated. World War II brought about an accelerated program to produce many new products and to improve existing ones. Amongst those in which vacuum processes played a major role were: Coating of precision optics, manufacture of reflectors for

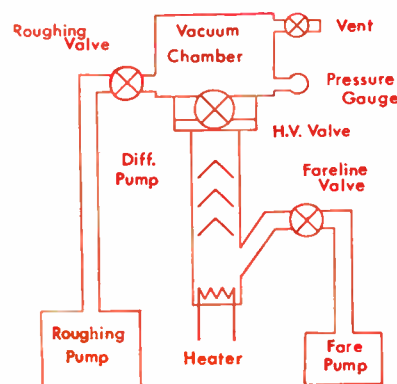


Fig. 1: Sketch shows a simple vacuum system.

optical systems, manufacture of penicillin, manufacture of vitamins, vacuum melting of metals, Radar—electron tubes, Cyclotrons, Betatrons, electron microscopes and atom fission.

Let us now consider some aspects of the production and measurements of vacuum. Fig. 1 shows a simple system. Essentially, it consists of a chamber, a pumping system, and a pressure measuring device, connected to permit the removal of gases, etc., from the chamber. The pressure level attainable is determined by the performance characteristics of the individual components.

One of the most confusing aspects of vacuum pumping is the selection of the correct vacuum pump for a particular use. This is not surprising when one discovers 32 different pumps defined in the *Glossary of Terms Used in Vacuum Technology*, issued by the Committee on Standards of the American Vacuum Society.* There are a number of variations on these

*This Glossary may be obtained from the Society by addressing Wilfrid G. Matheson, National Secretary, American Vacuum Society, P. O. Box 1282, Boston 9, Mass.

ACHIEVING A VACUUM (Continued)

pumps, particularly for exotic or unusual pumping needs. We shall consider here a few of the most commonly used pumps.

Common Pumps

Mechanical Oil-Sealed Rotary Pumps: This type pump is often classified as a "roughing pump." Pumps may be of single or 2-stage construction. Others may be duplex to increase volume and reduce vibration. (Various designs are available from a number of manufacturers.) Usual application range for these pumps is from atmospheric measure to 1.0×10^{-3} Torr. The greatest number are used for evacuation down to the Fine Vacuum range and to "back-up" diffusion pumps. The specially processed oil needed for lubrication and sealing of these pumps must have a low vapor pressure.

Within the limits of modern design and construction, the oil-sealed rotary pump produces a satisfactory vacuum for many purposes. Cold (refrigerated) traps often are used to reduce contamination from water and oil vapors in the vacuum chamber. Pressures lower than 1.0×10^{-3} are not uncommon. Fig. 2 shows the typical speed performance curve for single stage rotary type oil-sealed vacuum pumps.

Diffusion Pumps: The diffusion pump is an early development, dating back to Gaede, who in 1915 did the fundamental work which resulted in a basic diffusion pump. It was capable of pumping large volumes of gas at relatively low pressures. The operating principle is that it uses a jet, or a number of jets, of mercury or oil vapor so placed as to provide a very low pressure above the jet. Into this space, the molecules from the chamber diffuse rapidly, and are captured and carried from jet to jet in successive compressive stages. They are then exhaled into the atmosphere through a mechanical "back-up" pump connected to the foreline of the diffusion pump.

Many variations have occurred in the design of diffusion pumps. Research into pumping fluids has brought increased speeds and improved performance at all applicable pressure ranges. Various ejector type diffusion pumps have been developed for the higher pressure uses.

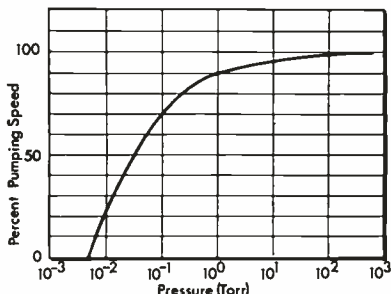


Fig. 2: A typical speed curve of a single stage oil-sealed mechanical vacuum pump.

Fig. 3 (r): A Welch two-stage oil-sealed mechanical pump.

Roots Blower Pump: This pump moves the gas by the propelling action of a pair of two-lobe inter-engaging impellers of special design. It is often called a mechanical booster pump when used in series with a regular mechanical pump and fills the gap between a mechanical and a diffusion pump. There is no fluid. However, the bearings must be lubricated. The Roots Pump is generally considered a "clean" pump.

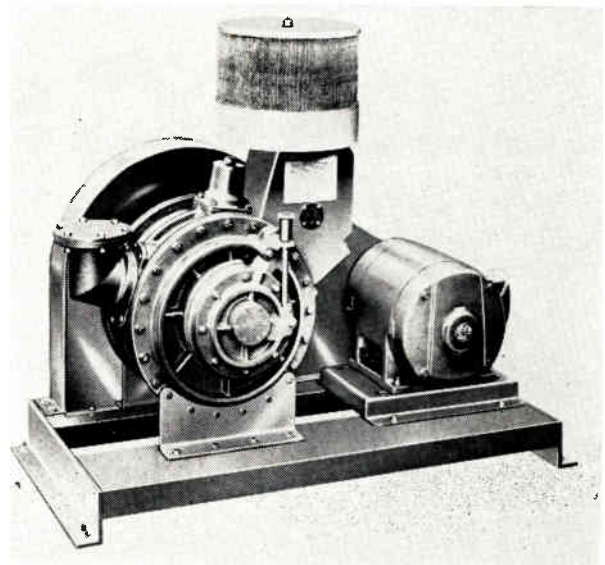
Ejector Pump: These are vapor pumps where the pumping action of each vapor jet depends mainly on the entrainment of gas by viscous drag and by diffusion of gas into the vapor at the boundary of a dense vapor stream. This stream carries the gas at supersonic velocities down a converging chamber (diffuser) and through a throat which is equal to, or smaller than, the cross section of the vapor stream.

Ion Pump: An ion pump is an electrical device for pumping gas. It comprises a means for ionizing the gas and a system of electrodes at suitable potentials, and in some cases also a magnetic field, which causes the ions formed to move towards an auxiliary pump or trap. Ion pumps have relatively low pumping speeds. They are almost always used in conjunction with mechanical and diffusion pumps to achieve higher vacuum after these roughing pumps have reached their practical limits.

Sorption Pump: Such a pump is one with a renewable trapping surface which reduces the partial pressure of gases by adsorption, absorption, or by chemisorption. There are combinations of ion and sorption pumps.

Getter-Ion Pump: The familiar vacuum tube with its built-in getter is an example of getter pump action. The getter-ion pump is an ion-sorption pump in which a getter is continuously or intermittently vaporized and condensed on the trapping surface to give a fresh deposit of sorbent.

Dri-Vac Pumps: There are a variety of pumps



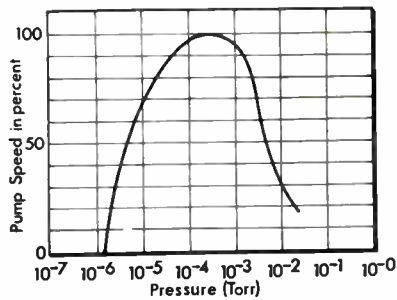
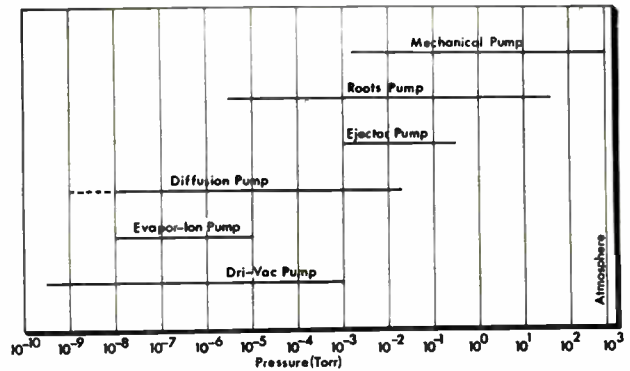


Fig. 4 (l): Pumping speed curve of a typical oil-diffusion pump.

Fig. 5 (r): Typical operating range for some vacuum pumps.



under this category. Turbo-molecular and evapor-ion pumps are forms of dri-vac pumps. Cryogenic pumps fall in this category.

Selecting A Pump

Fig. 5 shows relative pumping ranges for some typical vacuum pumps commonly used. Note that mechanical pumps are essential with few exceptions for first pumping from atmosphere pressure. As the speed of pumping decreases for a given pump, a more efficient pump for later pumping takes over. Not shown in Fig. 5 is the cryogenic pump, which like the evapor-ion pump, is a form of dri-vac pump and falls in the lower pressure region of the dri-vac pump range. The dotted portion of the diffusion pump range is an extension claimed by some makers of diffusion pumps.

Leak Detection

A vacuum system or product will only be successful when its leakage rate is negligible. The helium mass spectrometer is considered to be the most reliable type of instrument for detection of leaks. The sensitivity is so great that the presence of one molecule of helium in one billion molecules of air is detectable. Workers in the field of vacuum must become familiar with leak detection methods as well as the types of leak detectors available for this work.

Vacuum Measurements

Measurement of vacuum in itself is complex because of the wide range of pressures involved and the composition of the gases present. Fig. 7 indicates a number of gauge types and the pressure ranges where they are applicable. This grouping includes absolute manometers, hot wire and ionization gauges.

The McLeod Gauge: This instrument is basic. Its readings are absolute, since they are calibrated from the dimensions of the gauge. The gauge traps a known volume of gas which is then compressed in a closed capillary of known cross-section. Comparing the height of this column and that of a second column of mercury (equal to the closed capillary height) makes it possible, but use of Boyle's Law, to find the pressure. Condensable vapors, however, cannot be measured by this instrument, nor are continuous and remote readings possible.

Hot Wire Type Gauge: This type of instrument is essentially a filament placed in a suitable envelope. The filament is heated by constant voltage. The resistance changes as a function of the number of molecules present and their nature. The pressure is read in milliamps. By calibration against a McLeod Gauge, a series of pressure curves may be drawn for different gases, or mixtures of gases. In modern gauges the indicating meter is calibrated directly for air. This instrument is useful for remote and continuous monitoring of a vacuum system.

Ionization Gauges: This type of gauge is generally useful in the highest ranges of vacuum. It depends on ionization of the gas molecules present, and measurement of ion current. The latter being proportional to the pressure in the vessel. Ionization may be started by a hot filament, or by a radio-active element in the gauge. Cold cathode types, such as the Penning and the Philips, are also widely used. Their operation depends on the magnetic field surrounding the discharge tube causing the electrons to move in long spiral paths on their way to the anode. This ensures a continuous ion current which is proportional to the pressure. These gauges are rugged, in that exposure to the atmosphere is not harmful, as would be the case in a hot filament type.

Why Employ High Vacuum?

The most important reason for using high vacuum is the need to remove from a vessel the requisite number of molecules, so that electrons, ion beams and evaporated molecules can be moved about in the evacuated space without undue interference.

Secondly, there is the need to remove gas and vapors from many substances. This operation can be most readily performed by heating in a vacuum. Also, many gas free components can be produced and sealed in vacuum to prevent corrosive action.

The most recent use—and it may well prove to be the most exciting of all—concerns the extensive and

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ACHIEVING A VACUUM (Concluded)

ever-widening study of space. In this we are concerned with the behavior of man and materials operating in a high vacuum.

The earliest industrial use of a vacuum process was in the manufacture of the incandescent vacuum lamp. This quickly became a mass production item and continues to this day as a high speed pumping procedure. Development of the electronic industry is a further extension of mass production. High-speed equipment has been developed to such a degree that the normal pumping time for a 25 w. vacuum lamp is about 20 sec.

The deposition in vacuum of metals, alloys and compounds on various substrates covers a wide variety of products. In optics, we find coatings designed for high reflection or high transmission, from the ultraviolet through the infrared portion of the radiation spectrum, e.g., mirrors, filters, color control devices, beam splitters and decorative coatings. Resistors, capacitors, transistors and electrical circuitry may also be produced by the vacuum process. Presently, many scientists are engaged in the fundamental study of thin films.

In the field of metallurgy we have seen great advances. Physical, mechanical and chemical properties have been improved extensively. Pure metals have been made possible by vacuum melting. Gases have been removed effectively. Metals which when heated in air react violently are being melted successfully in vacuum. Castings made in vacuum have become commonplace and are generally superior to those produced by other processes.

Atomic and Nuclear physics depend on high vacuum, without which investigation into the ultimate nature of matter could not be made.

Fig. 7: Typical operating ranges for some vacuum gages.

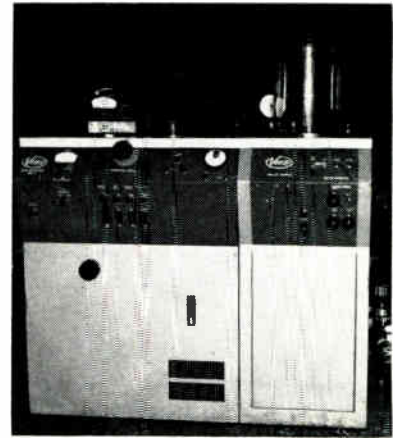
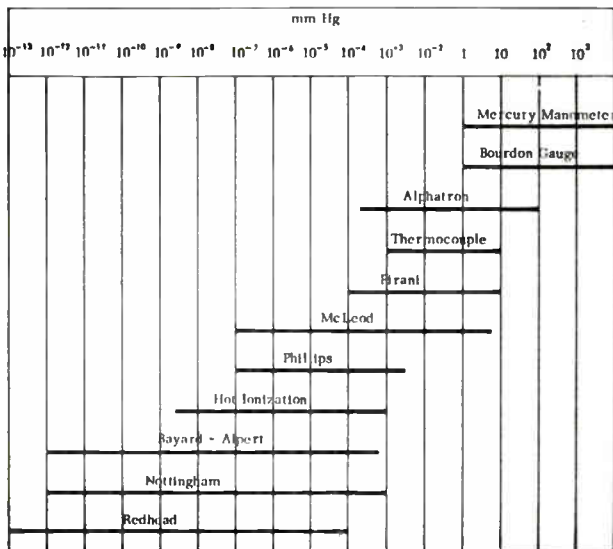


Fig. 6: A Helium mass spectrometer leak detector (VEE-CO).

In summation, for those who are working in industries which use the vacuum processes, it is essential to study and understand the fundamentals of vacuum physics. Selection of proper components for a vacuum system demands a careful analysis of the characteristics needed. After the materials have been selected, they must be expertly fabricated into a leak-free system, which is thoroughly clean. Maintenance of a vacuum system must be performed by properly trained personnel.

An understanding of these basic facts will aid greatly when making decisions involving new equipment and processes.

The American Vacuum Society is the largest technical society in the world devoted solely to the promotion of knowledge in the fundamentals and methods of vacuum science. The National Bureau of Standards has published a bibliography which is useful and several universities provide courses in vacuum science. Certain industries have established courses for their employees and training films are available. The American Vacuum Society is presently preparing a film on Leak Detection.

References

- Yarwood, J.: *High Vacuum Technique*, Chapman and Hall, Ltd., London.
- Jnanananda, S.: *High Vacua*, D. Nostrand Co., New York.
- Martin, L. H. and Hill, R. D.: *A Manual of Vacuum Practice*, Melbourne Univ. Press, Melbourne.
- Bachman, C. H.: *Techniques in Experimental Electronics*, John Wiley and Sons, New York, pp. 1-67, 89-130.
- Guthrie, A., and Wakerling, R. K.: *Vacuum Equipment and Techniques*, McGraw-Hill Book Co., New York.
- Dushman, S.: *Scientific Foundations of Vacuum Technique*, John Wiley and Sons, Inc., New York (Second Edition 1961).
- Jaekel, R.: *Kleinste Frucke, Ihre Messung und Erzeugung*, Springer-Verlag, Berlin.
- Holland-Merten, E. L.: *Handbuch der Vakuumtechnik*, Wilhelm Knapp, Halle.
- Davy, J. R.: *Industrial High Vacuum*, Pitman and Sons, Ltd., London.
- Reimann, A. L.: *Vacuum Technique*, Chapman and Hall, Ltd., London.
- Atta, Van, C. M.: *Design of High Vacuum Systems*, Kenney Manufacturing Co., Boston, Mass.

Film

American Vacuum Society-U. S. Atomic Energy Commission: *Introduction to High Vacuum*—16mm Color and Sound—Free Loan—Any A.E.C. Film Library.

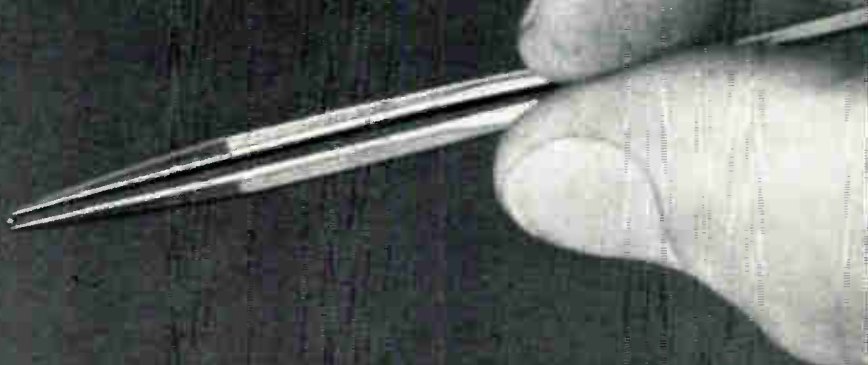
Bibliography

National Bureau of Standards *Nomograph No. 35*: Order from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.—Price \$60.

Technical Symposium Transactions

Annual Transcriptions of the Technical Symposia on High Vacuum 1954-1963, American Vacuum Society, P.O. Box 1282, Boston 4, Mass., U.S.A.

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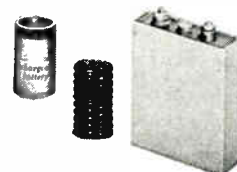
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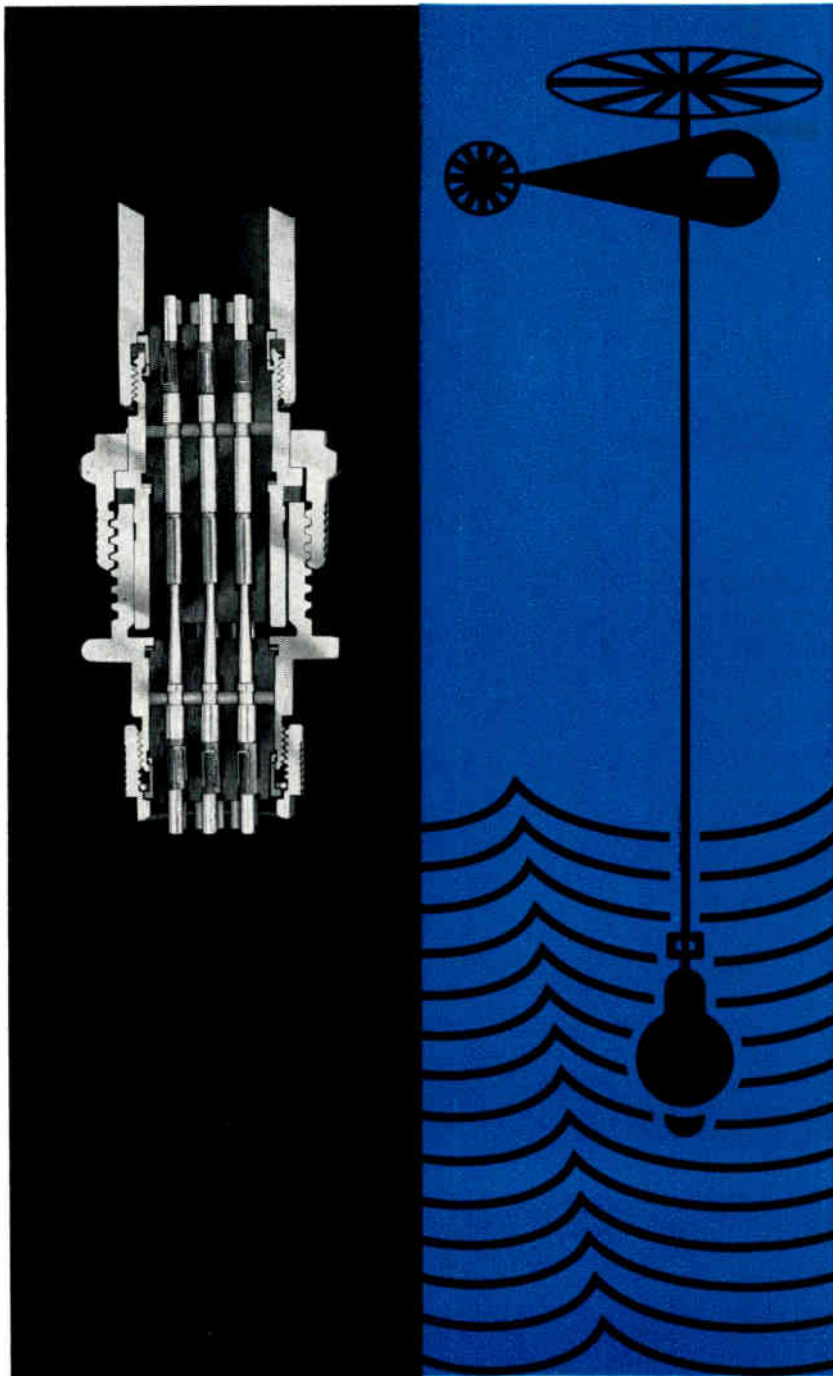
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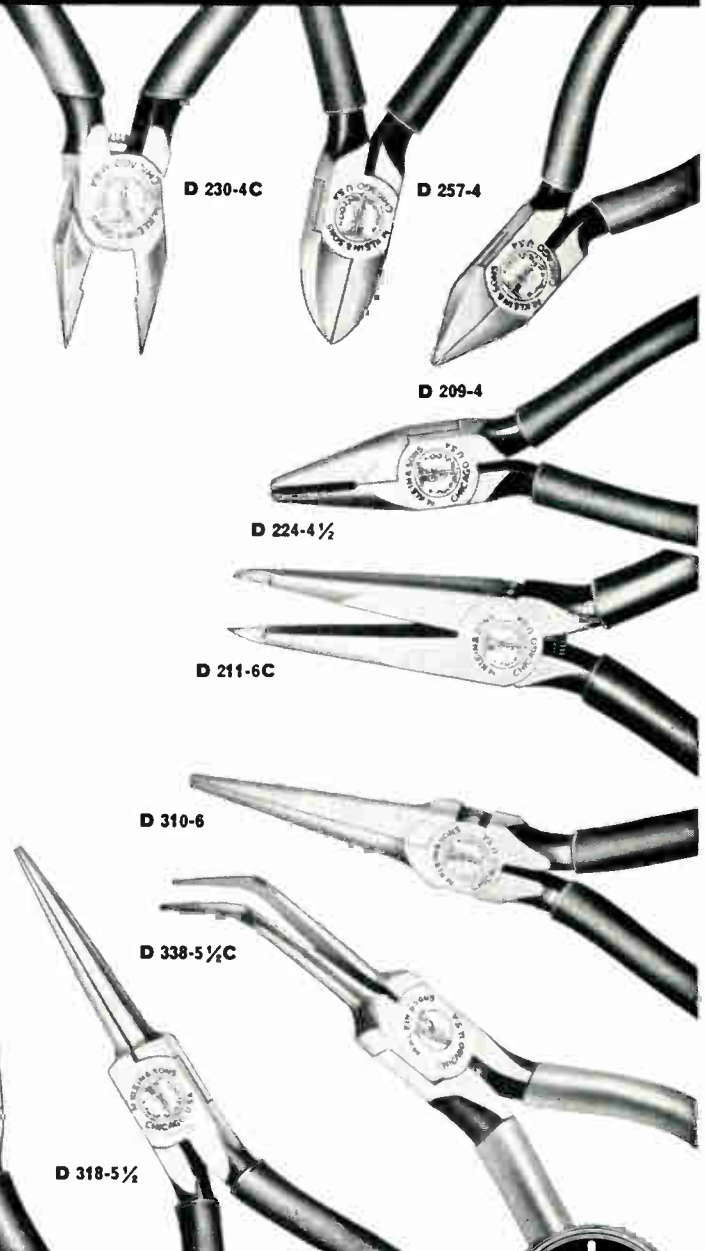
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HVD	5	30	200K ohms to 25,000 Megs	5 1/2	3/16
HVE	4	15	200K ohms to 25,000 Megs	2 1/2	3/16
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HPB	35	65	2 Megs to 100,000 Megs	10 1/2	1 1/8
HPC	55	90	4 Megs to 100,000 Megs	14 1/2	1 1/2
HPD	35	40	2.5 Megs to 100,000 Megs	6 1/2	2
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HFC	3	1400	65 ohms to 100 Megs	3	3/16
HFD	5	2600	120 ohms to 100 Megs	5 1/2	3/16
HFE	4	1100	30 ohms to 50 Megs	2 1/2	3/16
HFF	6	1900	50 ohms to 75 Megs	4	3/16
HFG	10	3100	80 ohms to 100 Megs	6 1/2	3/16
HFX	12	1250	20 ohms to 25 Megs	4 1/2	3/4
HFH	20	2750	35 ohms to 50 Megs	6 1/2	1 1/8
HFJ	30	4750	60 ohms to 100 Megs	10 1/2	1 1/8
HFK	50	6750	65 ohms to 100 Megs	14 1/2	1 1/2
HFL	30	3000	25 ohms to 100 Megs	6 1/2	2
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RX2	1	3,000	500K ohms to 50 Megs	2	.413
RX3	3	10,000	1 Meg to 200 Megs	3 1/16	.413
RX3HV	2	10,000	1000 ohms to 200 Megs	3 1/16	.413
RX4	5	800	200 ohms to 50 Megs	2	.413
RX5	10	2,000	200 ohms to 200 Megs	3 1/16	.413
RX8	2	750	100 ohms to 10 Megs	1 1/2	.240

*Wattage is reciprocal of resistance in megohms

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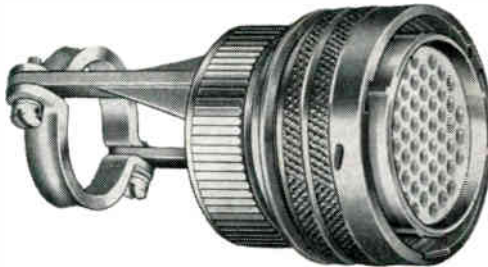
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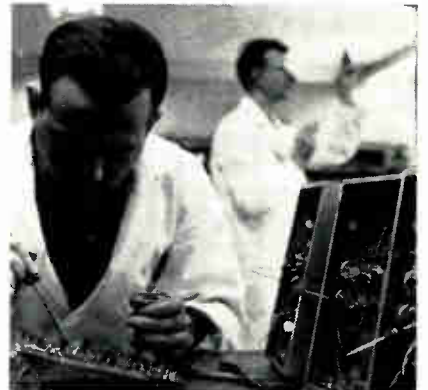


The cost of wages, salaries and fringe benefits amount to roughly one-third the total cost of the aerospace market.



Workers shifting from old skills to new have generated a need for retraining older employees, and assuring the nation of reaping a crop of skilled young workers.

Estimates of electronic workers vary from 700,000 to one million (some 300,000 unionized) depending on the source.



More than 25 affiliated and independent unions active in electronics are represented among large and medium firms.

GENERAL DYNAMICS ENGINEERS REJECT UNION

Results of a run-off election at General Dynamics Astronautics Division, San Diego, Calif., indicate the company's professional engineers overwhelmingly voted to reject continued union representation.

They followed the earlier example of the firm's engineers at the Pomona, Calif., location, who ousted the Engineers and Architects Association in June.

The run-off vote of 2,149 for professionalism and 1,388 voting for continued EAA representation is a stunning upset for engineering unions. In the first NLRB election on June 21, EAA received 1733 votes, the American Federation of Technical Engineers 286, and 1,592 voted "no union."

As EAA failed to receive a majority of the ballots cast, the run-off was held giving the General Dynamics engineers a clear choice.

National Society of Professional Engineers



By **SIDNEY FELDMAN**

Associate Editor
ELECTRONIC INDUSTRIES

When radio was young many unions were already old, though at the pinnacle of their power. The rapid growth of industrial and aerospace electronics has blown the fuse for some unions, depleted ranks in others, while adding new members to a few. Labor now faces two chief dilemmas—changing skills and technology, and automation.

IN THE SEPARATE WORLDS OF LABOR AND MANAGEMENT, there are strong forces affecting their respective futures. Management is making more concessions in union contract negotiations, while unions are losing ground through membership decline.

General Electric, for instance, has considered the union shops, arbitration, benefits, contract language, wage rates, security and other matters in negotiations with a number of unions for various employee groups. Current contracts in electronics include those covering some 70,000 workers of the International Union of Electrical, Radio and Machine Workers (IUE) (AFL-CIO) and 11,000 workers of the United Electrical, Radio and Machine Workers of America (UE) (independent), which expire in October, 1963.

May Have Bleak Future

While GE and other firms let down the fences a bit more and raise others higher, there is little doubt that many unions and their members may have to face a somewhat bleak future in some areas of the electronics industry. Labor's struggle to keep its place in the industrial sun in the face of the spread of automation reminds old-timers of the early '30's depression. The cost-competition swirl of the 1960's has electronics firms making hardware and systems for automation that will either supplement or replace workers in many industries. Thus, union members are working against themselves.

"The cost of wages, salaries and fringe benefits amount to roughly one-third the total cost of the aircraft-aerospace end-product," states the Aerospace Industries Association (AIA), counterpart of the Electronics Industries Association (EIA). Accordingly, the skills of management negotiating a union contract become paramount if a firm is to bid competitively for new Government contracts.

R&D has the highest ratio of brain power and skills, with minimum production equipment and number of hourly-paid workers. As R&D rose from 5% to about 20% of the U. S. defense and aerospace

ELECTRONICS GROWTH BRINGS TROUBLE FOR LABOR

budget, there was a steady downward slope in the employment of standard production workers, hence a slow exodus of union membership.

Labor the Costliest Ingredient

Engineering and production labor is the costliest ingredient of much electronic equipment. High technical input into such equipment requires a high ratio of about one engineer for every three production-line workers. If the so-called shortage of electronics engineers develops further, there may be an increase in the ratio of technicians to each engineer.

Though some electronics and aerospace engineers are organized, especially in the defense-aerospace complex of the West Coast, the decline of engineer union power and membership has been somewhat spectacular over the past few years. Many engineer-scientist unions—calling themselves "associations" but still labor organizations under the Taft-Hartley Law—have done an about-face, choosing professionalism and individuality over unionism and collective bargaining, which they once considered compatible.

Back in 1946, a small, energetic band of engineers kicked off a campaign to convince the profession that the salvation of the individual engineer was to organize and take up collective bargaining. As the years passed by, along with professional prestige, many unionized engineers began staggering disillusioned back to more "professional" circles.

Many Engineers Repudiate Unions

Then the engineers acted in a hurry to repudiate the union approach to the solution of their problems, once the necessity of choosing between the unions and professional status became obvious. Most of the larger engineer unions have either disbanded bit by bit, or have been voted out. The few remaining unions, mostly with limited memberships among small firms, plus a few big ones, chiefly RCA, Boeing and General Dynamics, no longer claim that they are not unions and some, in fact, have affiliated with the AFL-CIO. Since 1952, no major group of engineers

TROUBLE FOR LABOR (Continued)

has voted for unionization. Among recent firms where engineers voted out their unions are Western Electric Co., Sperry Gyroscope, and two divisions of General Dynamics, according to the National Society of Professional Engineers.

Dr. Bernard P. Indik, social psychologist of Rutgers University, who is now conducting a survey of the problems of engineers in industry, estimates that of a total of about 800,000 engineers in the U. S. in all categories, about 4.2% are represented by unions of one sort or another, and about 3% are actual members.

Other sources place the number of union organizations representing engineers at from 20 to 35 depending on how organizations are defined. They include independents representing engineers only, independents representing engineers and technicians, those representing engineers and members of other professions, some representing engineers, technicians and other white collar workers, while the remainder are locals of well-known national and international unions, some affiliated with the AFL-CIO.

Out of 30,000 to 35,000 engineers represented by unions today, the number of electronics engineers represented is estimated between 12,000 to 15,000.

Looking For Better Times

American labor began stirring for better times in the 1820's as economic and social trends led to trade unionism, reform agitation and small local labor parties—which have not grown into the strong national political parties exhibited by other nations.

Out of about 35,000 engineers represented by unions today, electronics engineers unionized are estimated at 15,000.



When Marconi sent his wireless signal across the Atlantic in 1901, organized American labor as such had around two million members in total. As radio and electronics grew over the past 62 years, so did unions representing electrical and electronics workers.

Today, there is an estimated 18,000,000 total membership (13,000,000 in AFL-CIO) in U. S. labor unions, which is about one-third of the total available U. S. labor force, not including agricultural.

Electronics worker estimates vary from around 700,000 (Bureau of Labor Statistics) to 1,000,000 (EIA), depending on the source of data and how workers are classified, of which some 300,000 are believed to be union members.

Union relationships with electronics firms today vary with company history, size, capabilities, products, type of work or skills, geographical distribution of plants, and other considerations. Some small firms either have a company union, or they have no relations with any union. Others may deal with one or a host of outside unions. General Electric's 260,000 employees, including electronics, are represented by more than 100 unions.

Changes in the character and the scope of electronic and aerospace products have added to unemployment in some areas. The switch from producing thousands of airplanes to making hundreds of missiles and mere dozens of spacecraft has left many ex-aircraft workers idle. Employment by aircraft and parts firms rose from 338,000 in 1950 to 769,000 in 1955, reports the Department of Labor. By the end of 1961, this figure had fallen to 646,000, supplemented by some 140,000 missile workers, including those in electronics.

Worker Retraining Needed

Workers shifting from old skills to the new have generated a need for retraining older employees, and requiring the nation to sow a new crop of skilled younger workers. The job of filling this need to put workers in a better position to work—and to bargain—has fallen on labor unions, industrial managements and the U. S. Government alike. Many of the larger firms have already embarked on active and long-range programs to upgrade skills or retrain older workers where they desire. One such is Philco, which has had a technical school for a number of years and has recently stepped up its program to retrain workers who apply through its tuition refund plan.

The International Association of Machinists (IAM) (AFL-CIO) cooperates with the California Department of Education in teaching IAM members new skills in electronics. Labor also backs expanded

youth training programs proposed under the Manpower Development Training Act. Two other large unions active in electronics and in furthering worker retraining are the United Automobile, Aerospace and Agricultural Equipment Workers of America (UAW) (AFL-CIO) and the Communications Workers of America (CWA) (AFL-CIO).

Earnings Vary Greatly

Hourly earnings of electronics workers vary greatly with work, skill and training, as they do in most other industries. They also vary between plants ac-

ording to location and the product. Bureau of Labor Statistics data show production workers in plants making radios, TV sets, radar and related gear averaged about \$90 weekly take home pay in January 1961. Workers making electron tubes averaged about \$85, or \$2.14 hourly. In January 1961, production workers in all manufacturing averaged about \$90, or \$2.32 hourly.

Figures from a number of union-management agreements show approximate ranges of hourly wage rates of workers in plants making electronic gear in 1960: *(Continued on page 60)*

UNIONS IN ELECTRONICS

Who's Who and What's What in electronic industries Labor Unions:

A GREAT, BUT GRIM INDUSTRIAL HISTORY marks unions in the electronics and aerospace industries.

Electronics manpower varies between 985,000 to 1 million, according to EIA, and some 670,000 according to Bureau of Labor Statistics. Equally varying are figures of union membership, since certain unions represent workers in electrical, electronic, aircraft, aerospace, machine and other fields.

One source roughly estimates these figures covering biggest firms in electronics, with about 281,000 employees covered by contracts in three categories. There are 220,000 in AFL-CIO unions; 35,200 with no union, or a company union, and 25,500 in independent unions.

Historically, union membership growth pattern has been in leaps, up and down. At present, union membership has fallen off.

Some estimated union memberships, which include electronics workers among others, are: IUE: reported a high of 350,000 in 1951, down to 288,000 in 1960; 231,000 in 1961. UE: had 55,000 members in 1962, nearly half said to be in Canada. IAM: about 840,000. UAW: about 1,200,000, with small but growing ranks of electronics workers in aircraft, aerospace, autos and machines.

IUE: International Union of Electrical, Radio and Machine Workers (AFL-CIO) has the largest electronics membership, and has "conference boards" for GE, General Motors, Westinghouse, RCA, Sperry Rand, and for radio-TV-parts, professional, technical and salaried groups. It has "councils" for Philco, Sylvania, and the battery, optical, lamp and skilled trades.

IUE appreciates that electronics-aerospace industries may become the nation's largest around 1975. "If IUE lags 28% behind the national average, other unions can be expected to do the organizing."

UE: United Electrical, Radio and Machine Workers of America (Independent), historically, is the arch foe of IUE. UE and IUE once were a single union with major control over electrical workers from 1936 to 1949. The "Communist faction" was expelled by the CIO in 1949, leaving two unions and much antagonism.

The original UE, a shadow of its former self, drew breath from Philco in 1933 as the "first successful strike of industrial unionism in the industry." UE has members in GE, Westinghouse, Minneapolis-Honeywell, Jerrold Electronics and others.

IAM: International Association of Machinists (AFL-CIO) is possibly the oldest, founded in 1888 by 19 machinists in a locomotive pit. It gained electronics membership as the aircraft-turned-aerospace industries gained more avionics work in the 1950's. IAM is both an old-time craft union (organizing workers by skills) and a modern industrial union (organizing

workers by industry). Astute IAM and U. S. Industries, Inc., founded the U. S. Foundation on Automation and Employment to study the fate of men, machines and unions.

UAW: United Automobile, Aerospace and Agriculture Equipment Workers of America (AFL-CIO) gained fame and strength with "sit-in strikes" in Detroit auto plants back in the 1930's, and today often works with IAM in cultivating electronics workers in their respective industries.

CWA: Communications Workers of America (AFL-CIO) espouses a labor statesmanship in relations with management and society which observers attribute to the relatively secure, predictable communications-telephone-telegraph industries which are public utilities wedded and wired to growing customer publics.

Other unions, depressed by "automation" problems, point happily and hopefully to an American Cable and Radio Corp. (IT&T) contract with CWA which provides that workers displaced by automation be put in other jobs with equal pay.

Other AFL-CIO-affiliated unions active in electronic industries include:

IBEW: International Brotherhood of Electrical Workers.

IUOE: International Union of Operating Engineers.

IBT: International Brotherhood of Teamsters.

AFGWU: American Flint Glass Workers Union of North America.

EST: Electronic & Space Technicians.

AIWA: Allied Industrial Workers of America.

UBC&J: United Brotherhood of Carpenters and Joiners.

URCL&PW: United Rubber, Cork, Linoleum & Plastic Workers of America.

OCAW: International Union of Oil, Chemical and Atomic Workers.

USW: United Shoe Workers of America.

AIW: Aircraft Industry Workers.

USWA: United Steel Workers of America.

GBBA: Glass Bottle Blowers Association.

MESA: Mechanics Educational Society of America.

ICW: International Chemical Workers.

Independent unions in electronics are:

IBTCWHA: International Brotherhood of Teamsters, Chauffeurs, Warehousemen and Helpers of America.

UWA: United Welders of America.

RCAU: Radio Communications Assemblers Union.

ICW: Independent Condenser Workers.

WEU: Weston Employees Union.

IMC: Independent Metal Craftsmen.

AMW: American Metal Workers.

TROUBLE FOR LABOR (Continued)

Occupation	Hourly Wage Rate
Machinist	\$1.90 to \$2.90
Troubleshooter	\$2.00 to \$2.60
Assembler	\$1.50 to \$2.45
Inspector	\$1.65 to \$2.70
Tester	\$1.50 to \$2.55

Highly experienced troubleshooters, testers and inspectors often earn wages much higher than scale. Electronic workers in general earn premium pay for overtime, Sunday and holiday work, plus a differential for evening and night-shift work. Most have health and life insurance plans.

Working conditions in electronics plants compare favorably with those in other industries, notes the Bureau of Labor Statistics. Plants usually are well-lighted, clean, and the quiet is broken at times by piped-in music. Some plants are air-conditioned. There is a relatively low frequency of injuries in electronics manufacturing for each million man-hours worked. Rates are far below the national average in manufacturing, and injuries often are less severe.

More than 25 Unions Represented

Against the general background, there is no single pattern of union membership in electronics firms. More than 25 affiliated and independent unions active in electronics are represented, mainly among large and medium-sized firms. At the end of 1962, electronics firms with more than 50% of sales in the U. S. had union contracts. Of these firms, about two-

BUGS IN OUTER SPACE

Man's best friend in deep space may be colorless bacteria. Dr. Leonard Bongers, Martin Company, said that among life-support systems studied, one may be the best of all. A proposed "chemosynthetic" system would use "hydrogenomonas" bacteria to make food from human waste products.

An attached electrolysis unit would provide oxygen for breathing.

Algae, somewhat favored as life-giving substance for far-ranging spacemen, may be replaced. A bacterial system, says Dr. Bongers, for a three-man, three-month trip, would be less than 300 pounds. This would be only about 20 to 35% as much as algae units.

Standard food supplies for the same mission would weigh about 5500 pounds. Standard food and water are still good for short flights, say to the moon and back. For long flights our spacemen must be self-sufficient. Chemosynthesis seems to hold the best answers.

thirds had contracts with the AFL-CIO, the rest with independent unions.

Thousands of new job opportunities beckon to new workers in electronics in the 1960's. Although electronics employment may not grow as fast as it did in the 50's, it may grow faster than other manufacturing. At this point, workaday projections of future workforces begin to border on marketing predictions, crystal gazing, defense requirements, possibilities of disarmament, and peaceful or military pursuits in space, as well as whether Americans or American-made instruments will go to the moon.

Seniority and security are foremost in the minds of union electronics workers, as in most industries, in view of some changing conditions. Microminiatur-

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ization will surely change or alter the character of component making. Cancelled and stretched-out defense and aerospace contracts affect workers adversely, while imports of foreign electronic products, especially consumer goods, actually represent imports of foreign labor and hardware. Consumer electronics factory sales are plateauing—\$2.4 billion in 1962 to an estimated \$2.5 in 1963—yet may be lifted by higher sales of color-TV sets.

Labor Wants Share of 'Security'

In the aerospace business which is getting deeper and deeper into more complicated electronic technologies and sophisticated hardware and systems, labor wants to share management's new "security." The recent Stanford Research Institute report on "The Industry-Government Aerospace Relationship" observes that unlike past feast or famine for aircraft, "for the first time in its history, the aerospace industry is experiencing a relatively high and stable sales volume."

Aerospace labor is asking for "more" as its "share" of these glad and happy times. Most recent union contracts in electronics include union security in some measure, with provisions for a union shop, an ever increasing controversy in aerospace and electronics. Most contracts have either clauses or riders outlawing strikes for the life of the contracts. Many contain statements of management rights, in effect, precluding union inroads into management by definition.

In 1962, non-union electronics firms kept out some unions by staying ahead of unionized firms in wages

(Continued on page 62)

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TROUBLE FOR LABOR (Concluded)

by raising hourly rates an average of 17 cents. Raises averaged only 7 to 8 cents an hour for firms with union contracts. In 1960, non-union firms paid an average of 13.2 cents in hourly wage increases, while union firms all averaged increases of 7 cents.

However, pennies-per-hour tend to overshadow fringe benefits which have been "increasing faster than wages and salaries," reports the Federal Reserve Bank of Philadelphia. In effect, the union vs. non-union relationship seems to be a trade-off of higher union security for higher wages—granted a certain amount of fringe benefits in both shops.

Firms Took Up Industrial Relations

In 1944, the Radio Manufacturers Association (now called Electronic Industries Association) formed its Employment and Personnel Committee which reported on labor matters to the board. In time many electronics firms took on a personnel or industrial relations manager. Paralleling this move, in 1954, the Radio-Electronics-Television Manufacturers Association (now also EIA) raised its labor committee into full status as one of its five service departments: the Industrial Relations Department.

Three important surveys conducted by this Department are: 1) contract expiration and opening dates, 2) analysis of industrial relations practices and supplemental benefits, and 3) survey of vacation plant shutdowns. It enables industry members to cooperate on industry-wide problems in employer-employee relations, manpower needs and legislation.

The Department gathers no data on wage rates, though larger electronics managements may exchange and use such data, as unions obviously do.

Today, many unions face two major sets of problems:

1) External—government intervention, businessmen's call for more restraints on unions, and the growth of automation.

2) Internal—the need for unions to reorient themselves to survive and grow by serving their members, and yet not demand too much from management during the present stage of high unemployment.

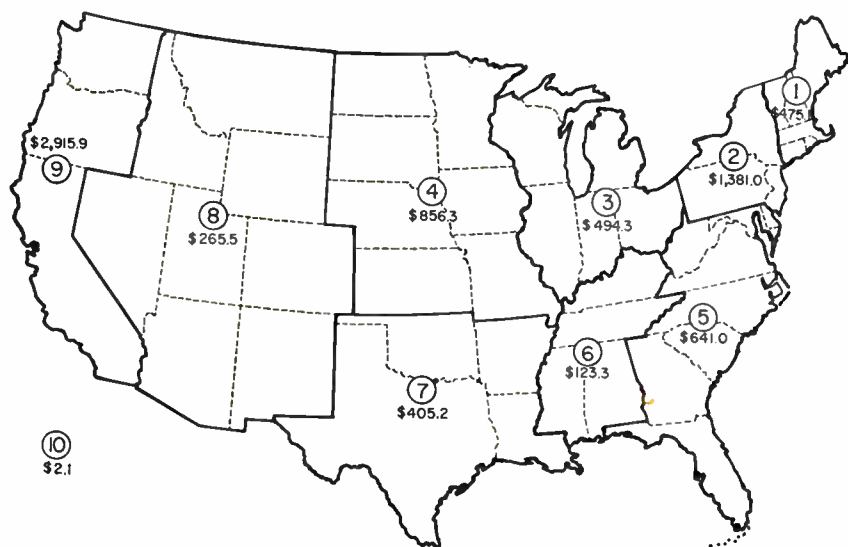
The biggest single thorn-in-the-side bothering the U. S. Government and nearly all unions is unemployment. Spelled backwards, unemployment is supposed to mean "automation"—the other side of labor's really big bugbear. For the first time in our history more than 70 million Americans have permanent jobs—but more people are unemployed than ever before. The unemployment figure is about 5 million, or about 6% of the total labor force.

Dr. Simon Ramo, vice chairman of the board, Thompson Ramo Wooldridge, Inc., suggests provocatively that "by the 1980's we may find ourselves with a shortage of the unskilled—if too small a fraction of human beings in the coming technological age will be willing to apply themselves to the relatively unchallenging jobs."

Some jobs in electronics plants are being automated, but Government sources estimate that increasing expenditures for missiles, spacecraft and electronic products are expected to result in large employment increases in industries making these products.

AEROSPACE MARKETING

WHERE DID MOST OF THE AEROSPACE MONEY GO FROM JANUARY TO JUNE 1963?



Region	Totals (in millions)
1 New England	\$ 475.1
2 Middle Atlantic	1,381.0
3 E. North Central	494.3
4 W. North Central	856.3
5 S. Atlantic	641.0
6 East S. Central	123.3
7 West S. Central	405.2
8 Mountain	265.5
9 Pacific	2,915.9
10 Outside U. S. A. Continental Limits	2.1

TOTAL \$7,559.7

HOW PART OF THIS AEROSPACE MONEY WAS SPENT FOR ELECTRONIC EQUIPMENT JANUARY TO JUNE, 1963

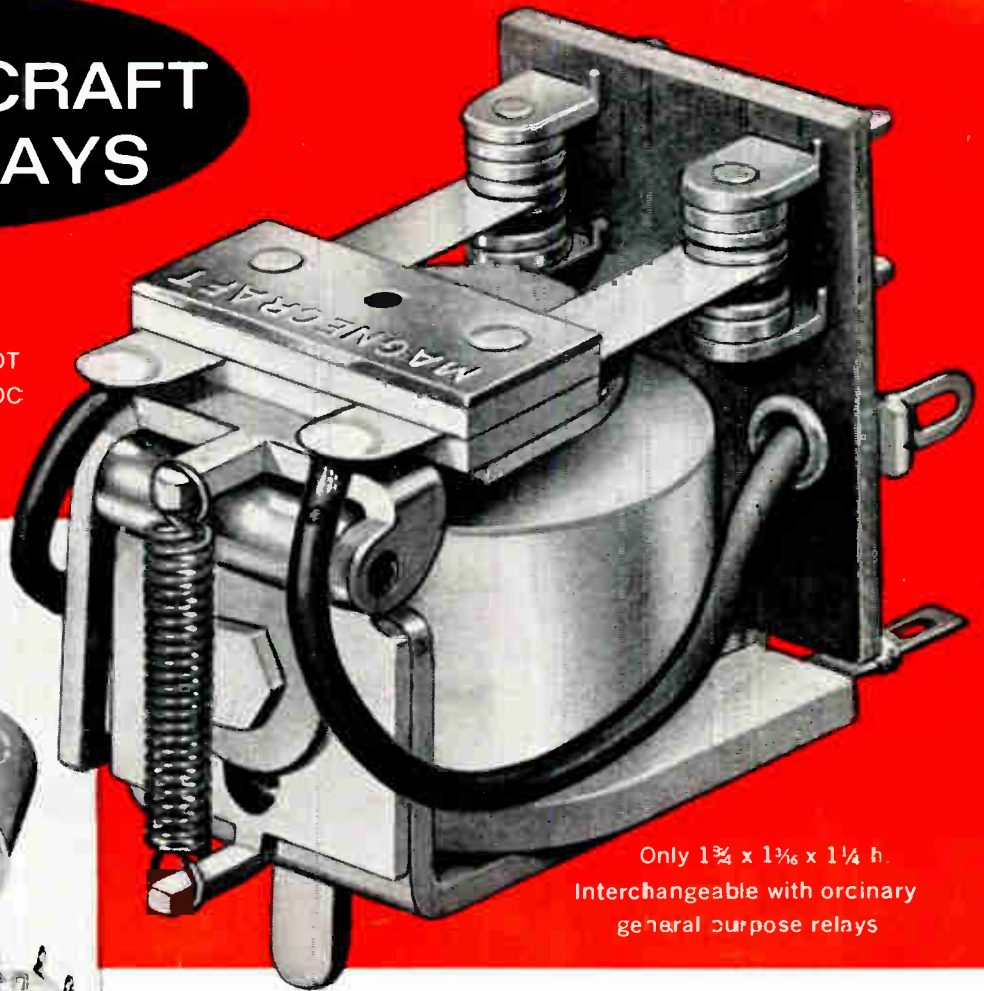
Equipment	Totals (in millions)
1 Guidance & Navigation Systems	\$334.3
2 Electronic & Electrical Instruments	878.7
3 Tracking & Telemetry Systems	78.4
4 Controls	140.0

TOTAL \$1,431.4

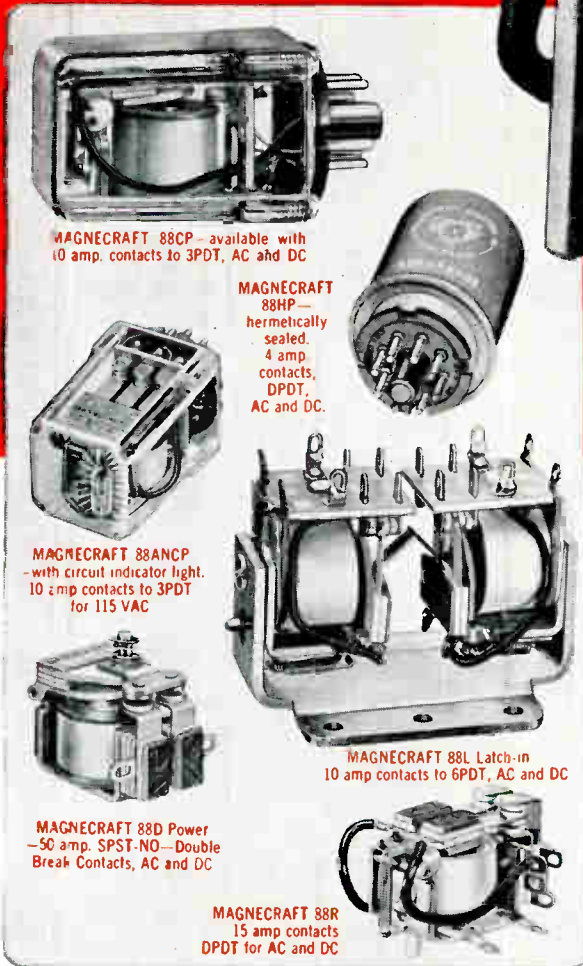
(Source—Aerospace Management)

MAGNECRAFT 88 RELAYS

Available with 10 amp contacts to 3PDT for standard coil voltages, AC and DC



Only 1 3/4 x 1 3/8 x 1 1/4 h.
Interchangeable with ordinary
general purpose relays



MAGNECRAFT 88CP—available with 10 amp. contacts to 3PDT, AC and DC

MAGNECRAFT 88HP—hermetically sealed. 4 amp. contacts, DPDT, AC and DC.

MAGNECRAFT 88ANCP—with circuit indicator light. 10 amp contacts to 3PDT for 115 VAC

MAGNECRAFT 88L Latch-in 10 amp contacts to 6PDT, AC and DC

MAGNECRAFT 88D Power—50 amp. SPST-NO—Double Break Contacts, AC and DC

MAGNECRAFT 88R 15 amp contacts DPDT for AC and DC

Extra Reliability at a Saving

MAGNECRAFT Class 88 Relays provide the high standards of reliability users have learned to expect from MAGNECRAFT Telephone Type Relays at general purpose relay prices.

Unique in a relay of this type MAGNECRAFT 88 Relays have precision-built hinge-pin armature bearings with oversize bearing surfaces—the same construction used in the finest telephone type relays for lowest friction and maximum contact effectiveness with stabilized adjustment over long life.

Glass insulation provides great di-electric strength unaffected by humidity and temperature changes.

Ruggedized, independently riveted coil terminals make connections you can depend on.

Molded Nylon bobbins with coil terminal inserts eliminate any possibility of shorts.

Built-in contact wipe with riveted contacts further advance reliability through long life.

Modular construction provides flexibility to meet varied specifications at low cost through use of standardized sub-assemblies.

The many refinements plus MAGNECRAFT Quality Control and Inspection Standards make Class 88 Relays so outstanding you can actually SEE the great superiority.

Investigate BEFORE you decide! Send for literature or phone the number nearest you.

Stocked by Leading Distributors
Call number nearest you for addresses

Phone numbers of Sales Representatives.

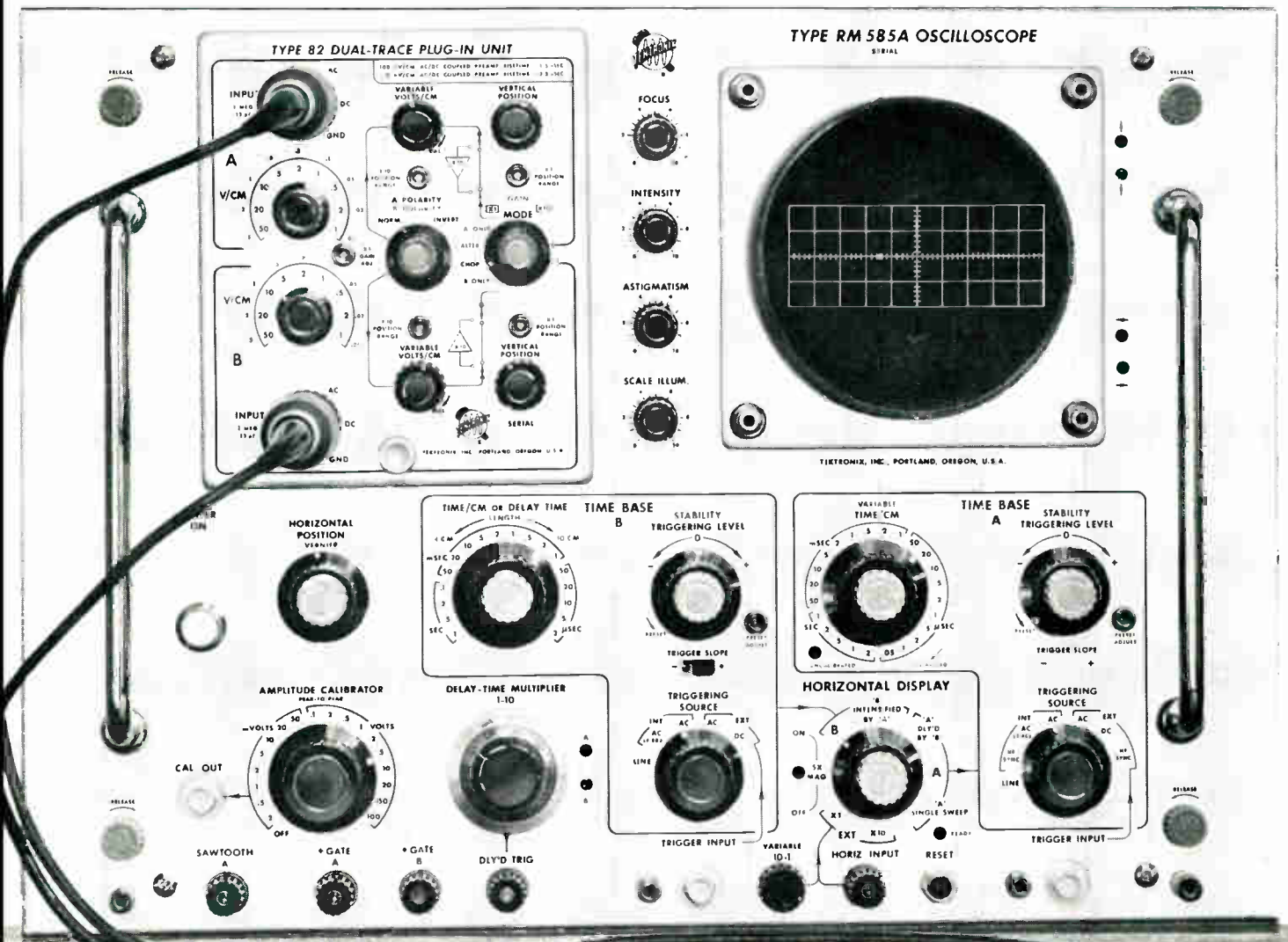
CALIF	Los Angeles, NO 3-8236	MO	St. Louis, WO 2-5627
	Oakland, 261-7676	N H	Manchester, 472-4091
COLO	Littleton, 798-0922	N J	Collinswood, 854-8559
CONN	Farmington, 677-9025		Livingston, IN 3-5000
	Trumbull, AM 8-9631		Orange, OR 4-4100
FLA	North Miami, WI 7-5080	N Y	Buffalo, TF 9-0200
GA	Atlanta, 758-7496		Fairport, BR 1-4370
ILL	Chicago, AV 2-5500		Fayetteville, NE 7-3851
IND	Fort Wayne, 483-6913	ORE	Portland, CA 6-3903
IOWA	Burlington, PL 2-3186	TEXAS	Dallas, FL 7-5713
KANS	Kansas City, JO 2-4108		Houston, MO 6-2277
MASS	Boston, FA 3-1008	VA	Arlington, JA 5-5898
MICH	Detroit, KE 8-4292	WASH	Seattle, AT 2-7200
In CANADA—Scarborough, Ontario, PL 7-3253			

MAGNECRAFT
The relays you can rely on

MAGNECRAFT ELECTRIC CO., 5571 N. Lynch, Chicago 30, Ill. Area 312—Avenue 2-5500

Circle 28 on Inquiry Card

new measurement convenience for high-sensitivity, wide-band dual-trace applications—





*Tektronix Type 580A series...
..... high-speed oscilloscopes
with general-purpose utility*

- **DUAL-TRACE OPERATION** with 4 operating modes and independent controls for each channel—for individual attenuation, positioning, inversion, and ac or dc coupling as desired.
- **PASSBAND** typically DC-TO-85 MC (3-db down) at 100 mv/cm (12-db down at 150 Mc), and typically DC-TO-80 MC (3-db down) at 10 mv/cm.
- **CALIBRATED SENSITIVITY** in 9 steps from 100 mv/cm to 50 v/cm, and in *10X Amplifier Mode*, from 10 mv/cm to 5 v/cm, variable between steps.
- **INTERNAL AND EXTERNAL TRIGGERING** to 150 Mc.
- **SWEEP RANGE** from 10 nsec/cm to 2 sec/cm.
- **SINGLE-SWEEP PHOTOGRAPHY** at 10 nsec/cm.
- **BRIGHT, HIGH-RESOLUTION DISPLAY** with small spot size.
- **CONVENTIONAL PASSIVE PROBES** for convenience.

PLUS

- **COMPATIBILITY WITH 17 LETTER-SERIES PLUG-INS** to permit differential, multi-trace, sampling, other laboratory applications—when used with Type 81 adapter.

Supplied small size passive probes provide high input impedance characteristics. Probes increase input R to 10 megohms and decrease input C to approximately 7 pf.

Risetime (of supplied probe, plug-in unit, oscilloscope) at over-all sensitivity of 100 mv/cm is approximately 4½ nsec.

Type RM585A Oscilloscope, illus. \$1825
Size—14" high, 19" wide, 22¾" deep.
Weight—81 pounds, approx.

Type 585A Oscilloscope \$1725
Size—16 ¼" high, 13 ½" wide, 23 ½" deep.
Weight—74 pounds, approx.

Types RM585A and 585A have 2 modes of calibrated sweep delay—either triggered or conventional—ranging from 1 µsec to 10 seconds.

Type 581A Oscilloscope \$1425
No sweep-delay capabilities . . . but other features similar to Type 585A.

PLUG-IN UNITS

Type 82 Dual Trace Unit \$ 650
(includes 2 passive probes)

Type 86 Single-Trace Unit \$ 350
(includes 1 passive probe . . . has single channel operation.)

ADAPTER Enhances Versatility
The Type 81 Adapter allows insertion of 17 Tektronix letter-series plug-ins. Bandwidth (up to 30 Mc) and Sensitivity depend upon plug-in used.

Type 81 Plug-In Adapter \$ 135

Oscilloscope Prices without plug-in units.

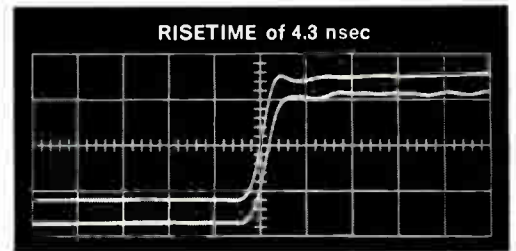
U.S. Sales Probes to b. Beaverton, Oregon

PLEASE CALL YOUR TEKTRONIX FIELD ENGINEER OR DISTRIBUTOR.

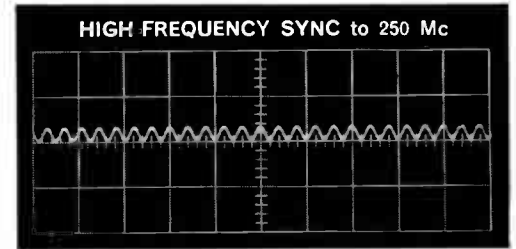
Tektronix, Inc. / P. O. BOX 500 • BEAVERTON, OREGON 97005 / Phone (Area Code 503) Mitchell 4 0161 • Telex. 036-691 • TWX: 503-291-6805 • Cable: TEKTRONIX • OVERSEAS DISTRIBUTORS IN 27 COUNTRIES

Tektronix Field Offices: in principal cities in the United States. Consult Telephone Directory • Tektronix Limited, Guernsey, Channel Islands
Tektronix Canada Ltd.: Montreal, Quebec • Toronto (Willowdale), Ontario • Tektronix Australia Pty. Limited, Sydney, New South Wales

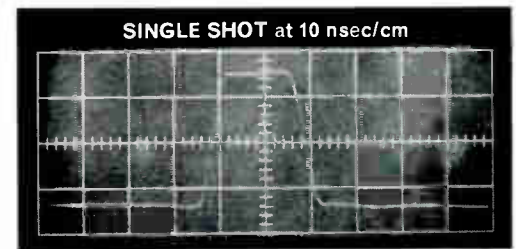
Circle 29 on Inquiry Card



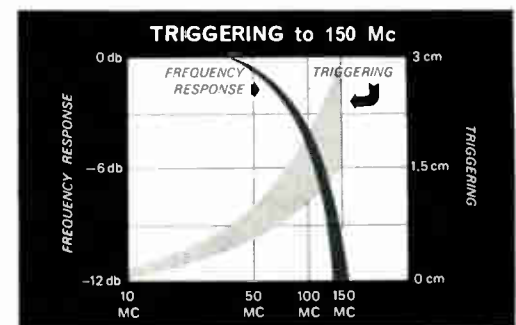
Dual-trace display of input and output pulses of a transistor amplifier at 10 nsec/cm—with lower trace delayed 1 nsec by amplifier under observation. Type 585A/82 combination can display time coincidence between input channels with no measurable difference at 10 nsec/cm



Display of a 250 Mc Sine Wave at 10 nsec/cm, using the H. F. Sync Mode. In this mode, the Type 585A/82 combination can display steady signals from 5 Mc to 250 Mc, with a fraction of a cm of displayed amplitude.



Display of a fast transient at 10 nsec/cm, using single-sweep operation and the Tektronix C-19 Camera. Single-sweep feature of the Type 585A/82 combination facilitates photographic recording of most one-shot phenomena.



Typical frequency response and internal triggering characteristics of Type 585A/82 combination—showing minimum number of cm necessary for triggering.

NATIONAL ELECTRONICS CONFERENCE

Over 200 papers and 500 exhibits will highlight this year's NEC. Seminars and panel discussions will "up-date" those attending on the newest developments in research and development

MORE THAN 20,000 ENGINEERS AND SCIENTISTS will participate in the three-day program of the National Electronics Conference, October 28, 29 and 30, at McCormick Place in Chicago.

The program, most extensive in NEC history, includes over 200 authoritative technical papers in some 55 sessions, many of them sponsored by Professional Technical Groups of IEEE, under auspices of the NEC.

Outstanding Speakers

Mr. William P. Roberts of Ampex Corp. will be the guest speaker at the Monday, October 28, NEC luncheon. At the Tuesday luncheon, the speaker will be Gov. George W. Romney of Michigan. Dr. William L. Everitt, Dean of Engineering, University of Illinois, will deliver the Wednesday luncheon address on "Engineering for Education."

Dean Everitt also will be honored twice at the Conference. He is to be initiated as an Eminent Member of Eta Kappa Nu, and will be presented the Mervin J. Kelly Award in Telecommunications. This award, for outstanding leadership and contributions in the field of Telecommunications, is presented each year on recommendation of the Recognition Awards Committee of IEEE.

Research into Man's Attempt to Communicate with Other Species ("Some Problems of Research With the Bottlenose Dolphin") will be the subject of a special program on Tuesday, 7:00 P. M., in the Little Theatre of McCormick Place. Dr. John C. Lilly, M.D., will show, through a combination lecture, motion picture and sound recording presentation, the clear and definite attempts of dolphins to imitate human conversation.

Program Highlights

The Conference will be highlighted by the following program:

Two intensive refresher seminars, five hours each, up-date the tools of the practicing engi-

neer. One course, "Quantum Devices in the Optical Region," provides the background and tutorial exposure necessary to read current literature in the field of quantum devices. The other, "The State Variable Formulation of Automatic Control," provides a basic understanding of formulation used in modern control theory problems.

Three full sessions make up the Second Symposium on Adaptive Processes, covering adaptive statistical inference with emphasis on non-parametric sequential processes.

Texas Instruments, Incorporated and Motorola, Inc. will sponsor Solid-State Seminars on Reliability, Advanced Semiconductor Devices and Network Technology, Low-Noise, Low-Level Amplification, Silicon-Controlled Rectifiers, Integrated Circuits and Radio Frequency.

A panel of authorities will explore Manufacturer-Representative Responsibilities in Electronic's Marketing.

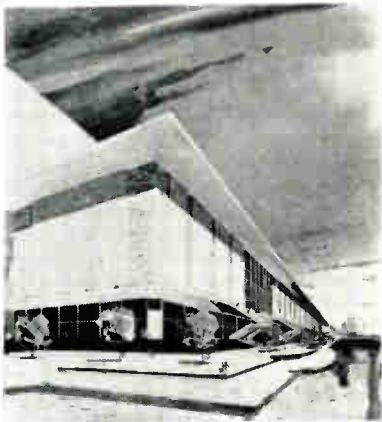
A total of ten papers make up a full-day program, Monday, on "Plasma Diagnostics and Plasma Engineering."

Leading research and industry scientists will discuss Energy Beams as Working Tools, Audio, Feed-Back Control Systems, Instrumentation, Switching Theory and Logical Design, and other timely subjects.

Exhibits

The latest developments in products and systems will be shown by over 500 electronic firms whose displays will occupy most of the exhibition center.

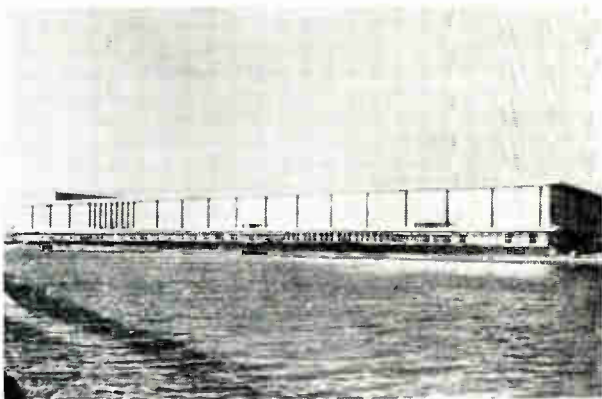
Presentations by ten midwestern universities will depict current activity in university research and academic programs. Government agency and military displays include those of NASA, Air Force, Navy, Argonne National Laboratory, and six departments of the Dept. of Commerce.



Artist's conception of Chicago's McCormick Place, site of this year's NEC.



The engineers and scientists attending will hear papers and see exhibits that cover a wide spectrum of our field. McCormick Place is located just south of the Loop.



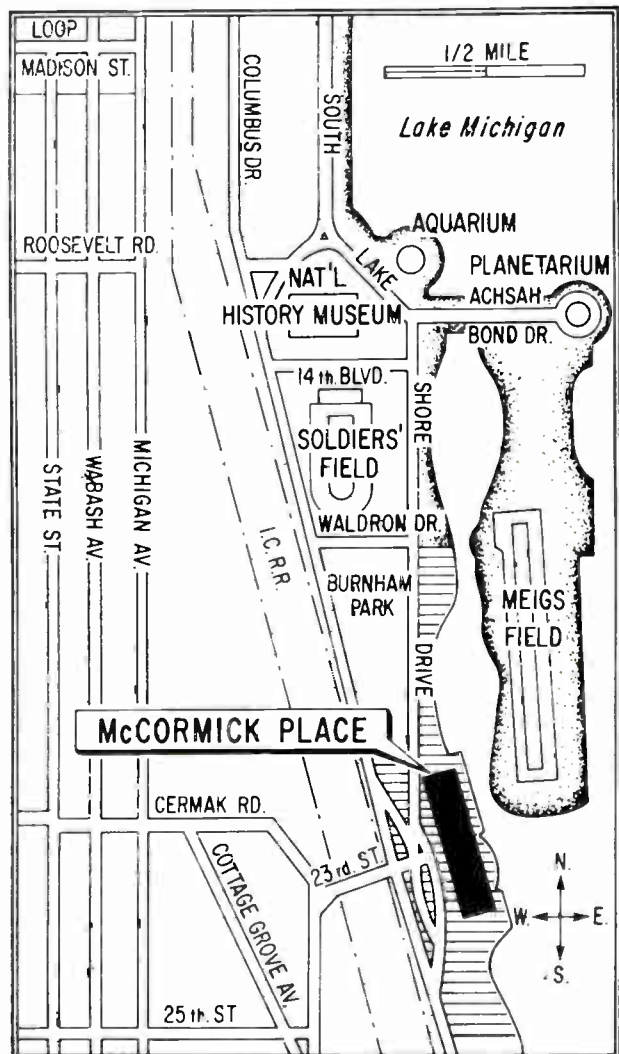
Eastern side of McCormick Place as seen from Lake Michigan.

New Products Seminar

In eighteen separate new products seminars, running concurrently with technical sessions, NEC exhibitors will describe and demonstrate their latest product relating to Interconnector Technology, Components and Techniques, and Instrumentation. The Seminars will be conducted in meeting rooms located in the Exhibit Hall.

Tours

Arrangements have been made for conducted tours to the Federal Aviation Administration Air Traffic Control Center, Aurora, Ill.; Argonne National Laboratory; and the Chicago *Sun-Times & Daily News* publishing plant.



TECHNICAL SESSIONS TO HIGHLIGHT NEREM '63

Research, advances and the future of electronics are themes for the 17th Northeast Electronics Research and Engineering Meeting. Millions of dollars in equipment and a broad technical papers program will encompass a wide variety of electronic fields and specialties.

A HIGHLY VARIED PROGRAM is set for NEREM '63, the 17th Northeast Electronic Research and Engineering Meeting to be held in Boston on November 4, 5 and 6. The program features more than 100 papers in 22 sessions on the more active electronic fields. They will be presented at the Somerset Hotel and the Commonwealth Armory.

More than 20,000 engineers are expected to attend some 300 exhibits in the Armory where millions of dollars worth of the latest in equipment and components will be displayed.

A variety of electronic subjects, covered by more than 130 authors and during the 22 sessions, will include such topics as space electronics, thermal energy conversion, biomedical electronics, and micro-electronic techniques and uses. Other topics include microwave measurements, plasmas, antennas and feed systems, transistor circuitry, quantum electronics and modulation, and hydrospace communications.

Meeting Highlight

A highlight of the meeting will be an evening session on large-scale project management. Key members of U. S. agencies and industry will present an appraisal of our areas of major concern to everyone. The areas include the Polaris weapons system, NASA space effort, ComSat, and weapons system management.

As a tribute to the meeting, Gov. Endicott Peabody issued a proclamation declaring November 4-11 as Electronics Week in Massachusetts. He cited the impact of the meeting on industry and the sciences. He underscored the fact that engineers, scientists, technical personnel and members of the industry will come to reevaluate and survey advances made during the year and the outlook for the future.

The annual banquet, on Wednesday evening, November 6, also reflects the stature of the program. In

a talk on the information revolution, G. L. Haller, vice president, General Electric, Defense Electronics Division, will assess broad developments from the early days of the industrial revolution to the present. The nation, the world, and science in general, are faced with a "spiralling information revolution, surely destined to create striking changes in our way of life."

NEREM Record

NEREM '63 is an IEEE event, under the sponsorship of the New England sections of the Institute. As in the past, all IEEE registrants will receive free of charge a copy of the NEREM Record, a report on all papers presented. The fifth volume in a series, with more than 200 pages and some 500 illustrations, this edition will include subject-author-indexing.

Cost of the Record to non-IEEE members attending NEREM will be \$2.00. After the conference, the price will be \$7.50, and copies will be available from: the Boston Section of IEEE, 313 Washington Street, Newton 58, Mass.

Other session topics to be covered include advanced radar technology, Information Technology, Coherent Propagation, Radio Astronomy, Instrumentation, Photovoltaic and electrochemical energy conversion, and automatic control.

Project Management

Four papers on large Scale Project Management, covering four areas in defense and aerospace, will be given. Rear Adm. I. J. Galantin, of the Navy's Special Projects Office, will present a report on the fleet ballistic missile system, how it evolved, its status and future. J. F. Shea, of NASA's Office of Manned Space Flight will discuss the NASA Space Effort, aims, purposes, current and projected effort.

Maj. Gen. C. H. Terhune, Jr., Electronics Systems Div., USAF, Hanscom Field, will discuss how man-

agement of weapons system programs differs from electronic system programs management. J. V. Charyk, of the Communications Satellite Corp. (Com-Sat), will review technical plans, programs and schedules of a single world-wide system of communications satellites. He will cover technical problems, plus international, political and economic aspects.

Plasma Developments

Plasma research and its snow-balling interest among scientists and engineers has become evident in recent months. In the paper "Plasma Measurements in Reentry Physics," E. Rolfe, of Raytheon Co., will compare plasmas, and application of plasma physics techniques to fluid dynamic and electromagnetic sheath parameters.

Biomedical Papers

In Biomedical electronics, a paper by G. L. Gerstein, Office of Computer Technology in Biomedical Sciences at MIT, discusses "Aspects of Sensory Coding in the Nervous System." The paper covers electrical activity of nervous systems in organisms and describes quantitative studies of these complex electrical signals. It treats with theory models of neural activity aimed at better knowledge of sensory data coding by the nervous system.

Another biomedical paper by A. T. Kornfield, Biosearch Co., Boston, deals with "Major problems and Concepts in Biomedical Electronics." The author, also chairman of the session, surveys current approaches to transducer design from living sensor models. Instrument development requirements for new classes of human performance variables, and new life support concepts requiring electronic techniques are also discussed.

Microelectronics

The current importance of microelectronic circuits and techniques is mirrored in papers on the topic.

"Design and Packaging of Miniaturized Digital Equipment," by F. Plemenos and W. McMorrان of Raytheon Co., treats with choosing integrated circuits. Designers are faced with compromises in speed, noise immunity, power use, cost and type of package. The paper cites real cases on compromises and systems needs. Westinghouse engineers J. R. Cricchi, W. N. Jones and W. F. List will talk about "A Planar Diffused General Purpose Monolith." They describe the making and testing of a functional block that contains diodes, resistors and transistors.

A pair of Sylvania engineers, E. Rasmanis and J. E. Cline, will give their ideas on "Vacuum-deposited

Silicon Thin-Film Diodes and Transistors." The paper will cover vacuum-evaporated silicon thin-film diodes and deposition techniques.

Space Technology

Wherever you go, whatever meeting you attend, the heavy overtones are outer space. The session on Space Electronics, aside from the space-flavored topics in most of the other sessions, will include a paper by J. T. Mengel, Goddard Space Flight Center. The paper will describe NASA ground support networks, which now involve 40 ground stations and two ships. An interstation radio system and allied computing and data systems will also be discussed. The paper is titled "Satellite Ground Data Networks."

"Physics of the Interplanetary Medium" will be discussed by C. W. Snyder, Cal Tech's Jet Propulsion Laboratory. We once thought space empty. Recent tests and theories hint at proving space occupied by a medium made up of charged particles and magnetic fields.

James E. Shepherd, of the Sperry Rand Research Center, Sudbury, Mass., is General Chairman of NEREM '63, to be held on November 4, 5 and 6 at the Somerset Hotel and the Commonwealth Armory in Boston. Some 20,000 are expected at NEREM.



...tick

Could you help give our military commanders one more second for decision and action?

MITRE's principal mission is to help make war impractical.

Example — the design and development of systems that enable military commanders to detect attack and retaliate instantly and conclusively.

Or the creation of systems that can survive nuclear bombardment.

Systems for space communication;

systems for nuclear detection; systems for localized military operations; systems to help end mid-air collisions . . . these are some of the other assignments now underway at MITRE.

This work is important to our country. It also presents one of the greatest challenges in the systems sciences.

MITRE is located just 25 minutes from Boston in the middle of a fast-growing scientific community, near mountains and seashore.

Engineers and scientists — preferably with advanced degrees and at least five years' experience in electronics,

mathematics or physics — write in confidence to . . .

Vice President — Technical Operations, The MITRE Corporation, Box 208 AN, Bedford, Mass. Openings are also available in Washington, D.C. and Colorado Springs, Colorado.

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Pioneer in the design and development of command and control systems, MITRE was chartered in 1958 to serve only the United States Government. The independent nonprofit firm is technical advisor and system engineer for the Air Force Electronic Systems Division and also serves the Federal Aviation Agency and the Department of Defense.

Through confidence in their reliability Avco used Allen-Bradley hot molded resistors

FOR THEIR RECEIVER IN THE FIRST MULTIPLE COMMAND CONTROL SYSTEM IN A NASA SATELLITE

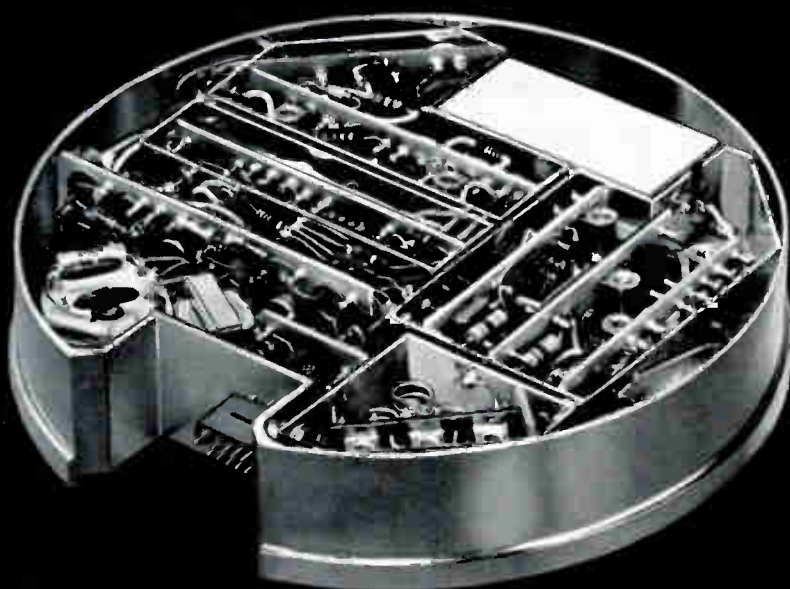
■ To insure continued reliable performance, despite the vibration and shock incidental to a missile launching, Avco Corporation uses Allen-Bradley hot molded resistors in their command receiver designed for space satellites. Operating with the receiver is a special Avco decoder, which activates on-off controls of electronic equipment in the satellite. Both use only Allen-Bradley Type CB ¼ watt hot molded resistors.

Allen-Bradley's exclusive hot molding process results in such amazingly uniform characteristics from resistor to resistor—and from year to year—that long term resistor

performance can be accurately predicted. Furthermore, there exists no instance on record where an Allen-Bradley hot molded resistor has failed catastrophically in service.

Just as has been the experience of hundreds and hundreds of users of Allen-Bradley resistors, you, too, can assure yourself of the ultimate in resistor performance by specifying standard A-B hot molded resistors—their quality has not yet been equaled.

For more complete information on the entire line of Allen-Bradley quality electronic components, please write for Publication 6024: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.



Satellite Receiver AD 183114 developed by the Electronics Division, Avco Corporation, uses A-B Type CB, ¼ watt hot molded resistors. This miniaturized receiver measures 6.3 inches in diameter, 1.13 inches high, and weighs only 1.5 pounds.

ALLEN-BRADLEY HOT MOLDED FIXED RESISTORS are available in all standard EIA and MIL-R-11 resistance values and tolerances.



ALLEN-BRADLEY
QUALITY ELECTRONIC COMPONENTS

World Radio History



**reliability and
Allen-Bradley
hot molded resistors
are synonymous**

The superiority of Allen-Bradley resistors is based on this company's heavy investment in highly specialized and expensive equipment, developed and built by Allen-Bradley, plus the experience gained over a quarter of a century in manufacturing quality resistors.

A-B hot molded fixed resistors have such consistent uniformity from resistor to resistor—year in, year out—that long term performance can be accurately predicted. At least ten billion field proven resistors—with not one catastrophic failure—conclusively attest to their reliability.

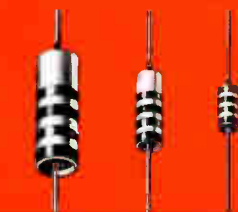
This same hot molding process is used in making Allen-Bradley variable resistors, which feature a solid, hot molded resistance element that has never been known to "wear out"—in fact, with age, it even improves in quiet operation.

For more complete details on all Allen-Bradley quality electronic components, please write for Publication 6024: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

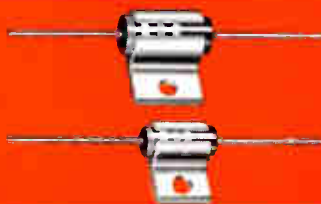
FIXED RESISTORS



A-B HOT MOLDED RESISTORS are conservatively rated. Stable and uniform characteristics. Rated 1/10, 1/4, 1/2, 1, and 2 watts at 70°C. Available in all standard EIA and MIL-11-R resistances and tolerances.



HERMETICALLY SEALED HOT MOLDED RESISTORS Environmental protection provided by sealing in ceramic tube. Remain stable. Rated 1/8, 1/2, and 1 watt at 70°C. Tol. = 2% and = 5%. Res. to 22 meg.



COPPER CLAD HOT MOLDED RESISTORS have heavy tinned copper heat sink for increased ratings. Rated 3 and 4 watts at 70°C; 4 and 5 watts at 40°C. Tol. = 5% and = 10%. Res. to 22 meg.

VARIABLE RESISTORS



TYPE J HOT MOLDED POTENTIOMETERS give smooth, quiet control—long life. On accelerated tests, good for over 100,000 operations with less than 10% resistance change. Can be built to any desired taper. Rated 2.25 watts at 70°C. Values to 5 meg.



TYPE K HIGH TEMPERATURE HOT MOLDED POTENTIOMETERS Same as above but rated 1 watt at 125°C; 2 watts at 100°C; and 3 watts at 70°C.



TYPE G HOT MOLDED POTENTIOMETERS are miniature controls—only 1/2" diameter. Smooth control with long life—on accelerated tests will exceed 50,000 operations with less than 10% resistance change. Rated 1/2 watt at 70°C. Values to 5 meg.



TYPE L HIGH TEMPERATURE HOT MOLDED POTENTIOMETERS are same as above but rated 1/2 watt at 100°C—can be used up to 150°C at reduced load.



HOT MOLDED VARIABLE RESISTORS for use in constant impedance attenuators. Smooth control with nearly infinite resolution. Characteristic impedance can be held to 10% throughout rotation. Excellent high frequency response. Rated up to 5 watts.



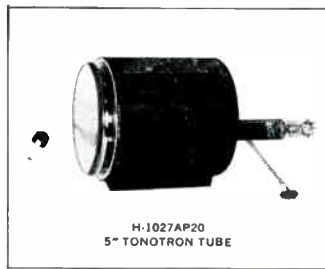
TYPE H HOT MOLDED POTENTIOMETERS for industrial and commercial electronic equipment requiring higher voltage and wattage ratings. Stepless control. Life exceeds 100,000 operations on accelerated tests with less than 10% resistance change. Rated 5 watts at 40°C and 3 watts at 70°C, with a maximum of 750 volts.



TYPE T HOT MOLDED POTENTIOMETERS have molded plastic covers that serve as actuators, making units unusually flat and compact. Smooth control. Furnished in any desired tapers. Long life—over 50,000 operations on accelerated tests with less than 10% resistance change. Rated 1/2 watt at 70°C. Values to 5 meg.



TYPE R ADJUSTABLE FIXED RESISTORS remain stable under extremes of shock and vibration. Moving element is self-locking. Smooth, continuous adjustment. Noninductive. Watertight case permits encapsulation. Rated 1/4 watt at 70°C. Values from 100 ohms to 2.5 megs. Tol. = 10% and = 20%.



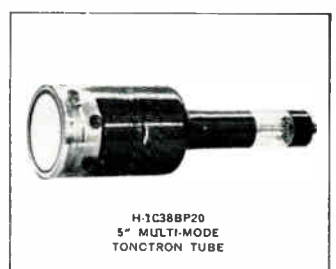
H-1027AP20
5" TONOTRON TUBE



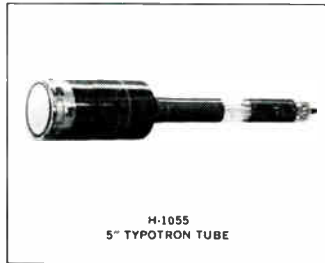
H-1010DP20
5" TONOTRON TUBE



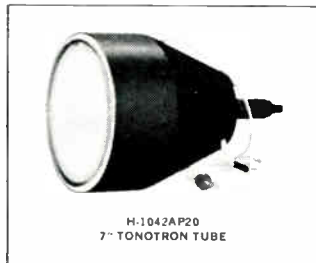
H-1076AP20
5" TONOTRON TUBE
(8" Overall Length)



H-1C38BP20
5" MULTI-MODE
TONOTRON TUBE



H-1055
5" TYPOTRON TUBE



H-1042AP20
7" TONOTRON TUBE



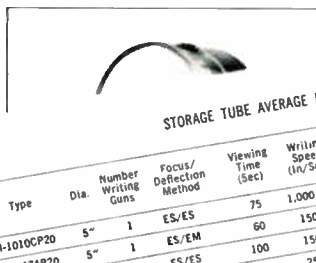
H-1066P20
10" TONOTRON TUBE
(Three Guns)



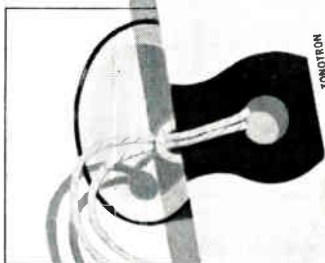
H-1033AP20
10" TONOTRON TUBE
(Magnetic Deflection)



H-1069AP20
10" TONOTRON
TUBE



H-1019
21" TYPOTRON TUBE



H-1044
21" TONOTRON TUBE

STORAGE TUBE AVERAGE PERFORMANCE SUMMARY

Type	Dia.	Number Writing Guns	Focus/Deflection Method	Viewing Time (Sec)	Writing Speed (ln/Sec)	Erase Time (MS)	Stored Res. (Lines/ln.)	Brightness (FTL)	Remarks
H-1010CP20	5"	1	ES/ES	75	1,000,000	50	85	1700	Very high writing speed
H-1027AP20	5"	1	ES/EM	60	150,000	80	75	1500	Potted and shielded 7033
H-1114AP20	5"	3	ES/ES	100	250,000	50	70	1500	Overall length 8 inches
H-1076AP20	5"	1	ES/EM	180	250,000	50	70	700	
H-1042AP20	7"	1	ES/ES	300	250,000	200	70	500	
H-1033AP20	10"	1	ES/EM	180	275,000	200	70	800	Very high tracking accuracy
H-1069AP20	10"	1	ES/ES	300	250,000	250	75	200	
H-1066P20	10"	3	ES/ES	300	275,000	250	60	150	
H-1044P20	21"	1	ES/EM	300	275,000	250	70	65	Bistable storage
H-1055	5"	1	ES/ES	Until erased	150,000	250	70	65	
H-1019	21"	1	ES/ES/EM	Until erased	120	25	400	25	150
			Focus/Convergence/Deflec. Method			Character Writing Time (μS)			20
			ES/EM/ES			65			150
			ES/ES/EM			25			150

NOTE: The figures tabulated above are averages based upon rated electrode voltages and conditions specified in the data for the particular tube type. For the TONOTRON tubes, resolution in all cases is measured at 50% equilibrium brightness.

Performance, reliability and variety... only from Hughes

Illustrated are but a few of the many types of halftone and bistable storage tubes available only from Hughes. They come in the largest variety of diameters, from 4 thru 21 inches. Attesting to their superior characteristics are the more than 20,000 Hughes storage tubes which have been delivered to customers throughout the U.S. and the Free World where a great many are known to have attained a record for reliability measured in terms of thousands of hours.

TONOTRON* tubes, with writing speeds in excess of 1,000,000 inches per second and stored resolution to 105 shrinking raster lines per inch at 10% equilibrium brightness, are available for applications from PPI, Sector and B-Scan radar, fire control and terrain avoidance to slow-scan TV, shipboard radar, air traffic control, seismological survey, ultrasonic track survey, and medical diagnosis.

MULTI-MODE TONOTRON* tubes, in 5 and 10-inch diameters, possess all the features of the TONOTRON* tubes plus selective erasure, simultaneous display of stored and non-stored writing and dark trace resolutions to 120 lines per inch.

TYPOTRON® character-writing tubes, both bistable and halftone, eliminate the need for intermediate storage facilities to match slow, mechanical read-out devices to high-speed electronic computing units. They are to be found in such applications as the SAGE System and air traffic control.

FIVE-INCH BISTABLE MEMOTRON® tubes capture and retain traces and single or superimposed transient phenomena for direct analysis and comparison. They plot a family of curves, monitor phase relationships, and display information for electrocardiographic and vectorcardiographic diagnosis.

For new short form catalog write: Hughes Storage Tubes, 2020 Oceanside Blvd., Oceanside, Calif. (Area Code 714, 722-2101) or 1 Bala Avenue, Bala Cynwyd, Penn. (Area Code 215, MO 4-3950). For export, write Hughes International, Culver City, Calif.

*TONOTRON is a trademark of the Hughes Aircraft Company.

HUGHES

HUGHES AIRCRAFT COMPANY
VACUUM TUBE PRODUCTS
DIVISION
OCEANSIDE, CALIF.

WHAT'S NEW

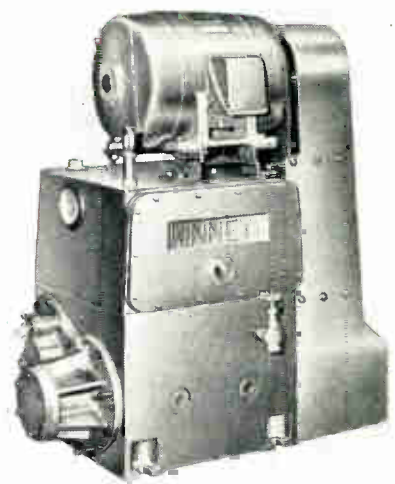
VIBRATIONLESS PISTON PUMP

EXCESSIVE VIBRATION HAS BEEN A PROBLEM in rotary piston vacuum pumps. Vibration is caused by the centrifugal-reciprocating unbalances. The Kinney KT series of Triplex High-Vacuum Pumps has licked this problem.

A new balancing approach brings all of the unbalanced forces, including the reciprocating components, into dynamic balance. There are no fundamental unbalanced forces or unbalanced moments of force, regardless of the assumed character of the distributed forces. Each force has an equal and opposite force during any instant of pumping. Along with defeating wear, the pump is vibrationless.

The pumps are available in two models: KT300 has a theoretical displacement of 301 cfm at 880 rpm;

Balancing centrifugal-reciprocating unbalances and operation at 760 Torr are two of the features offered by this pump.



KT500 has a theoretical displacement of 520 cfm at 796 rpm. The volumetric efficiency is above 90%. The pumps are forced oil feed and operate at pressures above 300 Torr. The feed is discontinued for pressures less than 50 Torr. With forced feed, the pumps can operate at atmospheric pressure (760 Torr) in excess of 1 hr. Kinney Vacuum Div., The New York Air Brake Co., 3529 Washington St., Boston 30, Mass.

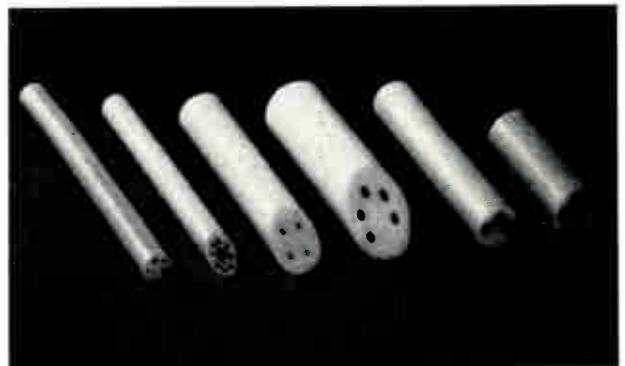
TEFLON EXTRUSIONS

HIGH MOLECULAR WEIGHT TEFLON EXTRUSIONS with multiple holes now are being made by Surf Chemical, Inc., a subsidiary of Driver-Harris Co., Harrison 3, N. J. They are available under the trademark "HYDEN."

The extrusions are made under a new ram process using virgin Teflon Grain Nos. 1, 5 and 7.

Round or shaped holes are available in round or shaped extrusions with key slots optional. Multi-colored holes are also offered for color identification, and with or without wires.

These extrusions, by reason of the process used, can be made to almost machining tolerances. Many sizes can be extruded to a maximum T.I.R. (total indicated runout) of 0.003 in. making many machining operations unnecessary. Inside diameters on many sizes are held to tolerances of ± 0.001 in.

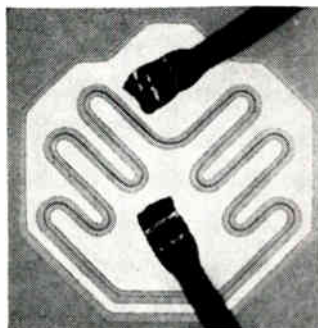


Variety of multiple hole extrusion sizes is shown.

Single or multiple hole extrusions can be made with a nominal web thickness equal to or over one half the hole diameter. These can be supplied with webs down to 0.020 in.

Construction features of the new epitaxial-base power transistor are shown in this diagram. The epitaxial-base construction substantially improves switching characteristics.





We've never had purple plague!

Why?

We use aluminum alloy leads; not gold. Without the gold, you just don't get the purple plague $AuAl_2$ compound that forms on conventional silicon planar transistors.

Purple plague will usually begin to show up around 50 hours—and almost always by 500 hours—at elevated temperatures. After 5000 hours at $300^\circ C$, Bendix® silicon planars are unchanged electrically and mechanically.

Why doesn't everybody use aluminum leads? Eventually, they probably will, but bonding the Al lead to the

Al metalized contact area is tricky and takes some rather advanced techniques. As proof of our bonding superiority, Bendix planar transistors have been tested in excess of 37,000 g's centrifuge and 5,000 g's shock without a failure. Our Al-Al bonding technique gives us a pull factor at least three times greater than any reported yet.

Order from your nearest Bendix franchised stocking distributor or contact the Bendix sales office nearest you for further information.

Bendix Semiconductor Division

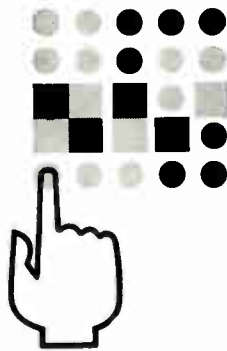
HOLMDEL, NEW JERSEY



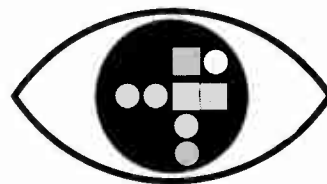
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HERMETICS



SWITCHLITES



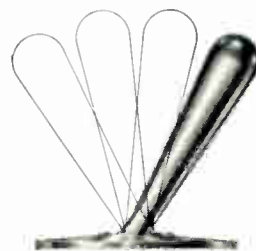
INDICATOR LIGHTS



BASIC SWITCHES

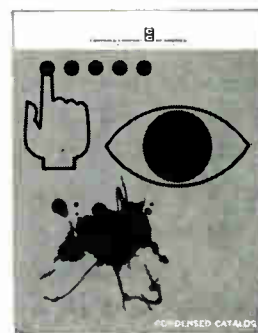


PUSHBUTTONS



TOGGLES

A QUICK GUIDE TO 60,000 SWITCHES—Here are specifications, dimension drawings and photos of our most popular switches. This handy reference catalog illustrates the great variety of standard and custom switches available to meet your design requirements. Included are: basic snap-action switches, toggle, pushbutton, interlock, limit, leaf, lever, hermetically-sealed, environment-free and lighted panel switches. Even indicator lights. All items in this catalog are immediately available from stock. If you ever need switches of any kind, you should write for our free *Condensed Switch Catalog #100*.



CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION
1420 Delmar Drive, Folcroft, Pennsylvania

WHAT'S NEW

LASER SYSTEM

ONE OF THE FIRST COMMERCIALY AVAILABLE LASERS has been announced by TRG, Inc., Syosset, N. Y. This pulsed ruby laser system is capable of outputs up to 3 joules at 6943Å. Accessories are provided for Q-switching with pulse widths as short as 30 to 40 nsec. It has already been integrated with a Kulicke and Soffa micromanipulator to form a complete welding system for the semiconductor industry.

The Model 104 laser has the characteristics of controllability and repeatability, necessary if the laser is to be practical for fabricating and machining uses. Energy output of the 104 can be accurately controlled and the pulse outputs are of a highly reproducible nature. To extend its range of use it can be easily fitted with a Q-switch for use in machining, vaporization, and other uses.

The laser head has the following characteristics:

Output: 3 joules normal, 1/2 joule when Q-switched

Input: 1000 joules

Lamp Cavity: Cylindrical optical reflector

Lamp Type: Straight tube, 3 in. arc, 1000 joule rating

Ruby Size: 7.3 cm long x 1 cm dia.

Threshold: 250 joules input

Output Wavelength: 6943Å

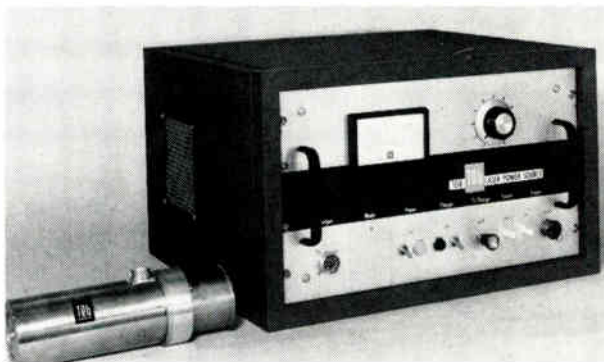
Duty Cycle: 10 ppm

Output Beamwidth: 10 milliradians

Cooling: Integral blower, 15 cfm room air

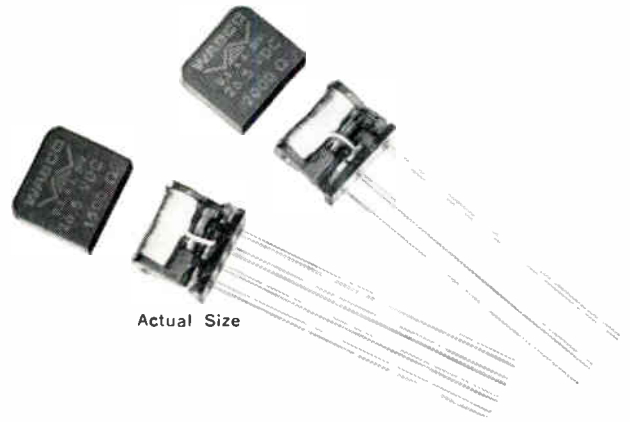
Q-Switch Provision: 104-003 Q-Switch mounts directly on rear of head. Blower remounts on Q-Switch

TRG 104 Q-Switched laser and laser power supply.



The complete 104 laser system consists of the 104-001 laser power supply, the 104-002 laser head, and the 104-003 megapulse Q-Switch. The system can be bought by itself or it can be integrated into customer systems to meet particular needs.

(More What's New on page 79)



NEW 1/6-SIZE CRYSTAL CASE RELAYS MODELS 900 (SPDT) and 901 (DPDT)

Meets requirements of MIL-R-5757D

Self-mounting to printed circuit boards

0.1" grid spaced terminals

Balanced rotary type armature

Positive contact wiping action

High-temp. coil wire rated +220°C

Large coil provides greater coil power

All welded rigid frame construction

Corrosion resistant throughout

Size: .500"L x .230"W x .430"H

Weight: 0.15 ounce

Coil rating: 6, 12, 26.5, 48, 76 VDC (others available)

Contact arrangement: Form C

Contact rated load: low level dry circuit to
1.0 amp resistive at 26.5 VDC

Contact life: 100,000 operations at rated load

Terminals: 1 1/2" or 1/2" leads, or solder hook

Vibration: 0.1" D.A. or 20G peak, 10 to 2000 c.p.s.

Shock: 50G for 11 milliseconds

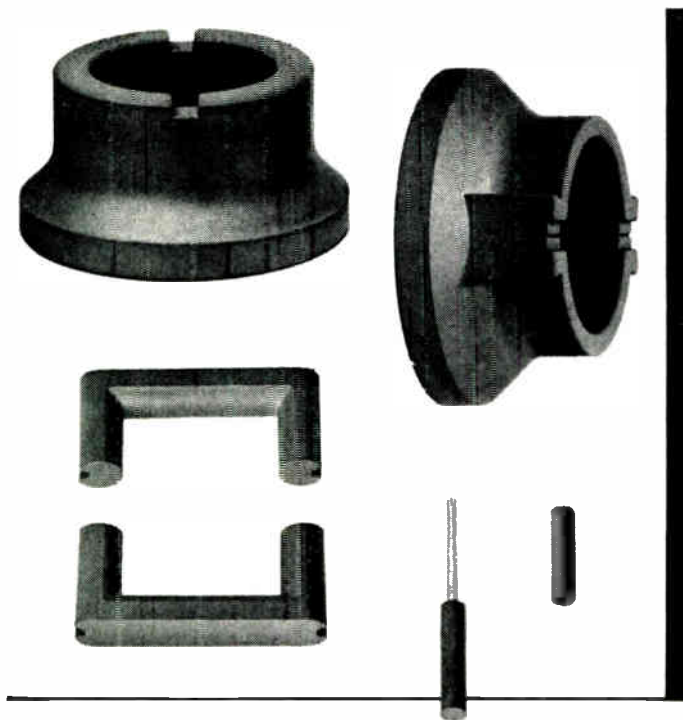
Temperature: -65° C to 125° C

Produced with meticulous care under white room conditions and rigid quality control procedures

These relays are reliable! They are constructed of precision made parts to exacting tolerances for uniformity of production, and provide consistent, dependable performance. Available from factory shelf stock and from stock in our Los Angeles and New York offices. Ordering references for 1/6-Size Crystal Case Relays with 1 1/2" leads, 26.5 VDC coil rating: Model 900-Catalog No. 90030301; Model 901—Catalog No. 90130301. For technical information call Aerospace Products, or write for Bulletins 1076 (Model 900) and 1077 (Model 901). Telephone: 242-5000, Area Code 412. TWX 412-642-4097, TELEX 086748.

WABCO

UNION SWITCH & SIGNAL DIVISION
PITTSBURGH 18, PA./Westinghouse Air Brake Company



Typical Ceramag Ferrite cores available in many sizes and grades . . . from stock at Stackpole. Check us on availability of other types, too!

The Ceramag® Ferrite cores you need may be in stock right now at Stackpole!

Note, especially, that we are tooled for both 70° & 90° yoke and transformer cores for Color TV.

Many Stackpole Ceramag ferrite cores have such widespread demand that we are now maintaining fairly substantial stocks on these items. *This means you can get a 5-day delivery or better on receipt of order!*

Stocked items include many types of cup cores, as well as insert and threaded cores for IF, RF, permeability tuning, TV width and linearity coils. Also: horizontal output transformer cores (including cores made from Stackpole's Ceramag 24A), 110° deflection yoke cores, toroidal yoke cores, and threaded cores of Ceramag 26.

Fast delivery on all other cores!

If we do not stock the core you need, chances are no other supplier does either. You can still depend on Stackpole for faster production and delivery of your item.

Stackpole got a head start as the first commercial supplier of ferrite cores in this country. We've never lost the lead . . . in production, research and design facilities, in quality, knowledge or service. Make it a point always to check Stackpole first on any ferrite core requirement. Call or write today.

STACKPOLE
CARBON COMPANY

Electronic Components Division
St. Marys, Pennsylvania

WHAT'S NEW

"FOOLPROOF" CONNECTOR

NEW ENVIRONMENT-RESISTANT CONNECTOR that provides "go-no go" reliability in electronic circuits on airplanes, missiles and spacecraft has been announced by Amphenol-Borg Electronics Corp., Chicago, Ill.

This new connector, the Ultra-Mate, will prevent a circuit checking out on the ground and later malfunctioning due to connector failure. Either a connector checks out as operative or it doesn't. There is no chance that the connector will falsely show good contact being made.

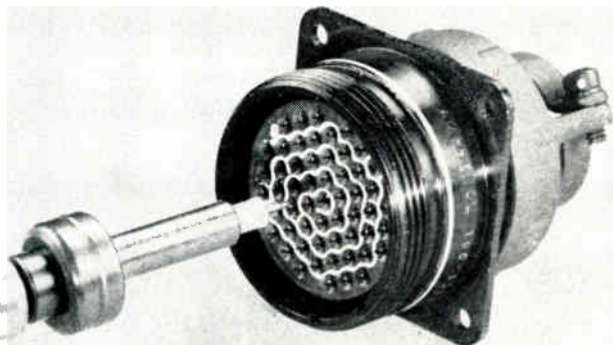
This increased reliability is due mainly to a new, hard-face dielectric insert. This insert has tapered entries to the female contacts. When the connector is mated like this, the male pin either goes into the female receptacle entry—making contact—or it doesn't go in at all. If it doesn't, the circuit will test out as negative, or "no-go."

Another advantage of this connector is front serviceability. You do not have to sort through a maze of back wiring to find the proper contact. Contacts can be removed from the front by using a simple tool.

The Ultra-Mate connector meets Military Specification MIL-C-26500. It is, in fact, an upgraded version of the MIL-C-26500 connector. It is completely interchangeable and intermateable with other MIL-C-26500 connectors and uses MS-26636 contacts.

A contact in the new connector may be removed with a simple extraction tool that never touches the contact's working mechanism. Thus the plated surface remains intact.

Amphenol-Borg has tooled up to produce this connector in all basic sizes and insert arrangements specified in MIL-C-26500.



NEW 1/2-SIZE CRYSTAL CASE RELAY MODEL 902 (DPDT)

Meets requirements of MIL-R-5757D

Rigid frame construction

Positive contact wiping action

High-temp. coil wire rated +220°C

Size: .80"L x .40"H x .40"W

Weight: 0.3 ounce

Contact arrangement: Form C

Coil rating: 6, 12, 26.5, 48 VDC (others available)

Contact rated load: low level dry circuit to 2 amps
resistive to 26.5 VDC

Contact life: 100,000 operations at rated loads

Vibration: 0.1" D.A. or 20G peak, 10 to 2000 cps

Temperature: -65°C to 125°C

Shock: 50G for 11 milliseconds

Dielectric strength: 1000 volts RMS except 500 volts RMS
from coil to case and across open contacts

Terminals: Plug-in, hook-type and 3" leads

Corrosion resistant materials used throughout

Produced with meticulous care under white room
conditions and rigid quality control procedures

This new relay is reliable! It is constructed of precision made parts to exacting tolerances for uniformity of production, and provides consistent, dependable performance. Available from factory shelf stock and from stock in our Los Angeles and New York offices. Ordering references for 1/2-size Crystal Case Relay with hook terminals and bracket mounting, 26.5 VDC is Catalog No. 90210320.

For technical information call Aerospace Products, or write for Bulletin 1073. Telephone: 242-5000, Area Code 412. TWX 412-642-4097, TELEX 086748.



UNION SWITCH & SIGNAL DIVISION
PITTSBURGH 18, PA./Westinghouse Air Brake Company

SPECTROL RECTANGULAR TRIMMERS

Better 5 Ways

1 One-piece stainless steel shaft (electrically isolated) provides mechanical strength for maximum reliability.

2 Unique spring loaded slider block design insures anti-backlash operation for setting stability, eliminating wiper shift and resistance change in high shock and vibration environments.

5 Silicone insulated copper mandrel provides uniform heat dissipation, eliminates hot spots and burn-outs.

3 Dual platinum alloy wipers on resistance element and twin collector contacts assure noise-free performance and high electrical reliability.

4 $\frac{1}{3}$ greater element length permits use of larger diameter resistance wire for greater reliability and longer operational life.

For Military Applications...

SPECIFICATIONS

	Model 42	Model 44	Model 74
MIL-R-27208 Equivalent Style	RT 11	RT 12	*RT 12
ELECTRICAL			
Standard Resistance Range	50 Ω to 100 K		
Standard Resistance Tolerance	$\pm 5\%$	$\pm 5\%$	$\pm 10\%$
Power Rating	1.0 watt at 70° C		
Operating Temperature Range	-65° C to +175° C		
MECHANICAL			
Number of Turns	25 ± 2	25 ± 2	22 ± 5
Case Dimensions	Width	0.190	0.280
	Height	0.312	0.312
	Length	1.250	1.250
Weight	Leads	4.5 grams	
	Pins and Hooks	3.5 grams	
Unit Price in 100 Piece Quantity	\$5.15	\$5.15	\$3.56

*Meets electrical and mechanical requirements, but is not sealed.

Advanced design of Spectrol rectangular trimming potentiometers guarantees higher performance and reliability for space and missile applications.

More economical use of space allows greater usable resistance element length (0.645") and larger diameter resistance wire to provide longer life, better heat dissipation and greater reliability.

Spectrol Models 42 and 44 are tested to assure compliance with the requirements of MIL-R-27208, including moisture resistance and immersion. Model 74 withstands steady state humidity per MIL-STD-202B, Method 106, but is not sealed and therefore recommended for medium severity applications not requiring potting or continuous operation in high humidity environments. Model 74 meets requirements of MIL-R-27208 other than humidity cycling and immersion.

All rectangular trimmers available in three basic terminal types: Teflon Insulated Leads, Printed Circuit Pins, Solder Hooks.

Call your nearest Spectrol distributor for immediate off-the-shelf delivery at factory prices, or write for complete specifications.

Spectrol also manufactures a complete line of square and round trimmers, miniature and precision potentiometers and turns-counting dials.

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IMMEDIATE DELIVERY

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74-1-1
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42-2-1
Printed Circuit Pins



44-2-1
Printed Circuit Pins



74-2-1
Printed Circuit Pins



42-5-1
Solder Hooks



44-5-1
Solder Hooks



74-5-1
Solder Hooks

Call your nearest **SPECTROL** distributor today for off-the-shelf delivery

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Circle 37 on Inquiry Card
World Radio History

IMPROVED CHECKOUT FOR IR DETECTORS

The key to reliability in airborne IR packages is in the design and manufacture of the detectors themselves, and in the checkout procedures used to keep them in operating condition. Because the chemical and physical nature of IR devices creates inherent problems of stability and uniformity, the test measurements play a vital role in successful systems.

THE INCREASING NUMBER of airborne IR systems has brought a demand for increased sensitivity, efficiency and reliability of a wide variety of detector types. These include lead sulfide, lead selenide, indium antimonide, gold- and copper-doped germanium and other materials.

With growing sophistication in associated optics, reticles and electronics, the need for uniformity and reliability has made itself felt in IR airborne instruments. Thus, the key to real reliability in flyable IR packages comes back to the design, manufacture and checkout procedures used in the detectors themselves.

* * *

As IR systems have become more complex, the detectors themselves have become more complex. Hence, system needs are forcing the "state of the art" for detectors in sensitivity and geometry. As these detectors become more sensitive and complex, it becomes essential to design test equipment that is capable of correctly evaluating their performance. Basic needs for any test equipment are these: (1) Equipment must be, after adequate instruction, simple to use. (2) It must be reliable and easy to calibrate. (3) It should perform a complete evaluation.

Equipment Beginnings

With the above points in mind, let us take a brief look at the history of some IR systems and test equipment.

Earliest test sets were used in the chemistry labs where the detectors were made. One of the first crude sets amounted to an ohmmeter which monitored detector resistance. A flashlight was the source. If the detector had a ratio of dark-to-light resistance which exceeded a certain value when the flashlight

was turned on and off, it was considered a good one.

You may be amused by a test as crude as this, but even today, the flashlight test is used on an advanced military weapon system, the Sidewinder Missile. True, the flashlight is not used to select the highly sensitive detector or for the completed missile checkout. But in the fleet, as a final checkout prior to takeoff, a ground crew member stands in front of the aircraft and shines a flashlight into the armed missile. If the missile is functioning correctly, the pilot receives an indication that tells him the system is operational.

From the raw beginnings of ohmmeters and flashlights, engineers began designing more complex IR systems. Absolute sensitivity of the detector thus became more critical. It was no longer enough to tell the systems designer that a detector had a particular dark-to-light resistance ratio when exposed to a flashlight. It was not even adequate to explain the calibration source as "chief chemist's flashlight with two D cell batteries, each less than 6 mon. old."

Detector measurement equipment has come a long way in the past several years. Fig. 2 shows the test station we used 10 years ago for obtaining data on thousands of detectors over a 2-year period. This test station was capable of evaluating detectors. Because of its intricacies and peculiarities, it could, however, be operated by only one or two people in the department.

Problems confronted the industry. Management would decide to enter the field of IR technology. An

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engineer, or team of engineers, would tour the country to find out how other labs, already in IR work were equipped. After about a month of traveling the engineers returned to begin a lab equipment program. They ordered individual pieces of equipment and gradually built up a roomful of test instrumentation. They also enhanced their job security because only they knew the purpose of each piece of equipment and how it functioned in the test program.

Invariably, as soon as the test equipment and the IR program for the company was running smoothly, the project engineer accepted a job with another company. Thus the cycle started again. Of course, the company he had just left was now in possession of a room full of equipment but without a knowledgeable operator.

As a result of this experience, managements of many companies were reluctant to develop IR programs because of the high cost of setting up an IR lab, to say nothing of the risks.

At present, a complete detector lab can be purchased in a single, compact, console. On this console, an operator can perform all the basic measurements needed by systems designers. In addition, system parameters can be simulated and detector performance, under these conditions, can be evaluated.

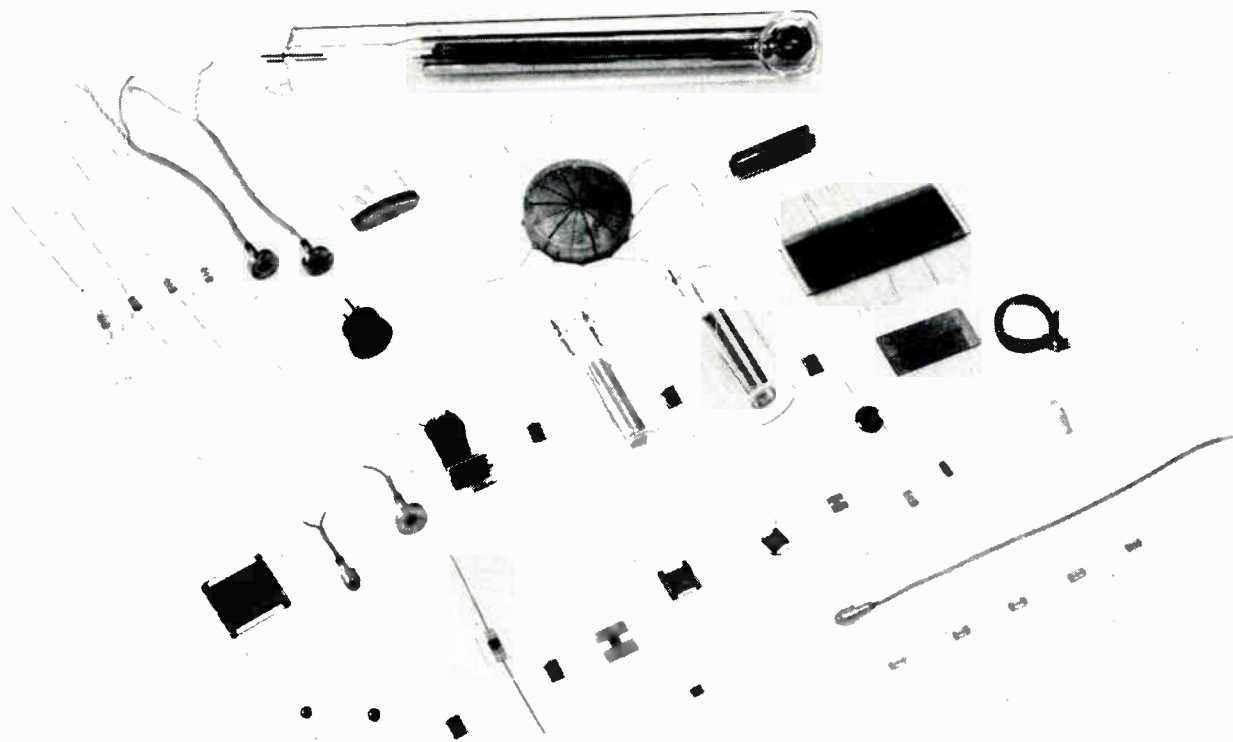
Description of Tests and Equipment

Since no two detector or systems manufacturers had the same test equipment, a group was formed at the U. S. National Bureau of Standards, later to become the U. S. Naval Ordnance Laboratory, Corona. Its purpose was to set up a facility that would provide IR detector measurement data to the military. This program, known as The Joint Services Infrared Sensitive Element Testing Program, is still being carried out.

The program at Corona was the first big step toward providing detector manufacturers and IR systems designers with the type of information needed to figure system performance.

The IR detector tests and interpretation of data that are desirable from a system designer's standpoint are described in a report by Eisenman & Merriam of the U. S. Naval Ordn. Lab, Corona.¹ Without going into the details of the report, these parameters include: signal, bias, frequency response, spectral response and noise. Various figures of merit which are covered include: responsivity, noise equivalent irradiance, noise equivalent power and D^* (pronounced D star). A block diagram of equipment designed to make all of these measurements is shown in Fig. 5.

Fig. 1: Typical IR detectors that must be evaluated by detector measurement equipment are these cooled detectors, multi-element arrays, detectors on optical elements and hardware wound detectors. They are typical of the types the modern systems designer needs.



IR DETECTOR MEASURING (Continued)



Fig. 2: This equipment comprised an IR detector measurement station in 1953. Detectors to be checked were placed in the metal box (center of picture), which slides along an optical bench to position it in front of the various IR sources.

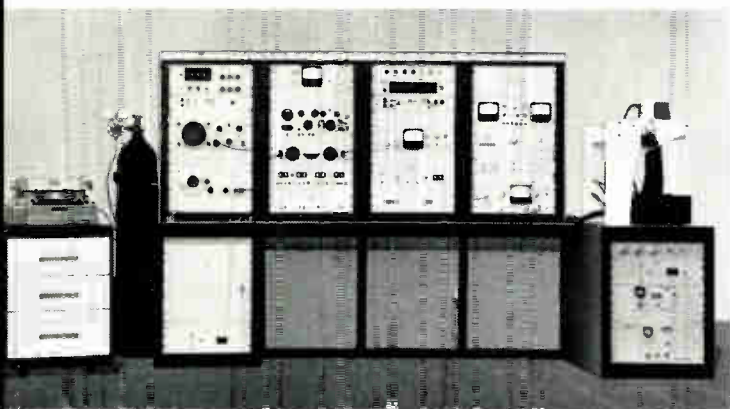
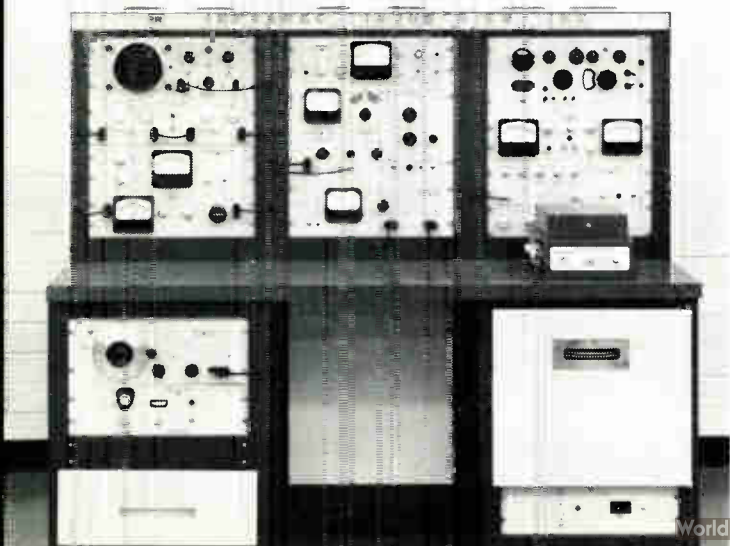


Fig. 3: Modern comprehensive detector measurement console for making a complete evaluation of an infrared detector.

Fig. 4: Fully-automatic checkout station for rapid production of single-unit or array-mounted IR detectors in large volume.



The blackbody temperature range could be varied from 50 to 1000°C. This temperature was monitored continuously with a precision pot and calibrated thermocouple which is built into the blackbody. The modulator housing and baffle assembly could be water-cooled. This might prove necessary for measuring long wavelength response detectors which are very sensitive to dc background radiation. The variable speed modulator was operable over the range of 10 to 10,000 cps. Limiting apertures were mounted on a wheel so that the emitted blackbody energy on the detector could be varied. A set of monochromatic filters was provided for spectral response measurements. These filters are normally spaced at 0.5 micron intervals. Data obtained indicated the detector spectral response. However, it does not have the fine resolution obtainable from a monochromator.

Detectors to be tested were mounted on plug-in fixtures and inserted into a temperature-monitored compartment. Detector bias was supplied from a dc source that included 1% meters for both voltage and current monitoring. Monitoring of these 2 quantities indicated the stability of the detector under test.

Console electronics calibration could be done at any time by turning a switch. A precision micro-voltage divider and oscillator made up the calibration equipment.

Detector signal and noise was amplified by a special low-noise preamplifier and the output was split into 2 readouts. One output went to a wave analyzer for narrow band signal and noise power spectra measurements. The other output fed through a variable tuned filter and into a broadband voltmeter to simulate actual system bandwidths. A noise integrator was included, to take the guess work out of noise readings.

Detectors in Space

With the advent of space flight and satellites, new environmental variables affecting the detectors were introduced. These included vacuum, radiation bombardment and temperature.

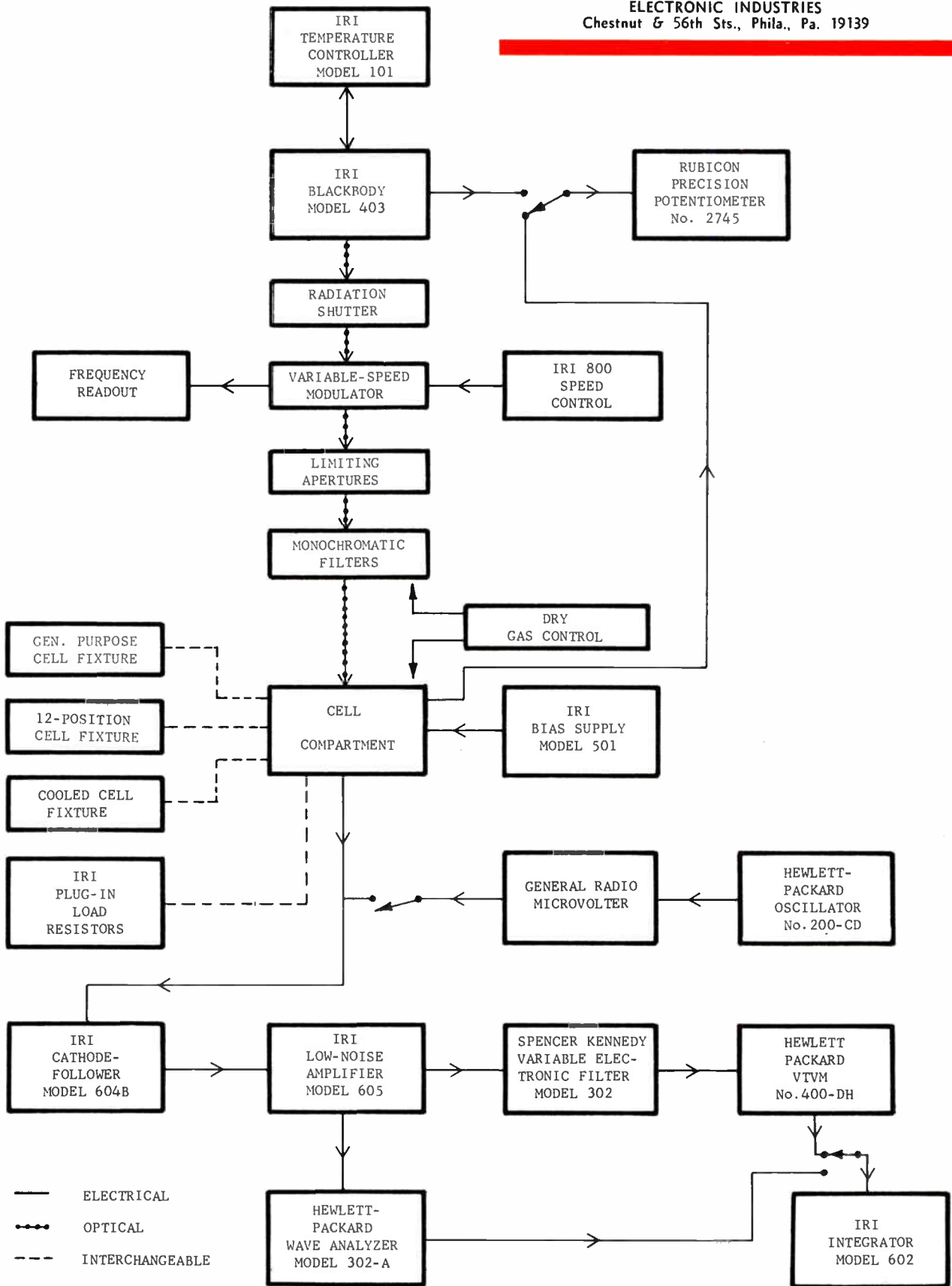
There have been so many questions about the effects of space environment on detectors that until recently even the detector manufacturers, themselves, were not able to answer all of them.

Vacuum effects have been studied in large vacuum systems.

Radiation bombardment studies have been conducted in several labs, among them Lincoln Laboratory² and Lockheed Missiles and Space Co.³ Data (which includes both electron and proton bombardment studies) is currently being taken under a USAF contract.

Fig. 5: Block diagram of a detector measurement console designed to measure responsivity, noise equivalent irradiance, noise equivalent power and D^* (pronounced D star).

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IR DETECTOR MEASURING (Concluded)

R&D Continued

The temperature of objects in space varies with altitude, internal power dissipation, and radiation and reflection qualities of the surface.

To evaluate detectors for space systems properly, it suddenly became imperative to know the effects of temperature upon resistance, sensitivity, wavelength, frequency response, etc. In general, a whole new concept of testing was needed for evaluating the properties of spaceborne detectors.

Testing of individual detectors at low temperatures is now routine. The detectors are mounted in vacuum dewar flasks and a liquid coolant is poured into these flasks. This coolant in most cases is either liquid nitrogen or a slurry of dry ice and acetone. These 2 coolants produce temperatures of -196°C and -78°C respectively.

With the need for testing not only individual detectors but multi-element arrays, at temperatures varying from $+20$ to -100°C , a complex problem arose. Measurement equipment had to perform all of the measurements described. It also had to include a temperature chamber which could bring individual detectors, or arrays of detectors, to a predetermined stable temperature and at the same time maintain a moisture-free atmosphere around the detectors and the IR transmitting window. (The latter was necessary to prevent frost from accumulating.)

Pieces of test equipment were built which used, among other means of temperature control, a resistance heater immersed in a heat sink which was cooled by a liquid nitrogen or carbon dioxide reservoir. This method was adequate for research lab studies on single detectors, but was cumbersome for multi-element arrays and no good for production work.

To remedy this a multi-stage refrigerator compressor system was designed and built. This system, when coupled with the environmental detector chamber, provided an environmental chamber which could be controlled to any temperature, from $+50$ to -80°C .

Since some of these arrays contained several hun-

dred detectors, the signal and noise processing alone became a big undertaking. Units were designed, built and operated. However, the sequence and the time involved in obtaining these first array measurements showed the pressing need for an automatic detector measurement console. As a result, the console shown in Fig. 4 was built. This console included automatic calibration and gain control which could be pre-programmed for recalibration as often as needed. Signal, noise, bias voltage and current, and s/n ratio were all read out directly on a digital voltmeter. At the same time they could be put on tape, typed on a Flexewriter, or punched into cards. A simple computer program could now provide the operator with all of the figures of merit.

Optimum bias at each temperature was determined automatically by programming a selection of bias voltages into the programmer. Noise integration time was selected to coincide with the noise bandwidth being used.

An optical focusing system enabled the operator to automatically measure contour sensitivity of the detectors. Contour output was printed on a strip chart recorder.

This console has been used successfully to measure entire detector arrays for reconnaissance type satellites.

Future of IR Detector Testing

The future of IR detector testing resides in the demands being made upon IR detectors by the military and civilian government agencies, as they step up their needs.

Research is now underway to examine the usefulness of IR detectors at greater and greater distances in space—with the attendant demands for continuing and improved high level performance.

An IR airborne instrument performing tasks and experiments on future programs involving millions of miles and under conditions of increasing difficulty, will have been made possible only by the continued refinement on the ground.

Bias supplies and amplifiers of even lower noise figures than currently available—control mechanisms insuring rugged detector structure yet maintaining delicacy of performance—these are the areas of research that continue on the ground, to make certain flying IR packages perform as intended.

References

1. Eisenman, W. L.; Merriam, J. D., *Interpretation of Photodetector Parameters*, NOLC report 558, Jan., 1962
2. *Solid State Research* (U), Lincoln Laboratory Quarterly Progress Report, Apr. 15, 1963.
3. Chow, K. T.; Day, R. P.; Lee, J. C.; Lodi, E. A.; Wallner, R. A., *An Experimental Study of Energetic Proton Radiation Effects on IRI Lead Sulfide Infrared Detectors*, I.MSD-704018, Feb. 1961.

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ENGINEER'S NOTEBOOK

69 ANTENNA EFFECTIVENESS

AN ANTENNA is usually judged on the basis of its radiation efficiency or its VSWR. But these two quantities, while both important, do not singly describe the actual effectiveness of an antenna.

The radiation efficiency is given by the ratio of the radiated power to the total power into the antenna

terminals. The total power is the sum of the radiated power and the power lost in ohmic losses in the form of heat.

On the other hand, the power going into the terminals of the antenna is given by the power which the transmitter can put out less the power reflected due to

antenna mismatch.

If we define the "effectiveness" of an antenna as the ratio of the radiated power to the power which the transmitter can put into a matched load, i.e., the forward or incident power, the "effectiveness" of an antenna is given by:

$$\text{Effectiveness} = \frac{4S}{(S+1)^2} \times \text{Efficiency}$$

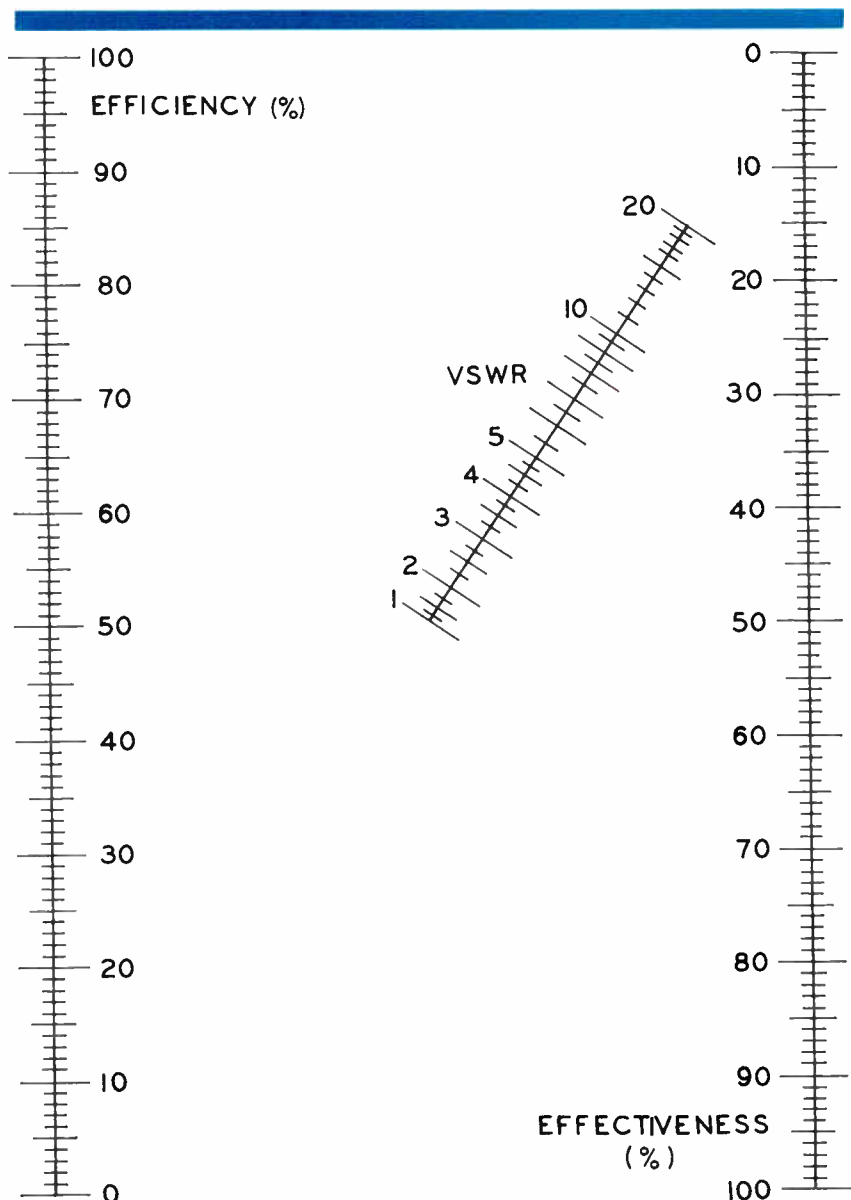
where S is the voltage standing wave ratio.

The nomogram is used to determine the antenna effectiveness (in percent) if the efficiency and VSWR are known. To use the nomogram, the points representing the antenna efficiency and VSWR on the appropriate scales are connected by a straight line, and the line extended to intersect the effectiveness scale. For example, a 60% efficient antenna with a 3:1 VSWR has an effectiveness of 45% compared to a perfectly matched, 100% efficient antenna.

In some instances, an antenna may be more effective by lessening its efficiency if in so doing the VSWR is reduced sufficiently.

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The terminal potential of a battery is a poor measure of its state of charge. Present methods do not give charge-rate information nor do they provide a reliable continuous indication of battery charge.

Here is a system which permits deep discharge and a safe, controlled high charging rate along with weight reduction.

A NICKEL-CADMIUM BATTERY CHARGE-CONTROL SYSTEM is described for satellite power supplies that offers significant advantages over present control methods. The system integrates the charge and discharge currents of the battery, providing a continuous and accurate indication of the battery charge state. This permits deep discharge and a safe, controlled high charging rate with significant weight reduction.

Telemetry information describing the battery state of charge and the magnitude of charge or discharge currents can be provided.

* * *

Existing solar-cell nickel-cadmium power source combinations control battery charge (to avoid high charging currents when the battery is fully charged) by sensing the battery potential or measuring temperature rise in the cells. Methods frequently used either limit the potential rise across the battery with a zener diode, or introduce an impedance between the battery and the solar cells when the battery potential or cell temperature rises to a predetermined value. Neither of these methods provides charge-rate information, but a more serious disadvantage is in not having any reliable, continuous indication of battery state of charge.

Battery potential is a poor indication of the state of charge of a battery for the following reasons:

1. Nickel-cadmium batteries have a temperature-dependent flat voltage characteristic over most of their range of charge and discharge.

2. The individual cells of multi-cell batteries may have different voltages caused by varying electrolytic concentration, cell temperature, or internal construction.

Thermal time lags seriously limit the value of temperature sensing.

The inadequacy of the potential and the temperature measurement methods usually forces the use of a low charging rate and thus a low depth of discharge to compensate for the uncertainty of the battery state of charge.

WELL REGULATED BATTERY-SOLAR CELL CHARGING

The battery charge-control system being described integrates the charge and discharge currents of the battery, thus giving a continuous indication of the battery charge state. This permits deep discharge and a safe, controlled high charging rate with its resultant weight reduction.

System Advantages

Telemetry information describing battery state of charge and the magnitude of charge or discharge currents is also available with this system. The following is a summary of the advantages of such a system:

1. Greater battery depth of discharge is used. This avoids the battery passivation that is common to the shallow depth of discharge now used in nickel-cadmium battery systems.

2. Total battery weight is reduced because of the greater depth of discharge. For example, this system would permit a payload orbiting at 500 statute miles with an average power load of 400 w to reduce its required battery weight by a factor of 4.5 (from about 200 lbs. to about 45 lbs.).

3. Continuous indication of battery charge or discharge current and battery state of charge is available for telemetry to the ground.

4. Destructive battery overcharging is avoided, if, by some equipment malfunction, the load is removed from the solar cells at a time when the battery is at full charge.

Charge-Control System

General: A generalized satellite solar-cell nickel-cadmium power source consists of a combination of solar cells and nickel-cadmium batteries powering

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an equipment that has a specific power demand versus time profile. The solar cells are exposed to the sun for some period of time during each orbit and have a power and voltage capability that varies with inclination to the sun. The batteries receive their charge while the solar cells are exposed to the sun, and power the equipment during the remainder of the orbit.

Existing battery systems for space use usually limit the maximum charging rate to about 10 hours. This is due to uncertainty in determining the battery 100% charge state. The system being described uses a high charging rate until it senses that the 100% charge state has been reached. The charging rate is then reduced for the remainder of the charging time.

Fig. 1 indicates the amount of battery use possible with existing systems, in circular orbits, as a function of orbital altitude. Fig. 2 shows the battery weight saving factor possible with the suggested systems as a function of orbital altitude. This curve is based on a 10-hour charging rate for the existing systems and a 50% depth of discharge with the charge-control system.

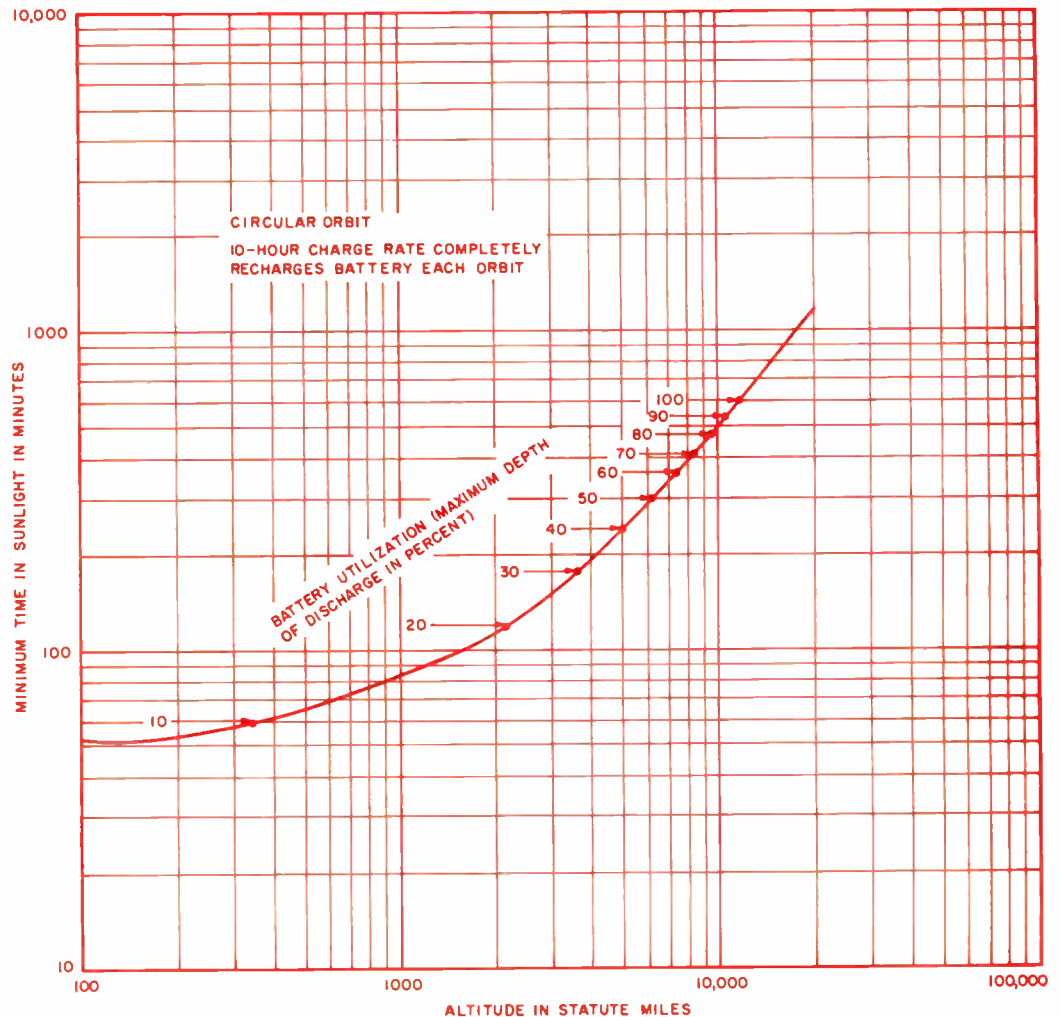
System Description

1. Introduction: The battery charger and controller, which comprise this system, must be of high reliability and accuracy. It must also contain inherent flexibility to adjust to the nonlinearities and variables known to occur in storage batteries.

The charger and controller must be able to perform the following functions:

- a. Accurately monitor the ampere-hours discharged from or charged into the battery.
- b. Apply a charging "efficiency-factor" to account for the fact that more ampere-hours must be delivered to the battery than are removed from it to restore it to a particular state.
- c. Apply a temperature and battery age correction to item b.
- d. Reduce the charging rate to a safe value after the 100% charged condition is reached.
- e. Increase the charging rate when the battery drops below the 100% charged condition.
- f. Provide an alarm if the battery charge decreases below a safe level. *(Continued on following page)*

Fig. 1: This graph shows the optimum use which can be made of a satellite's battery. This depends on the time during which the solar cells are facing the sun and altitude of the orbit.



BATTERY-SOLAR CELL (Continued)

The battery charger and controller described can fulfill the above conditions and can be integrated into space power-supply systems. Fig. 3 is a block diagram of the suggested system.

2. Battery Current Sensing and Dynamic Range: The battery current flows through a shunt that produces a dc voltage whose magnitude is proportional to the instantaneous magnitude of the battery current, and whose polarity indicates current direction. A shunt that produces 50 mv. at maximum current may be used. A dynamic range of at least 50:1 is practical.

3. Amplification of Shunt Voltage: To provide drift-free amplification of the mv. dc signal, a chopper-stabilized amplifier can be used. The shunt signal is modulated by the chopper at a 2 kc rate. It is then amplified with an ac amplifier and demodulated to a dc voltage of proper polarity.

The 2 kc signal is chosen as the modulation frequency to minimize the size of components, consistent with good design practice.

The chopper is a solid-state device.

The ac amplifier consists of two stages of R-C

coupled common emitter transistor stages with gain stabilizing unbypassed emitter resistors followed by an isolating emitter follower.

The demodulator is similar in appearance to the chopper. Its output will be suitable for the telemetering of battery current data.

4. Battery Current Integration: The current integrator requires a time constant of at least 20 sec. to allow a maximum integration period of about 1 sec. with an error of less than 5%.

Thus 1 sec. is allowed for the minimum expected current to accumulate to 1 unit of battery capacity. The extreme situation will occur when the entire battery capacity is discharged or charged at the minimum current. For this case, assuming a 20 ampere-hour battery and a minimum current of 0.4 a.,

$$\frac{20 \text{ amp-hrs.} \times 3600 \text{ sec.}}{0.4 \times 1 \text{ sec.}} = 180,000 \text{ or more charge units,}$$

are needed to ensure an error of less than 5%. In practice, this low current would flow for considerably less than 20 hrs., thus giving errors much less than 5%. For example, the same battery with a continuous

5 a. flow will register 1 charge unit in $\frac{0.4}{5} = 0.08 \text{ sec.}$

The error for this measurement is in the order of

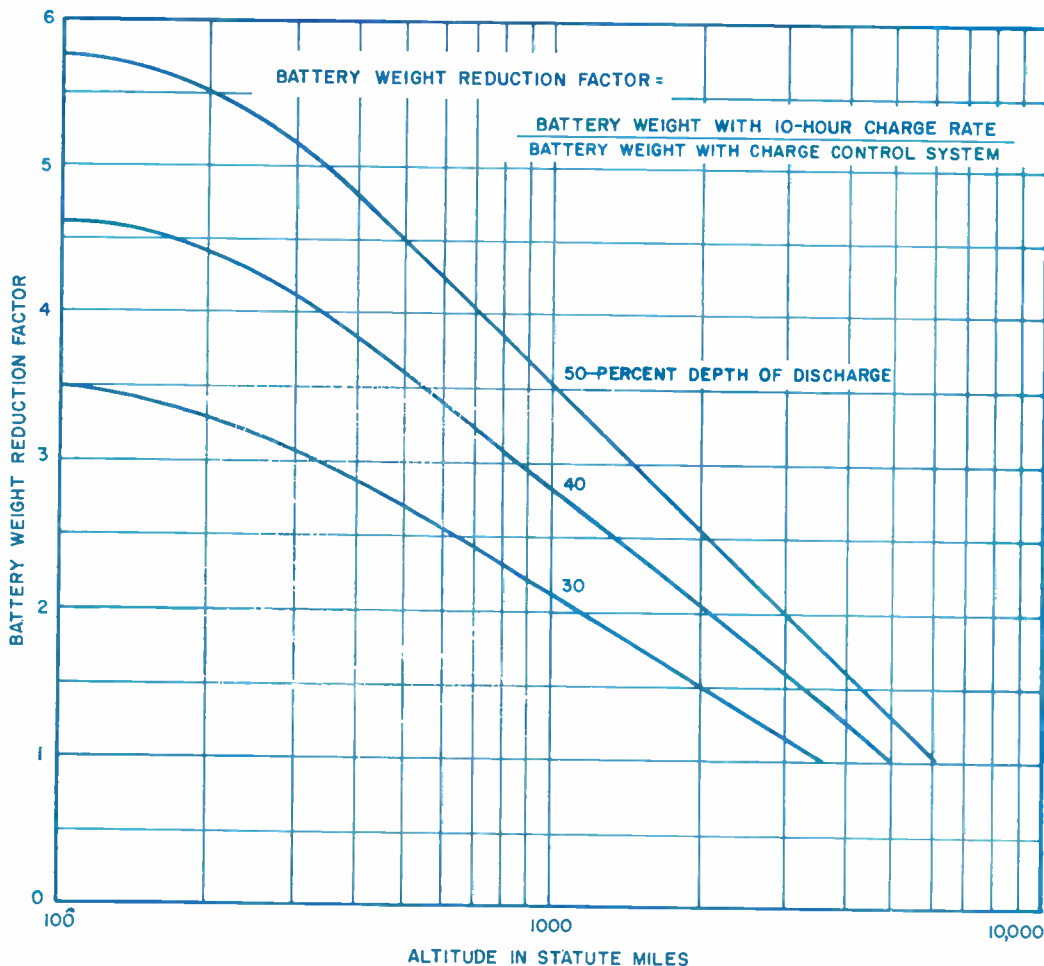
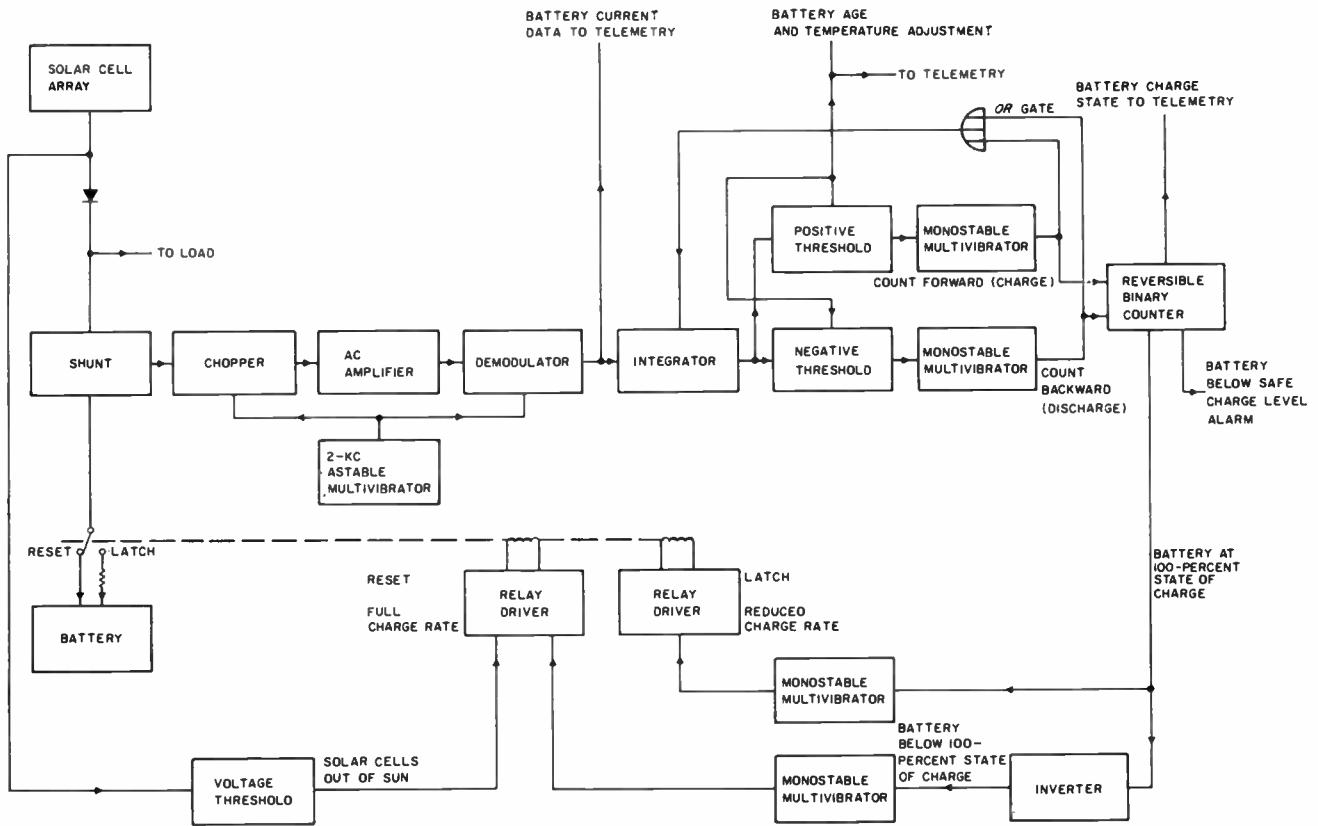


Fig. 3 (right): Block diagram of the battery charger and controller. Its various functions are described. Telemetry data on battery's charge and discharge currents is available.

Fig. 2 (left): Graph shows how the charge control system can save battery weight due to its high, safe charging. With its variable, fast rate to maintain 100% charge, fewer batteries are needed by allowing greater depth of discharge.



$$\frac{\text{integration time}}{\text{time constant}} = \frac{0.08}{20} = 0.004 \text{ or } 0.4\%$$

The integrator can be a transistorized operational type amplifier with capacitive feedback.

5. Charge Increment Detector: The charge increment detector senses when the integrator output has reached 1 unit of charge. Two voltage threshold circuits, one for charge and the other for discharge, each followed by a monostable multivibrator or Schmitt trigger, can provide this function. The multivibrator pulses can be of the order of 1 msec. and will step the charge state indicator and reset the integrator.

The charging threshold is adjusted (relative to discharge threshold) to compensate for the "charging efficiency" and may be varied by a temperature signal from the battery if necessary.

6. Charge State Indicator: The charge state indicator consists of a 17-bit reversible binary counter that is advanced 1 count each time the battery is charged 1 unit, and is retarded each time the battery discharges 1 unit. Data in Table 1 indicates the significant counter bit values.

The counter is unambiguous but must be restricted from overflowing when all bits are "ones." The least significant bit represents $\frac{100}{2^{18}} = 0.0004\%$ of battery capacity.

This represents one charge unit.

An additional function of the charge state indicator

Table 1

Bit Number	Value (percent full charge)
17	50
16	25
15	12.5
14	6.25
13	3.125

may be to provide an alarm if the battery charge falls below a safe level.

7. Charge Rate Control: Proper system operation requires that the charge rate be decreased to a low level after the battery reaches 100% charge. This is effected by a latching relay driven by outputs from the charge state indicator. When 100% charge is reached, the relay is latched and a current limiting device is inserted in the battery circuit. When the charge state decreases below 100%, the relay is reset and the current limiting device is shorted out, thus returning to the high charge rate.

Accumulation of errors in the integration of charge is thus avoided by converting to a safe trickle maintenance charge at the indicated 100% point. This effectively resets the charge integration system once each charge cycle.

References

1. Greenler, P. H., et al., "Final Report on Study of Sonotone Corporation Nickel Cadmium Size F Battery Cells," Space Technology Laboratories, Contract AF 04(647)-302, May, 1961.
2. Winkler, S. H., "Optimum Design of a Space Vehicle Storage System," *Proc. of 14th Power Sources Conference*, pp. 90-93, May, 1960.

AUTOMATIC TRACKING ANTENNA SYSTEMS

Ground-based antenna systems are being used for search and target acquisition, automatic tracking, command and telemetry.

The basic problems lie in physical size, noise and sensitivity. These are discussed along with performance and cost aspects of the various types.

THE AUTOMATIC TRACKING ANTENNA SYSTEMS being considered here are normally the ground end of an r-f communications link between a vehicle (such as a satellite, missile or deep space probe) and ground. They are not skin tracking radars; there is no need for rapid scan, tracking multiple targets, or very high peak power.

The final goal of most space missions is to collect useful data on the ground. The data may be scientific measurements from experiments conducted on the vehicle, vehicle status data, TV or other communications data either produced aboard the vehicle or relayed from another ground station, or combinations of the above. In any case, the ground tracking antenna system provides a basic function in receiving data, sending command information, and collecting angle-tracking data.

For obvious reasons it is highly desirable to minimize the size, weight, and power requirements of the space borne r-f equipment. One method of doing this is to maximize the sensitivity of the ground antenna

system. This is mainly true of deep space missions and high altitude satellites. The sensitivity of an antenna system varies directly with the gain of the antenna and inversely with the antenna system noise temperature. Maximum sensitivity therefore, points to greatest aperture size, minimum receiver and antenna noise, and lowest background sky noise.

Background Noise and Frequency

Fig. 1 is a plot of effective sky noise temperature in degrees Kelvin against frequency. The curves show that background sun bursts and galactic noise are the primary contributors to antenna noise temperature at frequencies in the range of 100 mc to 1 gc. Above 10 gc, noise from oxygen and water vapor absorption becomes the prime offender. A minimum sky-noise background exists from about 1 to 10 gc when the elevation angle of the antenna is more than 5° above the horizon. It should be remembered that noise stars, the sun, and even the ground will radically increase antenna noise temperature if the antenna is allowed to receive noise from these sources. From the curves in Fig. 1, it is apparent that a major part of frequency assignments for r-f links between space and ground will be in the 1-10 gc frequency range. Since a system noise temperature can never be less than the sky background noise, the background noise places a theoretic limit on sensitivity for antennas of a given size.

Physical Size and Surface Tolerance

System sensitivity can be increased by expanding

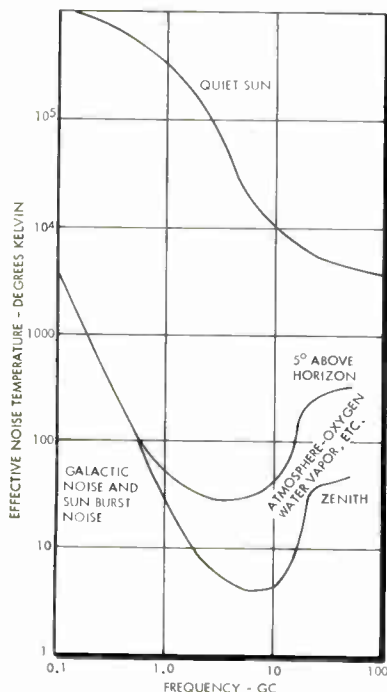


Fig. 1: Curves of the factors contributing to background sky noise.

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the physical size of the antenna aperture. There appear to be 3 fundamental limits to aperture size, and probably the most important is cost. Fig. 2 is a plot of reflector diameter as a function of frequency, on which has been spotted the estimated max. frequency (based on surface tolerances) for a number of typical large antenna systems. Neglecting fixed costs of such as the receiver and the servo system up to the drive motors, the structure's weight and cost vary closely with the diameter to the 2.7 power, and the cost is about \$2 per pound.

Steerable antennas with hemispherical coverage have thus far been cost-limited to diameters less than 300 ft., as seen in Fig. 2. The 600-foot radio telescope proposed for West Virginia was abandoned and the unduly high cost was certainly one of the deciding factors. The new 210-foot diameter antenna, shown in Fig. 3, will be among the world's largest when it is completed.

A second limiting factor on physical size is the ability to maintain reflector surface tolerances when the size of the reflector becomes thousands of wavelengths in diameter. Not only is it necessary to fabricate the surface to a tolerance of nearly $\pm 1/16$ wavelength, but the surface must be well-supported to maintain the surface contour tolerance under extreme conditions of position, motion, environment, etc. A number of relatively new methods of fabricating reflector surfaces are now in development or available. Reflectors with thousands of wavelengths in diameter may be relatively commonplace in the future.

The third limiting factor on physical size involves the variations of the relative propagation qualities of the received signal over various portions of the aperture. To be effective the phase coherence of all the energy striking the reflector should be extremely good. For very large antenna apertures however, propagation anomalies cause phase perturbations over the reflector surface which reduce gain even

though the reflector surface is acceptable. This factor is thought to become significant when the diameter of the antenna is in the order of 1,000 to 10,000 wavelengths. Thus, a practical limit is placed on maximum gain.

Economics

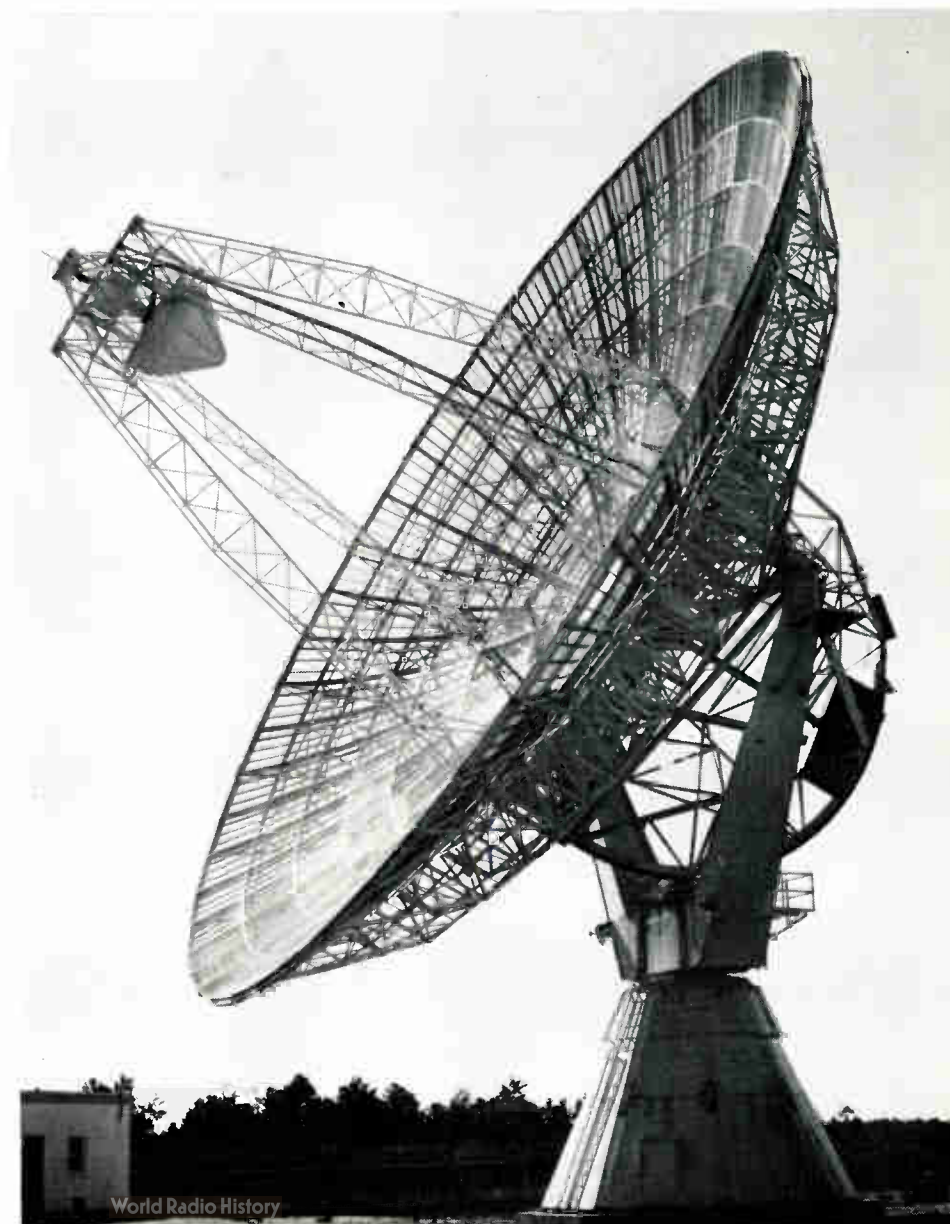
A second approach to large physical apertures involves slaving a number of small antennas together, each with its own preamplifier, and combining their received signals coherently by means of phase-locked circuitry. The relative economic advantage of this procedure depends upon many factors, but can be analyzed qualitatively as follows:

Assume the cost of an antenna system can be expressed as:

$$\text{Total Cost} = 5 (\text{DIA.})^{2.7} + (\text{Fixed Costs}). \quad (1)$$

Variable costs include the structure and the drive system. Fixed costs include such items as the receiver.

Here is seen the 85-foot diameter broadband automatic tracking antenna system. This equipment is being supplied by Radiation, Inc. for AFMTC.



AUTOMATIC TRACKING (Continued)

servo system, and control console. The total cost per unit aperture area is obtained as follows:

$$\begin{aligned} \frac{\text{Total Cost}}{\text{Aperture Area}} &= \frac{5 (\text{DIA.})^{2.7} + (\text{Fixed Costs})}{\pi (\text{DIA.})^2} \\ &= \frac{20 (\text{DIA.})^{0.7}}{\pi} + \frac{4 (\text{Fixed Costs})}{\pi} (\text{DIA.})^{-2} \quad (2) \end{aligned}$$

If the above assumptions apply, the minimum cost per unit area for a specified fixed cost can be determined by differentiating the total cost per unit aperture area with respect to reflector diameter and equating the derivative to zero. This expression reduces to

$$\text{Fixed Costs} = 1.75 (\text{DIA.})^{2.7} \quad (3)$$

Solving Eq. 3 for diameter will yield the reflector size for minimum cost-to-aperture ratio.

Fig. 4 is a plot showing relative costs of 1, 2, 4, 8, and 16 antennas to provide a given physical aperture. In this example, the assumed fixed costs were 200 thousand dollars per antenna and a reflector diameter of about 80 ft. is near optimum. From the curves, if a total aperture equal to about a single 80-ft. diameter reflector is required, a single antenna is most economical. When an aperture approaching the area of a 160-ft. diameter reflector is required, it is more economical to utilize four 80-ft. antennas. The aperture corresponding to 225 ft. in diameter can be most economically provided by eight 80-ft. diameter antennas. In this case the total cost is only 68% of that

of the single antenna. Another advantage of many small antennas might be in better over-all utilization, where each could be used on separate missions when maximum sensitivity is not required. Also, they could be slaved together for those missions requiring full sensitivity. A third advantage involves redundancy; i.e., if one receiver fails, the remaining units could function with relatively little degradation. A fourth advantage may involve the ability to coherently combine signals from a group of small apertures rather than a single large aperture. The requirement for phase coherence applies only to the smaller apertures because phase differences between these individual apertures can be corrected by the phase-locked circuitry.

The above analysis is performed only to indicate trends and makes many assumptions such as: negligible costs and degradation in performance in coherently combining the signals from the smaller antennas and also no price advantage in quantity purchasing.

A different approach to the very large aperture problem is use a number of feeds, each of which illuminates only a part of a large reflector surface. In this way, phase coherence need only be maintained over the small area "seen" by one feed and the phase errors between feeds can be minimized with phase-locked loops. The multi-reflector array on a single pedestal (similar to the Radiation Inc. Telscom antenna seen in a photograph) lends itself to this type of operation.

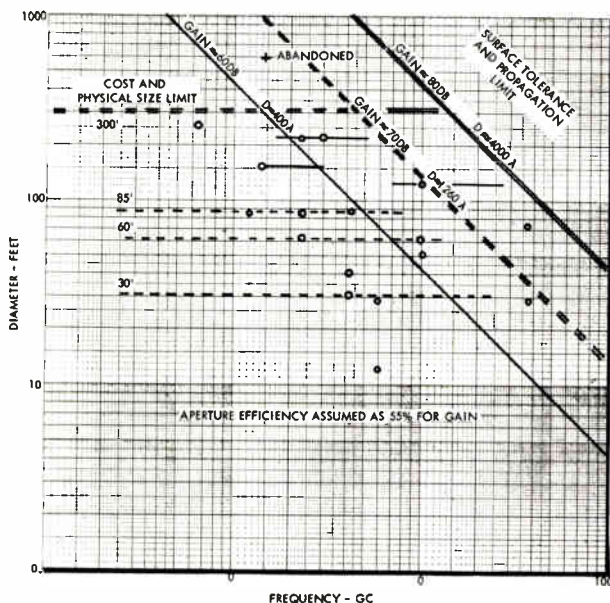
Antenna Noise Temperature

Low noise antennas, that is, antennas with noise temperatures approaching the background and sky noise, can be obtained by using some of the low noise techniques now appearing. One approach involves careful feed design in connection with Cassegrainian optics (see Fig. 3). A second is the big horn (Bell Labs) approach. Both of these systems have been very successful in achieving very low antenna as well as system noise temperatures. The lower curve in Fig. 5 is a calculated average antenna noise temperature for a high quality, large antenna system (approaching the state of the art) under "average" sky conditions.

Receiver Noise

Probably the most fruitful area for increasing system sensitivity per dollar lies in the development and application of low-noise solid-state receivers and pre-amplifiers. In Fig. 5, the average antenna noise temperature is combined with several types of receivers to provide an estimated system noise temperature. The advantage of liquid-helium cooled masers is

Fig. 2: The estimated maximum useful frequency, based on the surface tolerance of various large antenna systems.



evident in the frequency range from about 500 mc to 10 gc or higher. At 800 mc, for instance, the maser has about twice the sensitivity of a parametric amplifier and about ten times the sensitivity of the same antenna with a vacuum-tube amplifier. At higher frequencies the improvement is even more pronounced. These curves show that the use of masers or other equivalent low-noise receivers is an excellent method of achieving greater over-all system sensitivity.

Tracking Accuracy and Target Acquisition

Two problems associated with system sensitivity are tracking accuracy and target acquisition. High sensitivity normally means a large aperture and very small antenna beamwidth, frequently much less than 1° between half-power points. When the antenna is used for angle tracking and the readout data are used for orbital calculations, guidance, etc., tracking accuracy is relatively important. Tracking accuracy is a function of static mechanical parameters (such as static deflections, alignment, thermal expansion) and dynamic factors which involve the accelerations and velocities in the system.

Other contributing factors are error-signal generation as a function of off-target angle which normally varies directly with frequency, wind loading, and environmental effects. Typical tracking accuracies reported today for 85-foot antennas in the 200 to 2300 mc range are between 0.05° and 0.1° . Somewhat better accuracy has been reported for the Bell Labs horn. The dynamic pointing accuracy of the Haystack Radar Antenna is quoted as 0.005° .

When an antenna beamwidth narrows to a degree or less, target acquisition becomes a problem, and frequently a combination of methods are logically employed to assure target lock-on. Some methods employed involve computed coordinate location by coordinate conversion from other tracking systems or by the use of ephemeris data. A second technique is to use a sector, circular, elliptical, or spiral scan which covers a line or solid angle where the target is expected to appear. A third method involves slaving the narrow beam antenna to a relatively broad beam acquisition aid antenna which initially acquires the target and then the track can be transferred to the principal antenna.

Most of the previous discussions relate to high-performance, large antennas and these usually operate in a relatively narrow frequency band. With these high-performance systems, error-signal generation for auto tracking may be accomplished by means of sequential lobing (conical scan) but is more fre-

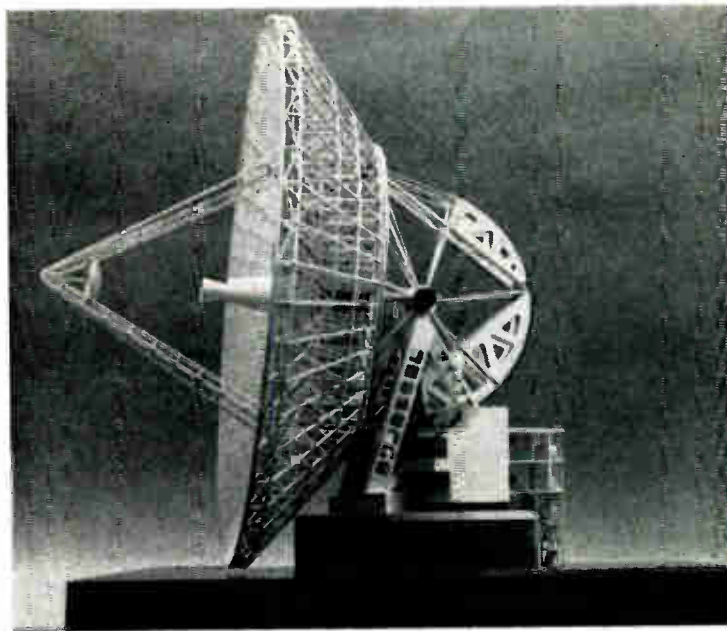
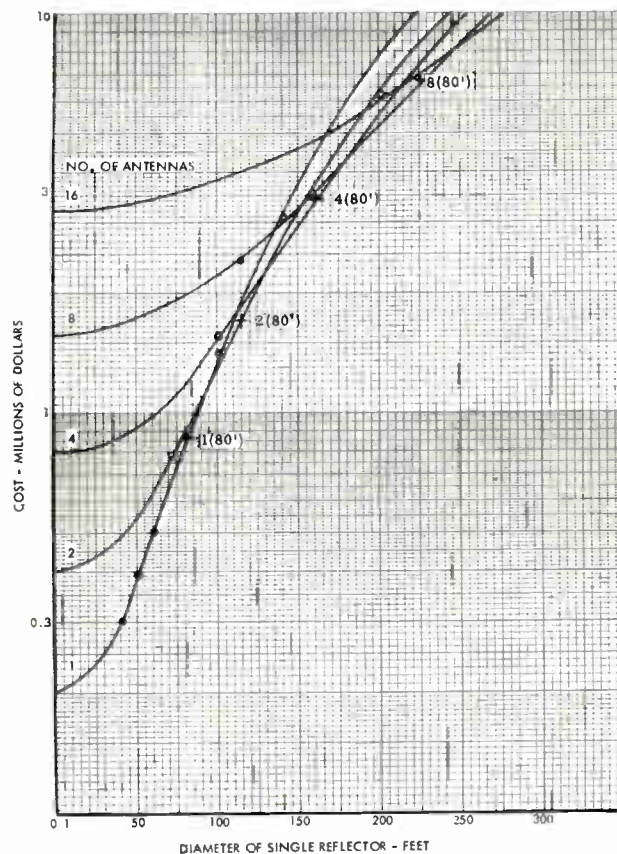


Fig. 3: Model of the new 210 ft antenna being procured by Caltech Jet Propulsion Laboratory for the NASA.

Fig. 4: Curve showing relative cost of providing a given aperture with a single reflector or using several smaller antennas. Fixed costs were assumed at \$200,000 each up to 80 ft.



AUTOMATIC TRACKING (Concluded)



Broadband "Telscom" (Telemetry, Surveillance and Communications) automatic tracking antenna system developed by Radiation, Inc.

quently achieved by simultaneous lobing techniques (amplitude monopulse or phase monopulse).

Frequency Coverage

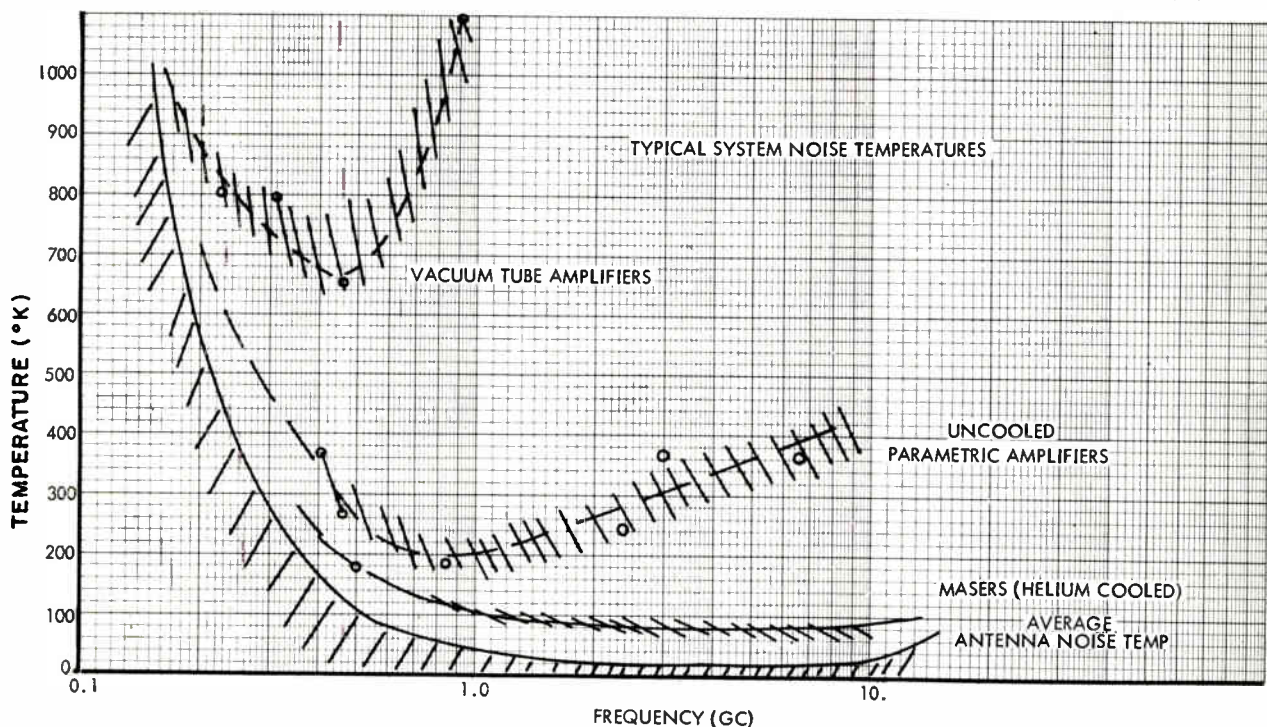
A large number of the tracking problems associated with missiles and low-altitude satellites do not require maximum sensitivity of the ground antenna system because of the relatively short ranges involved or the availability of higher vehicle transmitter powers for relatively short periods of time. Frequently, the ability to switch frequencies rapidly or provide simultaneous frequency coverage on a number of relatively widely spaced frequencies is of prime importance. Polarization diversity may also be an important requirement. To meet these requirements,

a number of relatively broadband automatic tracking antenna systems have been developed and are making their appearance.

One such system is the 85-foot diameter antenna (see picture). This system covers a frequency range from 100 to 2300 mc. The feed system consists of two conical spirals that are offset from the axis of the parabola. One spiral is right circular and the other is left circular and the entire feed structure is rotated to develop error signals by the conical scan approach. Since the spirals are oppositely polarized, both right-circular and left-circular polarization can be received simultaneously.

A second approach to the broadband tracking antenna problem is represented by the Telscom antenna system (see photo identified). This system consists of an array of reflectors, each of which contains a broadband feed system. The array can be conically scanned by introducing a variable phase shifter in series with each element, or the elements of the array can be connected in a phase-monopulse arrangement such that orthogonal error signals may be generated in the difference channels corresponding to the directions of motion of the antenna. The Telscom antenna is capable of operating over a frequency range from 216 to 2300 mc and orthogonal linear polarization is available throughout the entire band. These

Fig. 5: Curves showing system noise temperature expected with well-designed antenna (average conditions and various receiving systems).



signals can be combined as required to produce simultaneous right- and left-hand circular polarization.

A third approach to the broadband tracking problem involves the use of an array of four frequency independent antennas. These antennas have a gain that is essentially constant with frequency and must be arranged such that the effective phase center separation is essentially constant in terms of wave lengths. This implies that the effective aperture varies directly with the wavelength squared and hence the gain of the system is essentially constant. For arrays of log-periodic or log-spiral elements the gain is about 12 db.

Future Trends

It is the author's belief that one of the most significant factors in defining future automatic tracking antenna systems lies in the area of cost versus performance trade-offs. Low-noise receiving equipment will undoubtedly come down in price and its frequency coverage and versatility will increase. New ideas in structures and antennas will permit increased sensitivity for less cost. For a given requirement many factors have to be weighed carefully to arrive at the best system for a given cost. Frequently, antenna companies have capability and solutions to problems that are proprietary and hence unknown to the general public. One method of stimulating trade-off studies and encouraging ingenuity is to specify tracking antenna systems in terms of over-all performance requirements and stating the fixed-price budget for the job. It is quite possible that this procedure might also result in a better system for lower cost, in many instances.

References

1. McCoy, C. T., "Antenna Noise and Propagation," *Electronic Industries*, July 1962, pp. 110-113.
2. Holahan, J., "The Future of Radar," *Space Aeronautics*, March 1963, pp. 84-92.
3. Siegman, A. E., "Thermal Noise in Microwave Systems," Part III, *The Microwave Journal*, May 1961, pp. 93-104.
4. Senko, F. P., "Survey of Low-Noise Microwave Amplifiers," *Electronic Industries*, Feb. 1962, pp. 115-118.
5. Livingston, M. L., "The Effect of Antenna Characteristics on Antenna Noise Temperature and System SNR," *IRE Trans. on Space Electronics and Telemetry*, Vol. SET-7 No. 3, Sept. 1961, pp. 71-79.
6. Hansen, R. C., and Stephenson, R. G., "Communications at Megamile Ranges," *Microwave Journal*, Dec. 1961, pp. 79-85.
7. Hogg, D. C., and Mumford, W. W., "The Effective Noise Temperature of the Sky," *Microwave Journal*, March 1960, pp. 80-84.
8. Victor, Walter K., "Ground Equipment for Satellite Communications," Technical Report No. 32-137, Jet Propulsion Laboratory, California Institute of Technology, Aug. 1, 1961.
9. Antenna Lab, Ohio State University, "High-Gain Antenna Realization and Tracking Study," Final Engineering Report, 22 Jan. 1961.
10. Gangi, A. F., "The SGE Active Adaptive Antenna Array System—A Self-Focusing Antenna Array," Space General Corp., SGC TM 1-10.

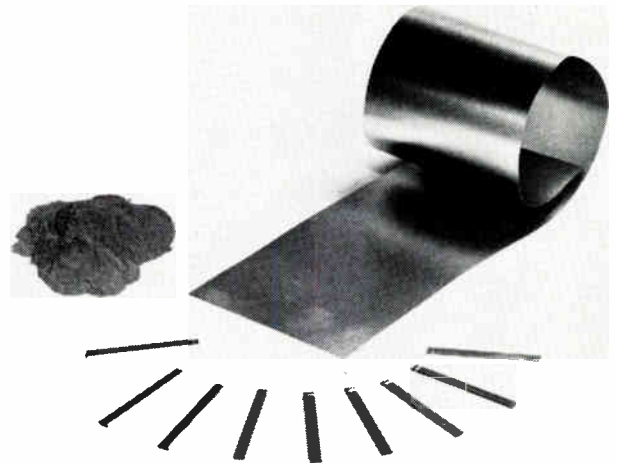
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WHAT'S NEW

POWDER METAL CATHODES

Receiving tubes with powder metal cathodes have been announced by Sylvania Electric Products Inc., New York, N. Y. The powder metal strip cathodes increase reliability and the life of components.

This material was developed jointly by General Telephone & Electronics Laboratories Inc., and Sylvania's Electronic Tube Div.



Process involves rolling the basic material carbonyl nickel powder (1) and additive powders into a thin gauge strip (2) which is necessary for normal cathode sleeves (foreground).

The expected failure rate of Sylvania's 6AF4, based on many tube hours of evaluation, has been reduced from 13.1% per thousand hours at 130v. line with the previous material (a selected premium vacuum melted material) to 1.5% per thousand hours under the same conditions when a special blend of the powder nickel alloy was put into the cathode.

Blended powders of basic carbonyl nickel powder and additive powders are rolled into a thin gauge strip. This prevents contamination which normally occurs in cast material during the melting, pouring, forging and hot-rolling operations. The powder rolled material is densified by cold rolling and annealing, and following densification, is treated in the same manner as normal cathode strip.

This type of preparation allows a large number of alloys and compositions to be made, some of which would be difficult or impossible to combine in any other manner.

GOV'T ELECTRONICS TO COST \$10 BILLION

From a total aerospace/defense project expense of \$55 billion, that includes NASA, FAA, and smaller agencies, for fiscal 1963-1964, the U.S. Government is expected to spend a little more than \$10 billion for electronic goods and services. (EIA and Aerospace Management)

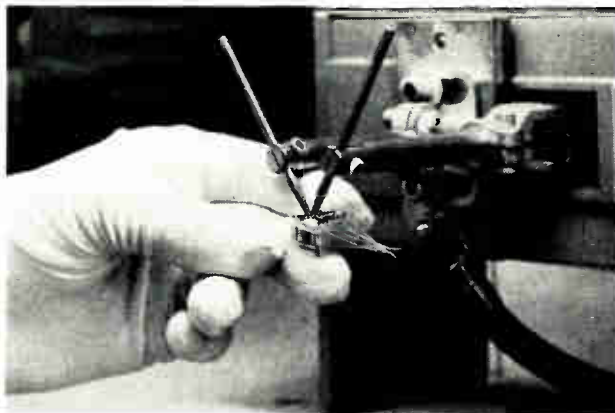
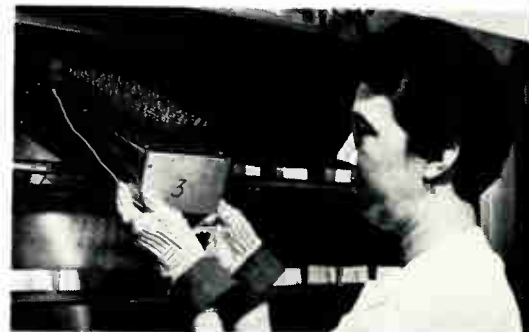
An instrument for space use must have minimum volume, minimum weight and small power consumption. Unfortunately, these requirements are not always congruous with greatest equipment reliability. Maximum reliability can be obtained by using the five important avenues in design and fabrication presented here.

BUILDING RELIABILITY INTO SPACE INSTRUMENTS



Mechanical reliability depends on a design that will be spaceworthy, can be built with no human error and can be easily reworked or changed in late stages.

Component evaluation identifies and rejects those whose characteristics can be correlated to potential failure.



Excellence of workmanship is achieved by well-defined practices, through training and skilled supervision.



By **STUART C. BAKER**

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THE SCIENTIST WHO WISHES TO INVESTIGATE physical phenomena in outer space needs an instrument that will measure the phenomena of interest, and then perform such functions that are needed to provide output signals compatible with a telemetry unit.

The scientist sometimes solicits the aid of an engineering and fabrication group to execute the detailed instrument design and to assemble the hardware. This group must satisfy the scientist's measurement needs as well as provide an instrument which is compatible with the spacecraft design philosophy. An increasingly important measurement need is that of operational reliability for extended periods. Five phases of reliability are considered in this article.

* * *

Reliability is often defined by the space scientist not just in terms of total instrument failure, but more significantly in terms of the stability of measurement accuracy over the mission duration.

An Engineering Solution

Consider the tasks confronting the engineer who must accomplish the instrument design. Laboratory instrumentation which might normally occupy several racks must be packaged into a volume about the size of a coffee can. Delicate sensors must be made impervious to launch shock and vibration environment. The instrument must withstand the rigors of hard vacuum, high and low temperatures, nuclear radiation and dust particle impact. At the same time it must not create static or oscillating fields which would interfere with performance of other instruments. Most important it must have inherent measurement stability when subjected to the severe environment conditions of space.

In the design of a space instrument, the needs for smallest volume, minimum weight, least power, and greatest reliability are not always compatible. Often a compromise must be affected which best satisfies the space scientist's needs. Yet, under given constraints, it is the responsibility of each member of the engineering and production team to provide an instrument with the highest possible reliability.

Five Phases of Reliability

It is easy to agree that reliability must be "built-in" and not just "tested-in". It is somewhat more difficult to choose those procedures which will "build-in" the maximum degree of reliability under a given set of ground rules. Five important avenues toward "built-in" reliability are considered to be (1) proper electrical design, (2) proper mechanical design, (3) component evaluation, (4) workmanship to high standards and (5) quality control. Although the

measures described below for implementation of these 5 phases have yielded good results, it is not to be inferred that these procedures either are unique or produce the greatest reliability attainable under all conditions.

Electrical Design

Circuit operation reliability depends heavily on both engineering conservatism and attention to detail during overall instrument "electrical system" design and individual circuit design.

During development of a block diagram, much can be done to enhance the ultimate instrument reliability. Three examples are: (1) Rearrangement of circuits or substitution can sometimes result in simplifications. (2) A thorough look at input and output points and an evaluation of the noise that could exist at these points will often lead to the establishment of conservative specs for input and output circuits. External noise has sometimes proved catastrophic to the operation of an otherwise well designed instrument. (3) A check of all possible conditions of a logic unit, considering both unusual timing and non-normal states caused by noise or existing after initial turn-on, can prevent situations where a logic unit becomes "hung-up" internally.

These examples are shown in Fig. 1. It is postulated that a circuit must be designed to produce an output pulse delayed from an input "start" pulse by exactly 13 clock pulses. Fig. 1a shows the desired timing. A circuit which provides the desired function is shown in Fig. 1b. The isolation amplifier was placed in series with the output line because a one-shot multivibrator, without buffer, can be particularly susceptible to noise on the output line. NAND and flip-flop set inputs are designed to have high thresholds for rejection of noise on the input lines. The circuit may be simplified and improved as shown in Fig. 1c. Not only are 2 blocks eliminated, but also the reset circuitry on the binary counter chain can be eliminated. Total parts saving is about 25% with an attendant increase in reliability. The circuit shown in Fig. 1c will also "self-clear" automatically should a noise transient introduce a false count into the binary chain prior to a "start" pulse, whereas the circuit shown in Fig. 1b would give the wrong output on the next readout under the same noise transient condition.

There are those who use redundant circuit blocks in cases where the reliability of a particular circuit block is not as great as the others. Although the merit of this concept may be sound, limitations of weight, power, and volume may often preclude the

SPACE INSTRUMENTS (Continued)

use of circuit redundancy for all but a few circuits. It is not unusual for the engineer to attempt to find ways of increasing the circuit block reliability rather than use a redundant circuit.

From block diagrams analysis of instrument operation comes the criteria and specs for design of the individual circuits within each clock.

Success in attaining reliable circuit design depends to a large extent on the design engineer's knowledge of the components to be used. Components of sturdy design and proven reliability must be used. It is also essential that the peculiar characteristics, and their changes with change of environment be recognized for each component, and taken into account during circuit design.

Other ways to build-in reliability in the circuit design phase are by component derating, use of redundant components in special cases, and most important, using a "worst-case" design. The "worst-case" philosophy assumes that the parameters of all components of a circuit will simultaneously change in the worst conditions. Some engineers consider

the design to be relatively safe if a circuit is designed to operate with a safety factor greater than 100% under these "worst-case" conditions.

In illustration of the "worst-case" philosophy, Fig. 2 is drawn to show a simple saturated transistor inverter. Under the conditions that $i_L = 2\text{ma}$, minimum value of E_{in} in the "true" state is +4 v., all resistors $\pm 5\%$, a typical value of $V_{ce\text{ sat}}$ for the transistor is 0.2 v., and a typical value of V_{be} is 0.6 v. for collector saturation. Required minimum β for the transistor may be found such that the collector shall remain solidly saturated at all temperatures down to -55°C . First, the "worst-case" philosophy is applied to component parameters as follows:

All resistors shall change in the worst direction by 10%.

$V_{ce\text{ sat}}$ shall be 0.3 v.

E_{in} shall be 3 v.

β_{sat} at -55°C shall be $1/2$ of β_{sat} at $+25^\circ\text{C}$.

β_{sat} shall be 50% of the linear (active region) β .

V_{be} shall be 0.9 v.

Second, the currents are then calculated as follows:

$$i_a = \frac{5.7}{1.8K} = 3.17 \text{ ma}$$

$$i_c = i_a + i_L = 5.17 \text{ ma}$$

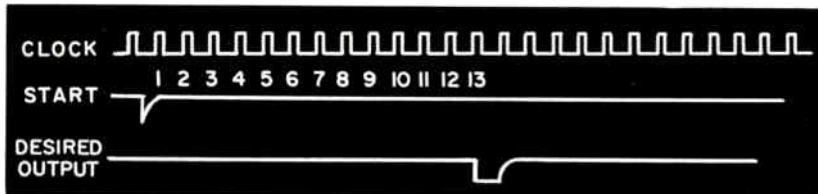


Fig. 1a: Timing for a circuit that must be designed to give an output pulse delayed from an input pulse by 13 clock pulses.

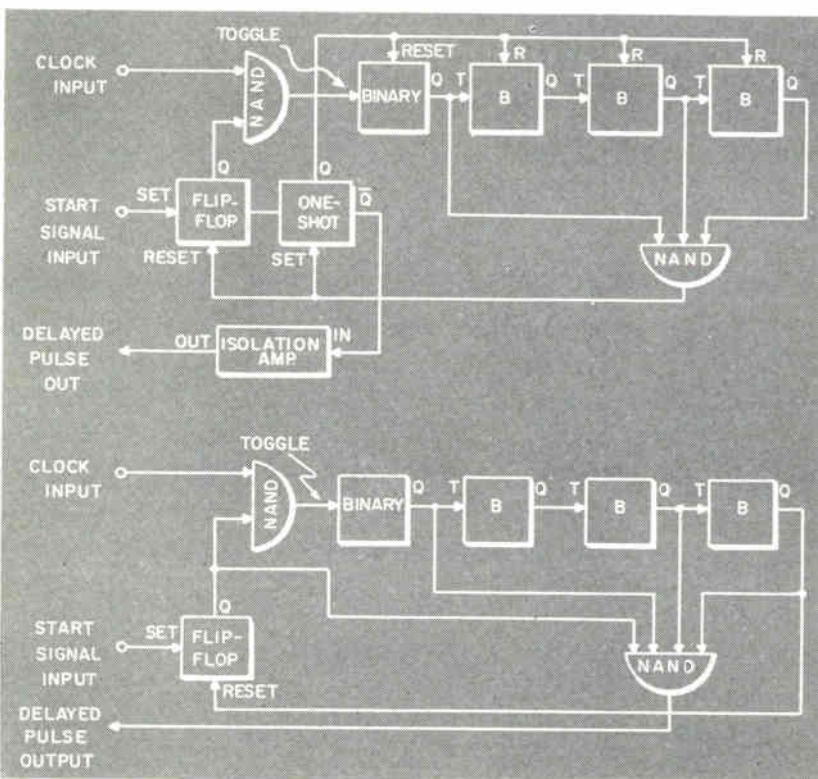


Fig. 1b: The isolation amplifier was placed in series with the output line because the multivibrator, without buffer, can be very susceptible to noise on the line. Fig. 1c: The circuit shown in 1b can be simplified by eliminating 2 blocks and the reset circuitry on the binary counter chain.

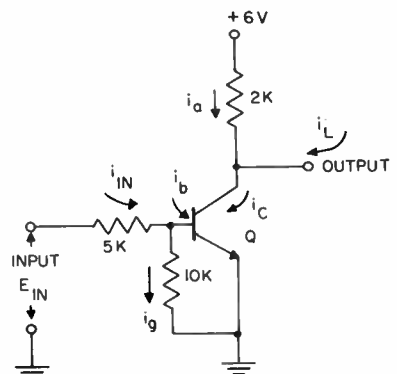


Fig. 2: A simple saturated transistor inverter (above) schematic drawing is used to illustrate the "worst-case" philosophy.

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$$i_g = \frac{0.9}{9K} = 0.1 \text{ ma}$$

$$i_{in} = \frac{2.1}{5.5} = 0.382 \text{ ma}$$

$$i_h = i_{in} - i_g = 0.282 \text{ ma}$$

The degree of conservatism indicated by these "worst-case" design tenets may yield circuit stability beyond that needed by the space scientist. By increasing the stability, the engineer is only increasing the confidence level that the original measurement stability needs will be met over the mission duration. The extent to which conservatism may be used to dictate increased stability is limited by other items such as budget, schedule, weight and power.

A frequent and informal design review is used by many engineering groups as a means for minimizing errors and checking design validity.

Mechanical Design

Others have stated that the 3 basic needs of a reliable mechanical design are that; first, the instrument, when assembled per the design, must be spaceworthy from a mechanical standpoint; second, the design and process specs must be such that assembly can be done by experienced personnel with best workmanship practice and no errors; and third, the final instrument can be opened, after assembly, for change or rework without impairing reliability.

The first need suggests an analysis of both structural and thermal design to ascertain that the stresses of shock, vibration, acceleration and temperature affect neither the structure itself nor internal elements. Heat dissipation may be a problem in certain space environments, needing an analysis of best conduction path and surface treatment to provide an acceptable internal temperature.

These factors, along with questions of shielding against nuclear radiation or r-f interference or the degradation of surfaces due to space dust particle impact, are all important factors in the mechanical design of reliable instrumentation. Many considerations not mentioned here, such as the design of bearings which must operate for long periods in a vacuum, are peculiar to certain instruments and need investigation prior to design use.

The second need of a reliable design calls for thoroughness on the part of the design team to think through each assembly step. Poor workmanship can be built-in to instruments by designing a unit which is almost impossible to assemble or by calling for processes which can be properly done by only the most highly skilled person. From this standpoint, it would seem that an "open," easy-to-work-on, package design is desirable; yet, an "open" design philosophy

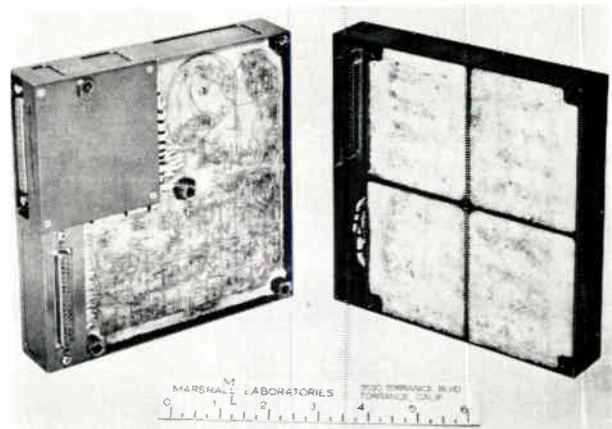


Fig. 3: Modularized magnetometer was built for the Goddard Space Flight Center to be flown on the EOGO space craft.

is almost always inconsistent with weight and volume needs. Sometimes such a dilemma can be resolved by designing a "tight" package, and at the same time designing manufacturing jigs and fixtures which ease or automate assembly.

The third need for ease of circuit change, rework, or repair seems to be an admission that the engineering team has no faith in their own efforts toward designed-in reliability. It must be recognized, however, that in the interim between initial concept and launch, measurement criteria, interface specification and engineering concepts have a way of being modified.

An example of a design fulfilling these 3 needs is an experiment shown in Fig. 3, which was built for the Goddard Space Flight Center to be flown on the EOGO space craft. The circuitry was modularized, with modules interconnected by a multilayer welded matrix. Final interconnections to the modules were made on the outer layer for ease of module replacement. Each of 2 such matrix assemblies were contained in surface-treated magnesium housings which plugged together to form the circuit interconnections. Lightweight encapsulant was used to give mechanical rigidity and a cushion against shock.

As in the case of circuit design, frequent design reviews may be used to advantage in ascertaining that reliability goals are met or exceeded.

Component Evaluation

Selection of reliable components which meet size and operational specification is done during engineering design. The purpose of component evaluation is to identify and reject those components which could fail. Often the evaluation process is done on all parts and components destined to become flight hardware rather than on a statistical basis.

(Continued on page 107)

The emergence of vacuum deposition methods of circuit manufacture has spurred interest in improved vacuum pumps that can quickly and efficiently develop pressures down to 10^{-9} torr. This discussion reviews the capabilities of two of the most popular devices, ion pumps and the cryogenic pumps. Additional details are given on the problem of vacuum analysis, determining the composition of the residual atmosphere.

HIGH AND ULTRAHIGH VACUUM are spreading throughout today's science and technology at a fast rate. Pressures of 10^{-9} torr and below, (Torr: the pressure of 1 mm. of mercury at 0°C . and standard gravity) formerly obtainable only in very small laboratory systems, are now achieved in chambers of many cubic feet in volume. Dynamic, demountable vacuum installations made mainly of stainless steel, ceramics and high-grade synthetics are providing vacuum capability which, at one time, was limited to static, sealed glass tubing of small diameter. Processing time and bakeout needs have been minimized.

This article will describe some of the most recent developments in high and ultrahigh vacuum equipment and technique, as related to creating and measuring vacuum. The capabilities and limitations of modern equipment will be discussed and possible future trends explored.

* * *

The emphasis in our discussion of pumping will be on condensation methods, such as ion pumping and cryogenics. These techniques allow the system to be isolated from the roughing system with a valve after high-vacuum pumping begins. This eliminates any atmospheric access and avoids problems which would otherwise arise in case of a power failure. They also have the virtue of pumping in a clean, oil-free manner. Older and more conventional kinds of equipment, using oil and mercury diffusion pumps, have been treated at great length by many authors over the past 50 or more years. Except for historical references, these are outside the scope of this article.

Oil diffusion pumps have been and still are used in many applications. However, there is an increasing number of areas in which hydrocarbon backstreaming, even if minimized, is detrimental. Other desires also, such as sealed-system operation, low maintenance, and minimum operating cost, have spurred the development of ion pumps and cryogenic devices.

OBTAINING HIGH AND ULTRAHIGH VACUUM

Ion Pumps

Present-day ion pumps stem from F. M. Penning¹, of Philips Laboratories, Eindhoven, Holland. He developed the technique of a cold-cathode discharge in a magnetic field by which the discharge is maintained, even at high vacuum.

The use of sputtered metal films in producing high vacuum was mentioned in one of Penning's patents.² The ions formed in the discharge sputtered cathode material onto the walls of the device, and the sputtered films trapped gas, resulting in a pumping effect. This is the effect which forms the basis for today's ion pumps. Out of all the many forms of ionic vacuum pumps,^{3,4} the Penning-type pump has emerged as the one in widespread use today. In the short space of five years, a multimillion dollar industry has developed around it.

Since ion pumps, like cryogenic pumps, are storage devices, it is reasonable to ask how they can have long life. As it turns out, they are intrinsically long-lived devices and, at this date, there is no known case of failure due to exhaustion of cathode material. In any case, pump elements are replaceable, while the pump casing is stainless steel and almost indestructible. The operating life of ion pump elements increases directly with decrease in pressure. For example, at pressures of 10^{-8} torr and below, it is measured in hundreds of years.



By Dr. LEWIS D. HALL

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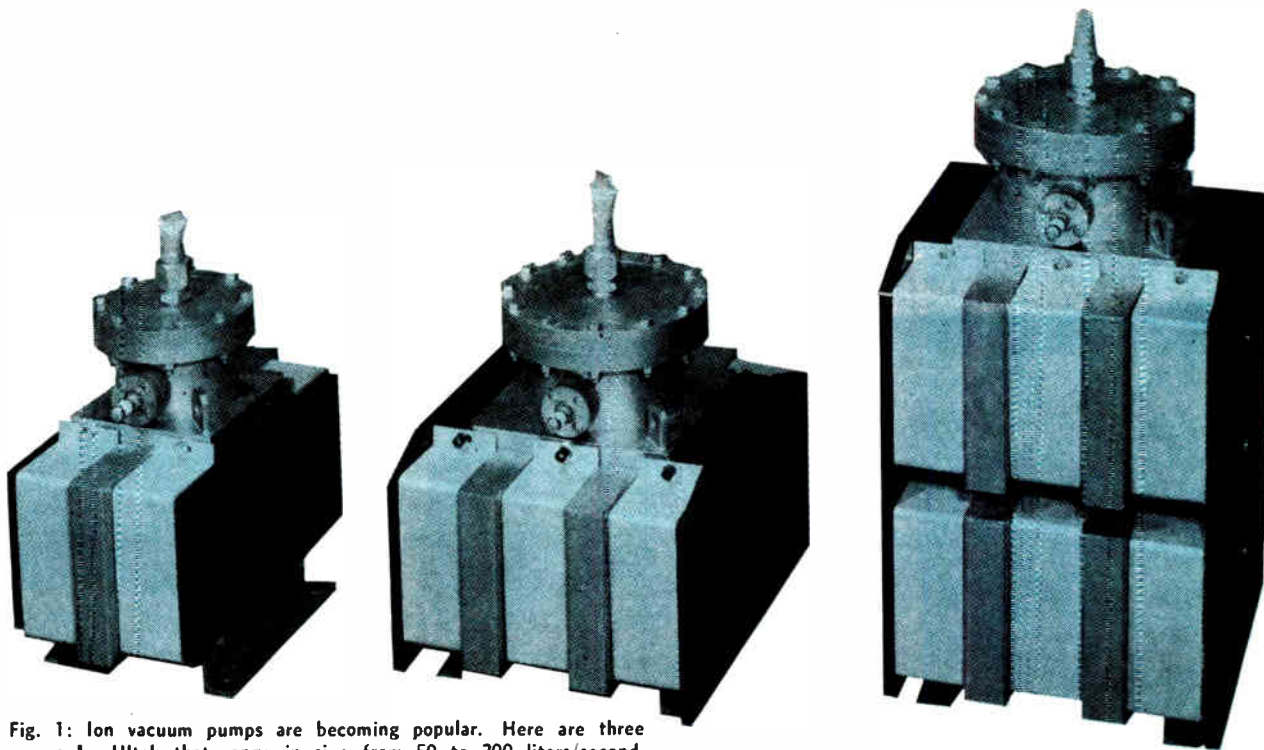


Fig. 1: Ion vacuum pumps are becoming popular. Here are three pumps by Ultek that range in size from 50 to 200 liters/second.

The BoostiVac

A recent Ultek invention, with the trade name of BoostiVac*, has extended the capabilities of the Penning-type pump. It is a combination of an ion pump and an additional, independently operated source of reactive metal. In the ion pump, the cold-cathode discharge produces great quantities of activated neutrals which saturate the sputtered films as fast as the films are formed. There is thus a large surplus of these active atoms and molecules at all times. Because they are neutrals, they do not aid in sputtering. Hence, they do not provide the material which would result in their own trapping. They can, however, be trapped much more easily than stable, unexcited molecules, if an additional source of titanium is available.

The BoostiVac thus provides an effective pumping arrangement. Great numbers of gas molecules are activated by the pump, and those which are not trapped inside the pump itself are captured by the evaporated titanium film. This interaction between ion pump and evaporated film is highly non-linear. Pumping speeds attainable with the combination are much greater than the sum of the individual pumping speeds of pump and film separately.

Using the BoostiVac in bell-jar systems, as shown in Fig. 3, has enabled pressures in the 10^{-10} torr scale to be achieved in glass bell jars with Viton A gaskets and without bakeout. Systems of this kind are useful for thin film deposition because of their high pumping speeds and freedom from oil.

This pumping combines the good features of evaporator and cold-cathode pump. It makes possible much higher pumping speeds than were previously obtainable with ion pumps, and without a great increase in cost. New kinds of ion pumps and ion-pumped systems now become feasible, and will be economically competitive with oil pumps.

Cryogenic Techniques

Cryogenic pumping, i.e., the trapping of gas molecules in refrigerated surfaces, is an old technique which has experienced a strong revival. It was first reported by Dewar,⁶ who created a vacuum by cooling activated charcoal with liquid air. The charcoal has a very high surface area and at liquid air temperature can trap large quantities of gas. Recent adaptations of Dewar's technique have used zeolites,

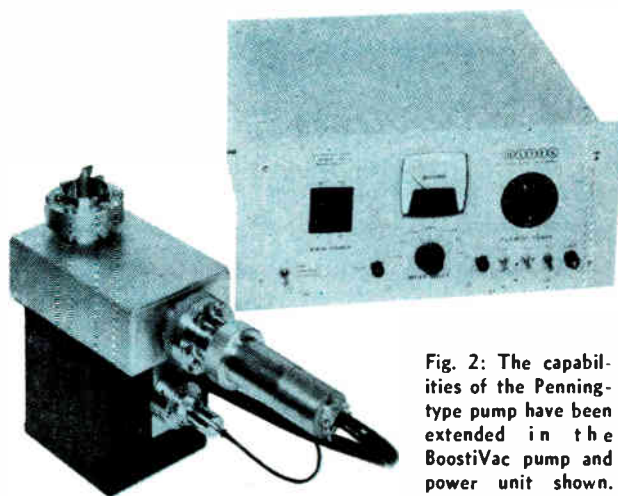


Fig. 2: The capabilities of the Penning-type pump have been extended in the BoostiVac pump and power unit shown.

VACUUM EQUIPMENT (Continued)

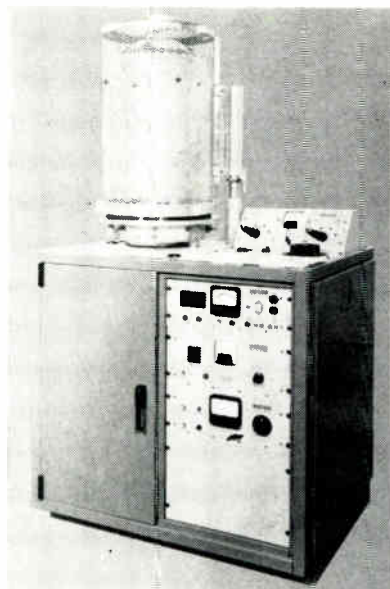
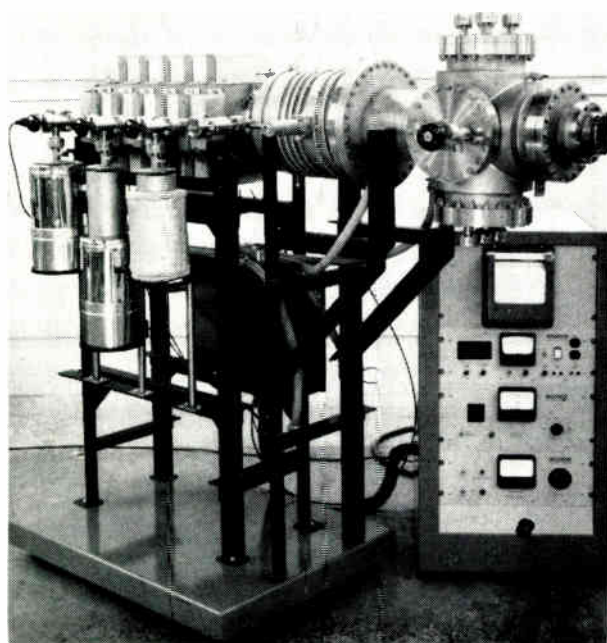


Fig. 3: Ultrahigh vacuum system enables pressures in the 10^{-10} Torr scale.

Fig. 4: Vacuum system below is for the 10^{-11} Torr range.



the so-called "molecular sieves," and have been used chiefly as a substitute for mechanical roughing pumps, rather than as a high vacuum technique.

Cryogenic methods can be of great value when combined with ion pumping or with the BoostiVac technique (ion pumping plus evaporation). As shown by Clausing⁷ and others, the pumping speed of an evaporated titanium film increases with decreasing temperature. Provision is made in certain kinds of ion-pumped systems to deposit titanium onto the surfaces of liquid nitrogen-cooled shrouds. Fig 4 shows such a system, designed for mechanical testing of metals.

The Bayard-Alpert Ionization Gauge

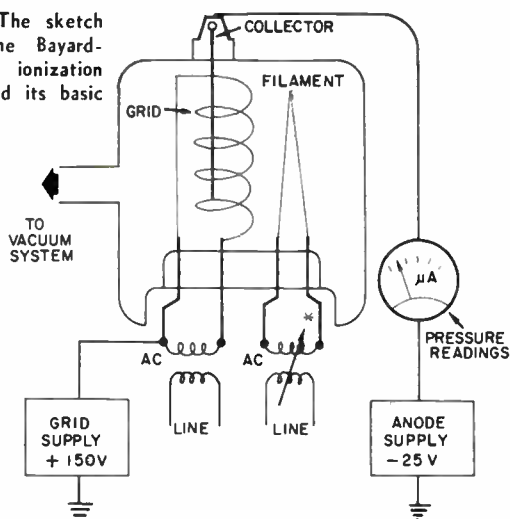
The Bayard-Alpert gauge,⁸ introduced in 1950, is the mainstay of the high vacuum field. Fig. 5 shows a line drawing of the gauge and its basic circuits. In operation, electrons are attracted by the transparent grid (anode) which is held 100 to 200 volts positive, with respect to the filament. Ions are formed by collision with gas molecules, and these ions are captured by the collector. The current represented by the arrival of ions at the collector is measured in the external circuit and is proportional to pressure.

The Alpert gauge, in various modifications, is used to measure pressures from the 10^{-4} scale down to below 10^{-9} torr. Its accuracy decreases below the 10^{-9} range because of the X-ray photo effect. This effect comes from X-rays created by the electrons striking the grid. The X-rays thus formed propagate in all directions, and those which strike the collector liberate photoelectrons. The resulting current in the external circuit provides a constant background level, independent of pressure. The lower the pressure, the more serious this background photocurrent becomes, since the ion current varies directly with pressure.

Recent Developments in Gauges

Pumping capability has now surpassed gauging. Available ion-pumped systems, for example, have attained pressures which cannot be reliably measured by gauges now on the market. In one such system, after baking above 650°C ., the pressure as indicated by pump current and rate-of-rise measurements was estimated at 2×10^{-12} torr or below. Like results have been obtained with other ion-pumped systems, such as that shown in Fig. 4, after a 300°C . bakeout of most of the chamber. Results of this kind are spurring the search for new and improved ultrahigh vacuum gauges.

Fig. 5: The sketch shows the Bayard-Alpert ionization gauge and its basic circuits.



One of the latest devices for use in the ultrahigh vacuum realm, the Redhead Gauge, was invented by P. A. Redhead.⁹ A ruggedized, bakeable modification developed by W. S. Kreisman is shown in Fig. 6. The operating range for this gauge, as quoted by its manufacturer, The Geophysics Corporation of America, is from 10^{-3} to 10^{-14} torr. There is no X-ray limit, but it requires a magnetic field.

A very interesting approach to the X-ray limit problem in hot-cathode ionization gauges was conceived and tested by W. C. Schuemann.¹⁰ This device, the Schuemann Photosuppressor Gauge, is shown in Fig. 7. The shield intercepts X-rays from the ionization region and prevents their reaching the suppressor. Ions pass through the hole in the shield and impinge on the collector. The negative bias on the suppressor rings prevents photoelectrons from escaping from the collector, and prevents any photoelec-



Fig. 6: The Kreisman gauge has an operating range from 10^{-3} to 10^{-14} Torr. It requires a magnetic field to operate.

trons ejected from the inside of the shield orifice from getting to the collector. Schuemann states that the X-ray photocurrent is entirely suppressed by this gauge, and pressures of 2×10^{-12} torr have been measured. The Schuemann gauge is the most positive approach taken to eliminate the X-ray effect, and its further development will be watched with great interest.

Vacuum Analysis

Vacuum gauges, as described earlier, can only give information as to the total pressure existing in the vacuum system. They tell us nothing about the composition of the residual atmosphere, and their readings become increasingly difficult to interpret as the pressure decreases, because they are calibrated in terms of a single gas—usually nitrogen—at pressures much above ultrahigh vacuum. In dealing with high and ultrahigh vacuum we need to know more about

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what gas species are actually present and in what amounts. For example, in an unbaked vacuum system the principal gas is water vapor, while in a baked system it may be carbon monoxide.

Devices which give information as to the kinds and amounts of residual gases are called mass spectrometers or vacuum analyzers. One of the most interesting mass spectrometers for vacuum analysis was developed in Germany by Paul and Raether.¹² This is called the mass filter, and is shown in Fig. 8. Some of the advantages claimed for the mass filter are:

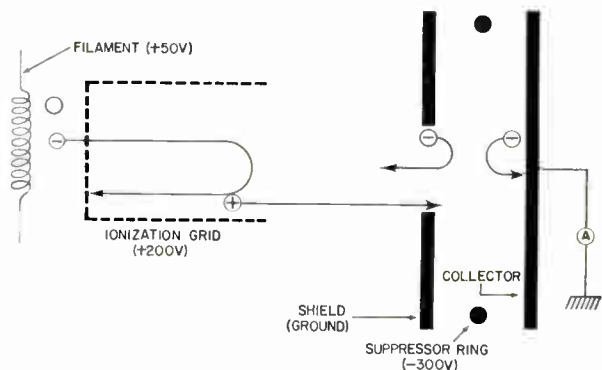
1. No magnetic field
2. High sensitivity
3. Rapid scanning
4. Compact
5. Can be entirely bakeable

These points make it very attractive for use in analyzing transient processes, as for example in monitoring changes in the residual atmosphere which occur during bell-jar operations, such as thin film deposition. The sensing head can be installed inside the bell-jar and, therefore, monitor the gases, including condensibles, which are evolved or already present during thin film evaporation and deposition. According to Boehm and Guenther,¹⁴ the range of mass numbers from 2 to 100 can be scanned in two seconds.

Future Trends

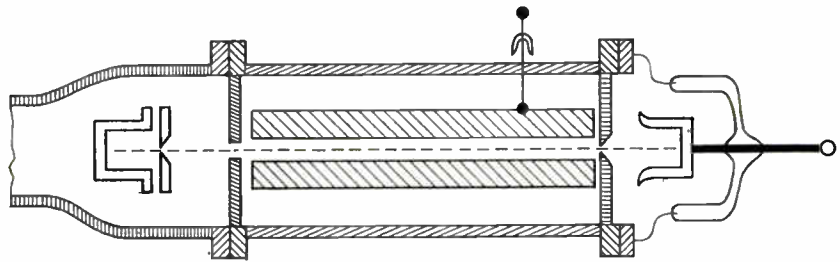
The applicability of ion pumps and cryogenic devices increases as the pressure decreases, hence it can be predicted that as we go to higher and higher vacuum their use will become even more widespread. Pressures which are too low to measure, but which are estimated at less than 2×10^{-12} torr have been

Fig. 7: Schematic of a photo-current suppressor gauge. This gauge by Schuemann licks the X-ray problem in vacuum measurements.



VACUUM EQUIPMENT (Concluded)

Fig. 8: Sketch shows a mass spectrometer that is used for vacuum analysis.



achieved by cold-cathode ion pumps unaided at room temperature, in single-walled vacuum chambers. Adding the BoostiVac technique and cryogenic panels gives even better performance in these bakeable systems.

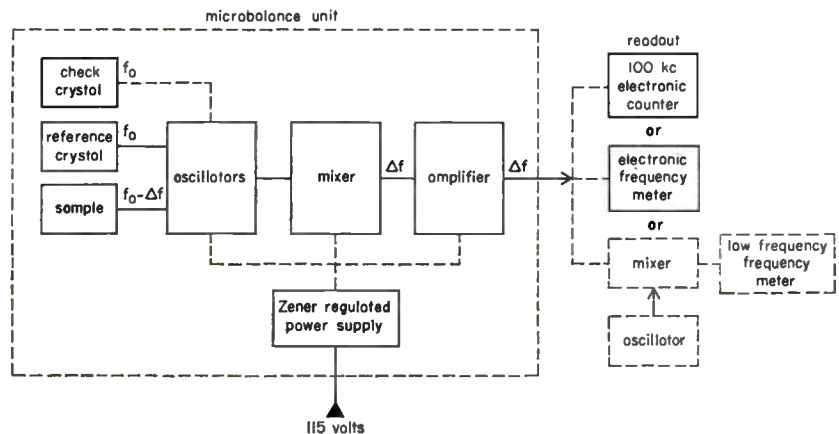
The vacuum system of the future for thin film deposition will probably contain, in addition to condensation type pumps and an ultrahigh vacuum gauge, a built-in mass spectrometer for analysis of gases present in the chamber during operation. Further refinements may include servoing the deposition process to the signal from the mass spectrometer.

References

- *Patent Pending
- *Patent Pending
- 1. F. M. Penning, *Physica* 4, 71 (1937).
- 2. F. M. Penning, U.S. 2,146,025; Feb. 7, 1939.
- 3. L. Holland, *J. Sci. Instr.* 36, 105 (1959).
- 4. S. Dushman, "Scientific Foundations of Vacuum Technique," Wiley, New York, 2nd ed., 1962.
- 5. L. D. Hall et al, U.S. 2,993,638; July 25, 1961.
- 6. J. Dewar, *Proc. Roy. Inst. Gr. Brit.* 18, 751 (1907).
- 7. R. E. Clausing, 1961 *A.V.S. Symposium Transactions*, p. 345, Pergamon Press, N. Y.
- 8. R. T. Bayard & D. Alpert, *Rev. Sci. Instr.* 21, 571, (1950).
- 9. P. A. Redhead, *Can. J. Phys.* 37, 1260 (1959).
- 10. W. C. Schuermann, 1962 *A.V.S. Symposium Transactions*, p. 428, MacMillan, New York.
- 11. J. H. Beynon, "Mass Spectrometry and Its Applications to Organic Chemistry," Elsevier Publishing Co., New York, 1960.
- 12. W. Paul and M. Raether, *Z. Physik* 140, 262 (1955).
- 13. K. G. Guenther, *Vacuum* 10, 293 (1960).
- 14. H. Boehm and K. G. Guenther, *Vakuum-Technik* 11, 240 (1962).

MICROBALANCE MEASURES ULTRATHIN FILMS

Unit determines thickness of thin film coating. One of two crystals is exposed to evaporant the same as substrate. Frequency on exposed crystal is beat against other crystal. Difference in frequency, due to coating, indicates the film thickness.



AN INSTRUMENT DESIGNED TO measure evaporated films as thin as 10^{-8} grams/cm² is now available from the Westinghouse Scientific Equipment Dept., Pittsburgh, Pa. The Model-701 quartz-crystal microbalance measures changes in mass deposited on a crystal surface by measuring the corresponding change in resonant frequency of the crystal.

The instrument can measure directly the mass of extrathin films, either metal or dielectric, without correction for any other physical properties. It can also measure these films over a range of 0.05 to 40,000 angstrom units with an accuracy of better than 1%.

Another important feature is the instrument's electrical readout. The readings may be used either to measure or to control the process rate of deposition.

The microbalance represents a valuable tool for many investigations in surface physics studies, such as oxidation, absorption and reaction rates, sputtering yields, studies of films formed by other methods,

and measurement of deposited film thicknesses and preparation rates.

Measured films, either conducting or insulating, may have been formed by evaporation, sputtering, chemical reaction, or other means. The unit can be used with electronic readout counters or frequency meters.

HOW NASA HAS GROWN

Growth of the National Aeronautics and Space Administration since it was created Oct. 1, 1958, is illustrated by the following table:

Fiscal Year	Appropriation (in millions)	Employees (Fiscal year)
1959	\$339	9,235
1960	524	10,232
1961	967	17,471
1962	1825	23,686
1963	3674	30,339
1964	5351*	32,500 (proposed)

*Authorization

SPACE INSTRUMENTS (Concluded)

... from page 101

Methods which have been successfully used to upgrade component reliability by the "weeding-out" process include (1) operational run-in at elevated temperatures under high power, (2) thermal cycling, (3) thermal shock, (4) mechanical shock and vibration, (5) mechanical shock at low and high temperatures, and (6) X-ray examination. For most of these tests, pertinent parameters are monitored for detection of erratic behavior. Along with these tests, microscope inspection of construction and workmanship is needed to discover flaws which may lead to deteriorated performance.

Certain high reliability programs call for component monitoring and evaluation procedures which go much further than the above test. Although the measures adopted in such programs are desirable, typical space mission schedules often preclude the use of these "high-rel" parts.

Assembly Workmanship

Workmanship practices are established in an engineering group through the processes of hard experience and common sense. These practices dictate acceptable methods of soldering, welding, routing cables, preventing cold flow, attaching connectors, cleaning circuit boards, conformal coating, and so on. Presumption is that if these methods are used with skill, quality workmanship is the result. Unfortunately this is not always true.

It seems fair to assert that skilled assembly people are needed if quality workmanship, the need for perfection, and a clear understanding of the methods to attain quality of workmanship must be communicated to the group who are expected to assemble a reliable instrument. Lectures, training programs, blown-up diagrams and, perhaps most important, qualified supervision are factors and devices which have been found successful in promoting excellence of workmanship.

Quality Control

Primary role of the QC group is to ascertain that the provisions of the reliability program, relating to hardware, are met. In one sense, the QC function in the flight hardware fabrication area is similar to the design review function in the engineering area.

Control of flight hardware quality is exercised through the processes of vendor surveys, receiving inspection of incoming parts or components, component evaluation, certification of weld schedules, in-process inspection of the completed flight unit.

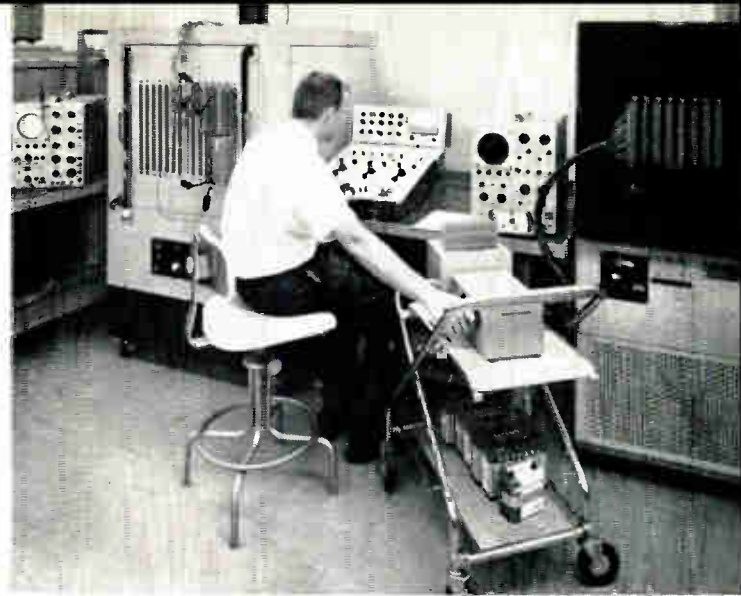


Fig. 4: The quality control function in hardware fabrication is similar to the design review function in engineering.

The QC group is sometimes also assigned the task of maintaining measurement standards by which part or component conformance to accuracy and stability are determined.

Conclusion

Providing built-in reliability is the responsibility of each member of the engineering manufacturing team. Evidence that the team has been successful in providing a space-worthy instrument is available only after the space scientist has obtained satisfactory data to the end of the spacecraft life.

AEROSPACE/DEFENSE FIRMS DISTRIBUTED BY STATE

From an estimated total of 6685 U.S. industrial firms now engaged in some way in the aerospace/defense industry and market, the following table indicates the distribution of numbers of firms by state, as of June, 1963:

Alabama	21	Nebraska	12
Arizona	34	Nevada	6
Arkansas	5	New Hampshire	28
California	1606	New Jersey	521
Colorado	41	New Mexico	25
Connecticut	417	New York	880
Delaware	15	North Carolina	33
District of Col.	35	North Dakota	1
Florida	115	Ohio	374
Georgia	13	Oklahoma	34
Idaho	2	Oregon	15
Illinois	459	Pennsylvania	414
Indiana	134	Rhode Island	38
Iowa	18	South Carolina	7
Kansas	21	South Dakota	4
Kentucky	14	Tennessee	22
Louisiana	4	Texas	112
Maine	11	Utah	14
Maryland	109	Vermont	12
Massachusetts	450	Virginia	55
Michigan	244	Washington	43
Minnesota	76	West Virginia	6
Mississippi	2	Wisconsin	111
Missouri	64	Wyoming	6
Montana	1	Alaska	1
		TOTAL	6685

(Aerospace Management)

A COMMUNICATIONS SYSTEM FOR "APOLLO"

A prime requisite in manned space programs is near-perfect communications. For the Apollo program an S-band radio system has been developed which is capable of handling both digital data and voice. The system is described here, with attention to the unusual aspects of its design.

S-BAND RADIO will maintain two-way contact with the Apollo spacecraft throughout its journey to the Moon and return. A transponder will receive up-link digital data and voice. It will transmit voice, digital data, and TV signals on the down-link, and will provide phase-coherent turn-around of the carrier and re-transmission of ranging signals for navigation.

The official designation for the transponder is "Unified S-Band Equipment" (USE). The ground terminals of the two-way circuit will consist of several transmitter/receiver stations similar to the DSIF Stations currently used.

The transponder is similar in electrical design to those used on the Ranger and Mariner missions. However, the bandwidth, sensitivity, and operational modes are tailored for the Apollo mission. Principal differences are in the transmitter, which will handle wide-band FM, narrow-band FM, and wide-band phase modulation.

* * *

The Unified S-band Equipment (USE) consists of a transmitter and phase-lock receiver. The

transmitter may be excited coherently with the received carrier signal or by either of two internal oscillators.

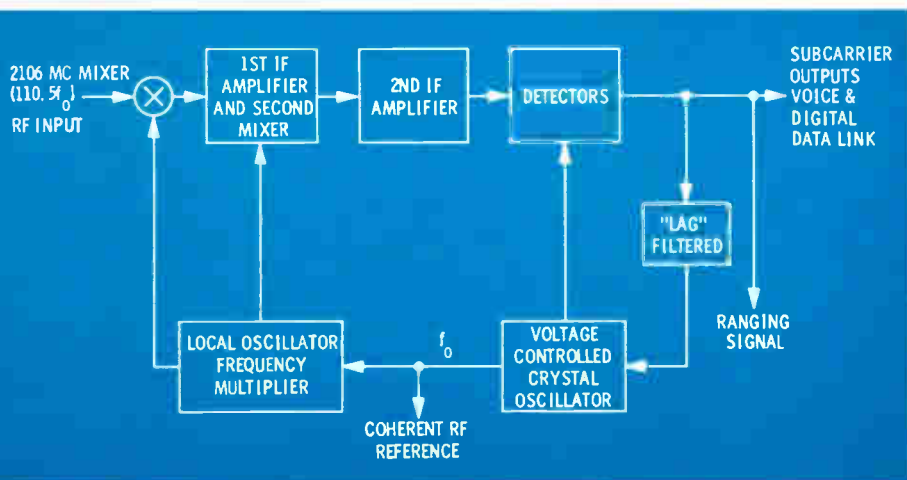
Three transmitter output modes are provided. The 300 mw. S-band output of the all solid state transmitter is fed to the spacecraft antenna through a diplexer, or through a TWT amplifier providing either 5 watts or 20 watts.

The Receiver

In the receiver, a voltage-controlled crystal oscillator (VCCO) is used as the reference signal for the local oscillator multipliers, and as the reference signal to the phase detectors. Phase lock on the received carrier is maintained by using the output voltage from the phase detector to control the frequency of the oscillator. Fig. 1 shows a block diagram of this loop. In operation, up-link phase lock is obtained by slowly sweeping the ground transmitter through the frequency region of the receiver input, which is about 2106 mc. Down-link telemetry shows when up-link phase-lock has been achieved.

The USE receiver has a carrier tracking thresh-

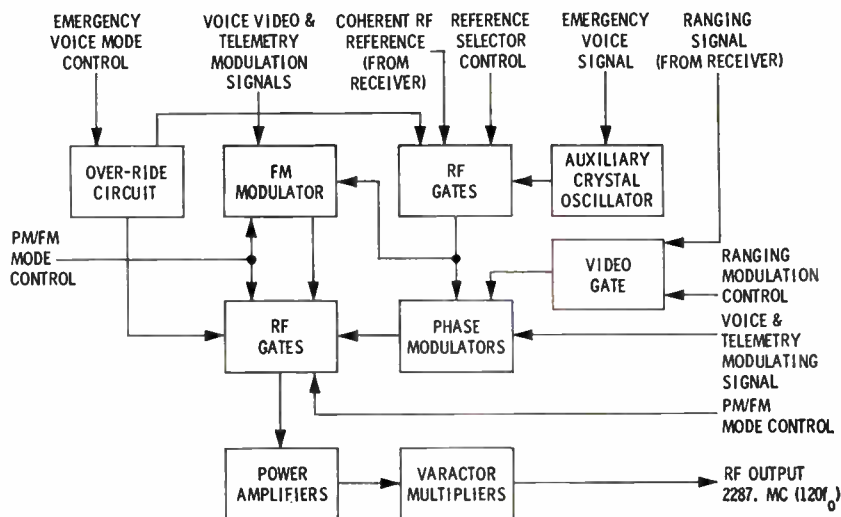
Fig. 1: Simplified receiver block diagram of unified S-band equipment.



By **DON R. HOLCOMB**
 Ass't Project Leader
 CW Transponder Sect.
 Military Electronics Div.
 Motorola Inc.
 Scottsdale, Ariz.



Fig. 2: Block diagram is a simplified drawing of the transmitter operation.



hold sensitivity of -132 dbm, a tracking loop noise bandwidth of about 1,000 CPS: at operating signal levels, and an Automatic Gain Control (AGC) dynamic range of 80 db. The receiver uses dual frequency conversion. The 1st i-f is 50 mc.

The 2nd i-f consists of two parallel amplifiers, a wide-band and a narrow-band amplifier operating at 10 mc. The narrow-band amplifier uses a 10 kc bandpass quartz crystal filter. Its output drives two phase detectors in quadrature, the phase-tracking detector and the AGC or amplitude detector. The AGC signal is fed through a Miller integrator-filter-amplifier back to control the gain of the 1st i-f amplifier.

The output of the tracking phase detector is fed through an R-C "lag" network to the VCCO. The output of this oscillator, is used as the reference signal to the phase detector, to the local oscillator frequency multipliers, and as the coherent r-f reference for the transmitter.

The wide-band 2nd i-f amplifier is simply an R-C coupled video amplifier with input and output L-C filters. The wide-band amplifier output is fed to a wide-band phase detector or demodulator, nominally phased at quadrature with the reference signal to detect phase-modulation on the up-link. This output contains both the up-link voice and data sub-carriers and the ranging signals.

The following outputs are available from the receiver:

1. The wide-band up-link information (voice, digital data and ranging signals)
2. An r-f reference signal output at $2/221$ of the incoming signal frequency (used in the transmitter)
3. A measure of received signal strength (AGC voltage)
4. A measure of the ground transmitter's apparent frequency offset from the tracking crystal oscillator's natural resonant frequency (Static Phase Error)

The Transmitter

The USE transmitter operates as an adjunct to the phase-lock receiver. In the coherent mode, the transmitter output is at a carrier frequency of $240/221$ times the incoming signal frequency. In other modes, the transmitter output is nominally at this same frequency, about 2287 mc. Fig. 2 illustrates the operation of the transmitter.

For coherent transmission, the r-f reference signal from the receiver is fed through R-F Gates, the Phase Modulators, additional R-F Gates, the transistor Power Amplifiers, and finally through the Varactor Multipliers to the output. In this mode only phase modulation is available. Voice and telemetry signals are modulated onto subcarriers for transmission to earth. Ranging signals may be modulated in a similar manner onto a cascaded phase modulator, provided the ranging modulation control is actuated, thus closing the Video Gate.

If the receiver is not locked to a ground station, the receiver's VCCO will be "noisy," since it will be modulated by low frequency receiver thermal noise, passed by the "lag" filter. A "clean" signal must be generated for transmission back to earth to enable ground stations to lock onto and angle track the spacecraft, preparatory to search and lock of the transponder receiver. Therefore an Auxiliary Crystal Oscillator is included in the transmitter.

In the Auxiliary Oscillator mode, modulation capabilities are identical to that of the coherent mode. A corollary mode of operation is "Emergency Voice." This does not refer to a spacecraft emergency but rather an alternate mode for voice communication. In this mode, all other modulations are gated off, and the voice signal is used to narrow-band frequency modulate the Auxiliary Crystal Oscillator.

The transmitter also operates in a wide-band FM

APOLLO TRANSPONDER (Concluded)

mode. In this mode an L-C voltage-controlled oscillator is modulated by a composite waveform of TV video and sync, and telemetry and voice sub-carriers. Modulation response is about ± 0.5 db from 5 cps to 1.5 mc. Frequency stability is achieved by an automatic frequency control-AFC-system that periodically compares the output frequency to a reference frequency and slowly varies the output frequency to reduce the difference. Either the r-f output from the receiver VCO or the Auxiliary Crystal Oscillator may be used as a reference.

The output of the transmitter modulators, either phase or frequency modulated, is fed through a final r-f gate to a series of transistor power amplifiers, varactor frequency multipliers and out through a microwave filter.

A problem of some concern is corona from the high frequency circuits of the transmitter. High Q traps in 5 w. r-f circuits can generate considerable voltage.

Power Supply

The power supply converts 115 v., 3 phase, wye-connected, 400 cycle power to +15 and -15 v. dc. It is a conventional, unregulated supply. Output ripple with specified maximum line unbalances is less than 3 mv, RMS. Critical transponder circuits, such as oscillators, are independently zener regulated at the circuit. Power supply efficiency is 80%. Overall power consumption is 16 w. (into the supply).

Reliability

Analytically, the reliability of the transponder has improved two-fold during development. A single transponder, including power supply, is now calculated to have an MTBF of greater than 30,000 hours based on a parts count and accepted component failure rates.

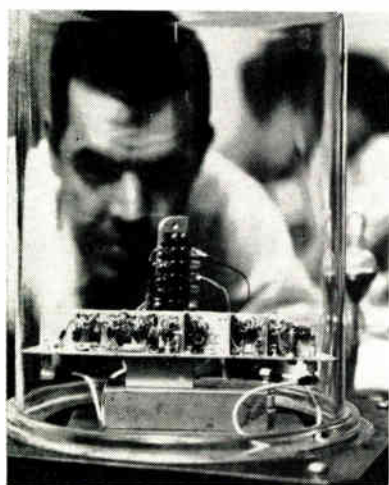


Fig. 3: An engineer is observing the discharge effects in the transmitter r-f circuitry at low pressures.

Mechanical Description

The complete transponder and spare are one integral package. The package consists of power supply, receiver and transmitter modules, bolted to a duplicate set of modules. A front plate is attached to one end, and a top plate covers the cableway.

This arrangement forms an active unit bolted to a complete spare transponder. To actuate the spare transponder, the front panel is unbolted (it is held by captive bolts) and rebolted to the opposite end of the symmetrical assembly. The complete unit is now identical to the arrangement using the normal unit. It may now be turned around and replaced into the equipment rack.

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The USE outward mechanical shape is determined by the standard equipment compartment in the spacecraft. Inside its compartment, the USE is clamped snugly against a heat exchange plate.

Within the housing of the receiver and transmitter are "Tee Section" modules. The Tee chassis construction is a well-proven technique. The Tee section module design is used in cavities to reduce all signal levels at the surface of the module to less than 10 microvolts into 50 ohms. Normal r-f signal amplification and processing is done on one side of the Tee. Power supply lines are decoupled as they pass through the web of the Tee from power distribution lines.

At least one other level of decoupling is obtained as the power lines are fed through the top of the Tee. The RFI level of 10 microvolts is a good conservative figure for these uses. However, the transponder is more sensitive to some frequencies. In the case of these frequencies, even further isolation is needed.

I-F and VHF signals are transmitted through miniature double-shielded coaxial lines. Microwave signals are fed through solid copper tube type cables—*Coaxitube*—and through larger flexible coaxial cables.

R-F output and input signals are fed through slide-on TNC connectors at the rear of the transponder. Power connections, control lines, monitor and test leads are brought out through plugs mated to the back side of the front panel.

The complete dual transponder weighs 34.5 lbs. and occupies a volume of 861 cubic inches. Components alone weigh about 22 lbs. giving a weight ratio of electrical parts to structure greater than 1.7 to 1.



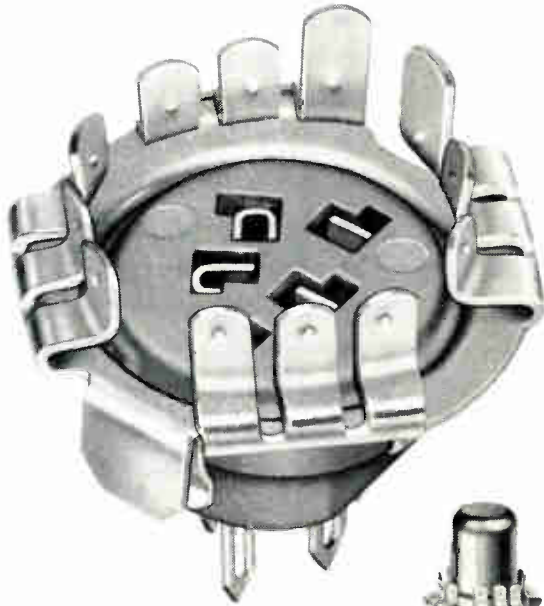
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*Patent Pending



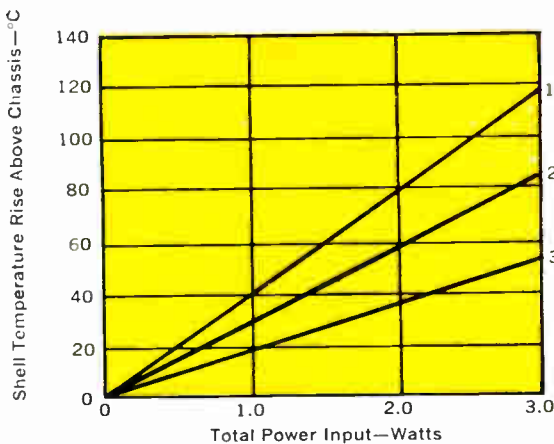
ACTUAL SIZE



This unique new Cinch socket (part No. 133-65-10-041), with the fingered-style base, will lengthen tube life and insure maximum performance from VHF and industrial type Nuvistor tubes. The appreciable reduction in envelope temperature (see graph) provides substantially increased tube reliability. The socket also permits very low inductance to ground at frequencies up to 1200 megacycles.

Cinch heat dissipating sockets and the other VHF Nuvistor tube sockets illustrated are all available for immediate delivery, in quantity, from your Cinch Distributor.

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1. Crimp mounted socket (with tube lugs not making contact with socket saddle)
2. Crimp mounted socket (soldered to brass chassis)
3. Heat dissipating socket (soldered to brass chassis)



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Crimp-Mounted
Nuvistor Socket



Saddle-Mounted
Nuvistor Socket

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If your design is limited to low voltage supplies, but requires the rugged, long life performance of neon lamps, specify TEC-LITE Low Voltage Neon Indicators. LVN Series' self-contained, transistorized circuitry steps up supply voltages as low as 3 VDC to high voltage AC that fires both elements of the neon lamp.

If desired, low level signals - as low as 2 volts - typically present in computers, industrial control, missile guidance and other solid state systems can be used to control these versatile indicators.

LVB Series Indicators offer features of the LVN Series plus an SPST normally open or normally closed switch rated at 100ma at 120 VAC, non-inductive. This combination indicator and switch simplifies design and conserves panel space. Specify reliable (life exceeds 10,000 hours) TEC-LITE Low Voltage Neon Indicators whenever high voltage is not readily available or not desirable in your design. Your TEC-REP has details, or write directly.

- Supply voltages: 6, 12, 18 or 24 VDC $\pm 10\%$ standard. Other supplies from 3 to 48 VDC available in custom designed models.
- Six cataloged models operate from a range of lamp control signals and polarities.
- LVN Series size: 9/16" dia. x 2" long backpanel. Price: As low as \$8.65 in 100-499 quantities.
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TIL Series controls replaceable incandescent lamp with small current signal. TIB Series adds isolated SPST switch.

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MTL Series controls neon lamp with small voltage signal. TBL Series combines same functions with isolated SPST switch.

2μSEC PULSE TURNS ON INCANDESCENT INDICATOR



TML Series with replaceable incandescent lamp turns ON with small signal, remains ON when signal is removed.

2 VOLT BINARY CODED INPUT SIGNAL CONTROLS DIGITAL READOUT



TNR Series display controlled by low level decimal or binary signals. Memory optional. Mounts on 1" centers.

TEC-LITE Transistorized Indicators are protected by one or more of the following patents: U.S. Pat. Nos. 2,985,874, 3,041,499, French Pat. No. 1,291,911, Italian Pat. No. 647,414, Belgian Pat. No. 604,246.

NEW TECH DATA

Vacuum System

The Model 120 ultrahigh vacuum system produces and maintains a guaranteed pressure of 2×10^{-10} mm Hg as measured by a modified Bayard-Alpert type gauge. The base pressure of the system, when measured by an ultrahigh vacuum cold cathode gauge and control, is in the low 10^{-11} mm Hg range. These low pressures are attained without additional bakeout during the pumpdown cycle and without cryogenic surfaces inside the chamber. Additional information contained in data sheet 120.1 from Ilikon Corp., Natick Industrial Ctr., Natick, Mass.

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Vacuum Measurement

This data describes the model 509 which measures in the 10^{-4} to 10^{-8} Torr. Using standard ionization techniques and adaptable to many popular tube gauges, it meters both emission and vacuum readings. Model 509A is available with a meter and strip-chart recorder. RIL Electronics, Box 143, Southampton, Pa.

Circle 161 on Inquiry Card

Vacuum Oven

The HB-1 is designed for use in controlled atmosphere production systems such as transistor fabrication. Particularly notable is a 10 in. cylindrical, stainless-steel muffle that distributes even heat to the work load in the shortest period of time. Heaters mounted in the door and curved heaters enveloping the muffle length provides max. temp. uniformity. Temp. level is controlled by a thermocouple. Philco, subs. of Ford Motor Co., Lansdale, Div., Lansdale, Pa.

Circle 162 on Inquiry Card

Pressure Meter

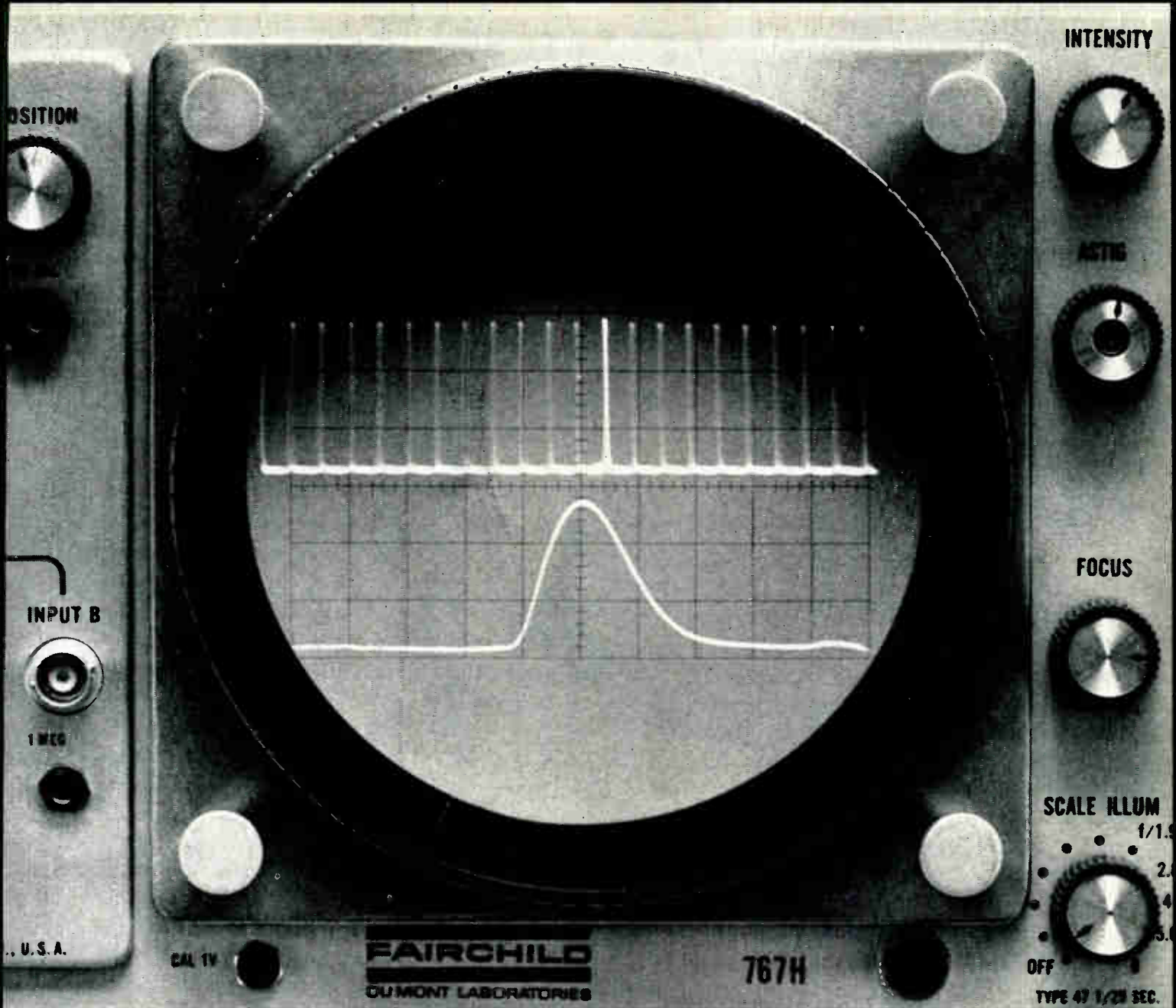
A meter that measures both vacuum and pressure with accuracies to 0.05% or better is described in this illustrated brochure from MKS Instruments, Inc., 45 Middlesex Tpk., Burlington, Mass. Included in the illustrated brochure are a broad range of applications for measuring, controlling and recording vacuum, ultra-low differential pressure and gage pressure. Detailed electrical and mechanical specs are also included with a circuit schematic.

Circle 163 on Inquiry Card

Electron-Beam Welder

Model 2406 produces high-power density variable spot sizes and offers adjustable beam alignments, rapid pump down, and precisely controlled, repetitive welds in single pass operations. Welds of up to 10 to 1 depth-to-width ratio have been made in 3/4 in. thick stainless steel. Spot sizes produced can be varied from 0.020 in. to more than 2 in. dia. The operator may view the spot on a test piece to obtain the best conditions for each application. The unit's high concentration of power is comparable to that of lasers. Additional data available from National Research Corp., 70 Memorial Dr., Cambridge 42, Mass.

Circle 164 on Inquiry Card



What's the delay here?

The delay here is what happened to a 10-nano-second radar pulse on its way through a Fairchild Type 767H Oscilloscope. The trace is a multiple exposure of a strobed delaying sweep and the magnified delayed sweep. Its clear, "locked in" display was made with the Delaying Sweep Plug-In unit of this new Fairchild solid state scope.



The 50 mc Plug-In used to make this trace has a rise time of 7.5 nsec, sensitivity of 50 mv/cm. Other available plug-ins provide many other capabilities — enough to replace half a dozen or more special purpose scopes.

Investigate the new Fairchild line before you invest in another scope. Write for our Instruments Catalog. Better yet, call in a field sales engineer (offices in

39 principal cities) for a demonstration. Fairchild Scientific Instruments, 750 Bloomfield Avenue, Clifton, N. J.

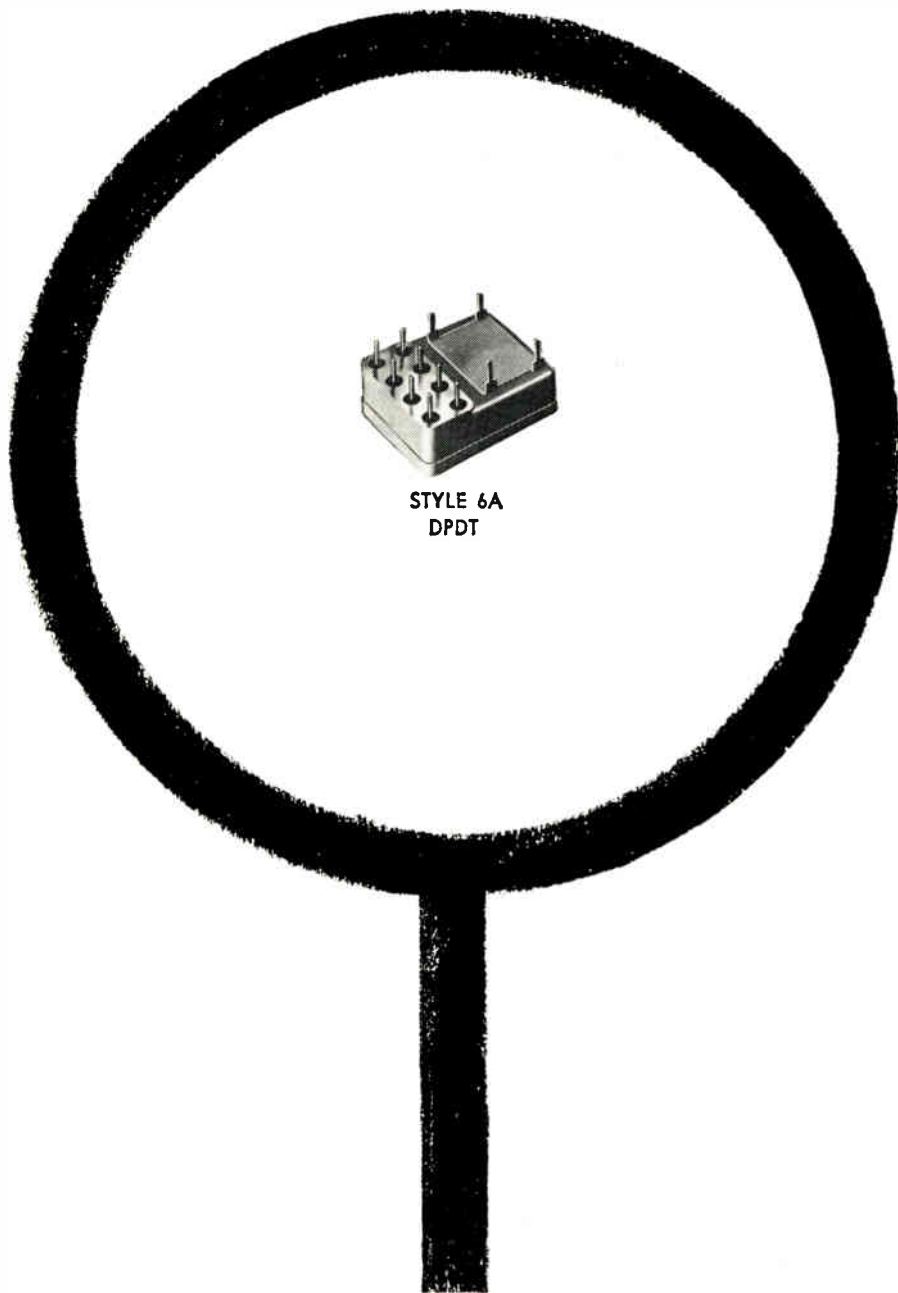
FAIRCHILD

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DIVISIONS OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
750 BLOOMFIELD AVENUE, CLIFTON, NEW JERSEY

Circle 40 on Inquiry Card

World Radio History



STYLE 6A
DPDT

MICRO-MINIATURE RELAY STYLE 6A FOR PRINTED CIRCUITS

**Terminals & Mounting Conform to 0.2" Grid Spacing
Less Space • Lower Mounting Height**

For reliable switching of low-level as well as power loads. Style 6A will operate at coil power levels below most larger current-sensitive relays in its general class, yet easily switches load currents of 2 amps resistive and higher at 26.5 VDC or 115 VAC. Contact arrangement to DPDT.

Unique construction permits flexible wiring and a variety of schematics. Withstands 50 G shock and 20 G vibration to 2000 cycles.

Meets applicable portions of specifications MIL-R-5757D and MIL-R-25018 (USAF) Class B, Type II, Grade 3.

For additional information, contact:

PRICE ELECTRIC

CORPORATION

312 Church St. • Frederick, Md. • Phone: 301/663-5141 • TWX 301/553-0462

Vacuum Encapsulator

In this unit, degassing, heating, stirring, evacuation and pouring are under the operator's control. All but pouring may be preset and automatically controlled. Neither the impregnants nor the molds are exposed to amb. conditions during or between any of the processes. Fluid flow is by pump, gravity and/or pressure differential. Multiple or single molds may be used. Data available from Red Point Corp., 105 W. Spazier Ave., Burbank, Calif.

Circle 165 on Inquiry Card

High-Vacuum Furnace

The 1100°C (2000°F) "cold wall" furnace has an all nickel "suspended muffle" and reflective shielding. The 1100°C temp. is achieved in 28 min., using graphite cloth heating elements. Additional data from Tri Metal Works, Inc., 1600 Barnard St., Riverton, N. J.

Circle 166 on Inquiry Card

Dry Ice Pulverizer

This dry ice pulverizer takes the full 50 lb. 10 in. cube blocks of dry ice and pulverizes them for use in vacuum traps. The crushed output size is adjustable. The machines occupy less than 3 ft. sq. floor space. Franklin P. Miller & Son, Inc., 36 Meadow St., E. Orange, N. J.

Circle 167 on Inquiry Card

Diffusion Pump

Model FPS-800 pump can be integrated with any pumping system having standard 4 in. ASM high-vacuum manifold flanges. It features 800 liters/sec. pumping speed; low backstreaming without baffles; high forepressure tolerances — 650 microns; and fractionating 5 pumping stages. Bulletin 6322 available from High Vacuum Equipment Corp., subs. of Robinson Technical Products Inc., Hingham, Mass.

Circle 168 on Inquiry Card

High Temp. Furnace

Model 1064 is a high-temp. physical testing furnace capable of attaining 3000°C in helium or hydrogen and higher in a vacuum. Unit is capable of vacuums to 1×10^{-6} Torr. It has a portable pumping system. Data is available from Vacuum Furnace Div., Richard D. Brew and Co., Inc., 90 Airport Rd., Concord, N. H.

Circle 169 on Inquiry Card

Vacuum Gauge

Spec. Sheet No. 306 describes the model SL-1 which provides absolute pressure measurements in the range of 10^{-2} to 10^{-7} mm Hg. Measurements are continuous and practically instantaneous. A voltage regulating transformer eliminates inaccuracies from line voltage variations. Hastings-Raylist, Inc., Hampton, Va.

Circle 170 on Inquiry Card

Thermal Impedance Chart

Wakefield Engineering, Inc., Wakefield, Mass., offers a chart showing the thermal impedance values, case-to-sink, for various semiconductor case sizes.

Circle 171 on Inquiry Card



select from
44 cased models of OHMITE "v.t."
 variable transformers

ALL AVAILABLE FROM STOCK

Input Volts	Maximum Amps.	Output Volts	Feature or Connection	Stock No.
120	1.4	0-132	Fixed Mtg.	VT2E
120	1.75	0-132	Portable	VT2F
120	1.6	0-120	Fixed Mtg.	VT2ME
120	2.0	0-120	Portable	VT2NF
120	2.8	0-140	Fixed Mtg.	VT4E
120	3.5	0-140	Portable	VT4F
120	3.5	0-140	VT4F w/gnd. in. & out.	VT4FC
120	3.8	0-120	Fixed Mtg.	VT4NE
120	4.75	0-120	Portable	VT4NF
120	4.75	0-120	VT4NF w/gnd. in. & out.	VT4NFC
120	6.0	0-140	Fixed Mtg.	VT8E
120	7.5	0-140	Portable	VT8F
120	7.5	0-140	VT8F w/gnd. in. & out.	VT8FC
120	6.0	0-120/140	Deluxe Portable	VT8G
120	6.0	0-120/140	VT8G w/gnd. in. & out.	VT8GC
120	8.0	0-120	Fixed Mtg.	VT8NE
120	10.0	0-120	Portable	VT8NF
120	10.0	0-120	VT8NF w/gnd. in. & out.	VT8NFC
120	20.0	0-120/140	Basic Case	VT20B
120	25.0	0-120	Basic Case	VT20NB
120	16.0	0-120/140	Fixed Mtg.	VT20E
120	20.0	0-140	Portable	VT20FC
120	16.0	0-120/140	Portable	VT20GC
120	20.0	0-120	Fixed Mtg.	VT20NE
120	25.0	0-120	Portable	VT20NFC

Input Volts	Maximum Amps.	Output Volts	Feature or Connection	Stock No.
WITH METERS				
120	6.0	0-120/140	w/voltmeter, gnd. conn.	VT8GCV
120	6.0	0-120/140	w/volt. & ammtr., gnd. conn.	VT8GCVA
120	6.0	0-120/140	w/volt. & wattmtr., gnd. conn.	VT8GCVW
120	10.0	0-120	w/voltmeter, gnd. conn.	VT8NFCV
120	10.0	0-120	w/volt. & ammtr., gnd. conn.	VT8NFCVA
120	10.0	0-120	w/volt. & wattmtr., gnd. conn.	VT8NFCVW
120	16.0	0-120/140	w/voltmeter, gnd. conn.	VT20GCV
120	16.0	0-120/140	w/volt. & ammtr., gnd. conn.	VT20GCVA
120	16.0	0-120/140	w/volt. & wattmtr., gnd. conn.	VT20GCVW
120	25.0	0-120	w/voltmeter, gnd. conn.	VT20NFCV
120	25.0	0-120	w/volt. & ammtr., gnd. conn.	VT20NFCVA
120	25.0	0-120	w/volt. & wattmtr., gnd. conn.	VT20NFCVW
TWO-IN-TANDEM ASSEMBLIES				
240	20.0	0-240/280	Series Conn.	VT20-2B
240	25.0	0-240	Series Conn.	VT20N-2B
120	20.0	0-120/140	Open Delta Conn., 3-Phase	VT20-2B
120	25.0	0-120	Open Delta Conn., 3-Phase	VT20N-2B
THREE-IN-TANDEM ASSEMBLIES				
240	6.0	0-240/280	"Y" Conn., 3-Phase	VT8-3E
240	20.0	0-240/280	"Y" Conn., 3-Phase	VT20-3B
240	25.0	0-240	"Y" Conn., 3-Phase	VT20N-3B



From this Ohmite selection which ranges from a small 1.4-amp unit in a simple case for fixed mounting to a portable 25-amp unit with dual meters, you can satisfy almost any normal application. But if you have a very special requirement, don't hesitate to contact Ohmite's custom-design department. It can engineer case arrangements for the most unusual service. A wide range of standard, uncased units are also available, as well as special designs made to your order. Write for Catalog 500A on Ohmite "v.t." variable transformers—the industry's fast-growing line.



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NEW TECH DATA

Transformer Catalog

Catalog TR-63/64 lists transformers for industrial and military users. Complete specs., dimensions and prices for more than 1150 transformers are included in the 48-page catalog. Triad Distributor Div., Litton Industries, 305 N. Briant St., Huntington, Ind.

Circle 172 on Inquiry Card

Voltage Dividers

Catalog Sheet C-44 describes Models DT 68, DT 58 and DT 47 Dekatran voltage dividers—6, 5 and 3 decade units providing accuracies to 1 ppm. Features, detailed specs., performance curves, dimensional drawings, and application drawings are given. Electro Scientific Industries, 13900 N.W. Sunset Science Park Dr., Portland, Ore.

Circle 173 on Inquiry Card

Control Devices

This bulletin provides application data, specs. and mounting dimensions for crystal oscillators, tuning-fork oscillators, ac voltage standards, crystal ovens, component ovens, freq. standard systems and freq. dividers. Delta-f, Inc., Crystal Lake, Ill.

Circle 174 on Inquiry Card

R-F Filter

Type RF1070, r-f interference filter is designed for installation on shielded enclosures. Nominal insertion loss is 100db throughout the freq. range of 14kc to 10gc. The filter can be installed in a 2 wire, 600Ω line. The pass-band attenuation is less than 1db from 0 to 3500cps. Further information from RF Interionics, Inc., 15 Neil Court, Oceanside, N. Y.

Circle 175 on Inquiry Card

Semiconductor Guide

A new quick reference guide on semiconductor (Form T481B) contains complete data on the company's silicon rectifiers, and both power and switching transistors. Also included is a full listing and data on Tung-Sol's Dynaquads, which are pnpn 4-layer germanium devices. The guide covers all basic types of semiconductors, including low, medium and high-current silicon rectifiers rated from 500ma to 250a., pressure fit and cold-welded, sub-miniature case construction models. Tung-Sol Electric Inc., 1 Summer Ave., Newark 4, N. J.

Circle 176 on Inquiry Card

Neon Indicator

Data Sheet #292 describes the LVN Series low-voltage neon indicator, which internally steps up dc supplies as low as 3vdc to high-voltage ac to fire the lamp's electrodes. Lamp is switched on and off by signals as small as 2v. Data includes mechanical, electrical specs, circuitry and mechanical options, plus applicable Mil or federal specs. TEC-LITE Dept., Transistor Electronics Corp., Box 6191, Minneapolis 24, Minn.

Circle 177 on Inquiry Card



Costly Originals...

but transistor heat dissipators like these, from volume production, cost as little as ordinary "fuse-clip" retainers.

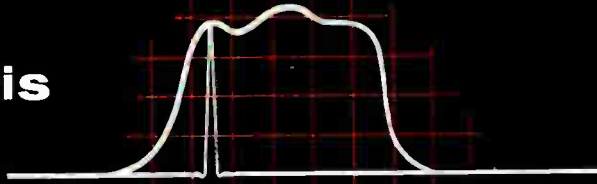
Our **Therma-link** retainers give you a choice of screw, rivet or solder mounting. **Fan-top** radiators provide easy slip-on installation. They effectively retain and cool TO-18, TO-5 and TO-8 cases on printed circuit boards, heat sinks or chassis. You can save assembly time because the beryllium copper fingers adapt to varying case diameters. Gold, nickel, black cadmium and our insulating finish, **Insulube**, are available for space and all other environments.

Research makes the difference in our complete line of advanced design heat dissipators. Request technical data and ask our field engineers about the most economical devices for semiconductor thermal control.

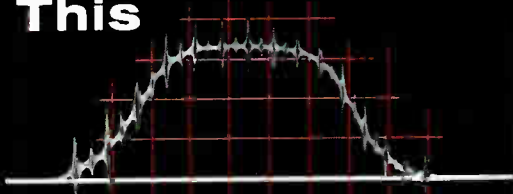
Patented and Patent Pending.

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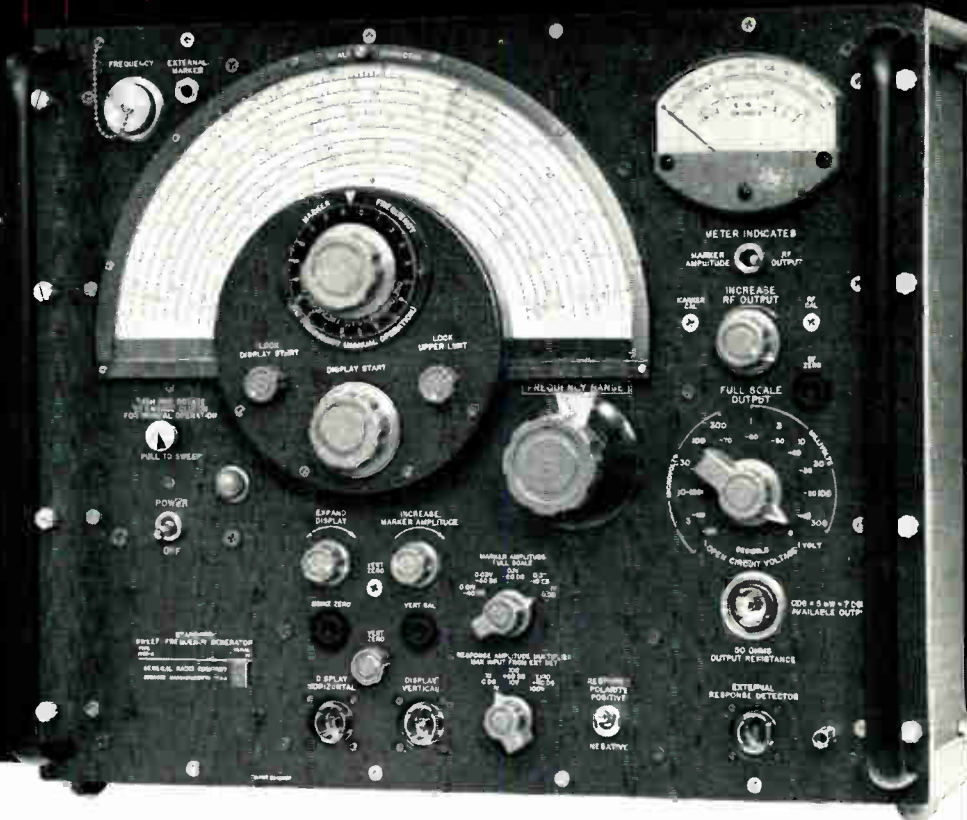
This



Not This



with the 1025-A
Standard
Sweep-Frequency
Generator



“The Sweep Generator with the perfect marker”

... a marker that's continuously adjustable in frequency and amplitude ... accurately calibrated in frequency and amplitude ... that lets you take your data directly from the display ... a marker that does not interfere with the response display ... a single marker, not an ambiguous, confusing string of pips.

The 1025-A has all you need for QUANTITATIVE frequency-response measurements ... a sweep generator, cw generator, marker generator, precision attenuator, and output meter. This instrument can be instantly switched from sweep to cw operation without changing adjustments or connections. A unique motor-driven capacitor produces a swept signal free of harmonic distortion and spurious responses. Low residual fm permits ready investigations of steep response slopes. Its meter measures both rf input and detected output. A high-impedance detector probe is supplied to minimize loading during response measurements.

In short, the 1025-A is the most complete sweep-frequency generator you can buy.

SPECIFICATIONS

Range: 0.7 to 230 Mc in ten overlapping octave ranges plus two bandspread ranges of 400-500 kc and 10.4-11 Mc. Other bandspread ranges available on special order.

Sweep Width: Entire selected range is swept. Portions of range as small as 10% can be expanded to full oscilloscope width for detailed visual display. Selected range is swept in 22.2 msec twenty times a second. Output is blanked off during return sweep.

Stability: Drift is less than $\pm 0.1\%$ over 5-hour period after warmup. Frequency dial accuracy is within $\pm 0.5\%$.

Marker: Adjustable from 3 mv to 1v; multiplier extends range to 100v. Resolution is better than $\pm 0.1\%$ of indicated frequency.

RF Output: 0.3 μ v to 1v behind 50 ohms. Output flat to within $\pm 1\%$ up to 100 Mc and within $\pm 3\%$ up to 230 Mc.

Price: \$3250 in U. S. A.

Write for complete information

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SAN FRANCISCO
(Em. Altos) 948-8233

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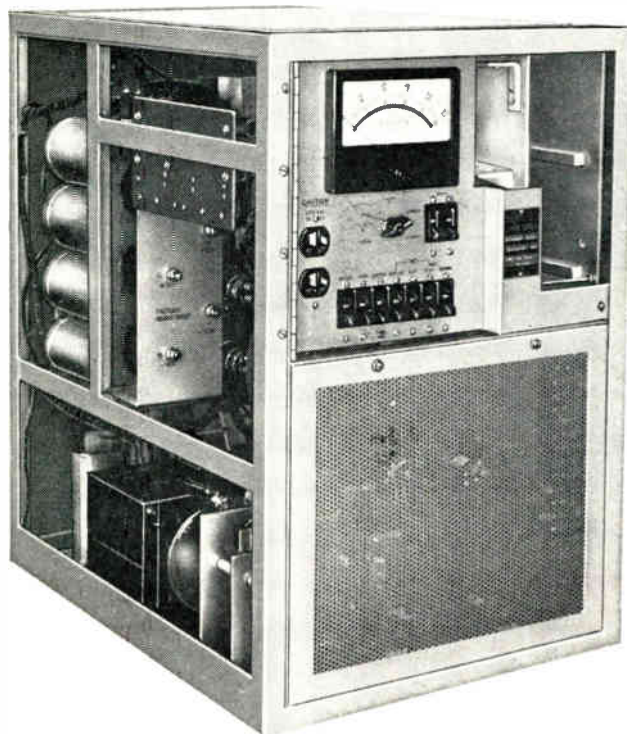
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Circle 44 on Inquiry Card

Acme Electric

MULTI-CIRCUIT POWER SUPPLY Designed for Precise Performance and High Reliability



Straightforward circuitry provides automatic correction for input line changes in the range of 170 Volts to 240 Volts AC.

Five regulated DC outputs between 6 volts and 50 volts can be used simultaneously or independently without affecting regulation. Three AC outputs provide stabilized voltage for auxiliary equipment. This is another example of how Acme Electric designs power supplies to meet the application rather than to exotic and needlessly expensive general specifications.

Acme Electric has an abundant experience, in developing hundreds of successful power supply designs, in power levels ranging from miniwatts to megawatts, and can probably adapt an established type to your application.

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Engineers and Builders of...

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SAA 3695/3022
REGULATED POWER SUPPLIES
STATIC POWER RECTIFIERS
VOLTAGE STABILIZERS
VOLTAGE REGULATORS

Circle 45 on Inquiry Card

NEW TECH DATA

Instrument Catalog

Included in this illustrated, 2-color catalog are condensed technical specs. and prices of oscillators and function generators, ac power sources and monitors, laboratory power amplifiers, variable electronic filters, and regulated power supplies. Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge 39, Mass.

Circle 178 on Inquiry Card

Tantalum Capacitor

Bulletin GET-2985 includes dimensional drawings, charts of typical performance curves and tables of standard ratings and catalog numbers. Application data and complete specs. are given. Available in 4 case sizes from 6 to 50v. and 0.0047 to 330mfd. General Electric Co., Schenectady 5, N. Y.

Circle 179 on Inquiry Card

PNPN Testing Bulletin

Bulletin 5200 includes circuit diagrams with component values, as well as detailed procedural instructions for measuring all parameters applicable to pnnp switching devices. Solid State Products, Inc., 1 Pingree St., Salem, Mass.

Circle 180 on Inquiry Card

X-Y Recorder

The F-80 X-Y recorder has independent servo-operated X and Y axes. Both use null-balance potentiometric principle to provide precise X-Y recordings. Specs: Accuracy, 0.2% range to range; reproducibility, 0.1%; pen speed, 17 cps (both axes); and writing speed, 15 cps. Data available from Varian Assoc., Recorder Products Group, 611 Hanson Way, Palo Alto, Calif.

Circle 181 on Inquiry Card

Solder Stripper

Metex solder stripper is a stable liquid which does not attack copper or most of the organic resists used in printed circuits. It quickly and completely strips solder plate and roll or flow coated solder at room temp. Complete tech. information is available from MacDermid Inc., Waterbury, Conn.

Circle 182 on Inquiry Card

Switch Catalog

Catalog 34, 25 pages, covers a line of snap-action and limit switches. A free sample of the S800B snap-action switch is included. The Milton Ross Co., 2nd Street Pike, Box 274, Southampton, Pa.

Circle 183 on Inquiry Card

Miniature Relay

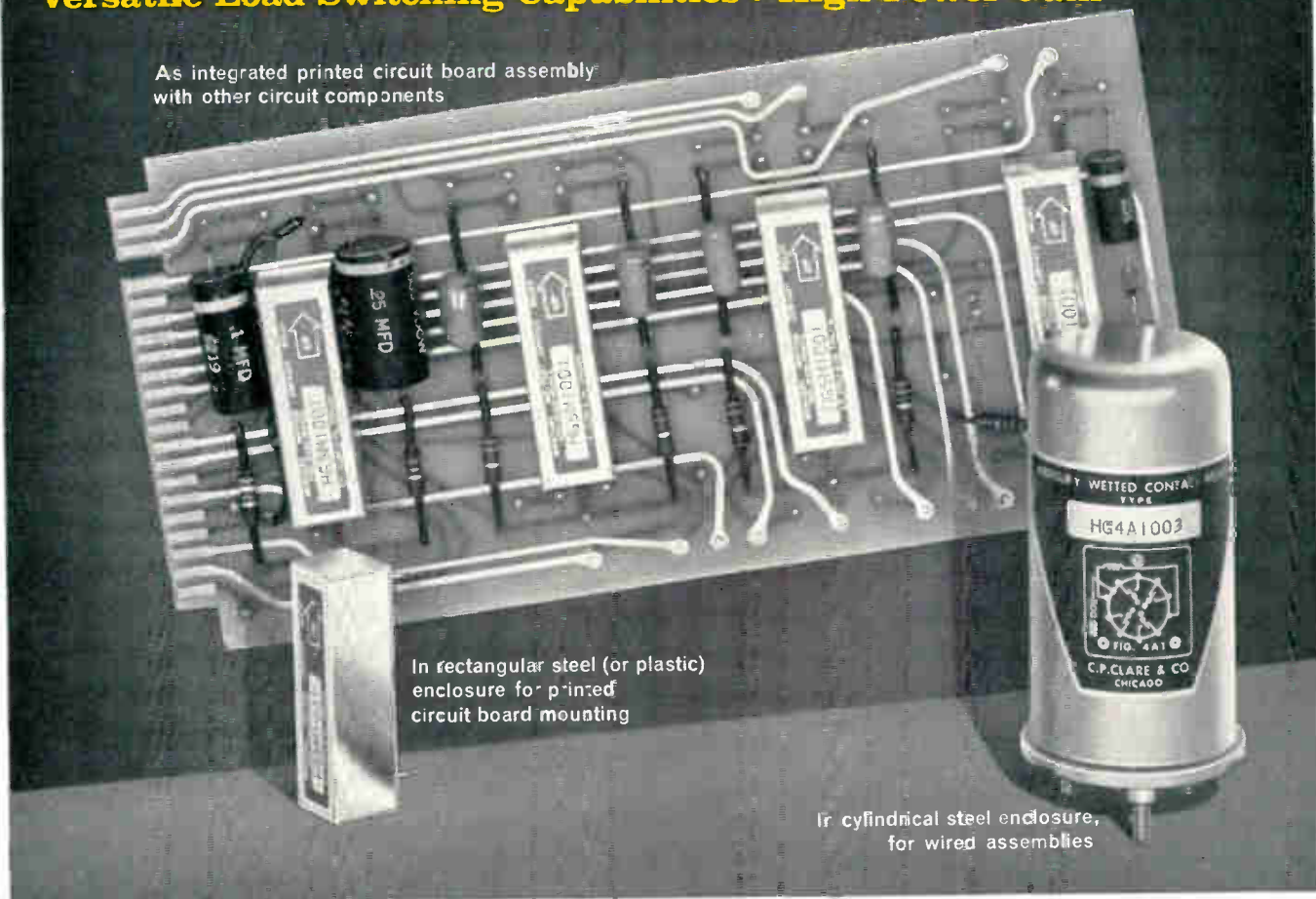
This general-purpose miniature relay is for ac or dc printed-circuit operations. The Series 5003 is rated at 5a. and is 26vdc resistive. Information from Cornell-Dubilier Electronics Div., Federal Pacific Electric Co., 50 Paris St., Newark 1, N. J.

Circle 184 on Inquiry Card

specify **CLARE** Mercury-Wetted Contact Relays

for billions of operations with
Low and Consistent Contact Resistance • No Contact Bounce
Versatile Load Switching Capabilities • High Power Gain

As integrated printed circuit board assembly
with other circuit components



In rectangular steel (or plastic)
enclosure for printed
circuit board mounting

In cylindrical steel enclosure,
for wired assemblies

CLARE Mercury-Wetted Contact Relays are fast, sensitive and provide high switching capacity. They operate with extreme reliability whether billions of cycles... or only one... are required. Clare provides both bridging and non-bridging Mercury-Wetted Contact Relays.

For applications where consistent contact resistance is critical, these relays will hold their original resistance within ± 2 milliohms through life. There is no contact bounce which may be misinterpreted by electronic circuits.

With **CLARE** Mercury-Wetted Contact Relays, the same contacts may pass a microvolt analog signal... or switch a 250 va tape transport reel motor up to 100 times a second. These relays can be driven at a 40 mw level by diode or transistor logic... and handle a 250 va solenoid load on their contacts.

For wired assemblies: plug-in, solder terminal, or AN connectors in one to four-pole multiples. For printed circuit board mounting: modules of molded plastic or steel enclosures. As integrated

printed circuit board assemblies: custom-built from your circuits or "black box" requirements.

(Complete information: Request Design Manual 201B by circling 149 on Reader Service Card • Concise information: Request Manual 800 by circling 150 on Reader Service Card.)

Address: Group 10D8. C. P. Clare & Co., 3101 Pratt Boulevard, Chicago 45, Illinois. Cable Address: CLARELAY. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ontario. In Europe: C. P. Clare International N.V., 6 Mombertstraat, Tongeren, Limbourg, Belgium.



Snowed Under by Transients?

TRY A CONTROLLED A

■ As you may know only too well, transient voltages, superimposed on normal voltages, can cause unexpected field failures of silicon rectifiers. Various devices, some quite effective, are used to suppress these transients. However, the controlled avalanche rectifier contains its own protection, inherent in the rectifier itself. The CAR cycles in and out of its breakdown (or avalanche) region to the full limit of its thermal capacity to dissipate heat losses. For example, a unit capable of handling 12 amperes (or 12 watts) in the forward direction can continually dissipate the same 12 watts in the reverse direction.

Sarkes Tarzian controlled avalanche rectifiers are made from low resistivity, low radial gradient silicon with controlled lattice dislocation. In effect, we've packaged zener diode characteristics into a silicon rectifier with much higher voltage ratings.

The hooker from a manufacturing point of view is that higher operating and transient voltages demand extremely high surface dielectric conditions. Breakdown voltages must be channeled through the junction bulk, not across the surface. Special selection of silicon establishes the path of least resistance, so that power doesn't sneak through narrow paths that lie along lattice faults. Result: Tarzian CARs dissipate, without damage, transient surges that are many times the steady state voltage and power rating of the rectifier.

Controlled Avalanche Silicon Controlled Rectifiers. As an extra added attraction, we've extended the controlled avalanche principle to Tarzian controlled rectifiers—a "built-in" reliability factor on reverse characteristics. These units are now available in 3 and 5 ampere dc ratings, with peak voltage as high as 500 volts.

Data Available. Send today for complete information on currently available Tarzian 6 and 12 ampere controlled avalanche rectifiers, rated to 600 volts, and on Tarzian controlled avalanche silicon controlled rectifiers, rated 3 and 5 amperes dc. Guaranteed to give any circuit designer a warm glow.

**V
A
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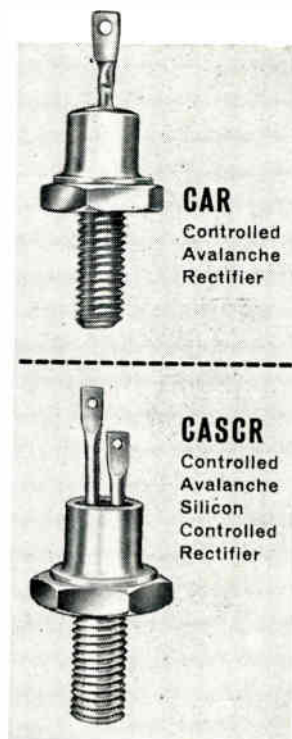


FIG. 1. AVALANCHE TEST CIRCUIT

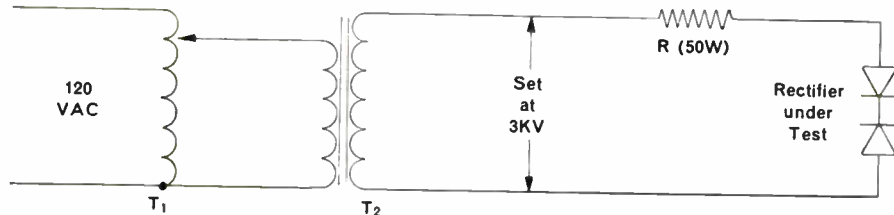


Fig. 1. This circuit tests the ability of the rectifier to operate within ratings in the avalanche region. The value of R is established by maximum steady state wattage rating of the unit under test. Using a 12 watt unit, Tarzian type ST2A60 rated 12 amperes dc, 600 piv, determination is as follows:

$$I_{max} = \frac{12}{3000 - 600} = 20 \text{ ma}$$

$$R = \frac{600}{.02} = 120,000 \text{ ohms}$$

T₁ = autotransformer; T₂ = 3KV, 90VA transformer. Provide adequate cooling to prevent thermal run-away.

FIG. 2. TRANSIENT IMPULSE TEST CIRCUIT

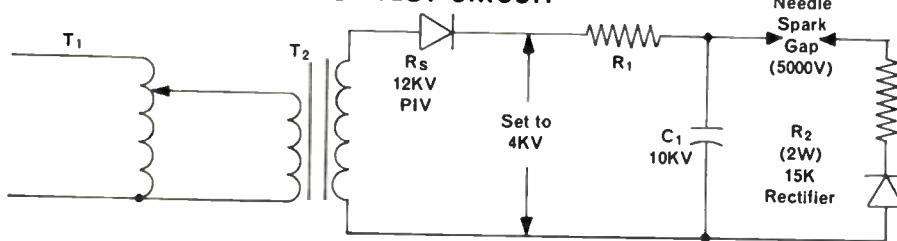


Fig. 2. This circuit tests for transient over-voltage conditions with steep wave fronts that provide high electron acceleration. Current limiting is achieved by R₂, selected for the peak power rating of the unit tested. R_s = Tarzian type S-5505; R₁-C₁ = determinants of proper time constant (RC factor approximately 1-3 seconds); T₁ = autotransformer; T₂ = 4KV, 40 VA transformer.

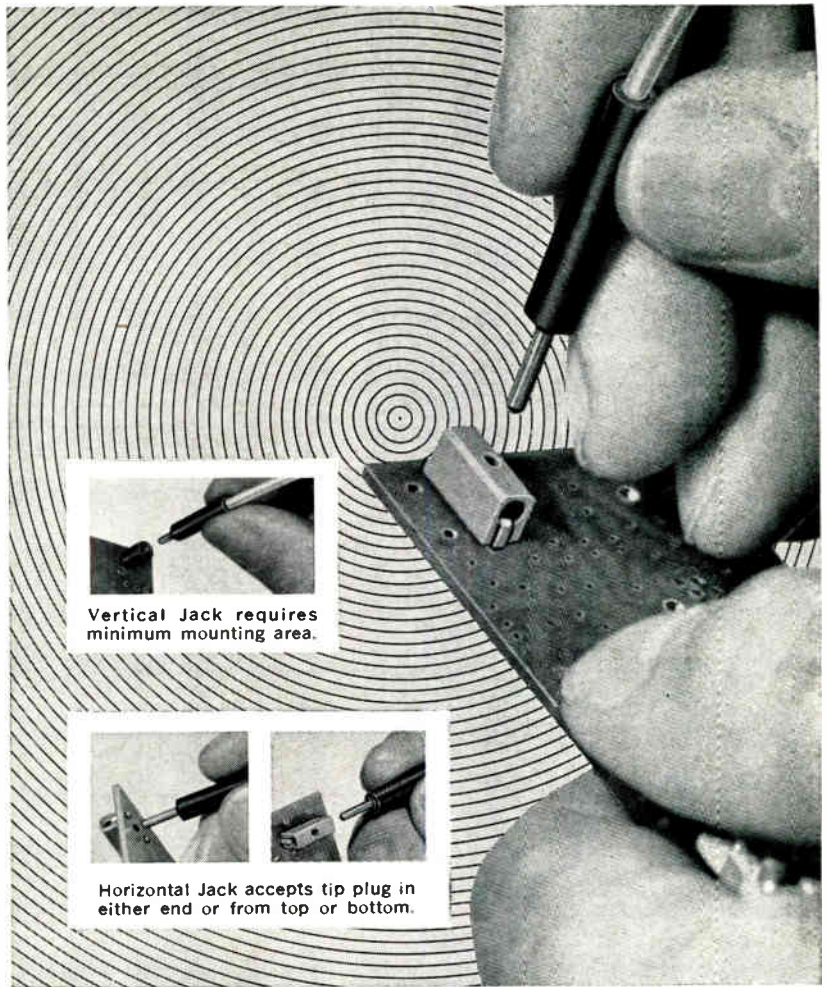


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MINIATURE NYLON PLUGS AND JACKS



Vertical Jack requires minimum mounting area.



Horizontal Jack accepts tip plug in either end or from top or bottom.

Operating voltages to 1500 V RMS . . . up to 5 amps current carrying capacity!

Extremely compact — highly resistant to extremes of shock, vibration, temperature and moisture, these tiny Johnson Nylon Tip Plugs and Jacks are ideal for limited space applications! Bodies molded of tough, low-loss polyamide per MIL-P-17091 (DuPont Zytel 101 nylon.) Available in 13 colors, including basic colors for MS16108C coding applications. Contact resistance: less than 2 milliohms. Capacitance between two adjacent jacks: less than 1 mmf. at 1 Mc.

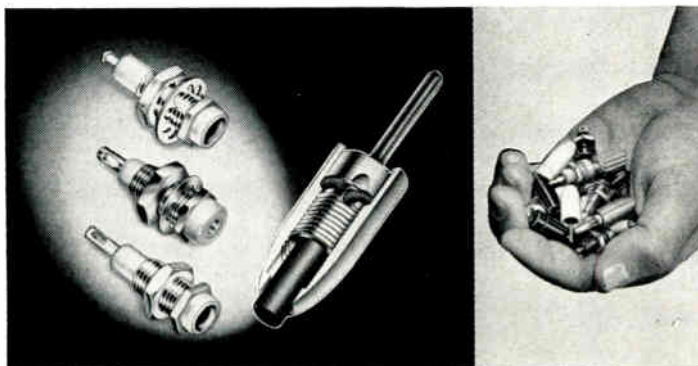
Series 105-751 Horizontal Jack — Unique design accepts .080" diameter tip plug in either end, or from top or bottom. Formed silver-plated beryllium copper contact. Two terminals.

Series 105-851 Vertical Jack — Mounts through single .052" hole, requires minimum mounting area. Silver-plated, machined beryllium copper contact.

Series 105-771 Sub-Miniature Tip Plug — For use with miniature jack. .080" diameter tip. Nickel-plated, machined brass body. Solder type lead connection.

Series 105-881 Long Handle Tip Plug — Identical to tip plug above, but with 4" nylon body for ready access to "hard to reach" test points.

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CAPACITORS • TUBE SOCKETS • CONNECTORS • PILOT LIGHTS
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◀ **OTHER CONNECTORS** — Johnson also manufactures a complete line of standard connectors including Tip Plugs and Jacks; Metal-Clad and Rapid-Mount Jacks; Banana Plugs and Jacks; Binding Post. Voltage breakdowns to 12,500 volts DC. Jacks designed for fast, easy mounting — plugs for solderless connection — available in 13 colors for coded applications. Current components catalog provides full specifications on complete line — write today for your free copy.

Reeves

RESOLVERS, SYNCHROS PHASE SHIFTERS



STANDARD RESOLVERS

A full line of compensated and uncompensated resolvers in standard BuOrd size 23, 15 and 11 cases. Size 23 series has functional accuracy of 0.05%; resolvers in other two series have accuracy of 0.1%.

Circle 295 on Inquiry Card



HIGH PRECISION SIZE 23 RESOLVERS

New series of extremely accurate resolvers, includes a 0.01% functional accuracy computing resolver with 100% compensation and data transmission resolvers with 20-second accuracy. The ultimate in precision for resolvers of this case size.



20-SECOND SIZE 23 SYNCHROS

These three wire synchros are the most accurate units available in a standard BuOrd size 23 case. Both transmitters and control transformers can be supplied, for either 400-cycle or 60-cycle input.

Circle 297 on Inquiry Card



PRECISION PANCAKE RESOLVERS

0.005% functional accuracy computer resolvers with 100% compensation. 10-second accuracy data transmission resolvers. Integral bearing design permits direct mounting to gimbal structure. Beryllium housings provide stable operation under extreme temperature variation.

Circle 298 on Inquiry Card



BOOSTER AMPLIFIERS

Complete line of vacuum tube and transistorized booster amplifiers, for use in conjunction with compensated resolvers. Transistorized units contain two fully encapsulated amplifiers in a single case.

Circle 299 on Inquiry Card

For data transmission; coordinate transformation and conversion; computer chain; and sweep applications. Write for data file 310.

REEVES INSTRUMENT COMPANY

Division of Dynamics Corporation of America, Roosevelt Field, Garden City, N.Y.

NEW TECH DATA

Reliability Report

A 24-page reliability report presents the results of environmental and life tests for functional electronic blocks. Sections are devoted to the audio amplifier product line, r-i amplifier product line, the line of digital logic blocks and the flat packages. Westinghouse Molecular Electronics Div., P.O. Box 1836, Baltimore, Elkridge, Md.

Circle 295 on Inquiry Card

Capacitor Catalog

Catalog 203B1, 24 pages, describes Type QE aluminum electrolytic capacitors. Applications include computers, power-supply filters, energy storage, telephone networks, etc. Standard ratings are listed for Type QE 61 (65°C) and Type QE 71 (85°C) units. Aerovox Corp., New Bedford Div., New Bedford, Mass.

Circle 296 on Inquiry Card

Ceramic Capacitor

TR-324 is a certified summary test report for the "V-LAM" ceramic capacitor. Tests performed in compliance with MIL-C-11015 showed 230,000 hrs. of life testing at 200% rated voltage determined a catastrophic failure rate of 0.6%/ thousand hrs. at a 90% confidence level. Vitramon, Inc., P. O. Box 544, Bridgeport, Conn.

Circle 297 on Inquiry Card

Klystron Booklet

"Introduction to Klystron Amplifier," is written for those who work with equipment using power klystrons. The 28-page booklet describes, in simple terms, the theory of klystron amplifier tubes, the equipment used with them, and general operating methods. Microwave Tube Group, Varian Associates, 611 Hansen Way, Palo Alto, Calif.

Circle 298 on Inquiry Card

Voltage Regulators

Magnetic voltage regulators are described in this consolidated data folder that lists 40 tubeless units with outputs stabilized to within $\pm 1\%$ for input changes of up to 15%. Standard models listed range from 10 to 3000va. Component and apparatus styles are illustrated and described with complete electrical and mechanical specs. Raytheon Co. Industrial Operation, Richards Ave., So. Norwalk, Conn.

Circle 299 on Inquiry Card

Plug-In Relays

Data sheet No. 551 describes 2 sizes of telephone-type relay assemblies, including the type-J relay, plastic dust cover, and special mounting socket. Other devices are covered. Complete electrical and mechanical characteristics are included. C. P. Clare & Co., 3101 W. Pratt Blvd., Chicago 45, Ill.

Circle 300 on Inquiry Card

FIRST AS A MATTER OF RECORD... SCOTCH® BRAND INSTRUMENTATION TAPES



The tape with the built-in duster!

1000 times greater conductivity than ordinary tapes! That's how "SCOTCH" BRAND Heavy Duty Tapes drain off static charges before they can attract dust. That's the built-in duster that flicks away the growing danger of dust-caused dropout errors . . . a danger greater than ever as higher and higher recorder speeds and tape tensions generate more and more static.

Electrical resistance of the oxide coating of "SCOTCH" Heavy Duty tapes is 50 megohms per square or less. The resulting conductivity, unusual in magnetic tape, not only avoids dust contamination, it minimizes such other static problems as tape drag and skew, noise induced by arcing.

Heavy duty formulation of binder and high potency oxides withstands temperatures from -40 to as high as $+250^{\circ}\text{F}$ to conquer high head



heat, assures tapes that outlast standard tapes by at least 15 times. Exclusive Silicone lubrication reduces recorder head and tape wear. And "SCOTCH" Heavy Duty Tapes are offered for all high-speed applications, even for extreme high frequency and short wavelength requirements. 16 different constructions include a variety of backing and coating thicknesses.

TECHNICAL TALK Bulletin No. 4 provides detailed discussion of the effects of static electricity on instrumentation recording, offers helpful information in solving static-caused problems. It's free. Write 3M Magnetic Products Division, Dept. MBR-103, St. Paul 19, Minn.

"SCOTCH" AND THE PLAID DESIGN ARE REGISTERED TRADEMARKS OF MINNESOTA MINING & MANUFACTURING CO., ST. PAUL 19, MINNESOTA. EXPORT: 99 PARK AVENUE, NEW YORK. CANADA: LONDON, ONTARIO ©1963, 3M CO.

Magnetic Products Division **3M**
COMPANY

NEW TECH DATA

for Engineers.

Test Instruments

This brochure describes an automatic transistor tester, a diode and rectifier tester, a resistor tester, and a zener diode tester. Data includes photos, descriptions, and test capabilities. Teradyne Inc., 87 Summer St., Boston, Mass.

Circle 185 on Inquiry Card

Glass Cloth Laminate

"CuClad Lamicaid" No. 6099 is designed for mechanical and electrical uses where low, controlled dielectric constant is not critical. Uses include computer circuitry, seals, bearings, etc. Information available from Dept. W3-342, Mico Div., 3M Co., 2501 Hudson Rd., St. Paul 19, Minn.

Circle 186 on Inquiry Card

Highly Flexible Computer

The PB440 uses 2 memories, one of which stores basic logic. This logic can be changed to equip the PB440 to perform radically different programs which would require different types of computers. It can run Fortran II, and perform fixed-point addition in 3 μ sec. Additional data available from Packard Bell Computer, a div. of Packard Bell Electronics, 1905 Armacost Ave., Los Angeles 25, Calif.

Circle 187 on Inquiry Card

Disc File

This brochure includes description and specs. for the Model 800 Random Access Disc File. Storage capacity is from 20,160,000 on a single disc to 161,280,000 bits on 8 discs. Modular construction allows more discs to be added as needed. Analex Corp., 150 Causeway St., Boston 14, Mass.

Circle 188 on Inquiry Card

Glass Components

These components include fixed capacitors, resistors, trimmers, and inductors. The brochure includes value ranges, voltage ratings, tolerances, physical dimensions, and Mil. Specs. Corning Electronics, Raleigh, N. C.

Circle 189 on Inquiry Card

Slide Rule

An electromechanical coupling coefficient slide rule for piezoelectric ceramics is available. This rule is intended for engineers involved in piezoelectric transducer design and similar applications. Electra Scientific Corp., Electra Way, Fullerton, Calif.

Circle 190 on Inquiry Card

Memory Technique

Technical Data Bulletin No. 2400 describes how phase modulation method of information storage offers advantages of economy, reliability and low-noise level operation. Technique insures a min. of one distinct flux reversal/storage bit. Laboratory for Electronics, Inc., 1079 Commonwealth Ave., Boston 15, Mass.

Circle 191 on Inquiry Card

Card Puller

CDS Card-Out facilitates the rapid removal of printed-circuit cards from their receptacles. Recommended for cards having $\frac{1}{8}$ in. I.D. grommets in the extraction holes. Information available from Correlated Data Systems Corp., 1007 Air Way, Glendale 1, Calif.

Circle 192 on Inquiry Card

Computer Terminology

This 12-page brochure listing definitions of terms commonly used in the computer and process industries is available from TRW Computer Div., Industrial Computers, 8433 Fallbrook Ave., Canoga Park, Calif. More than 200 terms are defined.

Circle 193 on Inquiry Card

A ROWAN CHOICE FOR any application

A complete line of versatile, multiple-pole relays and contactors with extreme reliability.

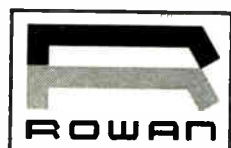
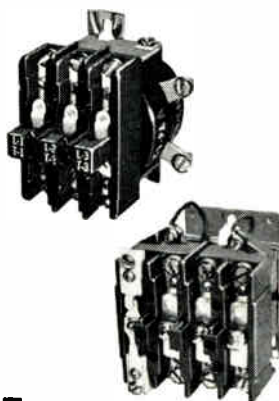
featuring:

Industrial (Nema sizes 0 to 5)

Special (10 to 75 amp) AC or DC, air-break or oil-immersed

(Also a full line of over-load relays & starters.)

write for literature



THE ROWAN CONTROLLER CO.

30 Bridge Ave., Red Bank, New Jersey (201) SH 7-5094

Circle 51 on Inquiry Card

You can rely on tested-approved Varflo to meet your most exacting specifications, including MIL-I-21557 and MIL-I-3190.

ON-THE-SHELF: Varflo is economical... saves on inventory and has long shelf life. No deterioration.

ON-THE-JOB: Varflo is dependable... withstands high heat, water, alkalis, mild acids, oil and grease. Has excellent heat aging qualities and stands up to abrasion, vibration and "after treating."

Why specify two when one will do?

● Available in 10 colors; in coils, spools, 36" lengths or short pieces; all of precise uniformity, end to end. Sizes .010" to 6" ID.

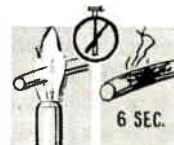
Send for FREE Folder containing Varflo test sample and results of laboratory performance ratings.

Varflex CORPORATION

506 W. COURT ST., ROME, N. Y.

Circle 52 on Inquiry Card

ELECTRONIC INDUSTRIES • October 1963



Flame Resistant — will not support combustion.



More Stable — retains dielectric value during soldering.

Honeywell Advanced Materials Research Yields

New Precision Ceramics!

A virtually new technology has been developed to increase the strength, precision and adaptability of ceramics, giving them almost unlimited possibilities.

Newly developed precision ceramics offer dimensional tolerances to 6-millionths of an inch, surface finishes to 2 RMS micro-inch, and electrical properties including high dielectric strength and high piezoelectric constants. These results have been achieved through a continuing program of materials research.

For the past nine years Honeywell has probed into the densities, purities and electrical and mechanical properties of ceramic materials. As a result, exclusive, superior piezoelectric and structural materials have been developed and proved. For example, Honeywell's Type K-12 piezoelectric material can be stressed to higher levels without depoling than other ceramic materials, thus giving it advantages for high voltage generators.

PIEZOELECTRICS FILLING

IMPORTANT JOBS. Honeywell's Type C-16 combines a high piezoelectric "g" constant and a high dielectric constant. Because it is very stable and has a low aging rate, it is especially suited for acoustic sensing devices such as hydrophones.

Type S-4 generates high voltages under stress and is ideal for impact fuzing devices. Type 101, a modified barium titanate, is used in large quantities in sonar and hydrophone drive elements to produce an ultra-low frequency. It is especially desirable where low price and reliability are of prime importance.

Exclusive techniques for hot pressing lead zirconate/titanate have resulted in ceramics with a theoretical density of 99.5%—a density up to 3.5 percentage points higher than conventional, atmosphere-fired materials. Such superior properties produce a dielectric strength of 250 volts/mil, or more than a 100% increase over other ferroelectric ceramics.



PRECISION SHAPED

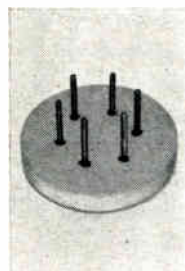
HIGH-TOLERANCE STRUCTURAL CERAMICS.

Honeywell's research has resulted in aluminum oxide ceramics that can be machined to 6-millionths of an inch. Used in gyro spin motors, these materials sharply reduce drift. Use of these materials also results in a theoretical life span that approaches infinity.

A magnesium oxide ceramic material has been developed that is 99.9% pure, is 98% of theoretical density, and has a melting point of 5,075°F. With these properties it has the highest known quality for electrical insulators, or for thermal conductors used in environments where dusting and spalling cannot be tolerated.



HIGH DENSITY



SEALING

SEALS AND METALLIZING. Both metallizing and ceramic-to-metal sealing techniques have been developed to seal high-expansion steatite ceramics to stainless steels, and to seal alumina ceramics to titanium, tantalum and molybdenum. Active metal soldering techniques for ceramic-to-metal sealing result in devices that withstand thermal cycling from -140°F to 750°F. Metallized ceramic surfaces are bonded so firmly with

electrodes of gold, nickel, stainless steel, silver, or copper that separation of the metal and ceramic is impossible without destroying the ceramic base.

WRITE FOR TECHNICAL BROCHURE.

These are only a few of the many ceramic materials and techniques that are available to you now. Suggestions on how precision ceramics may be used to advance the state-of-the-art of your systems are listed below.

We will be happy to discuss precision ceramics with you. Write for our technical brochure, or if you have a specific use in mind, send us details and we will analyze them to determine how precision ceramics may be applied to improve your system. Write Honeywell, Dept. 671-H, 2600 Ridgway Road, Minneapolis 40, Minnesota.



FREE BROCHURE

HONEYWELL PRECISION CERAMICS OFFER MANY ADVANTAGES FOR:

PIEZOELECTRICS

- | | |
|---------------------------------------|--------------------------|
| Ignition Systems | Sonar Listening Elements |
| Voltage Sources | Strain Gages |
| Ultrasonic Cleaners, Welders, Cutters | Depth Gages |
| Accelerometers | Pressure Sensors |
| Sound Detectors | Liquid Level Gages |
| Sound Emitters | Surface Gages |
| Sonar Drive Elements | Switches |
| | Fuzing Elements |

STRUCTURAL CERAMICS

- | | |
|--|---|
| High Temperature Heat Exchange Media | Precision Shaped Structural Members, such as Gimbals, Housings, Bearings, Seal Rings, Cylinders, Dies |
| Electronic Micro Module Substrates | Precision Orifices and Valve Components |
| Precision Shaped Electrical Insulators | Precision Gages |
| Radomes | |
| Antenna Housings | |

CERAMIC TO METAL SEALS

- | | |
|------------------------------------|---|
| Specialized Vacuum Tube Bases | Electrical Connectors, Terminals, Headers |
| Metal to Ceramic Structural Joints | Precision Coatings |
| Electrical Circuit Boards | Aerospace Vehicle Window Seals |

Honeywell

NEW TECH DATA

for Engineers.

Instrument Catalog

Catalog No. 6201-A, 20 pages, 2 colors, lists a line of revised rectilinear instruments that utilize the RECTIGraph translating mechanism. Listed are types, applications, case styles, chart drives, and measuring elements. Esterline Angus Instrument Co., Inc., Box 596, Indianapolis 6, Ind.

Circle 259 on Inquiry Card

Mica Capacitors

Bulletin 528 presents specs. on miniature mica capacitors. Available in feed-thru and stand-off styles, they offer a 31.5% reduction in size when compared to the conventional Button® mica capacitors. Available in 5pf thru 1000pf; closed tolerance to $\pm 20\%$; 250vdcw. Eric Resistor Corp., 644 W. 12th St., Erie, Pa.

Circle 260 on Inquiry Card

Thermistors

"VECO Rod Thermistors," gives detailed information on rod thermistors with Beta values from 1200 to 4170 and resistance values from $2\frac{1}{2}\Omega$ to $2\frac{1}{2}$ megohms. Specs, resistance-temp. tables, resistance-temp. characteristics graphs are given. Victory Engineering Corp., 124-28 Springfield Ave., Springfield, N. J.

Circle 261 on Inquiry Card

Coaxial Cable

This sheet lists RG-189/U to RG-306/U numbers applicable to air dielectric coaxial cable. Forty-seven government designations are matched with the manufacturer of the appropriate cable and its designation. Phelps Dodge Electronic Products Corp., 60 Dodge Ave., North Haven, Conn.

Circle 262 on Inquiry Card

Pin and Connector Guide

This 12-page booklet is the result of an intensive study into the needs of those using crimped pin and socket connections. It contains a step-by-step illustrated discussion of the field, including the latest in tools. It makes a comparison between the advantages and disadvantages of soldering vs. crimping. Buchanan Electrical Products Corp., Hillside, N. J.

Circle 263 on Inquiry Card

Transistor

The 2N2887 delivers 10w. of r-f power at 100mc with a collector efficiency of 50% min. from a 45v. power source. It features an isolated collector in a double-ended power package. Detailed specs. are available from TRW Electronics/Pacific Semiconductors, Inc., 14520 Aviation Blvd., Lawndale, Calif.

Circle 264 on Inquiry Card

Crystal Detector

This bulletin covers the Model 148 crystal detector used as a readout device for operation in the 30 to 1200mc range with 50 Ω coaxial lines. It also operates as a demodulator for amplitude or pulse-modulated waves. VSWR ranges from less than 1.2 to 1.5 across the full freq. range. Sensitivity and vswr curves are given. Sierra Electronic Operations, Philco Corp., Menlo Park, Calif.

Circle 265 on Inquiry Card

Regulated Soldering Tip

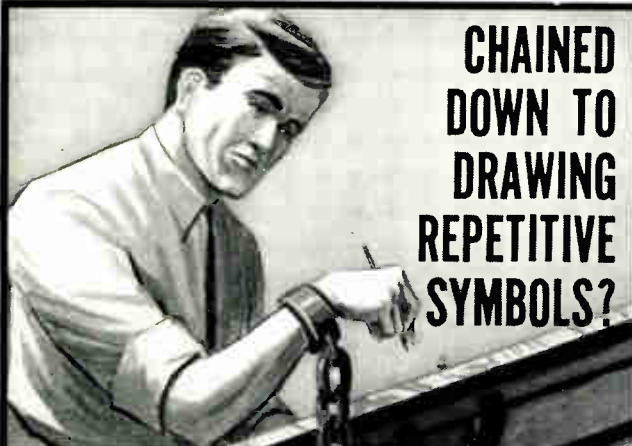
This temp.-controlled soldering iron has a solid-state device in the tip to regulate power. Temp. and power inputs can easily be read on instruments connected to the iron. The iron can "idle" at low temps. and produce high-heat input when needed. Data from General Electric Co., 901 W. Burlington Ave., Western Springs, Ill.

Circle 266 on Inquiry Card

Transistorized Power Supply

Data sheet describes 1 cu. in. power supply which gives isolated 28v regulated dc from 115v, 400 cps source. It can supply current up to 200ma Kearfott Div., General Precision Aerospace, Little Falls, N. J.

Circle 267 on Inquiry Card



CHAINED DOWN TO DRAWING REPETITIVE SYMBOLS?


STANPATs save you money in drafting time

Valuable man hours pile up when routine details have to be continually drawn. Now, with amazing STANPAT, engineers and draftsmen save hundreds of man hours each week.

Your own repetitive symbols and drawing details pre-printed for instant use . . . can be applied in seconds, rather than drawn in hours. Three hours can actually be reduced to 15 seconds! That's why STANPAT is used by thousands of companies, in every industry.

Prove it yourself . . . send for STANPAT literature and samples, or enclose your symbols for quote.

STANPAT COMPANY
Whitestone 57, N.Y., Dept. C10, tel. 212-359-1693



Circle 54 on Inquiry Card



It stands alone

You can't buy HYDRAZINE-ACTIVATED FLUX® or Core Solder under any other brand name. Fairmount is the sole producer.

Hydrazine-Activated Flux and Core Solder offers an exclusive combination of advantages:

- High wetting properties for good "bite."
- Non-corrosive connections.
- Residues removed by heating or water rinse.
- No change on aging.

These performance characteristics were confirmed in a recent evaluation of leading fluxes used in the fields of printed wiring and etched circuitry.

No one flux is best for all purposes. **TEST HYDRAZINE FLUX AND CORE SOLDER FOR YOURSELF.** The liquid permits pre-fluxing, is useful for soft-soldering a wide range of copper and copper-based alloys. The core solder flows at an ideal rate, leaves a minimum of soldering residues. Write for samples of either, or technical literature.

•U.S. Patent No. 2,612,459 and others

Fairmount
CHEMICAL CO., INC.
136 Liberty St., N. Y. 6, N. Y.

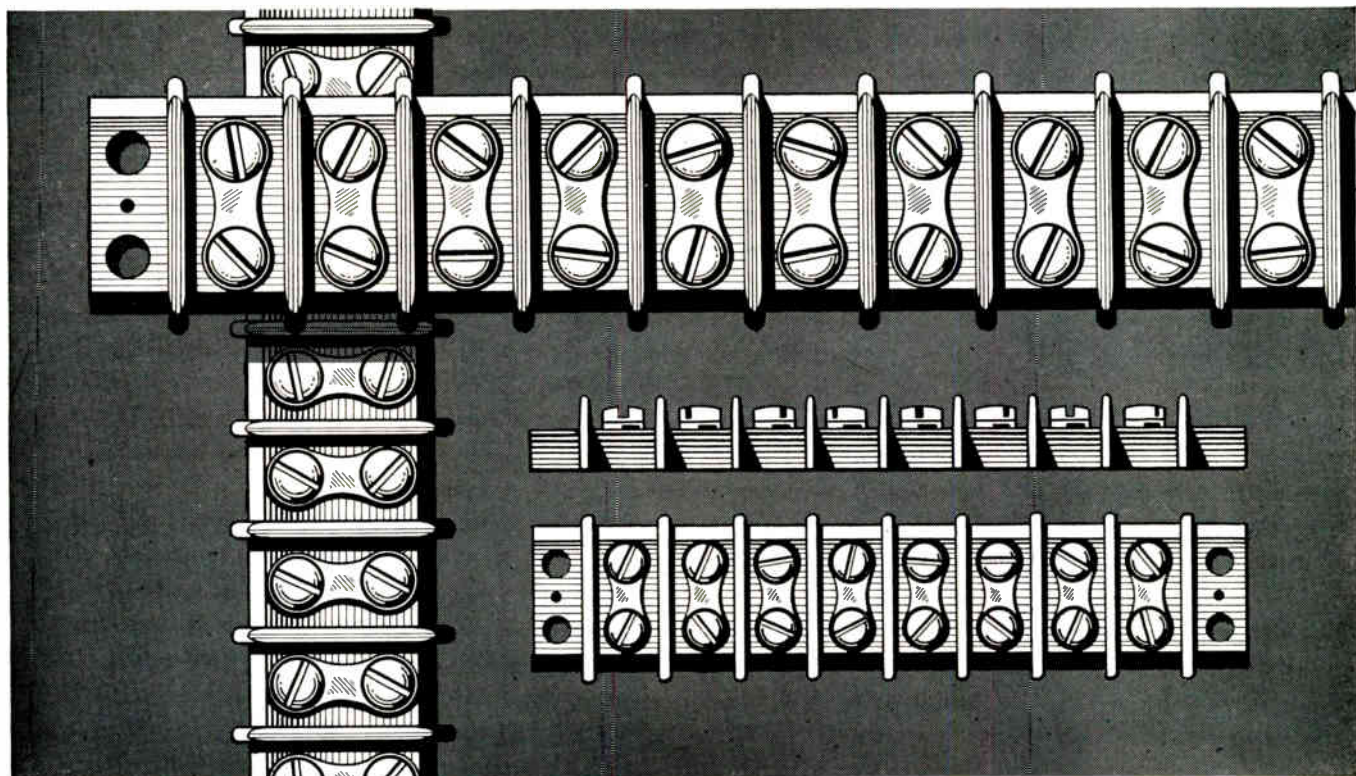
Available only from Fairmount and its sales agents.

Circle 55 on Inquiry Card

NEW GEN-PRO 700 SERIES INDUSTRIAL TERMINAL BOARDS

ALL SIZES AVAILABLE NOW FOR
TIMED DELIVERY AS NEEDED

Superior features • Competitively priced • Conveniently packaged



When you need terminal boards for any application, rely on Gen-Pro's great new 700 Series for the quality and interchangeability you want—on Gen-Pro's unique timed delivery for prompt as-needed shipments. Greater length—up to 46 terminals—permits a larger number of connections than ever before possible. Thicker, stronger barriers with rounded corners reduce breakage—creepage path is longer—saddle plates available for more secure mounting. All sizes and variations in number of stations—packaged in lots of 5, 10 and 20. The boards of your choice are delivered from stock in the quantities you require—when you need them. All types of hardware and special molding compounds are available in addition to standard-purpose phenolic. Write today to Dept. SMMD for illustrated literature.

Your assurance of quality.

700 Series terminal boards are subject to the same rigorous quality control procedures as Gen-Pro's famous 400 Series — the finest commercial terminal boards available anywhere today.

700 SERIES TERMINAL BOARDS

Model No.	Voltage, RMS	Terminals
740	1200	1-46
741	1600	1-39
742	2500	1-30
764*	1600	1-46

*6/32 screws



**GENERAL
PRODUCTS
CORPORATION**

UNION SPRINGS, N.Y.

TWX No. 315-999-1455
Phone: (area code 315) TT9-7367.

NEW PRODUCTS

SYNCHRONOUS MOTORS

The 60 and 400 cycle units operate from 900 to 24,000 rpm.

The size 15 hysteresis motors are 2-phase, 115v units. They are supplied with either plain or pinion shafts, the latter being a 15-tooth, 96 pitch type. Motors maintain constant speed. Kearfott Div., General Precision Aerospace, 1150 McBride Ave., Little Falls, N. J.

Circle 276 on Inquiry Card

POWER MODULE

Converts 115vac to any desired output from 5 to 3660vdc.

Model G6D is an unregulated unit that uses true hermetic sealing, full encapsulation, silicon-type semiconductors and transformers. It meets the environmental needs of Mil-E-5272C. Power rating is 60w. Abbott Transistor Laboratories, Inc., 3055 Buckingham Rd., Los Angeles 16, Calif.

Circle 277 on Inquiry Card

STANDOFF TERMINAL

An overall height of 0.531 in. makes it ideal for miniature chassis.



The ST-SM-27-TUR Press-Fit Teflon[®] standoff terminal has a 3 turreted lug separating the areas for wire soldering. It can be inserted into a 0.238 in. (± 0.002 in.) dia. hole countersunk 60° for metal chassis 0.040 in. or thicker. For chassis under 0.040 in. thick, an 80° countersunk hole 0.260 in. ($+0.010$ in. -0.000 in.) in dia. Sealectro Corp., 139 Hoyt St., Mamaroneck, N. Y.

Circle 278 on Inquiry Card

MICROCHOPPER

May be plugged in or soldered; can be driven from dc to 100kc.

The Model 20 fits into a standard 5 pin transistor socket. The encapsulated unit connects and disconnects a load from a signal source. It may be used as a synchronous demodulator to convert an ac signal to dc. Solid State Electronics Co., 15321 Rayen St., Sepulveda, Calif.

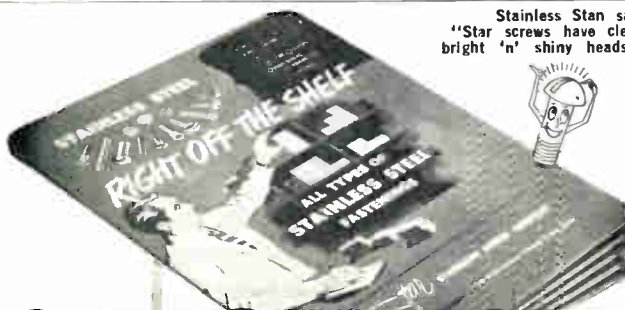
Circle 279 on Inquiry Card

PRESSURE CONTROL

Differentials of 0-30 in. Hg vac, 0-6psi, 0-40psi, or 0-90psi.

The J21K maintains a system differential between 2 separate pressure-vacuum sources, and sensitively transmits a signal (alarm, light, etc.) and/or shuts on or off equipment. On-off operating differentials are from 1/2 ($\pm 1/10$ in. Hg) to 3 (± 1 psi), depending on model. United Electric Controls Co., 85 School St., Watertown 72, Mass.

Circle 280 on Inquiry Card



Stainless Stan says "Star screws have clean bright 'n' shiny heads."

GET YOUR COPY

- STAINLESS STEEL
300 & 400 Series
- AN Drilled Fillisters
 - Bolts
 - Cap Screws
 - Cap, Socket Head
 - Cotter Pins
 - Dowel Pins
 - Hinges
 - Machine Screws
 - Nuts
 - Set Socket
 - Sheet Metal Screws
 - Stud Bolts
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 - Washers
 - Wood Screws

STAR'S CATALOG OF *Right-off-the-Shelf*® STAINLESS STEEL FASTENERS

Save time . . . save money. This book lists over 8,000 stainless steel fastenings available for immediate delivery RIGHT OFF THE SHELF®!

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Phone: (201) CLIFFORD 6-2300
Direct New York Telephone: WISCONSIN 7-6310
Direct Philadelphia Telephone: WALNUT 5-3660

Circle 60 on Inquiry Card

Weckesser Cable Clamps



In Stock—
Complete
Range of Sizes...

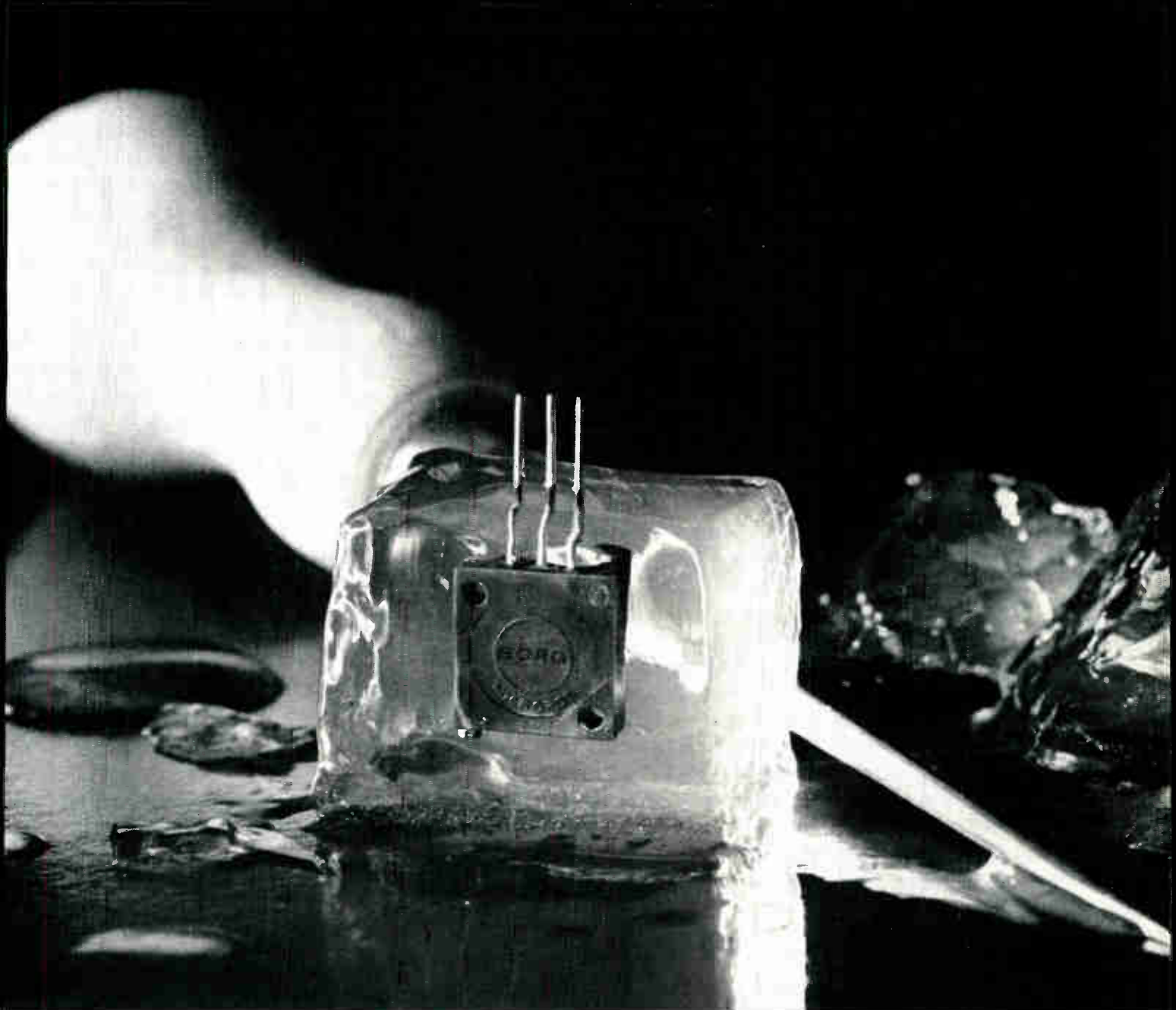
NYLON • ETHYL-CELLULOSE
BUTYRATE • TEFLON

Write for Free Samples, Prices, Complete Details

Weckesser COMPANY, Inc.

5711 Northwest Highway • Chicago 46, Illinois

Circle 61 on Inquiry Card



Freeze it. Wet it. Heat it. Jar it.

Here's why you can practically do anything to this new 1/2" square Micropot® trimmer:

SILVER BRAZED TERMINATIONS—no fine wire connections

POSITIVE, NO-SLIP WIPER POSITIONING—dent prevents movement even under severe shock and vibration

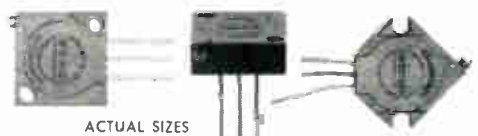
CLUTCH MECHANISM PREVENTS DAMAGE at end of travel

BONDABLE TEFLON LEADS assure most reliable possible sealing

SPECIAL HIGH TEMPERATURE (DU PONT ML) INSULATION between mandrel and resistance element prevents catastrophic failures

Where else can you get a 1/2" square trimmer with all these features—in your choice of terminal configuration? The subminiature Model 2900 Micropot trimmer is designed to meet all requirements of MIL-R-27208A. It is humidity-proof, dustproof, and shockproof to 100 g's. You can take it down to -65°C or heat it up to 175°C.

Now scan this trimmer's specs. Interested? Phone your nearby Borg distributor. Or drop a line to R. K. Johnson, Sales Manager.



Resistance values.....10 to 100 K ohms
Resistance tolerance..... ± 5%
Power rating....1 watt at 70°C, 0 watt at 175°C
Resolution of adjustment.....1.0% to 0.084%
Mechanical adjustment.....25 turns nominal
Temp coefficient of Pot.....30 ppm/°C nominal
Operating temperature range.. -65 to +175°C
Humidity—proof.....MIL-R-27208A
Mechanical stops...clutch allows contact idling

Circle 62 on Inquiry Card



BORG ELECTRONICS

A Division of Amphenol-Borg Electronics Corporation,
Janesville, Wisconsin

NEW PRODUCTS

SILICON DIODE RECTIFIER

Full-load operation even if one diode in each leg fails.

The assembly maintains adequate peak-reverse voltage ratio with suitable protection against commutation spikes and switching surges. It includes diode current-limiting fuses, balancing reactors, neon indicating lamps and overtemp. thermostats. Faulty individual diodes are cut out in less than 1 cycle by the fast-acting fuses. Diode voltage drop is 1v. Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

Circle 281 on Inquiry Card

CAPACITOR

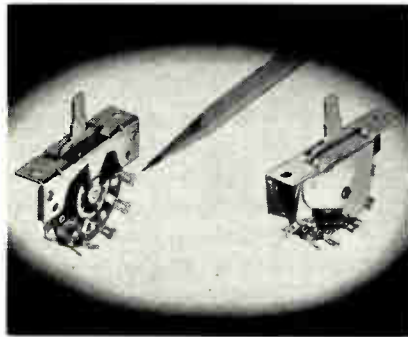
Temp. coefficient is 0 (± 25 ppm); capacitance from 10 to 1000pf ($\pm 5\%$).

The VY-Z capacitor has end radial lead configuration for use where board space is critical. Conforms to Mil-C-11272. Operates at 50vdc; temp. range is -55°C to $+125^{\circ}\text{C}$. Vitramon, Inc., P. O. Box 544, Bridgeport, Conn.

Circle 282 on Inquiry Card

LEVER SWITCH

Current-carrying capacity is 9a.; current rating at 115vac is 230ma.



The PA-222 lever switch is available in 2 or 3 positions—positive detent and spring-return with up to 12 contacts/switch. At 12vdc the make-and-break resistive load is 3.5a.; average initial contact resistance is 5 milliohms. Centralab, The Electronics Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.

Circle 283 on Inquiry Card

VIDICON TUBE

Useable pictures with face-plate illumination of 0.1 ft.-candle.

The type 8483 is a 1-in. vidicon capable of 900 line resolution. Used for black and white or color TV cameras. It uses magnetic focusing and deflection, and possesses an average gamma of 0.6. This tube has very good microphonic characteristics. Suitable for transistorized cameras. Amperex Electronic Corp., Tube Div., 230 Duffy Ave., Hicksville, L. I., N. Y.

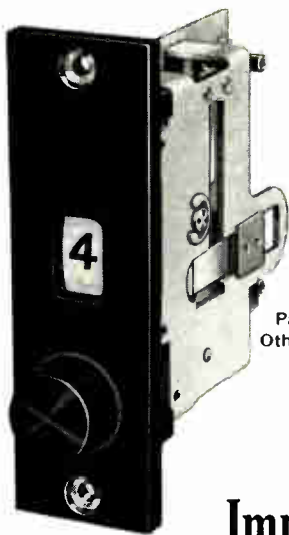
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CRYSTAL OSCILLATORS

Available in 1.0 to 5.0mc range; crystal Q is in excess of 1 million.

Model JKT0-60 features a proportional-controlled oven combined with a Dewar flask, offering low oven power consumption with a very close non-cycling temp. control. Unit requires 0.75w. max. at -30°C . Daily aging stability is 1×10^{-8} or better. The James Knights Co., Sandwich, Ill.

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Patent No. 3104299
Other Patents Pending

Impervious

The sealed front panel portions of Series PSB binary and decimal rotary push button switches are completely impervious to dust and liquids. Ten-positions. Ideal for limited space—require only 1" panel space per module. Simply press button to operate. Data sheets available.

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TRYGON Half Racks



Model HR40-5A

Model	Volt	Amps	Regulation	Ripple	Price
HR20-1.5*	0-20	0-1.5	0.01% line	0.25 mv	\$164
HR40-750*	0-40	0-0.75	0.05% load	0.15 mv	\$149
HR20-5A	0-20	0-5	0.01% line 0.01% load	0.5 mv	\$299
HR40-2.5A	0-40	0-2.5			\$299
HR40-5A	0-40	0-5			\$349
HR60-2.5A	0-60	0-2.5			\$379

*Single Meter Units

... the most versatile power supplies going!

In the lab—you'll find you can't beat a Trygon Half Rack for versatility and low cost! Want constant voltage with adjustable current limiting? You've got it! Want constant current with adjustable voltage limiting? You've got it! Want to select voltage and current with a remote control? You've got this too!

But check the features at the right—and the prices—for yourself. And remember—every Trygon power supply, large or small, goes through the same test procedures before shipment. Each is aged—burned in; each is subjected to stability runs. Each must pass shock and vibration tests—your assurance of long, trouble free performance along with versatility.

In a system—you merely take off the Half Rack dust cover, reverse it, add an inexpensive Trygon adapter, and you have a unit that slides right into a rack. What's more, you can place two Half Racks in a 19" rack width, occupying only 5¼" of panel height.

For complete specs—on the Half Rack Series as well as our catalog showing the complete line of over 100 Trygon Power Supplies, write to us today. Address: Dept. EI-7.



Two Trygon HR20-1.5's, rack-mounted side by side.

FEATURES

- **CONSTANT VOLTAGE OPERATION** with adjustable current limiting.
- **CONSTANT CURRENT OPERATION** with adjustable voltage limiting.
- **COMPLETE RANGE REMOTE PROGRAMMING** furnishes voltage and current selection from a remote control.
- **REMOTE SENSING** provides rated regulation at the load, available at both front and rear terminals.
- **HIGH RESOLUTION** for setting current and voltage is provided by coarse and fine adjustments for both (4 controls).
- **AUTOMATIC OVERVOLTAGE PROTECTION**—Trygon's unique over-voltage protection is available as an option.

TRYGON

ELECTRONICS INC.

111 Pleasant Avenue EI-7 Roosevelt, L.I., N.Y.
(516) FReeport 8-2800 TWX (516) 868-7508



NEW PRODUCTS

INDUCTION MOTORS

The 264 frame size has from 1/100 to 1/12 hp; the 33A has 1/50 to 1/5 hp.

The A-line induction motors include 26 and 33 frame motors, cover 2, 4 and 6-pole speeds, and are offered in permanent split capacitor, split phase, capacitor start, capacitor start-capacitor run, and polyphase types. Howard Industries, Inc., 1760 State St., Racine, Wis.

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PHASE MODULE

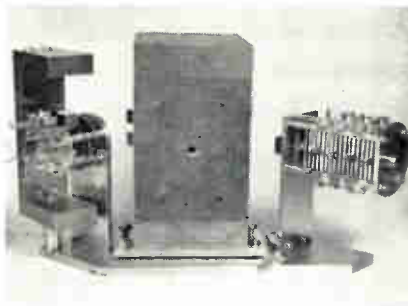
Continuously shifts the phase angle of an r-f signal from 0° through 360°.

The Variogon Series V-56A can be dialed manually or driven at speeds up to 5000 rpm. They produce continuous time delays or phase variation that are directly proportional to dial rotation. The units contain electrostatic type phase-shifters with phase-splitting networks. Special capacitor allows shifting without brushes. Nilsen Mfg. Co., P. O. Box 127, Haines City, Fla.

Circle 287 on Inquiry Card

MASS SPECTROMETER

Supplied with a completely open ion source and detector.



The MB Type "Nude" mass spectrometer is 14 x 7 x 10 in., and can be installed in any experimental vacuum chamber and oriented there in any manner. It detects pressures lower than 10^{-13} Torr; has a mass range of 1-85; and uses a stainless-steel-sheathed or gold-coated internal magnet. Nuclide Corp., 642 E. College Ave., State College, Pa.

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MULTI-SWEEP OSCILLATOR

Provides a full 30mc of swept-freq. output by FM techniques.

The model 159-A is a wide-range video VTR sweeping oscillator. It provides a linear swept freq. output and AGC. Includes provision for the insertion of external oscillators to generate variable birdie-bypass type markers on all freq. Freq. controlled by external dc-15kc. Calibrated freq. dial allows usage as an RF-VIDE oscillator. Kay Electric Co., Maple Ave., Pine Brook, Morris County, N. J.

Circle 289 on Inquiry Card

AVALANCHE RECTIFIER

Peak reverse voltage is 1000 to 1500; max. forward current is 1.6a.

Series 11 diode features top hat construction with a gold plated, hermetically sealed case. Dimensions are in accordance with JEDEC DO-1 outline. Syntron Co., 263 Lexington Ave., Homer City, Pa.

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HIGH-PRECISION CIRCUIT BOARD DRILLING MACHINE

42,000
Precision
Holes Per
Hour with
Outstanding
Reliability



The Quad-Drill is a four spindle precision circuit board drilling machine that is used for both long and short run production. Holes can be produced at the rate of 42,000 per hour while maintaining hole location on each spindle to within .001 inch of true template position. Has many other features that will increase production, cut cost and increase profits on every job. Write for specifications today.



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by *V/S*



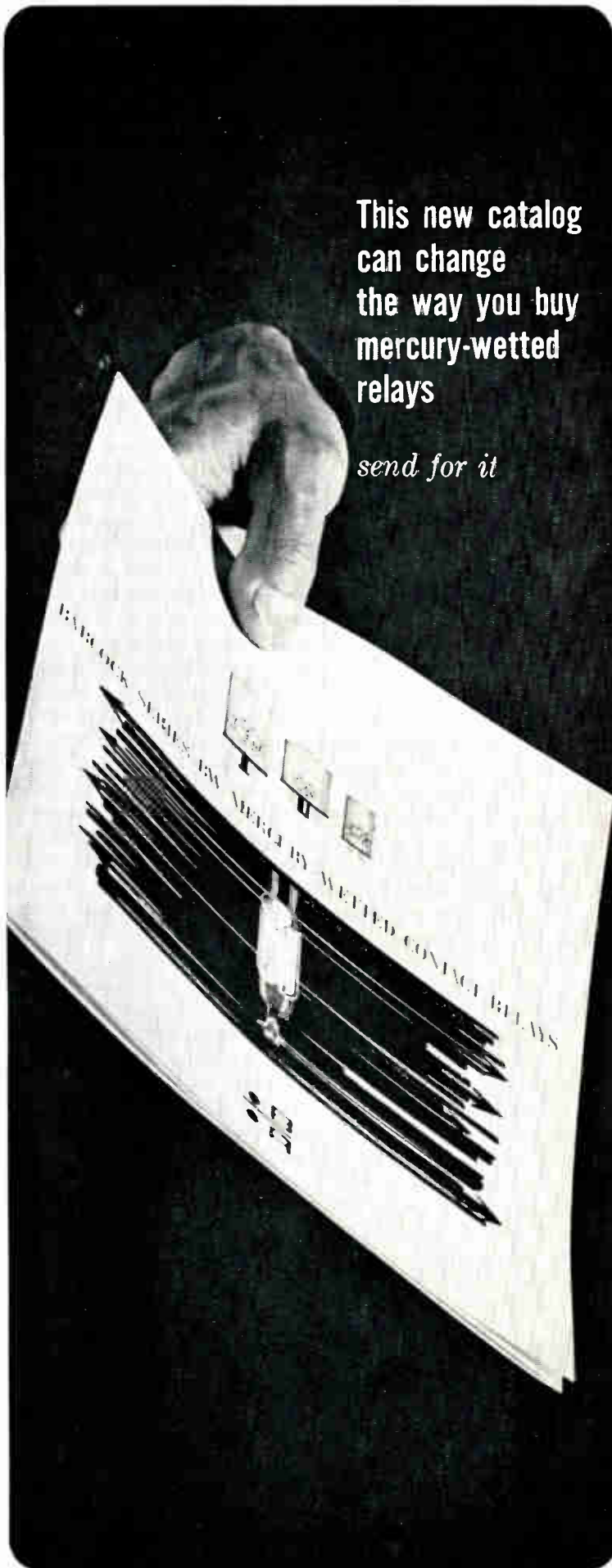
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DEUTSCH

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A new standard of excellence in mercury-wetted relays

Babcock's new non-bridging, mercury-wetted contact relays are designed for the high speed switching requirements of computer, control, and data processing applications. Operating at speeds as high as 1 millisecond or on power as low as 1.2 milliwatts, these high performance relays have a contact breaking acceleration of 1500 Gs.

Featuring Babcock's new form C mercury switch element, Series BW relays provide billions of trouble-free operations, constant contact characteristics and permanent low contact resistance without erosion, bounce or chatter.

An exclusive Babcock feature offers a wide variety of special adjustments.

Five models are available, each designed to meet specific applications.



Model BW-2: A single switch unit housed in a 1.234" steel container. Available in a wide range of single-side stable, bi-stable and chopper adjustments.



Model BW-3: Similar to the BW-2, but housed in a shorter steel container. Designed for use where mounting space is limited.



Model BW-4: A seven pin, miniature plug-in relay measuring only .625" (dia) x 1.891". Recommended for use in military and commercial applications where small size is a critical factor.



Model BW-5: Module form designed for printed circuit board applications. Plated steel enclosure can be grounded to provide both mechanical protection and magnetic shielding.



Model BW-6: Similar to the BW-5 but housed in an epoxy filled molded nylon enclosure for cooler operation. Recommended for applications where caustics and solvents are involved.

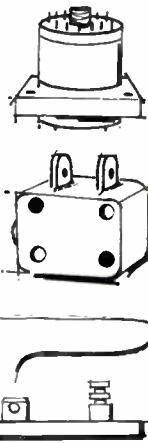
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**SINGLE OR GANGED LIT-SWITCHES
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Utilizes T-1 1/4 Bulbs, MS 25237-327-328, etc. No special tools are required for assembly in the panel or for changing bulbs. No screws are required through the mounting panel. The Lit-Switches are available with momentary or push-on-push-off actuation or solenoid operation and with Lock and Interlock. Matching Indicator Lights are available. Lit-Switches are ganged at no extra cost.

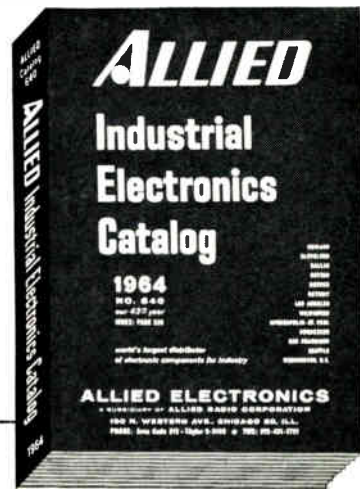
For complete specifications, write to Dept. EI1063.

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ELECTRONIC INDUSTRIES • October 1963

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SA-84WA
10-63,680 mc

This instrument was the microwave "hit" last August at WESCON. They were standing three deep to see it in October, at N.E.C. At NEREM, in November, we were demonstrating it **continuously**. At IEEE, eight months after its introduction, it was a **standout** attraction!

Why? Because it **stands alone**. No other manufacturer offers, in a single standard instrument, the complete complement of performance characteristics placed at your command by this **fully-equipped, truly quantitative** spectrum analyzer.

truly **Q**uantitative Universal Microwave Spectrum Analyzer

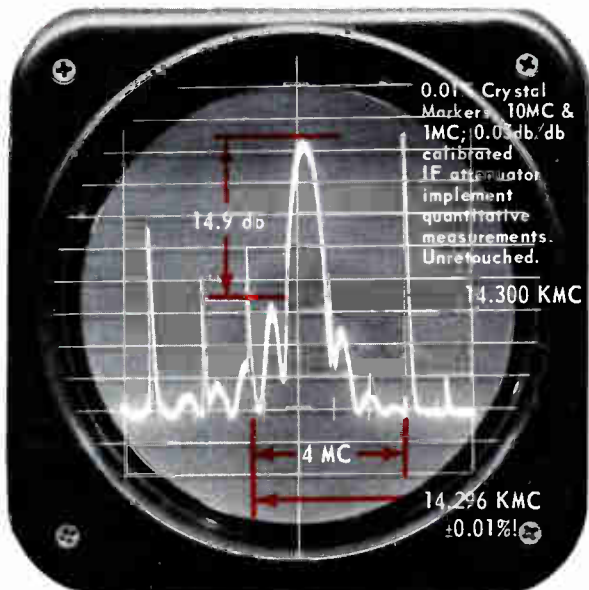
This exclusive combination of features is not merely desirable — it is **essential**, if you are to make **full use** of the enormous range of measurement capabilities inherent in spectrum analyzer techniques. As a minimum, for **truly quantitative** measurements, you must have:

- **ACCURATE CRYSTAL MARKERS** . . . $\pm 0.01\%$ in the SA-84WA!
- **ACCURATE IF ATTENUATION** . . . ± 0.05 db/db accuracy in the SA-84WA!
- **WIDE FREQUENCY RANGE** . . . 10-63,680 mc in the SA-84WA!

- **HIGH MAXIMUM SENSITIVITY** . . . to -115 dbm in the SA-84WA! (defined in the only **meaningful** way: $S + N = 2 \times N$)
- **CALIBRATED WIDE-RANGE DISPERSION** . . . over 80 mc in the SA-84WA!
- **WIDE-RANGE VARIABLE RESOLUTION** . . . 1-80 KC in the SA-84WA!
- **LOG/LINEAR AMPLITUDE SCALES** . . . to 36 db log display in the SA-84WA!
- **WIDE-RANGE VARIABLE-FREQUENCY MARKERS** . . . ± 40 mc in the SA-84WA!

We can only touch the high spots here — but our brand-new 40-page Spectrum Analyzer Bulletin A63 gives the complete specifications. Use this card — we'll send your copy by return mail!

Incidentally, we make seven classes of spectrum analyzers, in 35 standard versions, hundreds of standard variations. Turn the page for a brief summary.



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I may have an immediate requirement—have my local Polarad field engineer get in touch with me. (My telephone extension is _____.)

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Choose from the industry's largest, most complete line of microwave spectrum analyzers. Choose the exact price/performance combination to meet your needs, without compromise, without excessive cost. Remember, only Polarad makes them all — because Polarad originated and pioneered the microwave spectrum analyzer . . . and Polarad has consistently led the way in extending the range, the versatility, and the scope of applications of spectrum analysis. Experience really counts, too, when you must have reliable, accurate, "bug-free" measuring capability . . . and there are more Polarad microwave spectrum analyzers in service than all other types combined!



MODEL	PRICE	Config-uration	Freq. Range	Resolution	Dispersion	Display	Additional Features	Max. & Min. Sensitivity (S+N=2XN)	REMARKS
TSA	\$3,990.*	Multiple PLUG-IN HEADS	10 mc to 40 gc	1 kc to 80 kc	100 kc to 25 mc	LIN-LOG	Video Filter	-115 dbm to -50 dbm	Lowest cost analyzer for specific frequency application.
TSA-W	\$4,335.*	Multiple PLUG-IN HEADS	10 mc to 44 gc	1 kc to 80 kc	25 kc to 80 mc (25 mc on STU-1 band)	LIN-LOG	Sweep and Video Outputs. Video Filter	-115 dbm to -50 dbm	Lowest cost analyzer for specific frequency application requiring wide dispersion.
TSA-S	\$4,635.*	Multiple PLUG-IN HEADS	10 mc to 44 gc	Spect. Anal. { 5 kc 50 kc Syn-500 kc chro. 5 mc	400 kc to 25 mc	LIN	Sweep and Video Outputs. Trigger Output	-105 dbm to -50 dbm	Combined spectrum analyzer & synchroscope for frequency & time domain displays.
SA-84	\$5,000.	Universal MULTI-BAND	10 mc to 40.88 gc	25 kc	500 kc to 25 mc	LIN	Military Standard UPM-84	-90 dbm to -40 dbm	Lowest cost analyzer for wide frequency coverage
SA-84T	\$5,650.	Universal MULTI-BAND	10 mc to 40.88 gc	20 kc	500 kc to 25 mc	LIN	41 DB Calibrated IF Attenuator	-105 dbm to -55 dbm	Transistorized, portable, battery or line operated, wide frequency coverage.
SA-84W	\$6,290.	Universal MULTI-BAND	10 mc to 40.88 gc	1 kc to 80 kc	25 kc to 80 mc (25 kc to 100 mc on special order \$100 add'l)	LIN-LOG	20 DB Calibrated IF Attenuators IF & RF Crystal Markers, Video Filter	-105 dbm to -55 dbm	Wide frequency coverage with wide dispersion.
SA-84WA	\$6,490.	Universal MULTI-BAND	10 mc to 63.68 gc	1 kc to 80 kc	25 kc to 80 mc (25 kc to 100 mc on special order — \$100. add'l)	LIN-LOG	20 DB Calibrated IF Attenuator IF & RF Crystal Markers, Video Filter	-115 dbm to -45 dbm	Widest frequency coverage with wide dispersion.

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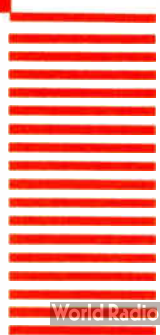
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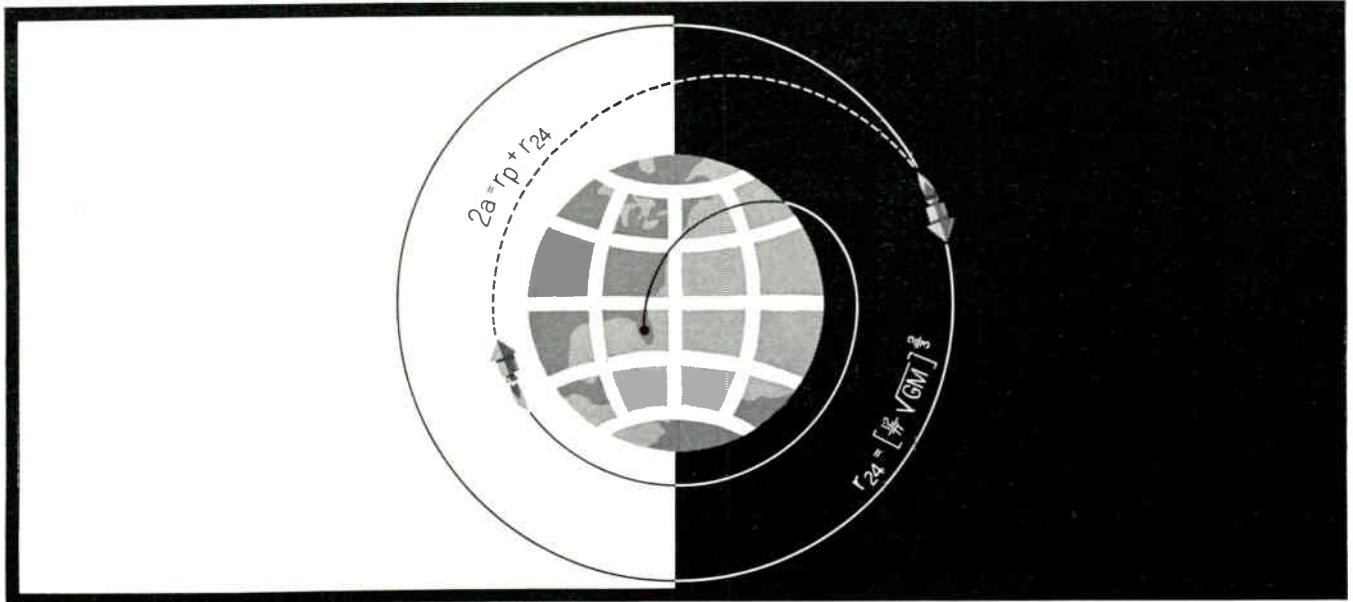
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Milwaukee (Systems Design, Development, Manufacturing)

SYSTEMS ANALYTICAL ENGINEERS—Perform analytical studies of inertial guidance systems, including analysis of system performance requirements, writing system model and error allocation specifications, conducting system simulations on digital and/or analog computers, conducting trajectory studies, and preparing guidance equations. BS, MS or PhD in EE, math and physics plus 2-5 years experience depending upon education.

SYSTEMS MECHANIZATION ENGINEERS—To design and mechanize inertial guidance systems or subsystems. BS, MS or PhD in EE, math or physics with minimum of 2 years aircraft or fire control experience employing closed loop systems, switching circuits and digital techniques.

CIRCUIT DESIGN & ANALYSIS ENGINEERS—To design and/or analyze servo amplifiers, DC operation amplifiers, power converters, feedback amplifiers and pulse circuits. Will work in the area of inertial measurement unit electronics. BSEE plus 3-5 years experience in above field required.

DIGITAL COMPUTER ENGINEERS—Logic design, evaluation of logic techniques, evaluation of memory storage, development of programming format and define computer subsystem functional block diagrams and input-output devices. BS or MS in EE or math and physics and 3-7 years experience in logic circuit design of digital computers.

GYRO ENGINEERS—Thermal and stress analysis of gyro instruments. Analytical ability and 2-5 years gyro design experience necessary. BS or MS in ME or EE.

RADAR SPECIALISTS—Circuit design and analysis of airborne radar systems. Prepare functional block diagrams and define subsystems, analyze and test error budgets, perform analog and digital computer simulations including interfacing of associated subsystems and aircraft performance characteristics. BS or MSEE and 5-10 years radar-radio systems experience.

SCIENTIFIC PROGRAMMERS—Concerned with simulation of guidance and control systems, electronic system design and logic designs. Will perform satellite and trajectory studies, numerical and statistical analysis and systems calibration. BS or MS in engineering, physics or math with 1-3 years experience.

SYSTEMS ENGINEERS—To assist in interface of Apollo airborne and ground support equipment, including the development of test circuits to ensure proper GSE checkout before interface. BSEE, plus 2-3 years related experience required.

MECHANICAL DESIGN & DEVELOPMENT ENGINEERS—To assist in the design and development of Apollo ground handling equipment, Titan GSE consoles, drawers and other hardware. BS or MSME and 2-3 years related experience required.

EQUIPMENT DESIGN ENGINEERS—Design and development of transistorized electronic airborne and GSE equipment on Titan and Apollo projects. BSEE or ME with 2-5 years design experience.

DEVELOPMENT ENGINEERS—Perform engineering development, product support and coordinate design changes. BSEE or ME required.

Boston Advanced Concepts Laboratory (Research & Development)

INERTIAL & SPACE SYSTEMS ENGINEERS—To engage in the analysis, synthesis and mechanization and/or evaluation of advanced inertial navigation systems. Will perform optimization studies, error analyses and systems configuration studies in the field of space navigation, avionics, and attitude control systems. Advanced degree or BS with analytical systems background required. Two or more years experience in inertial systems preferred.

DIGITAL SYSTEMS ENGINEER—To engage in the adaptation of digital techniques to inertial navigation and avionics systems. BSEE and 3-5 years experience in the design of digital control systems required.

MECHANICAL ENGINEER—Design of miniature inertial platforms and gimbal systems. BS and 3-5 years in above field and inertial instrument application.

SR. MECHANICAL ENGINEER—Responsible for the development of inertial instruments through the use of analysis and experimental verification. BSME plus 3-5 years experience in the design and development of precision electromechanical devices.

ELECTRONIC ENGINEER—To design transistor feedback and servo amplifiers, and low level switching circuits. BS or MS and 3 or more years experience in the above field desirable.

SR. METALLURGIST—To work in an expanding group conducting development programs and evaluation of both metallic and non-metallic materials as applied to inertial sensing devices. BS or MS with 3-5 years experience in metallurgical or related area.

ELECTRONIC ENGINEER—To design and develop semiconductor pulse circuits, logic circuits, digital analog circuits and precision DC amplifiers. BS or MS plus 3-5 years experience in above field. Experience in the area of precision electrical measurement desirable.

MATHEMATICAL ANALYSTS—To perform analysis as required in the development of inertial components and systems. BS or MS in applied mathematics plus 1-3 years experience in the development of inertial components and systems. BS or MS in applied mathematics plus 1-3 years experience in the field of mathematical analysis.

PHYSICISTS & ENGINEERS—Excellent positions are available for Senior Physicists and Engineers preferably having advanced degrees and experience in the theoretical and experimental development of precision devices. The particular area of investigation relates the application of mechanics, electricity, nucleonics and physical phenomena to inertial measurement components such as gyros and accelerometers.

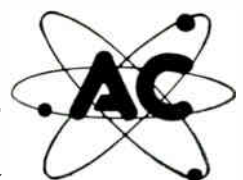
Los Angeles Advanced Concepts Laboratory (Research & Development)

SENIOR SCIENTIFIC PROGRAMMERS—To assist in trajectory analysis and guidance simulation problems. Strong mathematical background and experience on 7090 desired.

SENIOR MECHANICAL ENGINEER—Design of inertial guidance system hardware. BS or MSME with extensive background in thermodynamics and a minimum of 5 years related experience required.

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NEW PRODUCTS

AVALANCHE RECTIFIERS

Max. peak 1-cycle surge overload current is 400a.; *PRV* rating is 400-600V.

In the Type PZ140 rectifiers, avalanche breakdown occurs between 500 and 950v. Max. continuous power dissipation in the avalanche region is 10w.; at 10 μ sec duration the dissipation rating is 5kw. Average forward current is 25a. at 140°C, and 30a. at 100°C. Tung-Sol Electric Inc., One Summer Ave., Newark 4, N. J.

Circle 194 on Inquiry Card

DC POWER SUPPLY

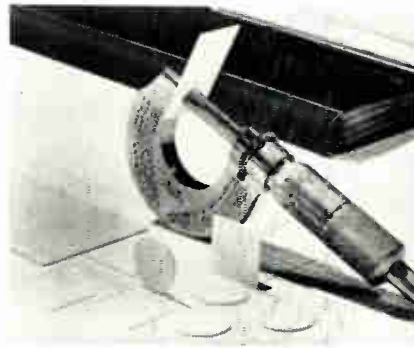
Remote programming and sensing, and continuously adj. current limiting.

The 313A solid-state dc power supply is capable of supplying up to 2a. from 0-50v. with calibration accuracy of 0.01% of its 6-digit in-line readout. The supply has a resolution of 10 μ v (5v. range) and 100 μ v (50v. range) with a stability of 0.002%/hr. and 0.005%/mo. John Fluke Mfg. Co., Inc., P. O. Box 7428, Seattle 33, Wash.

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ALUMINA CIRCUIT BASES

Provides good electrical properties and high resistance to softening.



These flat alumina plates are used as printed-circuit bases for assembly into electronic components. Made from high-purity 96% alumina, they are available in sizes up to 3 in. sq. in thicknesses to 0.008 in. (± 0.0005 in.). All pieces have polished or lapped faces and are made parallel within 0.0005 in. Saxonburg Ceramics, Inc., Saxonburg, Pa.

Circle 196 on Inquiry Card

DELAY RELAY

Standard delays of 5, 10, 15, 20, 30, 45, 60, 75 and 90 sec.

The Thermette is a thermal time-delay relay that fits a 9-pin min. tube socket. It is interchangeable with similar relays. The compensated bi-metal mechanism is enclosed in a shatterproof, dust-tight metal shell. Its contact arrangement is SPST, either normally open or normally closed. The contact rating is 2a. resistive at 115vac or 28vdc. G-V Controls Inc., Okner Pkwy., Livingston, N. J.

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VARACTOR MULTIPLIERS

Power levels up to several watts and spurious rejections of 20db to 30db.

Operating at freqs. from 125mc to 10gc these multipliers are used as single units or cascaded to provide any multiplication to your desired freq. Standard doublers and triplers have 60% efficiency. LEL, Inc., 75 Akron St., Copiague, N. Y.

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AC dielectric strength tests**

of electronic parts and components, small tools, appliances, motors, transformers, etc.

Simple to operate. Make breakdown, leakage and shorts tests to U.L., C.S.A., ASTM, NEMA, IEEE, MIL and EASA standards. 115 vac, 50/60 cycle input. Continuously adjustable output. Included are: complete metering, controls, safety features, case with removable cover, test leads, line cord, instructions.

VISUAL INDICATOR MODELS

Have neon "breakdown" light for breakdown, corona or arcing indication . . . and separate neon "leakage" light for leakage indication. 5 models from 0-1500 to 0-10,000 volts output. Priced from \$137.50 to \$199.50. Model 411 shown.

AUTOMATIC "SQUAWKER" MODELS

Provide audible and visual test indications. 4 models from 0-1500 to 0-6000 volts output. Priced from \$255 to \$290.

Get all facts . . . write for Bulletin 4-1.3

Associated Research, Inc.
Manufacturers of Electrical Testing Instruments since 1936
3787 W Belmont Ave. Chicago 1 60618

Circle 73 on Inquiry Card

DOW-KEY DK60 SERIES COAXIAL RELAYS

Size
2 3/4 x 3 3/4 x 1 1/2
Less than 9 oz.
DK60-C2C



4 Standard Models, AC or DC,
UHF, N, BNC, TNC or C Conn.

Ruggedly built, individually inspected to assure dependability. Quality and versatility make DK60 Series relays adaptable to a multitude of applications, military, industrial and amateur.

COIL RATINGS: 6, 12, 24, 28, 32, 48, 110 and 220 V DC @ 2 watts. 6, 12, 24, 110 and 220 V AC @ 6 VA 50-60 cps. Special coil voltages available on request. Coil terminals are solder connections feed-through insulators.

r.f. RATINGS: 1 kw power rating to 500mc. 20 watt power rating to 500 mc in DK60-G and DK60-G2C in de-energized position. The DK60-G and DK60-G2C have a special isolation connector in the de-energized position to reduce crosstalk to a minimum.

AUXILIARY CONTACTS: Form 2C (DPDT) on DK60-2C and DK60-G2C. Bifurcated contacts rated at 5 amperes at 110-V AC non-inductive.

VSWR: Less than 1.15:1 from 0 to 500 mc (50 ohm load). 72 dbm relays available.

ISOLATION: Greater than 60 db @ 10 mc in DK60 and DK60-2C. Greater than 100 db from 0 to 500 mc in DK60-G and DK60-G2C when in the energized position.

OPERATING TIME: Less than 30 milliseconds from application of coil voltage; less than 15 milliseconds between contacts.

(Also industrial and military requirements modified and built to specifications)

STANDARD RELAYS WITH TYPE UHF CONNECTORS INCLUDE:

DK60-SPDT r.f. switch. \$12.45

DK60-G

SPDT r.f. switch with special "isolation" connector in de-energized position. \$13.70

DK60-2C

SPDT r.f. switch with DPDT auxiliary contacts. \$14.35

DK60-G2C

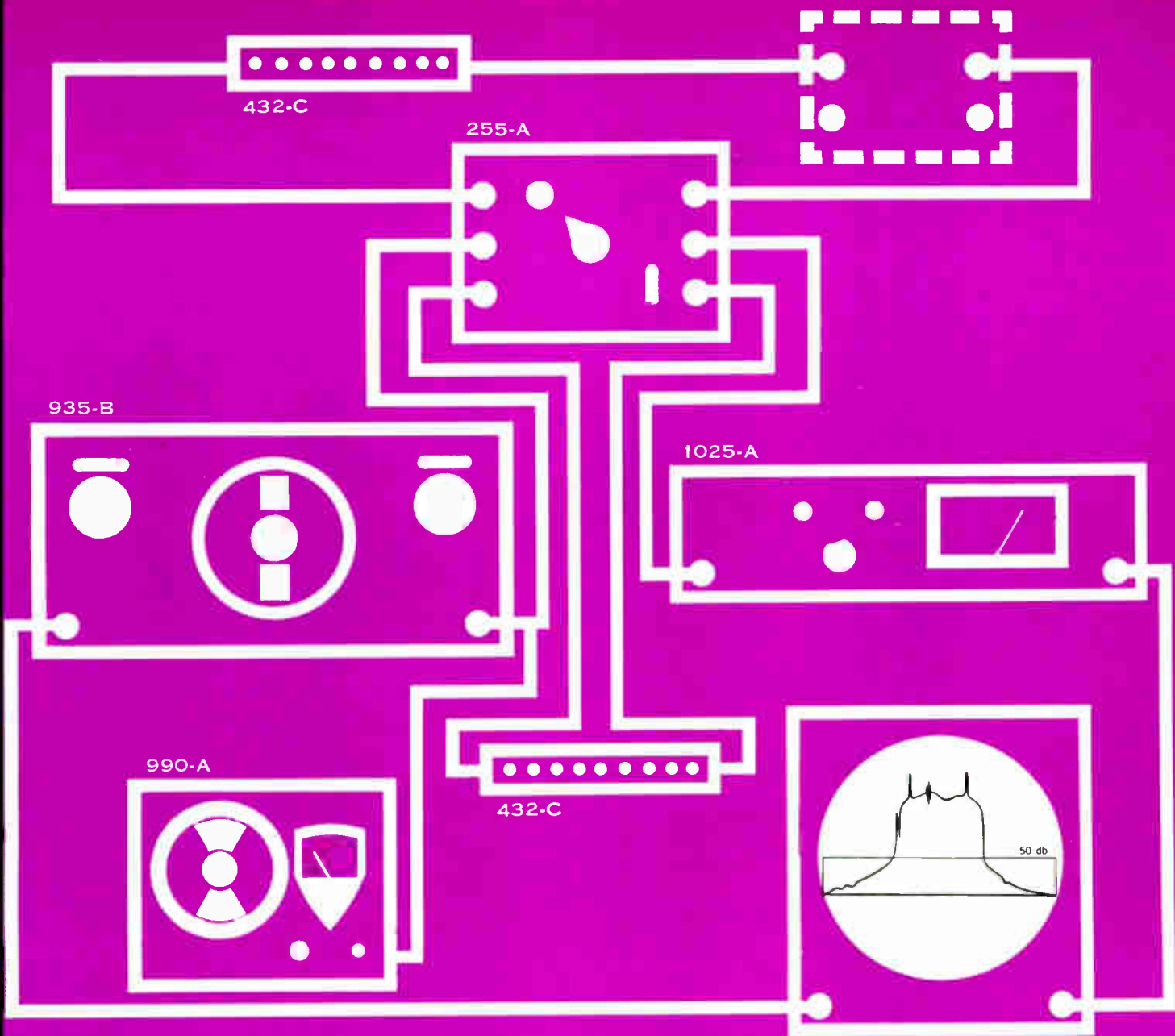
SPDT r.f. switch with DPDT auxiliary contacts and special "isolation" connector in deenergized position. \$15.65

Unconditional Guarantee for 1 year.

Cat. sheets avail. at Dist. and Dealers, U.S. & Can. or write:

DOW-KEY COMPANY
Thief River Falls, Minnesota

Circle 74 on Inquiry Card



Swept, Marked, Logged, Calibrated... by **KAY**

A sharp filter, swept and marked in frequency (fixed and variable) by 935-B and 990-A on the log amplitude display of the 1025-A, with calibrated level line set by the 432-C, switched in by the 255-A.

935-B Sweeping Oscillator

50 cps to 220 mc
Audio Video, VHF

Price: \$1295.00

990-A CW Oscillator

4.5 to 220 mc
1.0V rms, AGC'd

Price: \$373.00

1025-A Log Amplifier

200 kc to 220 mc
80 db Dynamic Range

Price: \$795.00

432-C Attenuator

DC to 500 mc
0 to 101 db in 1-db steps

Price: \$110.00

Write for complete catalog information

KAY
ELECTRIC COMPANY

Maple Ave, Pine Brook, Morris County, New Jersey

Circle 75 on Inquiry Card

255-A Coaxial Electronic Switch

DC to 500 mc
70 db "off" at 200 mc

Price: \$295.00

NEW GERTSCH PHASE ANGLE VOLTMETER



—measures in-phase voltages, quadrature voltages, and phase angles

This versatile instrument accommodates up to 3 frequencies, employing plug-in filters and networks to 10 KC. You can order a single-frequency unit—then add or change frequencies as they are needed.

Variable gain control permits full-scale setting of any voltage from 1 mv to 300V, allowing equivalent angular error to be read directly in degrees and minutes. Ideal for synchro and resolver testing.

Band-pass filtering of both the signal and reference voltages minimizes effects of harmonic distortion, and noise.

Instrument can also be used as a standard VTVM (50 cps to 50 KC), and a phase-sensitive null indicator ($5\mu\text{v}$ sensitivity).

Available with isolation transformers for both signal and reference channels.

“Go”—“no-go” testing—enabled by optional full-scale meter relay.

Complete information on all Gertsch synchro/resolver test instruments in catalog #11—40 pages of technical information, specifications, theory, application data and engineering bulletins. A valuable reference source for design and test engineers.



Gertsch

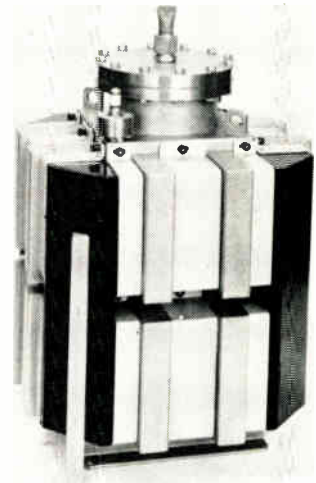
GERTSCH PRODUCTS, INC.

3211 S. La Cienega Blvd., Los Angeles 16, Calif. • UPTON 0-2761 • VERMONT 9-2201

NEW PRODUCTS

ION PUMP

Ion pump has 2 gauss at the flange and 42 gauss max.



This high-vacuum ion pump substantially reduces fringing fields. This reduction allows min. interference from stray magnetic fields to external instrumentation such as linear accelerators, neutron generators and other beam devices. Ultek Corp., P. O. Box 10920, Palo Alto, Calif.

Circle 199 on Inquiry Card

WIRE MARKERS

Fireproof, nonconductive, and resist constant temp. to 300°F.

Self-sticking B-500+ wire markers grab instantly on contact to plastic, rubber or glass-braid insulations, or those which are slip-coated or contain plasticizers. They stay stuck indefinitely. They have fadeproof inks and conform to Mil-E-5272A, Mil-D-10369B, IPCEA-NEMA's new specs. W. H. Brady Co., 726 W. Glendale Ave., Milwaukee 9, Wisc.

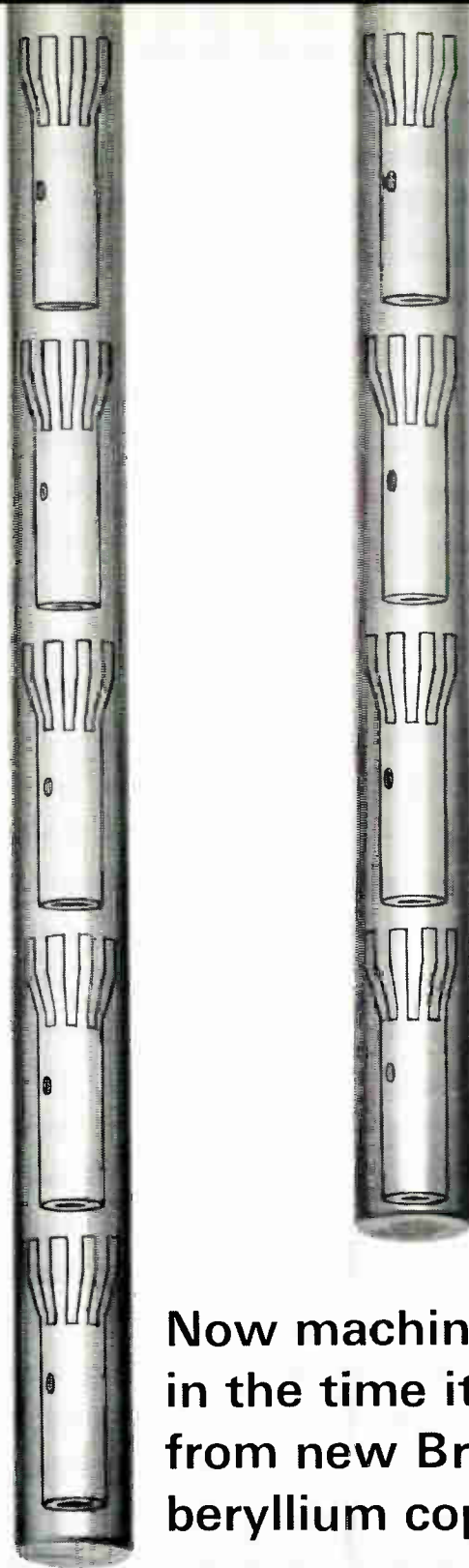
Circle 200 on Inquiry Card

VARIABLE ATTENUATORS

Insertion loss is 5db at 0db setting; max. power rating is 100w.

Model E101 covers the 1 to 2gc range; Model E103, 2-4gc, and Model E105, 4 to 8gc. Attenuation range is greater than 60db, continuously variable in L-, S- and C-bands. Freq. sensitivity is less than $\pm 3/4$ db at min. attenuation with external terminations having vswr less than 1.1:1. Calibration accuracy at midband is ± 0.2 db or $\pm 2\%$, whichever is greater. Alfred Electronics, 3176 Porter Dr., Stanford Industrial Park, Palo Alto, Calif.

Circle 201 on Inquiry Card



Now machine five parts in the time it took to do four from new Brush free-cutting beryllium copper rod

When you need high fatigue strength and hardness uniquely combined with excellent electrical and thermal conductivity, resistance to corrosion and wear, and dependable operation through a wide temperature range . . . you need beryllium copper.

And, when you want all these properties plus a minimum of 25 percent better machinability, specify Brush free-cutting beryllium copper rod.

Our beryllium copper rod costs no more. Its better machinability saves time, extends tool life, reduces waste. We supply it annealed or cold drawn to close tolerances, with controlled metallurgical composition, in lengths to suit automatic machine operations.

Write to us for technical service and information about beryllium copper rod, strip, bar, plate, wire, casting and master alloys; beryllium oxide ceramics and beryllium.

Brush Beryllium Copper 25 Alloy MACHINABILITY RATING*

	turning	drilling	tapping
Annealed	175	200	80
Cold Drawn	125	180	50

*Based on index of 100 for AISI Steel B1112 (cold rolled or cold drawn). Study by Metcut Research Associates, Inc. Copy on request



THE BRUSH BERYLLIUM COMPANY

17876 St. Clair Avenue • Cleveland 10, Ohio

Phone: 486-4200 • Area Code: 216 • TWX: 486-5790

World Radio History

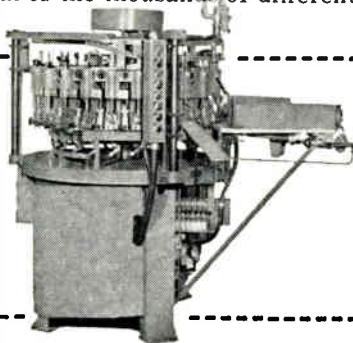
Speed Production... Lower Costs!

with **KÄHLE**

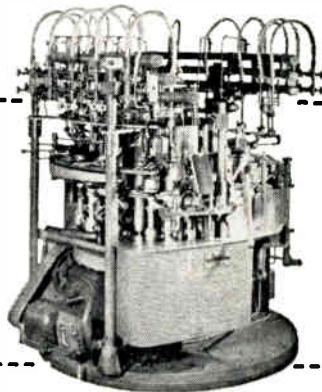
AUTOMATIC PRECISION

ASSEMBLY MACHINES

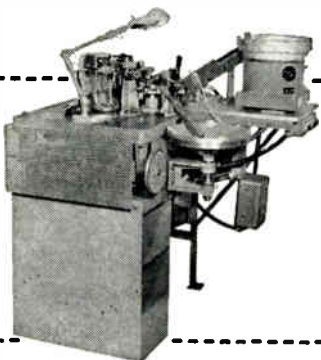
KAHLE service encompasses the complete responsibility for special machine projects from design to final testing. KAHLE designs and builds high efficiency production machines for manufacturers in electronics, glass and general industry. The machines illustrated are typical of the thousands of different types now in use.



Assembly Machine No. 3383—Automatically makes the final seal on crystal diodes. Capacity 2,200 seals per hour.



Sealing-Exhaust Machine No. 2187 — Automatic machine features 16 positions for high speed production.



Assembly Machine No. 3711 — Cat-whisker welder for crystal diode assembly. Automatically welds 3,000 units per hour.

KAHLE Engineers have the Experience and Facilities to Solve Your Production Problems!

Call or write KAHLE for recommendations on your specific assembly and production problems. KAHLE automatic high speed, precision machines are in use by hundreds of leading manufacturers where they have earned an industry-wide reputation for high efficiency and dependable performance!



3320 HUDSON AVENUE, UNION CITY, NEW JERSEY

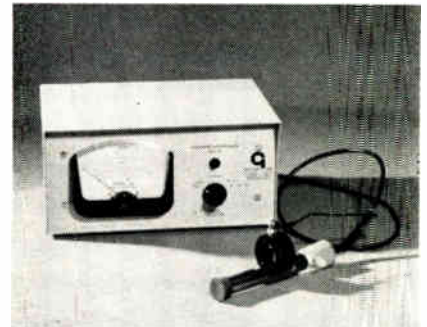
Telephone: UNION 7-6500 (Area Code 201)

DESIGNERS & BUILDERS OF AUTOMATIC MACHINES FOR HIGH SPEED, PRECISION PRODUCTION

NEW PRODUCTS

VACUUM GAUGE

Covers range 25 microns to 10^{-7} Torr; has replaceable 1500 gauss magnet.



Model 700 cold-cathode gauge and Model 710 stainless-steel gauge tube make up this system. Model 710 is a cold-cathode discharge gauge tube suited for uses which experience pressure "bursts," since it will not burn out. It can be rapidly outgassed by baking up to 450°C for precise vacuum measurement. It can be supplied with step seals for glass-to-metal joints, and is adaptable to any type of flange or fitting. Vactek, Inc., subs. of Geophysics Corp. of America, Bedford, Mass.

Circle 202 on Inquiry Card

RELAY

Contact rating of the 6 PDT unit is 5a.; meets Mil-R-5757 and 6106.

In style 801, the 2-coil bi-polar magnetic actuator is coupled with a balanced armature for max. immunity to shock, vibration, and acceleration. Single or bifurcated contacts are available to cover a variety of contact loads. Withstands 50g shock, 10g vibration to 1500cps. Available with solder lug, wire leads or plug-in type termination. Price Electric Corp., 300 Church St., Frederick, Md.

Circle 203 on Inquiry Card

CERAMIC CAPACITORS

Eliminates failure due to humidity; available in 50 and 200vdc models.

The SCH 70 series are said to afford absolute humidity protection. These hermetic-seal ceramic capacitors using a glass-to-metal case seal have passed more than 90 days of continuous humidity cycling/Mil-C-11015C, which required only 10 days of continuous humidity cycling for qualification. They come in the CKO6 size package in ranges of 10mmf to 10,000mmf for 200vdc, and up to 100,000mmf for 50vdc. The Scionics Corp., 7400 Deering Ave., Canoga Park, Calif.

Circle 205 on Inquiry Card



R-Series
2-sizes: 3-1/2", 4-1/2"

TRIPLET

"CLEAN SWEEP" PANEL INSTRUMENTS

A fresh approach to ultra-modern instrument design provides a "clean sweep" of the pointer over the full scale.

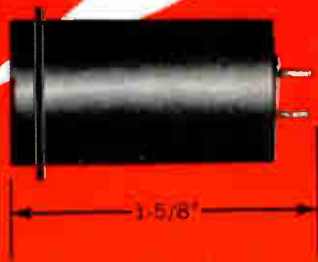
- 1** You get instant readability easier and at greater distances—plus more attractive designs to integrate into your equipment.
- 2** Self-shielded, accurate, reliable D.C. instruments have the exclusive Triplet BAR-RING movements.
- 3** Whatever your panel instrument requirement, look to Triplet for the right size and style, the right capability at the right price.



M-Series
4-sizes: 2-1/2", 3-1/2", 4-1/2", 5"



New 3/4" Meter
Model .75S

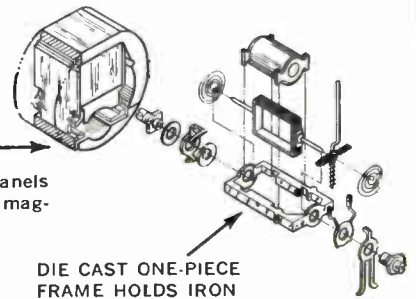


SHIELDED BAR-RING MOVEMENTS

ALNICO MAGNET IS MOUNTED INSIDE SOFT IRON RING; FULLY SELF-SHIELDED

Not affected by magnetic panels or substantially by stray magnetic fields for D.C.

More Torque
Lower Terminal Resistance
Faster Response
Exceedingly Rugged and Accurate



DIE CAST ONE-PIECE FRAME HOLDS IRON CORE IN EXACT ALIGNMENT



TRIPLET ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO

NEW PRODUCTS

OSCILLATOR-OVEN UNIT

Available at 1.0mc; it is calibrated $\pm 1 \times 10^{-3}$; daily aging 1×10^{-9} or better.

JKTS-1000 is suited to lab. and equipment uses requiring an ultra-stable signal source. It is a large-dia. 1mc crystal, glass-enclosed with an oscillator-buffer, voltage-control and oven-control circuitry all housed in a double proportionally-controlled package. External voltage can be applied for external trimming or control of exact freq. The James Knights Co., Sandwich, Ill.

Circle 215 on Inquiry Card

STATIC INVERTER

Supplies 800va continuous power, or 200va for 1 min., from standard 28vdc source.

Model 1S102 features 90% (min.) efficiency and has a capability of 250% sustained overload for motor starting needs. It uses a crystal reference circuit to assure a stable freq. output. Output voltage is precisely regulated 115vac rms $\pm 1\%$. The basic model is available for 800-cycle, 400-cycle and 60-cycle systems. Microdot Inc., 220 Pasadena Ave., So. Pasadena, Calif.

Circle 216 on Inquiry Card

TIME-DELAY RELAYS

Accepts spade terminals; increased reliability by no soldered connections.



The TER series of solid state electronic timers are compact, 1.5 x 2.0 x 2.8 in., and extremely versatile. They are unconditionally guaranteed for 3 years. Life of each unit is a min. of 10 million operations. Syracuse Electronics Corp., Box 566, Syracuse, N. Y.

Circle 217 on Inquiry Card

MINIATURE RHEOSTATS

RP06 is rated 12 $\frac{1}{2}$ w. and RP07 is rated 6.25w. as required by Mil-R-22B.

Miniature rheostat styles RP06 and RP07 of military spec. Mil-R-26C are available. The new sizes have slotted shafts only—either with $\frac{1}{4}$ -32 standard or locking-type bushings in various lengths. Locking bushing types are available for styles RP10 through RP30 now listed by Mil-R-22B. Additional information is contained in Military Catalog 50C. Ohmite Mfg. Co., 3650 Howard St., Skokie, Ill.

Circle 218 on Inquiry Card

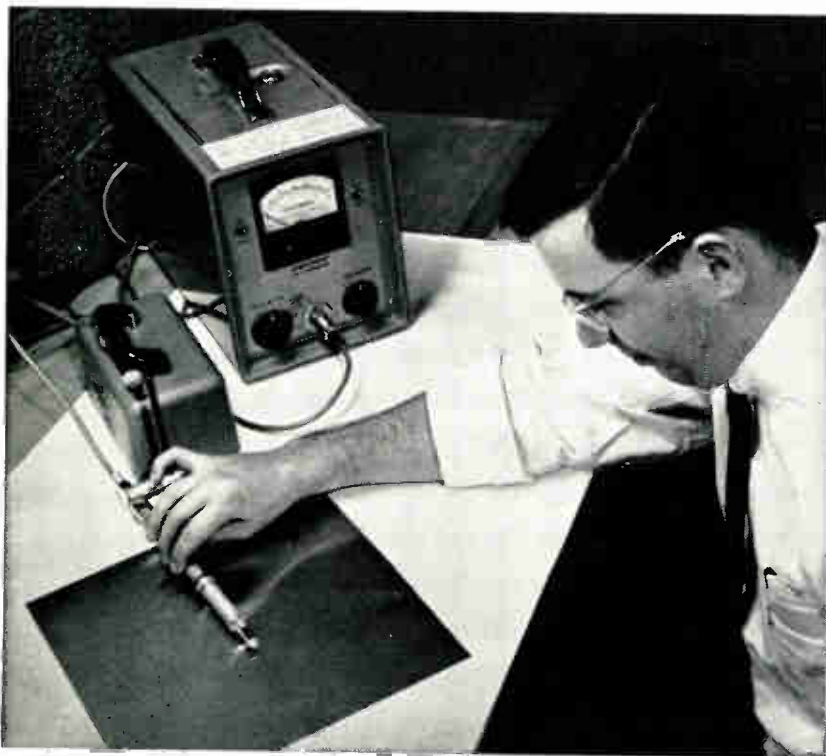
TEMPERATURE CONTROLLERS

Features: Null balance input and continuous cold-junction compensation.

Micro Sentry temp. controllers feature a measuring circuit made up of a high-gain magnetic amplifier and a SCR. The units respond to furnace temp. changes of less than $\pm \frac{1}{2}\%$ of full scale 1000°. They are non-indicating devices designed for precision on-off temp. limit applications. Operation is from a thermocouple sensing element. Magnetics Inc., Butler, Pa.

Circle 219 on Inquiry Card

How Taylor copper-clad quality control



One of the many instruments used by Taylor to check product quality is the Profilometer. Here a quality-control specialist is inspecting surface finish on a composite sheet.

You get clean copper-clad material. The copper-clad laminated plastic, used in making etched printed circuits, is prepared for pressing in Taylor's dustfree "white rooms."



NEW PRODUCTS

FIXED CERAMIC CAPACITORS

Each unit has a minimum Q of 3000; overlapping ranges from 5 to 10,000pf

Unicerams® are 1/10 the size of units of comparable capacitance values and have a ceramic sandwich construction and exceed Mil-C-11272B. Temp. coefficient (ppm/°C) at 1mc through the range from -55°C to +125°C is 90 (± 15). Insulation resistance is a min. of 10^9 at +25°C; at 125°C it is 5×10^8 (or 500 Ω farads). JFI Electronics Corp., 15th Ave. at 62nd St., Brooklyn 19, N. Y.

Circle 220 on Inquiry Card

COLLET KNOB

Configuration permits identification of pointer direction by touch alone.

Molded as a single unit of styrene for use on 1/4 in. D-shafts, part No. 3008 double-locks by means of a tapered aluminum collet fitting that contracts on the D-shaft when the collet screw is tightened. The screw, in turn, is locked by a nylon plug when tightened. Cambridge Thermionic Corp., Cambridge, Mass.

Circle 221 on Inquiry Card

PRESSURE TRANSDUCER

Thermal sensitivity shift is within 0.005% of full range output/°F.



The Type 4-354 pressure transducer operates under acceleration, vibration, and shock at temp. ranging from -459°F to +300°F. Thermal zero shift is within 0.01% of full range output/°F over the compensated temp. range of -320°F to +250°F. Measures absolute and gage pressures of fluids in ranges from 0-100psi to 0-5000psi. It provides a 20mv output. Consolidated Electrodynamics Corp., a subs. of Bell & Howell, 350 Sierra Madre Villa, Pasadena, Calif.

Circle 222 on Inquiry Card

DC SUPPLY

Ranges are from 0-35 to 0-90v output, at from 2.8 to 24a.

Four Solavolt dc power supplies are continuously adjustable from zero to max. voltage, over their entire range without step-switching. Regulation of $\pm 1\%$ at max. voltage and full load is provided by a constant-voltage transformer which also provides current-limiting and short-circuit protection. Sola Electric Co., Div. of Basic Products Corp., 1717 Busse Rd., Elk Grove Village, Ill.

Circle 223 on Inquiry Card

SYNCHRONOUS MOTOR

It provides 75 oz.-in. starting, 700 oz.-in. pull-in, and 130 oz.-in. pull-out.

Model 37411P1 is said to be 1/3 the size of its conventional hysteresis motor counterpart; it starts and reverses in half the time, provides 2 to 3 times the damping, has 1/5 as much jitter, and requires no extra cooling. Operates on 60cps 1 ϕ , 115vac with a speed of 1200 rpm. Electro Products Div., Western Gear Corp., Pasadena, Calif.

Circle 224 on Inquiry Card

provides high reliability in etched circuits



Every precaution is taken to protect the surface. Before leaving the "white rooms" for the laminating presses, copper-clad loads are covered with plastic film to prevent dust or other foreign matter from contaminating the surfaces of the material.

Taylor copper-clad laminates are custom-engineered to provide assured performance by combining thermosetting resins, reinforcing materials, and copper foil in carefully formulated combinations.

Composite sheets are made in atmosphere-controlled layup rooms under strict quality control (MIL-Q-9858 qualified). All have low moisture absorption, excellent chemical re-

sistance, and high mechanical strength, combined with good dielectric strength, high surface resistivity and insulation resistance.

The standard glass epoxy grades shown in the table meet most of the critical requirements of today. If you are working on requirements for tomorrow, let Taylor assist you by developing a copper-clad material engineered to your planned application. Bulletin 8-1B gives technical information about our standard grades. Write for your copy today.

TAYLOR COPPER-CLAD GLASS EPOXY LAMINATES

TAYLOR GRADE	NEMA GRADE	MILITARY SPECIFICATIONS	PRINCIPAL CHARACTERISTICS
Fireban 1011-E	G-10, G-11, FR-4, FR-5	MIL-P-13949 Types GE, GB, GF, GH	Combines all desirable properties of G-10 (GEE) and G-11 (GEB), plus flame retardance in one grade.
Fireban 600-E	G-10, FR-4	MIL-P-13949 Types GE, GF	Self-extinguishing. Excellent electrical properties under high humidity conditions. Extremely high flexural, impact and bond strength.
GEC-500-E	G-10	MIL-P-13949 Type GE	Extremely high flexural, impact and bond strength. Low moisture absorption. High insulation resistance.

Taylor corporation

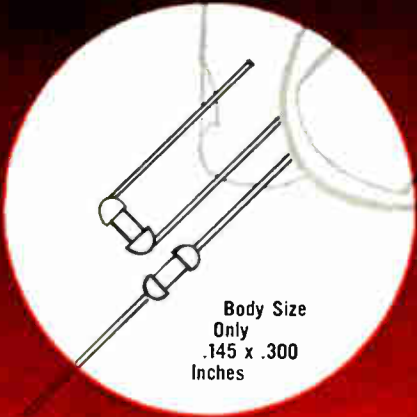
ENGINEERED PLASTICS

FORMERLY TAYLOR FIBRE CO.

VALLEY FORGE 53, PA.

WEST COAST PLANT: LA VERNE, CALIF.

BUSS Sub-Miniature PIGTAIL TRON FUSES



Body Size
Only
.145 x .300
Inches

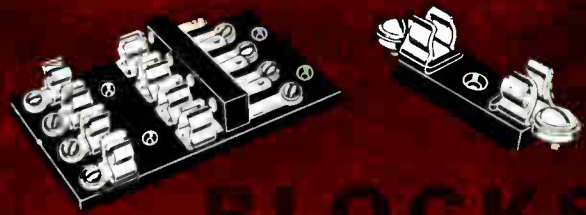
Tron fuses are so small they can be used as an integral part of circuit—to protect miniaturized devices—or gigantic multi-circuit electronic devices, without sacrifice of space.

They are hermetically sealed for potting without danger of sealing material affecting operation and have high resistance to shock or vibration. Operate without exterior venting. May be teamed with other components in replaceable unit.

BUSS

Write for BUSS
Bulletin 57B.

BUSSMAN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.



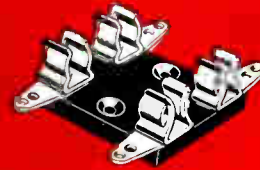
BLOCKS for BUSS FUSES



All Types Available for
Every Application . . .

Single pole, multiple pole, small base, full base, molded base, bakelite base, porcelain base for fuses from $\frac{1}{4}$ x $\frac{1}{8}$ inches up to $\frac{1}{2}$ x 2 inches. Also signal fuse blocks and special blocks of all types.

Send us your requirements—we have the block you need or our engineer it for you.



BUSS

Write for BUSS
Bulletin 57B.

BUSSMAN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

Circle 81 on Inquiry Card

Circle 81 on Inquiry Card

BUSS : the complete line of fuses .

NEW PRODUCTS

COAXIAL CABLE

Solid-sheath, semiflexible, and flexible coax. available with different jackets.

The Alumiline and Copperline series have seamless aluminum or seamless copper tube as outer sheaths. They are available with either Polyethylene, Teflon® FEP or Teflon TFE, and a broad range of optional jacketing materials including polyethylene. Times Wire and Cable, Hall Ave., Wallingford, Conn.

Circle 225 on Inquiry Card

PLUG & SOCKET CONNECTOR

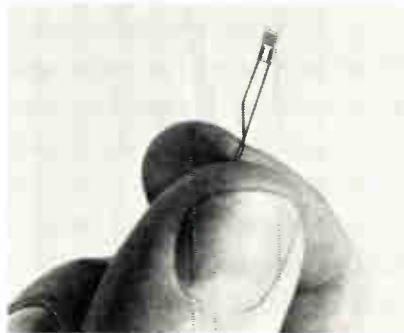
Right-angle plug and socket connector is for printed-circuit boards.

Series 683-40 and 41 have 19 solderless wrap-plug and 38 taper-pin socket terminations. Each wire-wrap termination has 2 taper receptacles in common when the connector is mated. Contact spacing is staggered and the center-to-center dimension is 0.250 in. Guide pins and guide sockets are polarized to prevent improper mating. Continental Connector Corp., 34-63 56th St., Woodside 77, N. Y.

Circle 226 on Inquiry Card

FLUX-SENSITIVE RESISTORS

Operating temp. range is from absolute 0 to +100°C.; values, 0.1 to 10K.



MistoR™ MR-A magnetic flux-sensitive resistors change resistance directly as a function of applied magnetic-flux density. These miniature, thin-film magneto-resistors are available in 4 sizes. The elements are 0.004 in. thick. Sensitivity is approx. 4% change in resistance/kilogauss at room temp. American Aerospace Controls, Inc., 123 Milbar Blvd., Farmingdale, N. Y.

Circle 227 on Inquiry Card

CERAMIC CAPACITOR

Range: 1000pf - 10,000pf. 100vdc over the range -55° to +125°C.

In V-Lam ceramic dielectric and platinum electrode materials are laminated in alternate layers and molecularly fused to form a dense, homogeneous unit. This provides ruggedness and stability. Ideal for coupling and by-pass applications. Conforms to Mil-C-11015. They are 0.1 dia. x 0.280 long. Solderable and/or weldable leads. Vitramon, Inc., P. O. Box 544, Bridgeport 1, Conn.

Circle 228 on Inquiry Card

INSULATED SCREWDRIVER

Dipped blade coating has good dielectric properties. Available in four blade lengths.

Series 620 shank screwdriver has the blade insulated with hard plastic, highly resilient to cutting, cracking or chipping. It is thin enough to permit using the screwdriver in confined places. Tip of screwdriver is exposed $\frac{1}{8}$ in. beyond the plastic. Available with 3, 4, 6, or 8 in. blade. Mathias Klein & Sons, Inc., 7200 McCormick Rd., Chicago 45, Ill.

Circle 229 on Inquiry Card

NEW PRODUCTS

NOISE ANALYZER

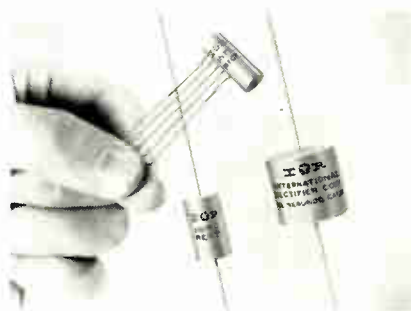
Features 1/10-octave, 1/3-octave, and all-pass bandwidths.

Freq. range of the Type 1564-A sound and vibration analyzer is 2.5cps to 25kc. High-input impedance (25 megohms in parallel with 80pf) permits use directly with microphones and vibration pickups to measure sound pressure levels from 44 to 150db re 0.0002 μ bar and acceleration from 0.0005 to 100g. Lower levels can be measured if the analyzer is used with a sound-level meter or a vibration meter. It can be used as a tuned filter after a random-noise generator to produce 1/10- or 1/3-octave bands of random noise. Unit may be operated from either ac lines or a rechargeable nickel-cadmium battery. General Radio Co., West Concord, Mass.

Circle 230 on Inquiry Card

SELENIUM HV RECTIFIER

Max. rms input ratings range from 45 to 17,600v. (res. load).



These half-wave selenium cartridges provide peak-reverse voltage ratings of 63v./cell. All units are assembled in new, lightweight housings. International Rectifier Corp., 233 Kansas St., El Segundo, Calif.

Circle 231 on Inquiry Card

LOG VOLTMETER-CONVERTER

Features 70db range with 0.2db accuracy; dc output is 1mv/db or 0.1mv/db.

The HLVC-150 gives continuous measurement and conversion of voltages. A reading of 70db corresponds to a range of 1mv to 3.16v. or 100mv to 316v; either range is selectable with an attenuator. Readings are indicated on a logarithmically-divided upper scale and a lower scale calibrated in db. The upper 3.5 decade true logarithmic reads accurately regardless of level. The lower scale is moveable, allowing any arbitrary level to be chosen as the 0 db point, thereby eliminating subsequent additions and subtractions conducive to error for 0 db reference correction. Houston Instrument Corp., 4950 Terminal Ave., Bellaire 101, Tex.

Circle 232 on Inquiry Card

..... of unquestioned high quality

BUSS Sub-Miniature FUSE-HOLDER COMBINATION



A light weight, protective device for space-tight applications in multiple circuit apparatus. Fuse has transparent window for visual inspection of element. Fuse may be mounted alone or used in holder on printed circuit boards.

HWA holder can also be panel insulated with or without use of knob. Knob makes holder water proof for front of panel.

BUSS

For full details write for BUSS Bulletin 373

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

Circle 81 on Inquiry Card



If you should have a special problem in electrical protection...

... we welcome your request either to quote or to help in designing or selecting the special type of fuse or fuse mounting best suited to your particular conditions.

Submit description or sketch, showing type of fuse to be used, number of circuits, type of terminal, etc. If your protection problem is still in the engineering state, tell us current, voltage, load characteristics, etc. Be sure to get the latest information BEFORE final design is crystallized.

At any time our staff of fine engineers is at your service to help solve your problems in electrical protection.

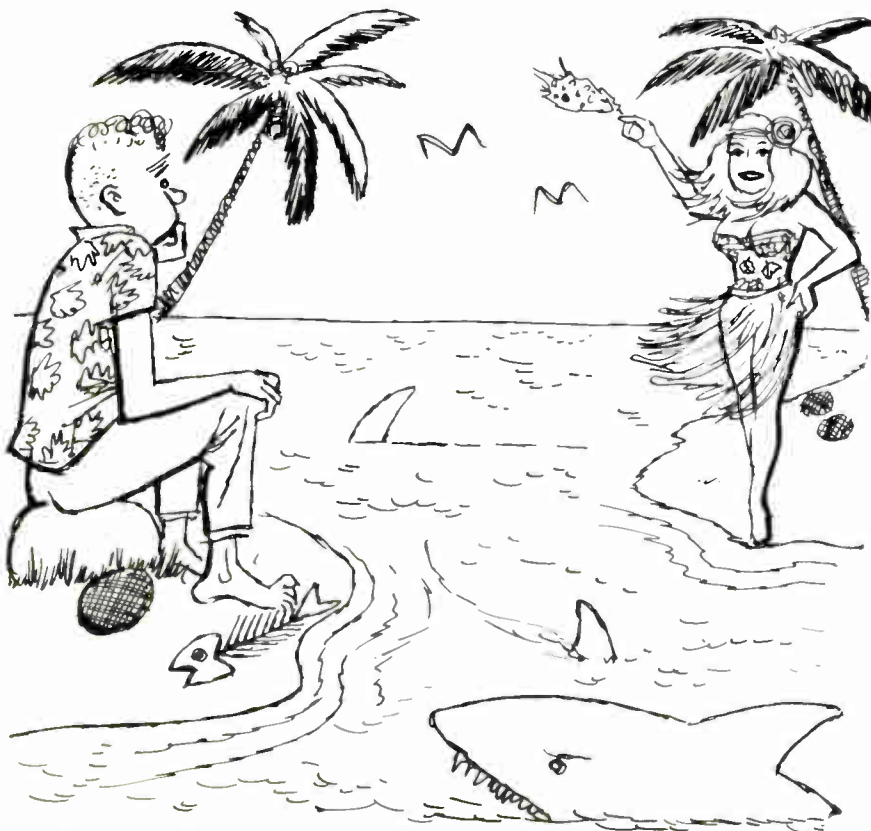
BUSS

Just call or write.

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

Circle 81 on Inquiry Card

GOT A CONTACT PROBLEM?



PROBLEM: To select a contact material for current-carrying hinge rings for power circuit breakers.

A current carrying movable joint in a power circuit breaker requires contacts of low contact resistance so that they can operate at the continuous rating with a minimum generation of heat. They must also be capable of withstanding fault current surges without welding. They must slide against each other under considerable force with low wear and friction.

ANSWER: **Gibsiloy NC-205 contact rings.** Silver is selected as the principal ingredient because of its high conductivity. Nickel is added to increase the hardness. Graphite is added to provide self lubrication and increase the non-welding characteristics. The resulting material—Gibsiloy NC-205—has the right combination of properties for this application—low contact resistance, resistance to welding, ability to withstand sliding action under heavy pressure without galling. This is a good example of how powdered metal contact materials can be “engineered” to provide specific combinations of properties.

OTHER APPLICATIONS: Because of these desirable properties, Gibsiloy NC-205 (and other Silver-Graphite Gibsiloy) have found application in disconnect switches, contactors, relays, rheostats, and various sliding contact applications.



Write for Catalog C-604 and Bulletin TB-507

GIBSON ELECTRIC COMPANY
A subsidiary of TALON, INC.

BOX 598 DELMONT (PITTSBURGH DISTRICT), PA.

Representatives in Principal Cities of the United States and Canada

Gibsiloy
ELECTRICAL CONTACTS
Since 1933

Circle 82 on Inquiry Card

NEW PRODUCTS

VACUUM POTTER

Degassing and casting chamber can be heated to 300°F (max).



The Model 5A-R is for: mixing and degassing the resin and catalyst prior to casting; evacuation of components prior to potting; and provision for casting all under initial vacuum. Max. resin and catalyst capacity is approx. 1 pt; ultimate vacuum during degassing and casting cycles, 0.1mm Hg; max. height of mold or shell, 8 in. Hull Corp., Hatboro, Pa.

Circle 206 on Inquiry Card

WAVEGUIDE TERMINATION

Short, low vswr terminations for use over range of 2.6 to 40.0cc.

These terminations absorb virtually all of the applied power and assure min. vswr values. The resistive block used to absorb power is of min. size and stable under varying conditions of temp. and humidity. Over the full operating freq. range the vswr is 1.02 max; power-handling capacity is 1w. average. Waveline Inc., Caldwell, N. J.

Circle 207 on Inquiry Card

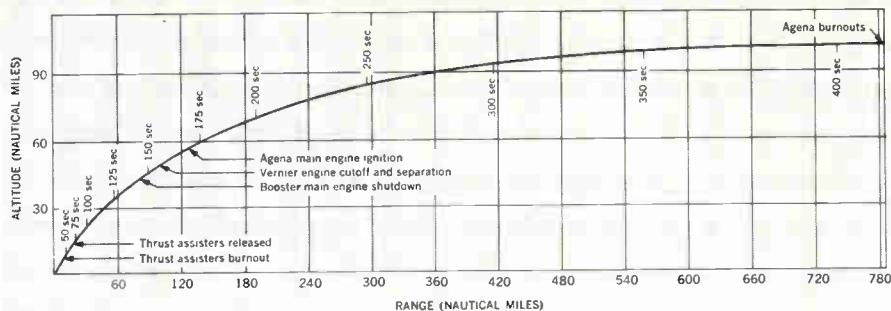
SEMICONDUCTOR TESTER

Measures beta with as low as 50Ω emitter-to-base loading.

Model #245 In-Circuit Tester is used for quantitative trouble-shooting of diodes, rectifiers, and transistors, either in- or out-of-circuit. It weighs less than 10 lbs. and operates on standard flashlight batteries. It measures: beta over the 1-1000 range, ($\pm 10\%$); resistance between semiconductor electrodes (power limited to 1 μ w) independent of semiconductor loading; shorts and opens in diodes and rectifiers with resistive loading of 20 Ω ; transistors for I_{cbo} ; and diodes and rectifiers for reverse leakage. American Electronic Laboratories, Inc., Box 552, Lansdale, Pa.

Circle 208 on Inquiry Card

TYPICAL ASCENT TRAJECTORY



Trajectory analysis, directly affecting payload capability, is vital to any satellite flight. As Lockheed Missiles & Space Company is responsible for the orbiting of over 60% of all U.S. satellites, considerable effort has been given to the study of vehicle dynamics-performance problems.

The result: Many trajectory problems are being solved routinely through the use of automated computer programs. Some of these in use at Lockheed are: Optimal trajectory shaping programs, maximizing payload weight capability for a given set of mission parameters • Targeting programs for specific configurations, which automatically develop ascent trajectories

and orbit ephemerides • Automated trajectory programs for generating dispersion analyses needed to establish propellant margins and expected injection errors • Post-flight analysis programs which establish the actual subsystem flight performance characteristics.

As missions become more complex and demanding in terms of payload capability, accuracy requirements and mission flexibility, the sophistication of ascent and orbital systems increase, demanding greater detail of trajectory and performance analysis. Engineers and scientists at Lockheed are continually expanding their capabilities to meet these needs.

LOOK AT LOCKHEED...AS A CAREER.

Consider Lockheed's leadership in space technology. Evaluate its accomplishments —such as the Polaris missile and the Agena vehicle's superb records of space missions. Examine its outstanding advantages—location, advancement policies, creative climate, opportunity for recognition.

Then write for a brochure that gives you a more complete Look at Lockheed. Address: Research & Development Staff, Dept. M-50 F, P.O. Box 504, Sunnyvale, California. Lockheed is an equal opportunity employer.

SCIENTISTS & ENGINEERS: In addition to positions relating to Trajectory Analysis, such as mathematicians, engineering mechanics, guidance & control and electrical engineers, other important openings exist for specialists in: Laser research • Bioastronautics • Guidance and control • Operations Research • Trajectory analysis

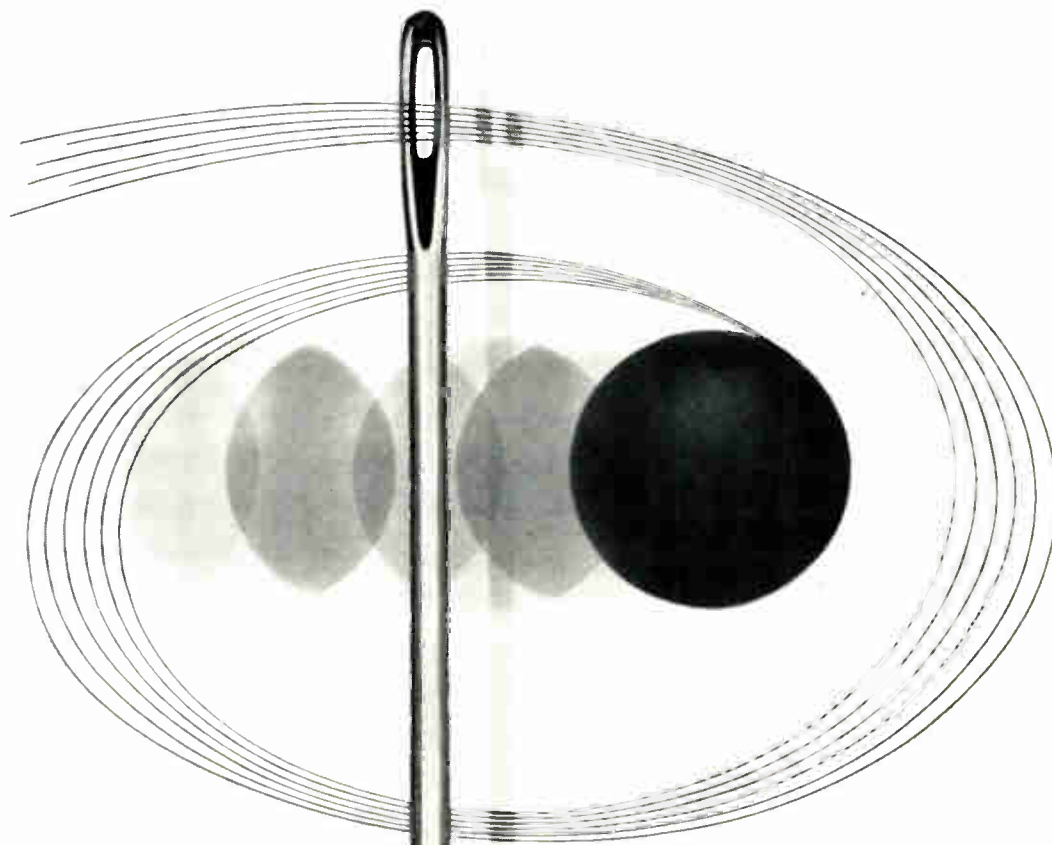
LOCKHEED

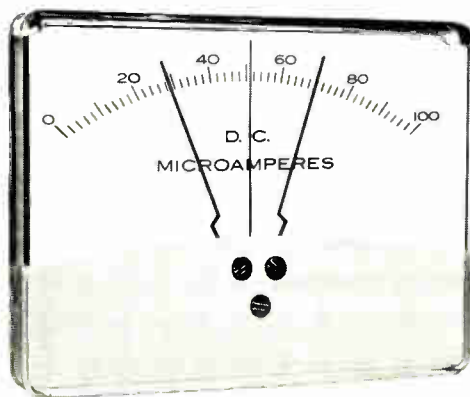
MISSILES & SPACE COMPANY

A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION
Sunnyvale, Palo Alto, Van Nuys, Santa Cruz,
Santa Maria, California • Cape Canaveral,
Florida • Huntsville, Alabama • Hawaii

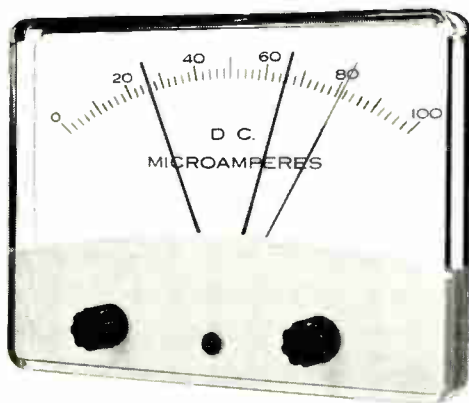
LOOK AT LOCKHEED...IN TRAJECTORY ANALYSIS

Automation of highly complex trajectory programs





LOCKING-COIL METER-RELAY



OPTICAL METER-RELAY

WHICH ONE IS BETTER?

It all depends on the control job you have in mind.

For manual-reset (limit) operation where there is sufficient open-circuit voltage between contacts the old standby, the API locking-coil meter relay, is your best bet. Circuitry for this type of operation is simpler and, generally, the cost is lower.

But for control requiring automatic reset, our new optical meter-relay clearly has the edge on both counts—simplicity and cost. In addition, it gives you continuous indication over the entire scale. Control deadband is only 0.25 percent f.s. (adjustable deadband optional). Set-points, on double set-point (high/low) models, are adjustable to as close as 2 to 3 percent f.s. And you have a choice of three control outputs: on-off, time-proportioning, or SCR triggering.

The API optical meter-relay is probably as notable for the complications it avoids as it is for the advantages it provides. It uses sealed fiber-optic light pipes and so does not require a light-tight meter case. It has a minimum of moving parts. It doesn't need an interrupter (no contacts). And it is inherently fail-safe.

Both our locking-coil and optical meter-relays are available in a number of new and striking case styles, and both can be furnished as controlling pyrometers.

The choice, then, is up to you. But we'll be glad to supply all the help we can. For a starter, we suggest you look over our new Bulletin 33-B. It gives detailed technical data and price information on our line of optical meter-relays. For information on our locking-coil meter-relays, Bulletin 5-C is the one to ask for. A quick note or phone call will bring either or both.



ASSEMBLY PRODUCTS, INC.
Chesterland 92, Ohio • Phone: (216) 423-3131

SA 2836

NEW PRODUCTS

OMEGATRON

Used as an appendage tube for measuring gas amb. in vacuum devices.



The SY 1301 Omegatron is a mass spectrometer analyzer tube which operates on the same principle as the cyclotron. Gas molecules ionized by electronic bombardment are accelerated in a cycloidal path under the influence of r-f and magnetic fields. Under conditions of resonance, ions with a certain mass-to-charge ratio are collected and the resultant output recorded as one peak of a gas spectrum. Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

Circle 209 on Inquiry Card

DC TO AC SUPPLIES

Output power: 15 to 75va at any power factor from 0.95 lag to unity.

Model SHX-46 is a 75va, 400 cps inverter which operates on 25-29vdc and produces an output of 115v rms ($\pm 5\%$); output current is 0.65a. Input ripple current is 0.3a p-p. Output voltage regulation of 105-125v rms is unaffected by varying loads from 15 to 75w., or changing the input from 25 to 29vdc. Meets environmental requirements of Mil-E-5272D; operating range is -55°C to $+71^{\circ}\text{C}$. Units drive roll, rate, yaw, and pitch gyros. Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle 210 on Inquiry Card

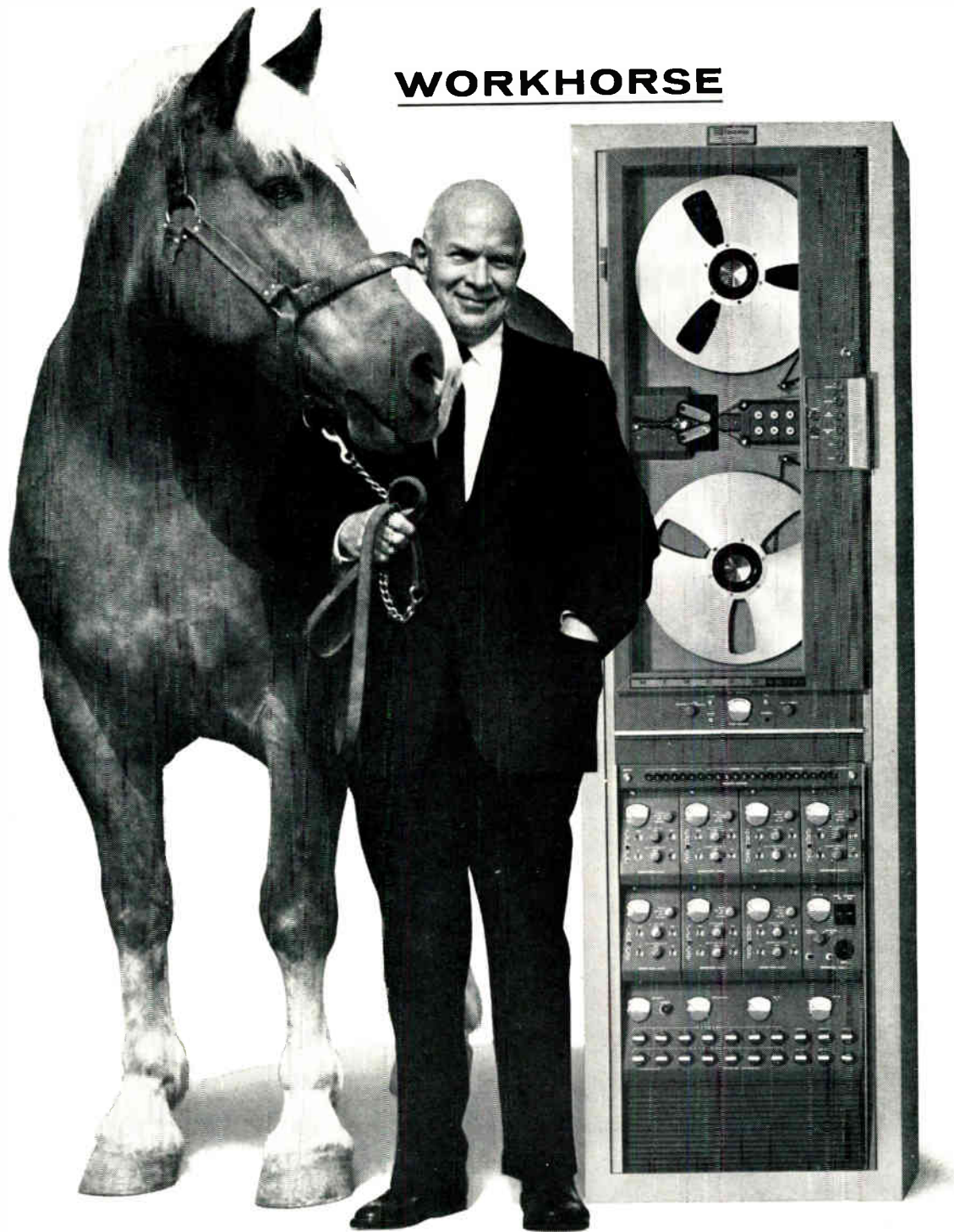
PHOTOSENSITIVE TRANSISTOR

Input sensitivity is $5\mu\text{a}/\mu\text{w}$; spectral response is 0.4 to 1.1 microns.

The P-102 PHOTOFET (photosensitive field-effect transistor) consists of a diffused, passivated, silicon photodiode functionally integrated with a high-impedance, low-noise preamplifier in a windowed TO-18 package. Specific detectivity of $10^{10}\text{cm-crs}^{1/2}/\text{w}$. (equivalent input noise power of $10^{-12}\text{w./crs}^{1/2}$ @ 1kc) can be obtained with the detector output operating into a 2K to 10K Ω load. Dark current is 10na (max); amplifier transconductance 1000 $\mu\text{mhos min}$; and amplifier noise figure ($R_0 = 1\text{ meg, 1kc}$) 1.0db. Ideal for high-impedance, high-output transistor systems. Siliconix Inc., 1140 W. Evelyn Ave., Sunnyvale, Calif.

Circle 211 on Inquiry Card

WORKHORSE



Downtime's nemesis, rugged and reliable as a purebred workhorse — that's Mincom. Common denominator of dependability in all four basic Mincom Recorder/Reproducers is the exclusive Mincom DC Top Plate. Here's a tape transport built with beautiful simp'icity: Only 12 moving parts with four easy adjustments, full dynamic braking, instant six-speed pushbutton control, seven or fourteen tracks — plus tape speed accuracy within $\pm 0.005\%$ using Mincom's Cyclelock®. Whether your specifications call for wideband predetection at 1.5 mc, or a comfortable 120 kc at 60 ips, there's a reliable Mincom workhorse to meet your facility's needs. Write today for details.

Mincom Division **3M**
COMPANY

2049 South Barrington Avenue, Los Angeles 25
425 13th Street N.W., Washington 4, D.C.

JENNINGS VACUUM CAPACITORS

OVER 300 TYPES

TO MEET HIGH VOLTAGE CIRCUIT DESIGN PROBLEMS

Of course this unusually large selection didn't just happen overnight. It represents the accumulation of twenty years experience in the manufacture of vacuum capacitors. During this time Jennings has developed exclusive vacuum processing techniques. Examine the representative types shown below, all of them proven successful in thousands of applications.

HIGH VOLTAGE

Type VMMHHC
Capacitance Range 25 to 200 mmfd
Peak Voltage 120 kv
RF Current 125 amps RMS
Length 20 3/4 inches



HIGH CURRENT

Type VMMHCW
Capacitance Range 50 to 400 mmfd
Peak Voltage 55 kv
RF Current 500 amps RMS
Length 17 inches



HIGH RATIO OF CAPACITANCE CHANGE

Type UCSSL
Capacitance Range 7 to 1000 mmfd
Peak Voltage 5 kv
RF Current 42 amps RMS
Length 7-9/16 inches



SMALL SIZE

Type ECS
Capacitance Range 3 to 30 mmfd
Peak Voltage 15 kv
RF Current 20 amps RMS
Length 4 1/4 inches



Our radio frequency laboratory with 12 functioning transmitters ranging from 17 KC to 600 MC and up to 100 KW CW power is at your service to test our products under your particular circuit conditions.

Write for our special brochure describing our complete line of vacuum capacitors.

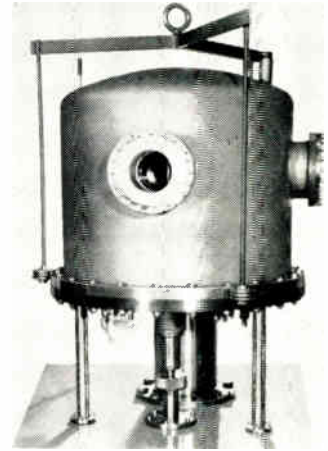
RELIABILITY MEANS VACUUM / VACUUM MEANS *Jennings*

JENNINGS RADIO MFG. CORP., 970 McLAUGHLIN AVE., SAN JOSE 8, CALIF., PHONE CYpress 2-4025

NEW PRODUCTS

VACUUM SYSTEM

Provides working pressures of 1 x 10⁻⁸ Torr; volume is over 3200 cu. in.



Model 125 is composed of a bell jar and base plate made from stainless steel, a high-vacuum oil diffusion pump, a roughing manifold with an ejector and a 2-stage roughing vacuum pump, valving and associated instrumentation and controls. The chamber can be baked to 450°C and/or cooled to -196°C with liquid nitrogen. By cooling with liquid nitrogen, pressures of approx. 1 x 10⁻⁸ Torr are possible within 2 hrs; under a 16-hr., 400°C bakeout cycle, pressures of 3 x 10⁻¹⁰ Torr or less are obtained. Cooling to -196°C permits 1 x 10⁻¹¹ Torr. Westinghouse Scientific Equipment Dept., P. O. Box 868, Pittsburgh 30, Pa.

Circle 212 on Inquiry Card

PRESSURE CALIBRATOR

Generates pressure of 0.0005psi resolution in a 0-50psia range.

Model PCS pressure control system is manually adjustable to generate precise pressure in open or closed systems. In a 0-500psi range, resolution is equal to the resolution of the pressure sensing element. If used with the companion TI precision pressure gage, resolution is 1 part in 100,000 for pressures up to 200psi and 1 part in 25,000 up to 500psi. Texas Instruments Incorporated, P. O. Box 66027, Houston 6, Tex.

Circle 213 on Inquiry Card

TEMPERATURE CHAMBER

Eliminates conventional heater-power relay and cycling about control point.

Model SD8 is a 2.6 cu. ft. bench-type chamber which operates over the range of -100°F to +525°F. It has a control accuracy of ± 1/4°F. It features 24 lineal inches of calibrated set-point scale, with temp. readout by means of a deviation meter calibrated in 1° increments. Stat-ham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Circle 214 on Inquiry Card



BELDFOIL

BREAKS THE NOISE BARRIER!

APPLICATIONS: Beldfoil is effective over the entire audio frequency range. Typical applications include instrumentation, data processing, and telemetry equipment, and any information and measurement circuits.

QUIET PERFORMANCE!

Yes, Beldfoil* shielding definitely breaks the noise barrier. It breaks the noise barrier by *being* a noise barrier. Beldfoil gives *total* shielding . . . 100% isolation between adjacent pairs. For audio and radio frequency, it completely eliminates cross talk, spurious signal impulses . . . and it's ideal for stationary or limited flexing. Beldfoil is lighter in weight, requires less space, and is usually lower in cost.

MINIATURIZES!

Beldfoil shielding reduces the diameter of multi-conductor cables . . . by as much as 66 $\frac{2}{3}$ %. It gives design engineers extra space . . . extra conduit space, extra raceway space, extra console and rack space. Beldfoil shielding means that you can "think small."

ASK FOR DATA SHEET. Get your copy of newly published bulletin 8-63-A and technical data sheet. They give complete information on Beldfoil shielding. Write Belden Manufacturing Company, 415 South Kilpatrick Avenue, Chicago 44, Illinois.

WHAT IS BELDFOIL? It's a lamination of aluminum foil with Mylar** that provides a high dielectric insulation. A patented Belden method of folding*** gives definite benefits. An inner fold creates a continuous metallic path around the surface of the cable. This eliminates any possible inductive effects. An outer fold tucks the cut edge of the aluminum under the Mylar. This gives complete isolation from other adjacent shielded cables.



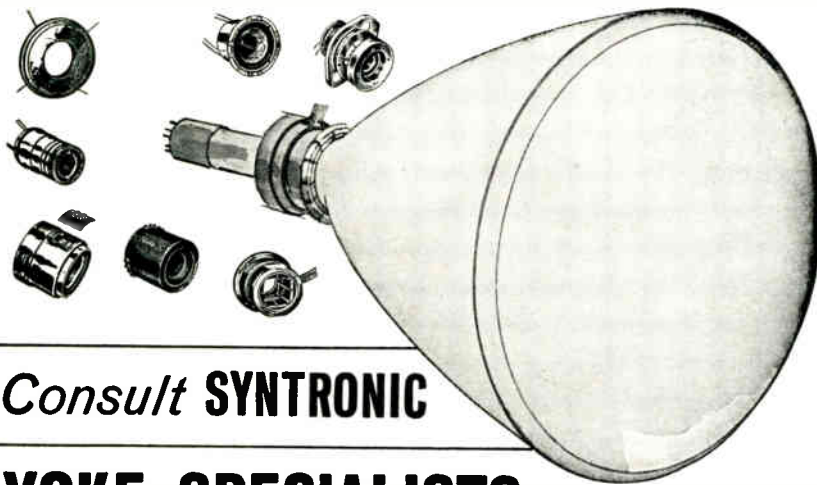
Typical cross section looks like this.

*Belden Trademark Reg. U. S. Patent Office
du Pont Trademark *U. S. Patent 3,032,604

Belden
WIREMAKER FOR INDUSTRY
SINCE 1902 - CHICAGO

8-1-3

WHICH DEFLECTION YOKE FOR YOUR DISPLAY ?



Consult **SYNTRONIC**

YOKE SPECIALISTS

Syntronic's team of experts knows more about yoke design, engineering and quality control than anyone else. A solid 10-year record of leadership—acknowledged throughout the industry. Benefit from it.

syntronic INSTRUMENTS, INC.
100 Industrial Road, Addison, Illinois
Phone: Kingswood 3-6444

Circle 131 on Inquiry Card

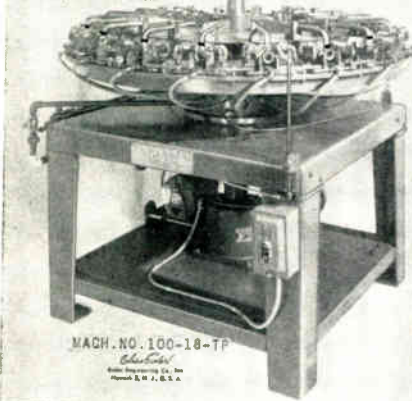
EISLER...

soldering and
brazing equipment
—gas & high frequency

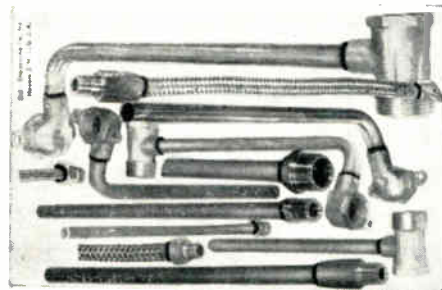
CONTINUOUS AND
INDEXING TYPES

Please write for full particulars

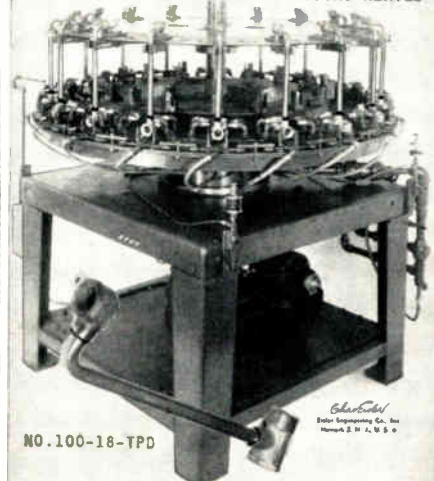
AUTOMATIC BRAZING & SOLDERING MACHINE, SINGLE
TURRET TYPE, 18 POSITION, PRODUCTION 1600 per H
EISLER CONTINUOUS TURNABLES HAVE SOLVED
HUNDREDS OF DIFFICULT OPERATIONS
CONTINUOUS TYPE



MACH. NO. 100-18-TP



EISLER AUTOMATIC BRAZING MACHINE
DOUBLE TURRET TYPE ADAPTABLE & ADJUSTABLE
FOR MANY DIFFERENT OPERATIONS. GAS HEATED



NO. 100-18-TPD

EISLER ENGINEERING CO., INC. / 770 S. 13th St., Newark 3, N. J., U.S.A.

Circle 132 on Inquiry Card

NEW PRODUCTS

RACK/PANEL PLUG

Operates in a temp. range of -57°F to 257°F . Accommodates three wire sizes.

The DPJMB98 is a miniature environmental rack/panel plug incorporating the Little Caesar rear release system. The plug is keystone-shaped for polarization and accommodates wire sizes #20, 22, and 24. A moisture-proof peripheral seal and a grommet cemented to the rear of the insulator provide environmental sealing for high-altitude uses. Cannon Electric Co., 3208 Humboldt St., Los Angeles 37, Calif.

Circle 291 on Inquiry Card

PATCH BOARDS

Receptacle panel can be used as a patch board with patch cord wires.

The terminations on the back of the WASP receptacle panel are for wire-wrapping. Patch plugs may be used. The patch contact can be supplied loose for a crimp tool or in chain form for a crimping machine. Contacts cover wire from 16-26 AWG., and all 6 wire sizes can be crimped without changing or adjusting the crimping machine. Shrinkable tubing (105°C) insulates the crimp barrel and is a strain relief. Malco Mfg. Co., Dept. ES-2, 4025 W. Lake St., Chicago 24, Ill.

Circle 292 on Inquiry Card

SPECTRUM MONITOR

Converts microwave receiver to spectrum analyzer; 150kc to 25mc dispersion.

Model DM-1 has an input freq. of 140mc and can be used with RI/FI meters to provide spectral displays in accordance with Mil-I-11748B and proposed Mil-STD-826. It provides spectral characteristics of pulsed AM and FM signals, display and measurement of multiple r-f signals, detection and identification of spurious signals, and rapid determination of signal bandwidth. Logarithmic display for relative amplitude measurements over large dynamic ranges is readily achieved. Polarad Electronic Instruments, 34-02 Queens Blvd., Long Island City 1, N. Y.

Circle 293 on Inquiry Card

PANCAKE RESOLVER

Total primary requirement is 0.030w; input voltage is 28v. at 800 cycles.

Model 48DRU816 is a 2-speed unit which provides 16- and 1-speed outputs. Accuracy is better than 10 sec. for the 16-speed output and 3 min. for the 1-speed. Phase shifts are 14° and 2.4° respectively. Reeves Instrument Corp., Garden City, N. Y.

Circle 294 on Inquiry Card

NEW PRODUCTS

SPACE SIMULATOR

Designed to provide an ultimate vacuum capability of 5×10^{-9} torr.



The ultra-high vacuum chambers can simulate temps. from -320° to $+400^{\circ}$ F, and produce combined space environments that simultaneously simulate solar radiation, random, or sine vibration: at vacuum to 1×10^{-4} torr. Each chamber provides test space $2\frac{1}{2}$ ft. dia. x $2\frac{1}{2}$ ft. deep, and 12.3 cu. ft. in volume. Cook Electric Co., Technological Center Div., 6401 W. Oakton St., Morton Grove, Ill.

Circle 233 on Inquiry Card

AC RATIO STANDARD

Min. ratios to -0.0111111 , and max. ratios to 1.111111 .

Required values on model 1011R are set by means of 7-in. line-control knobs. The output is kept connected while settings are being changed, virtually eliminating switching transients. Unit operates over a freq. range of 50-10,000 cps. Terminal linearity is better than 0.0001% (1ppm). Designed for standard rack mounting, instrument measures $19 \times 5\frac{1}{4} \times 7\frac{1}{2}$ in. Gertsch Products, Inc., 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

Circle 234 on Inquiry Card

PRECISION POTENTIOMETER

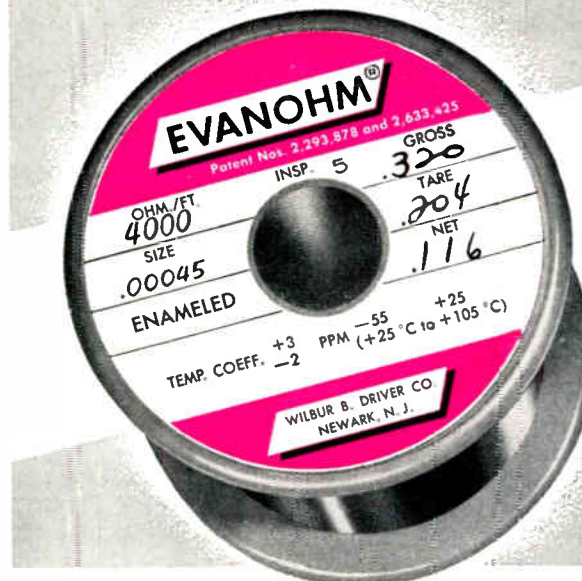
Independent linearity is $\pm 0.25\%$, and absolute linearity is $\pm 1\%$.

The Series 65 is used in accelerating voltage circuits for CRTs and other high-voltage uses. Long leakage paths within the 3 in. dia. produce a 4000vdc to ground rating. Available with insulated or metal shafts. Resistance ranges can be specified to 200K. Dual assemblies are also offered. Available with continuous rotation or with stops. Mounting is either bushing or tapped hole. Clarostat Mfg. Co., Inc., Dover, N. H.

Circle 235 on Inquiry Card

THE ONLY HIGH RESISTIVITY ALLOY USED AS A RESISTANCE STANDARD

EVANOHM[®]

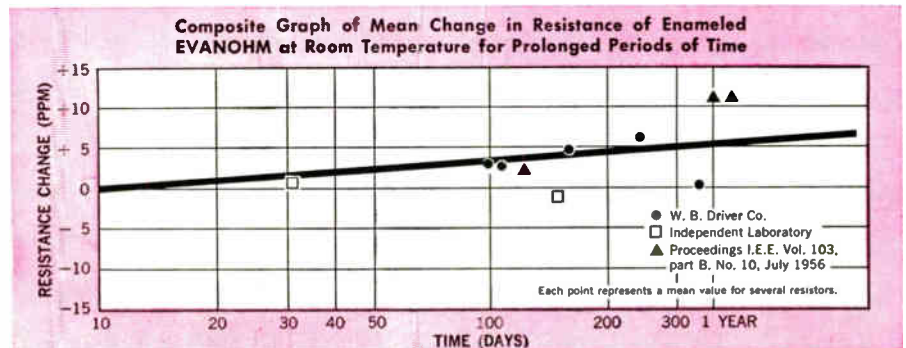


- High Resistivity
- Low TC of Resistance
- Low Thermal EMF to Copper
- High Reliability

SPECIFICATIONS	
Nominal composition	
75% Nickel	
20% Chromium	
2.5% Aluminum	
2.5% Copper	
Specific resistance 20° C	
800 ohms/cm ²	
134 microhm cm	
Temperature Coefficient of Resistance	
-65° C to $+150^{\circ}$ C	
$\pm .000005/^{\circ}$ C	
Coefficient of linear expansion	
20° to 100° C	
.000014/ $^{\circ}$ C	
Magnetic permeability	
1.0005	
Average tensile strength	
180,000 psi	
Mean thermal EMF vs copper	
-65° C to $+150^{\circ}$ C	
.2 μ v/ $^{\circ}$ C	

Maintains Highest Stability Over Long Periods of Time and Wide Ranges of Temperature!

EVANOHM, the time-tested standard of the precision wire-wound resistor industry, features the lowest thermal EMF versus copper of all resistance alloys . . . with stability within a few parts per million per year. EVANOHM is recommended for all precision requirements where highest reliability is essential, and is well suited for analog computers and guidance equipment for space applications. EVANOHM, in .0004 and heavier gauges, can be supplied from stock, either bare or enameled, for immediate delivery. The Wilbur B. Driver Company's engineering "know how" is available to help solve your problems. Call or write WBD for recommendations on your requirements, or request EVANOHM brochure!



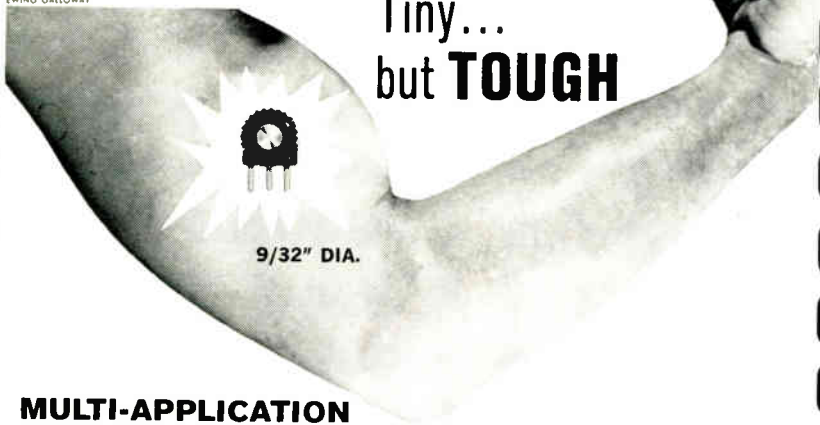
WILBUR B. DRIVER COMPANY
Newark 4, New Jersey—Tel. HUmboldt 2-5550 (Area Code 201)

MFG. PLANTS—1875 McCarter Highway, Newark 4, New Jersey; 50 Ronson Drive, Rexdale (Toronto), Ontario, Canada
BRANCH OFFICES—Chicago*, Philadelphia, Los Angeles*, Minneapolis, Cleveland*, Hartford (*Indicates Warehouse)

Melters and Manufacturers of Custom Electrical, Electronic, Mechanical and Chemical Alloys for all industries.

EWING GALLOWAY

Tiny...
but **TOUGH**



9/32" DIA.

MULTI-APPLICATION MICRO-MINIATURE VARIABLE RESISTORS

For miniature transistor hearing aids, miniature radios, telephone equipment, pocket dictating machines, medical equipment and industrial applications requiring extremely small size and high reliability. Micro miniature M250 Series has knobs in 4 sizes in a choice of colors.

- Ultra quiet element.
- Controlled turning torque can be tailored to your knob-size requirements.
- Versatile mounting arrangements.
- Molded phenolic base available in colors to match color of knob—an exclusive feature.
- Noise-free volume adjustment because stud not electrically connected to element—an exclusive feature.
- Limitless variety of tapers and resistances available from 100 ohms through 10 megohms.
- Fast, dependable delivery.

Founded  1896

Write for Catalog page describing Series M250.

CTS OF ASHEVILLE, INC.
Skyland, N. C.

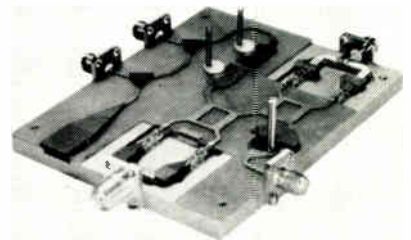
Subsidiary of **CTS CORPORATION**
Elkhart, Indiana

Circle 88 on Inquiry Card

NEW PRODUCTS

TRANSMISSION LINE

Eliminates most of the dielectric; hence low line losses are obtained.



Air-strip overcomes problems encountered in solid-dielectric strip lines at higher freqs. Leakage has been eliminated by continuous metal barriers in the ground planes. Air-strip offers no r-f leakage; low insertion loss; identical reproduction; no spurious modes; wide bandwidths and adjustable elements. Tunable filters, diodes, ferrites, adjustable attenuators, phase shifters and loads may be installed. Micro-Radionics, Inc., 14844 Oxnard St., Van Nuys, Calif.

Circle 236 on Inquiry Card

PHASE-SENSING RELAYS

Intended for monitoring 3-phase 280v., 60 and 400 cps current.

The P and Q units provide protection in the event of phase failure or phase reversal. The P-characteristic maintains closed contacts only when all 3 phases are energized in proper sequence. The Q-characteristic provides the additional feature of de-energizing if any input terminal is disconnected or grounded. Contact rating is 32vdc, 2a. or 115vac, 1a. Hi-G Inc., Bradley Field, Windsor Locks, Conn.

Circle 237 on Inquiry Card

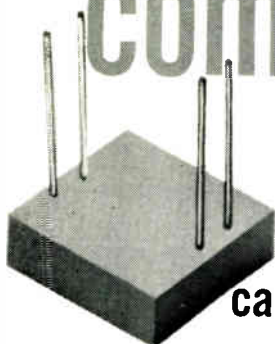
ADJUSTABLE TIME DELAYS

Time delay range is 0.1 to 200sec.; nominal voltage is 20 to 30vdc.

The Model 3900, a dpdt time-delay relay encased in a package measuring 0.4 x 0.8 x 1.3 in., employs an electromechanical relay capable of switching 1a. resistive at 26.5vdc. The Model 3907, a solid-state switch in a 0.4 x 0.8 x 1.0 in. case, features an internal spno solid-state device rated at 250ma resistive at 26.5vdc. Trimpot Div., Bourns, Inc., 1200 Columbia Ave., Riverside, Calif.

Circle 238 on Inquiry Card

Now complete voltage reference units in modular component size



ACTUAL SIZE
"700" SERIES

small ■ printed circuit or chassis mounting ■ simplifies circuit design ■ no temperature compensation needed ■ low priced—unlimited variations of voltages, current, temperature coefficient, regulation, output impedance, case and mounting.

call, write, **INSTRULAB, INC.**
or wire 1205 LAMAR ST. DAYTON 4, OHIO



CUT BACK-PANEL SPACE REQUIREMENTS UP TO 20%

WITH NEW, RECTANGULAR MINISig® TRANSISTORIZED INDICATORS

Here's the new shape of indicator miniaturization. In these tiny MINISig models, the typical 2" extension behind the panel shrinks to about $\frac{3}{4}$ "; at the same time, overall volume is reduced by as much as one-fifth.

Performance, however, is king-size. These are high-gain devices with built-in transistor driver-amplifiers and low-voltage incandescent lamps. They operate directly and brightly from low-voltage signals, yet are a light load on the signal source. Lamp currents stay inside the indicator housing, out of your sensitive logic circuits.

If your needs are highly specialized, chances are EECo's design staff can find a fast, economical answer — an answer backed by the MINISig record of reliability in hundreds of major systems.

THREE MODELS AVAILABLE

Model R-382: -11V, off; -3V, on.

Model R-481: 0V, off; -6V, on. Features keep-alive current to extend bulb life.

Model R-381: 0V, off; +6V, on.

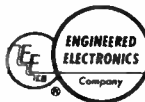
Back-panel dimensions: $\frac{3}{4}$ " x $\frac{3}{8}$ " x $\frac{1}{2}$ "

Lens colors available: red, green, amber, white.

EECo offers you a full line of MINISig indicators. Choose from neon, filament and thyratron types. Many have adjustable operating characteristics, and will accommodate a broad range of input signal conditions.



Competitive prices, fast delivery. Write today for technical data.



ENGINEERED ELECTRONICS Company

1441 East Chestnut Avenue, Santa Ana, California
Telephone: 547-5651 Cable Address: ENGELEX

NEW HIGH DENSITY RELAYS DELIVER 200 OPNS. PER SECOND



These contact form C relays follow signals up to 200 operations per second without variation in timing. Are available in single-side-stable, bi-stable and chopper forms. Adlake MWSA 16000 relays like the one on the left are the only ones you'll find anywhere molded in epoxy. Though less expensive, they stay cooler. Contain no wax to overheat and run. Parts are rigidly secured—no movement to cause circuit noise. Epoxy is proof against all caustics and solvents except acetic acid. The metal encased version on the right can be grounded to assure magnetic shielding. Use it where magnetic interference is a special problem. For more information, call Adlake. And remember, *Adlake makes more kinds of mercury relays than anybody.*

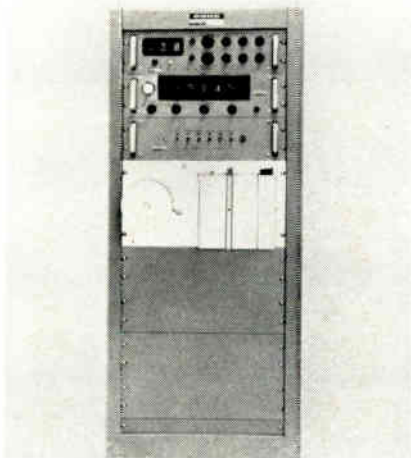


The Adams & Westlake Company
Dept. 8810, Elkhart, Indiana
Phone Area 219, COngress 4-1141
Circle 91 on Inquiry Card

NEW PRODUCTS

DATA LOGGING SYSTEM

Measures and records voltages from 0.0000 to $\pm 999.9v$.

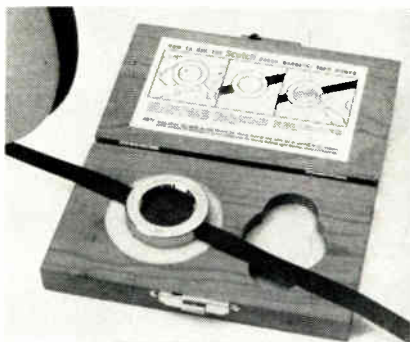


The 864-100 is a basic, medium-to-high-speed dc voltage logging system with high-input impedance. Information consists of 4 digits, polarity, range indication, and channel identification, and can be logged at rates up to 400 channels/min. A closed-loop system control automatically adjusts the system logging rate in accordance with the component requirements. Accuracy is 0.02% of full scale $+0.01\%$ of reading; temp. coefficient is less than 0.002% of full scale/ $^{\circ}C$ over the operating range of $+10^{\circ}C$ to $+40^{\circ}C$. Cohu Electronics, Inc., 5725 Kearny Villa Rd., San Diego 12, Calif.

Circle 239 on Inquiry Card

TAPE VIEWER

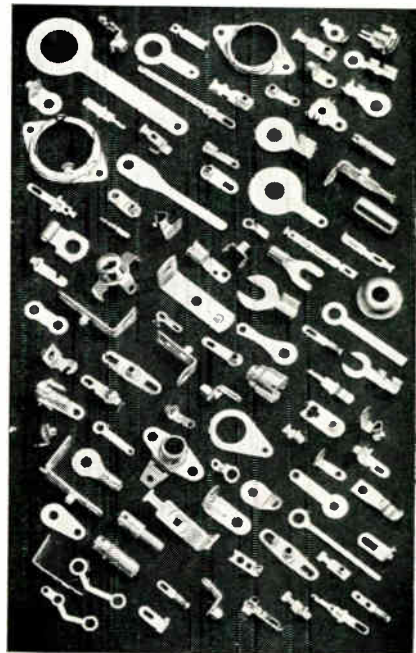
Makes visible the data recorded on magnetic tape without damaging the tape.



Tape Viewer No. 600 is used to check recorder-head alignment, track placement, pulse definition, inter-block spacing and dropout areas in computer and instrumentation work. It also can be used to examine and synchronize the audio track on video tape and the pattern of recorded sound on audible range tapes. Viewer determines whether tools, heads or guides are magnetized. 3M Co., 2501 Hudson Rd., St. Paul 19, Minn.

Circle 240 on Inquiry Card

Malco IS YOUR BEST SOURCE FOR SOLDERING LUGS TERMINALS PRINTED CIRCUIT HARDWARE

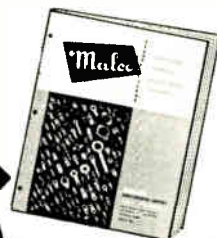


HERE'S WHY:

- Specialized high production techniques afford lowest possible unit cost.
- Precision tooling, rigid quality control assure tolerances to critical specifications.
- Ample stocks of over 1000 different parts permit prompt delivery.
- Malco specializes in a complete line of small stampings for Radio-TV, electrical/electronic and automotive industries.
- Our line includes terminals and printed circuit hardware in loose or in chain form for automatic insertion.

Let Malco show you how you can save on production time and costs. Contact us today.

REQUEST
CATALOG
NO. 10



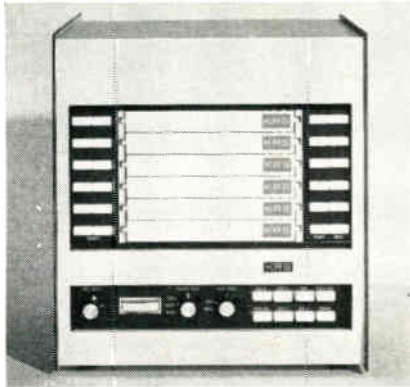
Malco MANUFACTURING CO.
4037 W. Lake St., Chicago 24, Ill.

Circle 92 on Inquiry Card

NEW PRODUCTS

TAPE RECORDER

Six endless-loop-type cartridges can be handled simultaneously.



The Model DR-1 provides separate controls for each cartridge and permits simultaneous recording or playback of any desired combination of cartridges. Each cartridge has 2 data channels. Cumulative wow and flutter of the solid-state unit is below 0.15% RMS over the range of 0 to 300cps, and less than 0.05% with bin-storage type tape-loop cartridges. KRS Electronics, 4035 Transport St., Palo Alto, Calif.

Circle 241 on Inquiry Card

PRESSURE TRANSDUCER

Can withstand exposure to 1200°F; radiation resistance is 10¹⁸ NVT.

The Variable Mu Pressure Transducer converts mechanical input pressure to an electrical voltage output which is a linear function of the applied pressure. It has no moving parts and operates from -320°F to 800°F; provides a 0.2v. output into a 10KΩ load (800°F unit), or 0.5v. into a 50KΩ load (500°F unit); withstands 500g shock in an axis. Pressure ranges from 0 to 400 up to 0 to 10,000psi for inputs of 4 to 6v., 400 to 5000cps. International Resistance Co., 401 N. Broad St., Philadelphia, Pa.

Circle 242 on Inquiry Card

MINIATURE INDUCTOR

Nominal inductance is between 0.006h. and 150h.; min. is 0.0054h., max. is 165h.

The HVV Variductors™ are used where precise matching to other components, such as tuning to capacitors with standard 10% tolerances is needed. Units are hermetically sealed to Mil-T-27B, Mil type TF4RX20YY, and provide a vernier inductance variation of ±10% of nominal value through an adjusting screw with a 90° range. United Transformer Corp., 150 Varick St., New York 13, N. Y.

Circle 243 on Inquiry Card

SHRINKS DOWN 1/2

7
SECONDS
TO
YOUR
JACKETED
CABLE

WITH
ALPHLEX®

SHRINKABLE
TUBING
WITH CONTROLLED SHRINKAGE

Alphlex FIT-105 Tubing with "controlled shrinkage" is an economical, easy-to-use, irradiated PVC tubing that provides a snug, extremely flexible cable covering.

Cable cores may be pulled through FIT-105 Tubing with ease and shrunk down to form a jacket with all the qualities of the finest extruded plastic jackets. The tubing is supplied in expanded form and in continuous lengths and shrinks 50% upon application of heat (325°F). Heat may be applied through the use of the Alpha Heat Gun, or other heat sources. FIT-105 conforms to MIL-I-631C (105°C).

FIT-105 Tubing is available at your local electronics distributor in 14 sizes ranging from 3/64" to 4" I.D. before shrinking.

Write for your FREE Alphlex™ Catalog AT-63 describing the industry's most complete tubing line.



**ALPHA WIRE
CORPORATION**

Subsidiary of LORAL Electronics Corporation
200 Varick Street, New York 14, N. Y.
PACIFIC DIVISION:
11844 Mississippi Ave., Los Angeles 25, Calif.

NEW FROM ROBINS CANNON XL CONNECTORS

EFFICIENT, RUGGED
AND LOW COST
FOR CONTROLS, COMPUTERS,
INSTRUMENTS, AUDIO
AND VIDEO!



- Self-latching for locking mated fittings together securely
- Wide variety of mountings

STRAIGHT CORD PLUGS

3 and 4 conductor plugs with socket or pin contacts feature cable relief spring entry, satin nickel finish.

RECEPTACLES

Socket and pin type 3 and 4 conductor, for wall or panel mounting. Panel units can mount on panels from $\frac{1}{32}$ " to $\frac{3}{16}$ ".

SINGLE GANG AND 2-GANG

Assembled to single or double wall plate. 3 and 4 conductor, with socket or pin contacts.

MICROPHONE OR 90° MOUNTING RECEPTACLES

3 conductor with pin contacts.

ADAPTOR RECEPTACLE

3 conductor with pin contacts mounts in or on to microphone and other units.

The Cannon XL connectors are interchangeable with and mate with Cannon XLR connectors.

ROBINS INDUSTRIES CORP.

FLUSHING, N. Y. 11356

Robins Industries Corp. is the Exclusive U.S. Supplier of Cannon XL Connectors.



FREE CATALOG

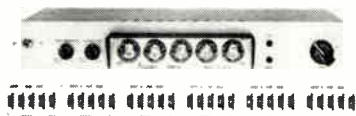
Manufactured by Cannon Electric (Australia) Pty. Ltd. © "CANNON" is a trade mark registered in the U. S. Patent Office and in other countries by Cannon Electric Company.

Circle 94 on Inquiry Card

NEW PRODUCTS

TIME BASE COUNTER

Freq. range is 1cps - 120kc; input sensitivity is 10mv RMS, 3cps-120kc.



This solid-state, variable time-base counter has an integral 6-channel, time-base programmer. Readout display is a wide-angle, long-life Nixie®. An integral 6-channel selector switch permits readout of any input channel. Each channel has an independently adjustable time base and can be set from 0.0001 to 99.99 sec. by 4 thumb wheel switches and a 3-position range multiplier switch. Anadex Instruments Inc., 7617 Hayvenhurst Ave., Van Nuys, Calif.

Circle 244 on Inquiry Card

PRESSURE TRANSDUCER

Pressure ranges from 0-100 to 0-6000 psig; static-error bands above $\pm 0.75\%$.

In model PT-101 series gage-pressure transducers, a cermet potentiometer replaces the standard wirewound, carbon-film or conductive-plastic types. A built-in fusing mechanism prevents damage to the element in the event of high-surge currents. Intermediate linkages and bearings are eliminated by transmitting the motion of a temp. stable Ni-Span-C Bourdon tube directly to the potentiometer through multiple fingered wipers. Tec-tron Electronic Corp., P. O. Box 222, Jamaica, N. Y.

Circle 245 on Inquiry Card

POTENTIOMETER

Sine-cosine unit is accurate to 0.25% absolute of p-p input voltage.

The Type 754SC (Model 754-6046) offers this accuracy in a resistance range of 10 to 50K Ω ($\pm 5\%$ /quadrant). Accuracy is absolute in accordance with MIL-R-12934. Specs: life is 1×10^6 revolutions; spec. is less than 0.1% of the input voltage; operates at 70°C temp. and 95% humidity; angular resolution is 0.1° to 0.3°, and voltage resolution is 0.035% to 0.1%. Fairchild Controls, div. of Fairchild Camera and Instrument Corp., 225 Park Ave., Hicksville, N. Y.

Circle 246 on Inquiry Card

EXTREMELY
BROADBAND

2-16 Gc

MODEL T-601

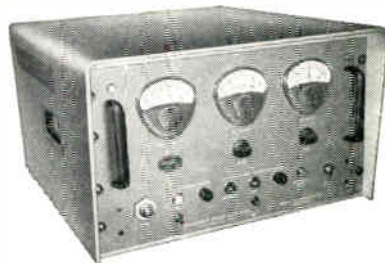
OCTAVE
BANDWIDTH

1-12 Gc

RANGE COVERED BY 4 MODELS



TWT POWER AMPLIFIERS



with 1 watt output guaranteed over octave bandwidths

FEATURES

- Periodic permanent magnet focusing on all tubes
- Ruggedly built for long service
- Continuously variable gain controls
- CW, pulsed or AM modulated operation

CHARACTERISTICS and PRICES

Model	T601	T607	T608	T609	T610
Frequency, Gc	2-16	1-2	2-4	4-8	8-12
Min. Pwr. Output, Watts	1*	1	1	1	1
Min. Small Sig. Gain, db	50.0*	36.0	30.0	30.0	36.0
Price	\$3990	\$2150	\$2150	\$2750	\$2750

*Over center octave band.

Prices subject to change without notice.

Write for more information.



American Electronic
Laboratories, Inc.

1313 RICHARDSON ROAD, COLMAR, PENNA.
Just north of Philadelphia

Circle 95 on Inquiry Card

NEW PRODUCTS

CASTING FURNACE

Unit can be adapted for operations at 2800°C; capacity is 3-12 lbs.



Model 519 has a vacuum chamber that is 30 in. in inside dia. x 15 in. deep. All operating controls are placed where they can be easily reached or observed by the operator. The upper chamber surface allows attachment of bridge-breaker, additions-maker, thermocouple-immerser, and a long-bore sight glass for an optical pyrometer. The vacuum pumping system consists of a 4-in. "Ring-Jet" oil booster pump backed by a Microvac mechanical pump; it can be adapted to several other pumping options—such as a 6 in. diffusion pump, an additional cold-trap, etc., without removing the other components. F. J. Stokes Corp., 5500 Tabor Rd., Phila. 20, Pa.

Circle 247 on Inquiry Card

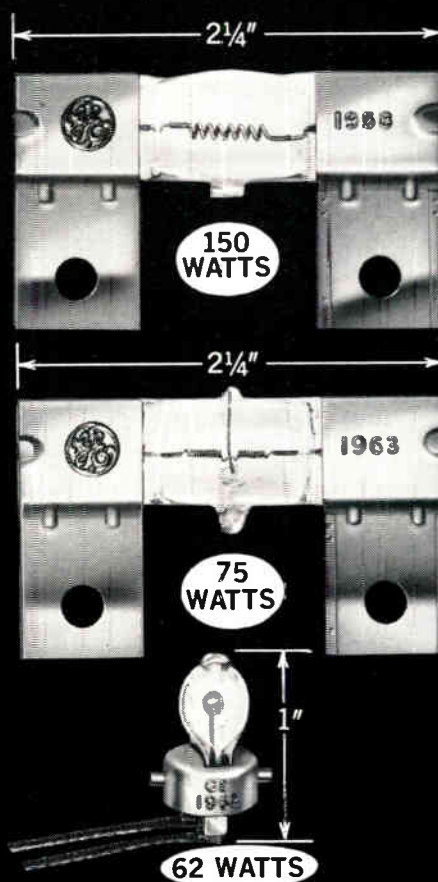
RESISTORS

Rise times as low as 100nsec.; ranges to 20 meg.; wattage to 2.5w.

Series RT are for use in computing, data processing, process control and other related systems. They provide good h-f performance and can be supplied with rise times as low as 100nsec. (from 10% to 90% of peak pulse amplitude with a 100kc pulse input), depending on resistance values and physical configurations. Available in axial lead, radial lead, and lug types, they are rated at 0.15w. to 2.50w. based on a max. amb. temp. of 125°C, derated to 0w. at +150°C; max. resistance ranges from 560K to 20.0 meg; tolerances are 1% through 0.005%. Kelvin Sales Co., 5919 Noble Ave., Van Nuys, Calif.

Circle 248 on Inquiry Card

New G-E Quartzline lamps pack 60 to 150 watts into less space than ever before!



General Electric's use of quartz bulbs and a regenerative iodine cycle make it possible to package high wattages in small spaces.

The iodine cycle within the lamp essentially eliminates bulb blackening so that light output is not diminished throughout lamp life. Besides providing a "package" for a high concentration of radiant energy (visible and infrared), this quartz bulb can withstand extreme thermal shock.

You can use these tiny G-E Quartzline lamps individually or mount them in closely spaced clusters to give you even higher levels of radiant energy.

At present, there are six lamps in the G-E Quartzline. They give designers a new dimension which allows greater design freedom in applications that require concentrations of light and/or heat.

For complete specifications on the entire line offered by General Electric's Miniature Lamp Department, write today for Bulletin 3-3407. General Electric Co., Miniature Lamp Dept. M-316, Nela Park, Cleveland, Ohio 44112.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

WHAT GASEOUS DIELECTRIC HAS...

- high heat transfer
- high dielectric strength, power to microwave frequencies
- no dipole moment
- unusual sonic properties
- remarkable inertness
- high molecular weight
- low condensation temperature
- high compressibility
- virtually unlimited life
- colorlessness
- odorlessness
- non-toxicity
- detectability
- ready availability from two producing locations

SF₆ offers all of the above. This dielectric gas has found successful application in heavy electrical units, miniaturized electronic devices and X-ray equipment. If the unusual properties of sulfur hexafluoride suggest other potential applications to you, mail the coupon for our 22-page technical bulletin.

E1-1036

Baker & Adamson* Fine Chemicals
GENERAL CHEMICAL DIVISION
P. O. Box 353, Morristown, N. J.



Please send your technical bulletin on SF₆.

Name _____

Title _____

Firm _____

Address _____

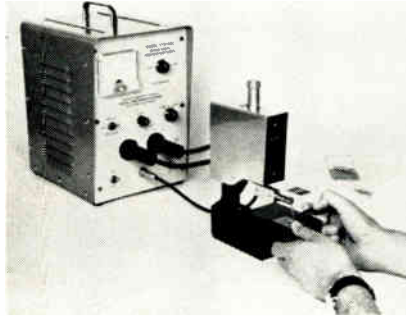
City _____ Zone _____ State _____

Circle 97 on Inquiry Card

NEW PRODUCTS

WELD HEAD

For interconnecting micro components or integrated microcircuit leads.



With the model UTA-62 "Split Electrode" weld head, common lead materials in ribbon or wire configurations, ranging in thickness from less than 0.0005 in. to 0.010 or more, can be bonded to copper, gold, nickel or Kovar laminates or to fired-on metallic frits or other films down to 0.0005 in. Hughes Aircraft Co., Vacuum Tube Products Div., 2020 Short St., Oceanside, Calif.

Circle 249 on Inquiry Card

LONG LIFE CAPACITORS

Expected useful life is in the order of 10 years or more.

Type 34D series of tubular aluminum electrolytic capacitors have ratings from 10,000 μ f at 2.5v. to 70 μ f at 450v. They employ welds at all critical anode and cathode terminations. Elimination of riveted or pressured connections insure no open circuits even when operated in the mv or μ v signal range. Protection against drying out is assured by a molded phenolic end seal and synthetic gasket design. Sprague Electric Co., Marshall St. No. Adams, Mass.

Circle 250 on Inquiry Card

IONIZATION GAUGES

Sensitivity of 100 μ a/micron with a grid current of 4.0ma.

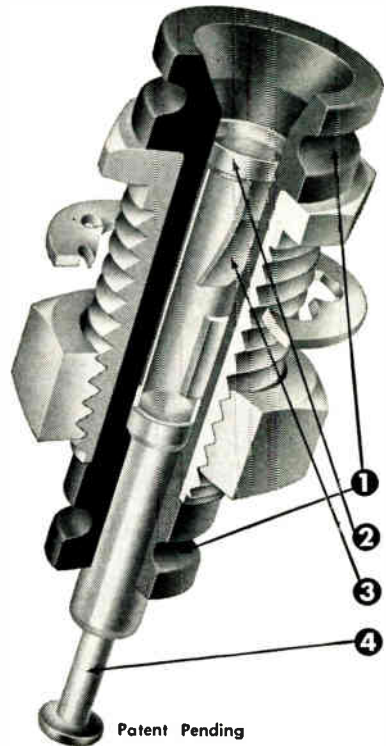
Gauges have 2 filaments which will not suffer burn-out or emission decay if exposed to atmospheric pressure during operation. Each filament is capable of 3000 hrs. life when the gauge is operated at a pressure of 10⁻⁸ Torr or better. Heater power is 7w. Gauges are capable of pressure measurements between 10⁻³ and 2 x 10⁻¹¹ Torr. The X-ray limit is 2 x 10⁻¹¹ Torr. Resitron Laboratories, Inc., Vacuum Products Div., 3860 Centinela Ave., Los Angeles 66, Calif.

Circle 251 on Inquiry Card

AUGAT TEST JACKS

for .080 diameter prods

Meeting Requirements of MS16108 (Ships)



Patent Pending

Look at these features . . .

- ① Front and rear barriers for additional voltage breakdown
- ② Closed entry contact design
- ③ Heat treated beryllium copper contact
- ④ Choice of three terminal styles



WIRE WRAP*
for No. 20, 22,
24 or 26 wire

EYELET

TURRET

Plus ten brilliant Nylon** colors (also available in Teflon**).

Write today for Data Sheet 162 describing Augat Test Jacks in detail.

*Gardner-Denver Company trademark
**DuPont trademark

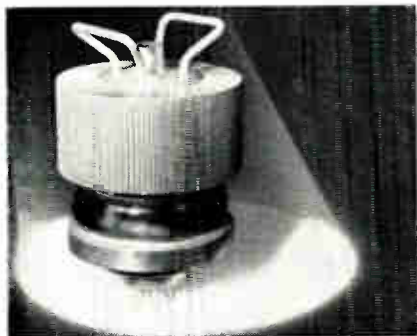
AUGAT INC.
39 Perry Avenue, Attleboro, Mass.

Circle 99 on Inquiry Card

NEW PRODUCTS

BEAM PENTODE

Handle facilitates insertion and removal; driving voltage is 110.



The PL-195 is capable of over 5kw of useful power output in Class AB₁ linear amplifier. The tube uses a coated unipotential cathode and requires 102w. of heater power. Cooling requirements with the tube operating at the full rated output are 70 CFM of air at a pressure drop of 0.26 in. of water column. Max. plate voltage rating is 5kv; 2.0a. is the max. plate current. Length is 8.25 in. and dia. is 5.53 in. Penta Laboratories, Inc., 312 N. Nopal St., Santa Barbara, Calif.

Circle 252 on Inquiry Card

DIGITAL DELAY GENERATOR

Interval range of 0-9999nsec. in 1nsec. steps; no ± 1 count ambiguity.

Model 610 has an input sensitivity of 1v. min., with 0.1v. risetime, and output pulse risetime of 1v/nsec., 5v. max. Delayed output is always referenced to the Start channel pulse. Trigger modes are manual, remote, external pulse, and internal 2kc multivibrator. Provision can be made for extended delays to 10⁴nsec. Eldorado Electronics Co., 1832 Second St., Berkeley 10, Calif.

Circle 253 on Inquiry Card

ZENER DIODES

Temp. compensated at 5ppm/°C; voltage ranges from 8 to 200v.

These hermetically-sealed silicon zener diodes have a power dissipation of 1.5 to 2.5w. With voltage drops independent of current over a wide current range, they are effective in regulating dc voltages, low impedance dc level changing, clipping, limiting and surge protection within their max. rating areas. They are temp. aged and scope-tested to check stability: temp. range is -55°C to +100°C. Units meet environmental requirements of Mil-202, Methods 103A, 106A, and 202A, and Mil-E-11D. Tighter tolerances and higher voltages are available. Solitron Devices, Inc., 500 Livingston St., Norwood, N. J.

Circle 254 on Inquiry Card

NEW! BALLANTINE SENSITIVE TRUE-RMS RF MILLIVOLTMETER

Measures 300 μ V to 3 V
from 0.1 Mc to 1,000 Mc

Measures True-RMS regardless of Waveform and Voltage

High, Uniform Accuracy and Resolution over entire 5-inch scale



Model 340
Price \$760
(with all accessories*)

Ballantine's new Model 340 is an extremely sensitive RF millivoltmeter designed for accurate True-RMS measurements with high resolution. Its 5-inch voltage scale spreads out the readings logarithmically so that you can make measurements to the same high resolution and accuracy at the bottom as at full scale. This advantage means that you can not only measure voltages accurately, regardless of waveform, but also calibrate the 340 using a signal source that may be far from sinusoidal. The new 340 is now available in both portable and rack versions.

SPECIFICATIONS

Voltage Range.....	300 μ V to 3 V	Crest Factor.....	100 to 3 depending on voltage range
Frequency Range.....	0.1 Mc to >1,000 Mc; calibrated to 700 Mc	Scales.....	Two logarithmic voltage scales, 0.95 to 3.3 and 3.0 to 10.6. One decibel scale, 0 to 10
Indication.....	True-RMS on all ranges, all voltages	Mean Square DC Output..	0.1 V to 1.0 V dc. Internal resistance 20 kilohms. (For connection to recorder.)
Accuracy....% of Reading	0.1 Mc — 100 Mc, 4%; 100 Mc — 700 Mc, 10%; above 700 Mc as sensitive indicator		

*Accessories include a probe tip for in-circuit measurements, an adapter for connection to N or BNC, a T adapter for connection to a 50 ohm line, and a 40 db attenuator

Write for brochure giving many more details

— Since 1932 —



BALLANTINE LABORATORIES INC.
Boonton, New Jersey

CHECK WITH BALLANTINE FIRST FOR LABORATORY VACUUM TUBE VOLTMETERS, REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY, OR WAVEFORM. WE HAVE A LARGE LINE, WITH ADDITIONS EACH YEAR. ALSO AC/DC LINEAR CONVERTERS, CALIBRATORS, WIDE BAND AMPLIFIERS, DIRECT-READING CAPACITANCE METERS, AND A LINE OF LABORATORY VOLTAGE STANDARDS 0 TO 1,000 MC.

AMPERITE

Thermostatic DELAY RELAYS

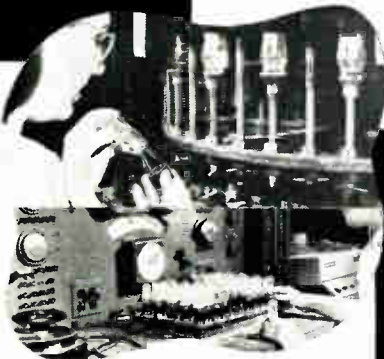


Delays:
2 to 180 seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current . . . Being hermetically sealed, they are not affected by altitude, moisture, or climate changes . . . SPST only—normally open or normally closed . . . Compensated for ambient temperature changes from -55° to $+80^{\circ}$ C. . . Heaters consume approximately 2 W. and may be operated continuously . . . The units are rugged, explosion-proof, long-lived, and—inexpensive!

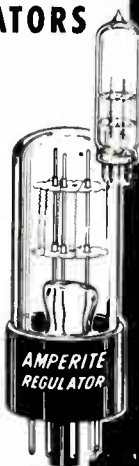
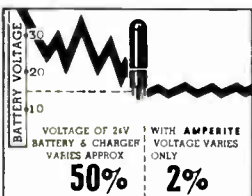
PROBLEM? Send for Bulletin No. TR-81

TYPES: Standard Radio Octal, and 9-Pin Miniature.
List Price, \$4.00



Individual inspection and double-checking assures top quality of Amperite products.

AMPERITE BALLAST REGULATORS



Hermetically sealed, they are not affected by changes in altitude, ambient temperature (-50° to $+70^{\circ}$ C.), or humidity . . . Rugged, light, compact, most inexpensive.

List Price, \$3.00

Write for 4-page Technical Bulletin No. AB-51

AMPERITE

600 PALISADE AVE., UNION CITY, N.J.

Telephone: 201 Union 4-9503

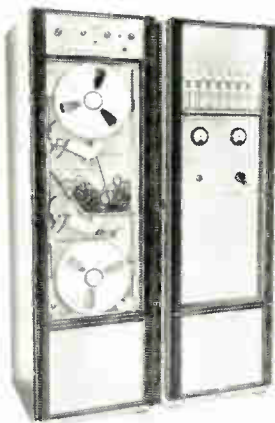
In Canada: Atlas Radio Corp., Ltd.,
50 Wingold Ave., Toronto 10

Circle 101 on Inquiry Card

NEW PRODUCTS

RECORDER

Analog correlation is accomplished in reel-to-reel or continuous-loop.



The Delta-Tau 480 series is a dual-capstan, time-delay recorder/reproducer used for sophisticated applications of auto- and cross-correlation. Other applications include overlap data editing, 1-pass capture of PCM data, and continuous-loop monitoring and infrequent data. Accurate, fixed or continuously variable time delays are made possible by a light-mass drive and speed control system at each head station. Data can be recorded at high speed and simultaneously or later played back with a greatly expanded time base. Sangamo Electric Co., Electronic Systems Div., Springfield, Ill.

Circle 255 on Inquiry Card

MIXER-AMPLIFIERS

Provides 30mc or 60mc output. Wide-band and narrowband models available.

Type 135 waveguide mixer-amplifier solves the problem of matching mixer and amplifier stages for microwave use. Airborne Instruments Lab., Deer Park, L. I., N. Y.

Circle 256 on Inquiry Card

TRANSISTORS

Ideal choppers for low-level saturation switching: switching speed is 1mc.

Types 2N2871 and 2N2872 transistors have applications in telemetry, analog computers, dc to ac conversion, and modulators. They are matched for offset voltage at less than 200 μ v and are packaged in a 6 lead TO-5 case. They feature low offset voltage, low saturation resistance, and high voltage operation with the space saving advantage of 2 units in 1 can. Amb. temp. variation will not affect the offset matching since the junction temps. are equal. Hughes Aircraft Co., Semiconductor Div., Newport Beach, Calif.

Circle 257 on Inquiry Card

new Allen hex screwdrivers

work faster, easier . . . reach where wrenches won't go



fixed handle SCREWDRIVERS

11 hex sizes:
.050" to 1/4"
Precision formed, alloy steel blades
Shockproof, breakproof, amber plastic (UL) handles

detachable BLADES

8 hex sizes:
1/16" to 3/16"
Fit all "99" Series handles
Available singly — as a set of six in free plastic pouch — or in roll kit with handle



WRITE FOR BULLETIN N763

XCELITE

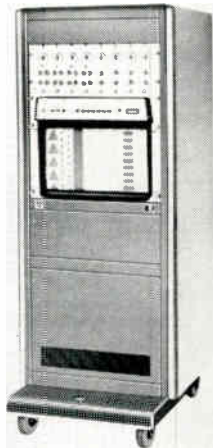
XCELITE, INC., 28 BANK ST., ORCHARD PARK, N. Y.
Canada: Charles W. Pointon, Ltd., Toronto, Ont.

Circle 102 on Inquiry Card

NEW PRODUCTS

THERMAL WRITING SYSTEM

Chart speeds may be varied from a few mm/hr. to 200mm/sec.



Model 15 1784 70 is an 8-channel pressure-thermal writing recording system that permits long-term monitoring at extremely slow chart speeds. Thermal pens exert a constant force of 25gm on the chart paper. They eliminate the effect of extraneous vibrations that might be transmitted to the pens. If the heat to the pen is accidentally turned off, the pen's force is sufficient to make a trace. System produces a sharp, uniform, rectilinear trace even where transients of extremely high rise time exist. System accuracy is 1/2% full scale, static and dynamic. Brush Instruments div. of Clevite Corp., 37th & Perkins, Cleveland 14, Ohio.

Circle 268 on Inquiry Card

SOLAR SIMULATORS

Units rated at 500w. @ 120v. and 1000w. @ 200v. respectively.

Models 5236-5 and 5236-10 are modular solar heat-flux simulation radiant heating units. They have 5 and 10 in. lighted lengths and are rated at 500w. @ 120v. and 1000w. @ 200v. respectively. They can be arranged in a space simulation chamber to produce from near zero to approx. 300w./sq. ft. ($\pm 10\%$) of programmable simulated solar or albedo radiant heat-flux density on the test-vehicle surface. Units satisfy the general solar heat and albedo heat-flux test conditions and can be reused and reoriented to provide a variety of test set-ups. Research, Inc., P. O. Box 6164, Edina Sta., Minneapolis 24, Minn.

Circle 269 on Inquiry Card



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CHRISTIE ELECTRIC CORP. 3408 West 67th Street, Los Angeles 43, Calif.

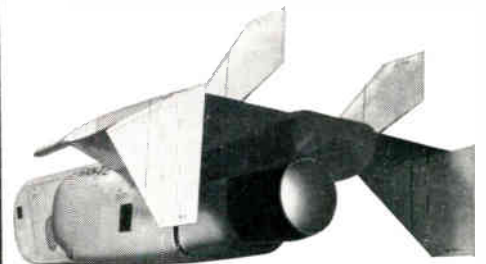
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for automatic go/no-go testing of voltages, limits, responses and programming of GAM-72 Quail Decoy Missiles.

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For information about how you can apply this capability to your electronic system and equipment requirements, write:

W. W. Toole
Manager of Sales, Dept. 946
McDonnell EED
Box 516, St. Louis 66, Missouri



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AVNET

requirements specify STC

over 150 2N type nos. in 12 package sizes in power ratings from 5 to 300 watts. 21 MIL approvals; features major breakthrough in miniaturized power without heat sink; isolated collector in 75-85 watts; PNP transistor with NPN complements.

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S.T.C.

of STC silicon power transistors



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- FLICKERLESS DISPLAY STORE
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Single-gun, dual-gun, multi-tube systems to convert scan for radar, sonar, television, and to perform analog processing, data analysis, contract or expand time scale, auto correlation.

- SLOWED TELEVISION TRANSMISSION

by telephone line or other narrow-band systems.

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OPTICAL CHART READERS, FLYING SPOT SCANNERS, LOW-LIGHT-LEVEL CAMERAS, and IMAGE RECTIFICATION. Automatic inspection and recognition of size, shape, color, and texture.



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2300 Washington Street
Newton 62, Massachusetts
617 Woodward 9-8440

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LETTERS

to the Editor

"Photoconductive Devices —"

Editor, ELECTRONIC INDUSTRIES:

Your article, "Photoconductive Devices in Control Circuits," in the June 1963 issue of ELECTRONIC INDUSTRIES was read with great interest, especially the references to CdS photocells.

We are currently working on the development of an electronic fire simulator for Defense Atomic Support Agency, and in our prototype a CdS cell was used as the radiant energy sensor. You state that "all types of CdS and CdSe photocells are limited to a maximum operating temperature of 70° to 80° C."

While our device will actually operate at a normal ambient temperature, after it is triggered the cell may be exposed to temperatures around 600°F. Since the cells are made by sintering, we are curious as to what temperatures are used and what the consequences of repeated high temperature exposures might be. They could easily be cut out of the circuit at such times if desired.

If this information is not readily at hand, we would appreciate your suggestions as to a suitable source.

Lester A. Eggleston
Senior Research Engineer
Fire Research Section

Southwest Research Inst.
8500 Culebra Rd.,
San Antonio, Tex.

Ed: This letter was directed to Dr. F. E. Jaumot, author of the article. Other readers' comments would be welcomed.

"Mathematical Models—"

Editor, ELECTRONIC INDUSTRIES:

If available, I would appreciate a reprint of the article entitled "Mathematical Models for Engineers" which appeared in the September 1963 issue of ELECTRONIC INDUSTRIES.

F. A. Edwards,
Principal Engineer,
Maintenance Engineering
Division

Directorate of Maintenance,
Washington 25, D. C.

Editor: We anticipated a large number of requests for reprints of this article, and we have not been disappointed. Fortunately, we still have a good number on hand—enough to fill any reasonable requests.

(Continued on page 176)

New! Low-cost
Instrumentation Head
tooled for high volume
... fast prototype delivery!

"BQQ" 4-CHANNELS ON 1/4" TAPE



SHOWN
2 1/2 TIMES
ACTUAL SIZE

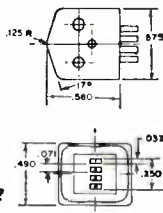
Deposited quartz gaps down to 50-millionths. Gap is extra-hard with precision edges—eliminates smear!

Multiple channels for less — with Nortronic's new, compact "BQQ" heads. Designed for digital, instrumentation, analog and audio recording or reproduction, "BQQ" heads are readily available in production quantities — will fit existing 4-track systems. Types include Record only and Record/Reproduce heads in no-mount, base-mount, rear-mount and side-mount styles.

TYPICAL APPLICATIONS — Used for instrumentation recording including carrier modulated types such as: AM, FM or Pulse; as straight Digital and Analog recording. Ideal for Audio Duplication, Background Music and 4-Channel "in-line" Stereo. In multiple staggered channel use, the "BQQ" accommodates 14 channels on 1" tape and 7 channels on 1/2" tape.

"BQQ" SERIES—Laminated core; flush or relieved metal face; hyperbolic contour; pin terminals. Impedances to 360 millihenrys. Wide range of gap lengths.

NEED MAGNETIC HEADS?
Cut specification time—check Nortronic's first! Industry's specialized "standards" plus specialized "know-how".



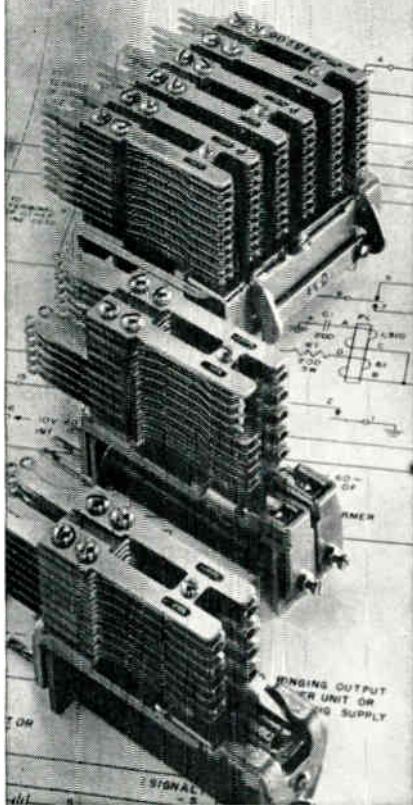
Nortronic

8144-B 10th Ave. No., Minneapolis 27, Minn.

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Stromberg-Carlson TELEPHONE-TYPE RELAYS



The sound design and long, reliable life of these Stromberg-Carlson relays have been proved by many years of successful use in the exacting field of telecommunication:

Type A: general-purpose relay. Up to 20 Form "A" spring combinations.

Type B: multi-contact relay. Up to 60 Form "A" spring combinations.

Type BB: multi-contact relay. Up to 100 Form "A" springs.

Type C: two relays on one frame; mounts in same space as one Type A.

Type E: general-purpose relay; universal mounting; interchangeable with relays of other manufacturers.

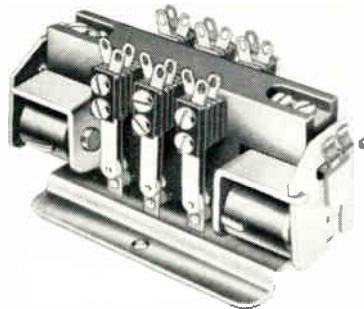
All standard spring combinations are available in these telephone-quality relays. For complete technical data and details on special features, write to Industrial Sales Department.

STROMBERG-CARLSON
A DIVISION OF **GENERAL DYNAMICS**
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BALL-CAM RELAY

Switch actuation allows max. movement without retraction when coils de-energize.



In the ball-cam multi-pole relay type F-505 switch, actuation is accomplished by movement of ball bearings which are positioned by a sliding nylon bar. The action is positive to the extent that max. movement is accomplished without back-off or retraction after coils are de-energized. It can be built with any combination of open or closed contacts up to 30-pole throw. Contact ratings up to 12.5a. resistive. It operates either for ac or dc, with a power requirement of approx. 5w. Guardian Electric Mfg. Co. of Calif., 5755 Camille Ave., Culver City, Calif.

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The Avnet System, coast to coast

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Stock Sizes

MAIL
IT TODAY!



FOR GROUP WIRE



FOR SINGLE WIRE



FOR FLAT
TWIN LEAD-IN



SEND SAMPLES OF PLASTIC CLAMPS

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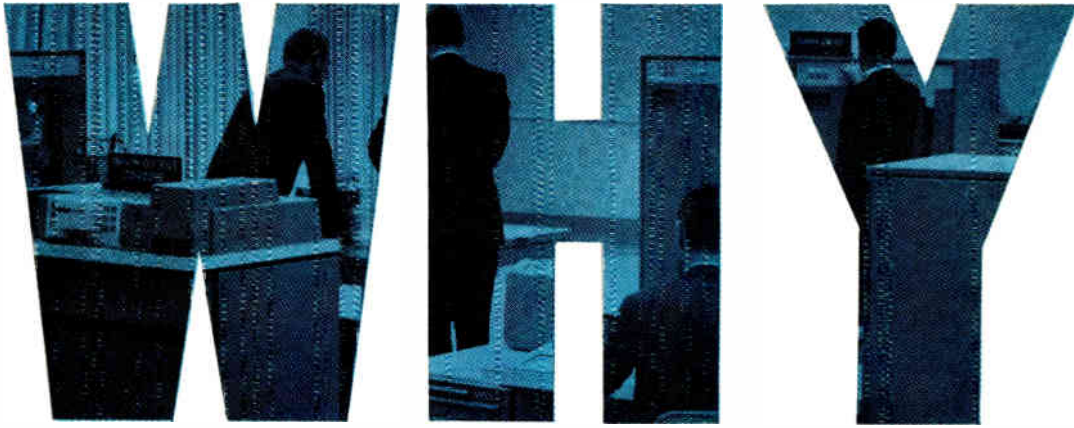
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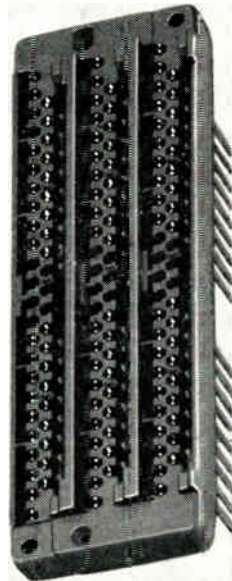
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HOLUB INDUSTRIES, Inc.

448 Elm St., Sycamore, Ill.



did **NCR** select **ELCO VARICON*** Series 7028 bus-strip connectors?

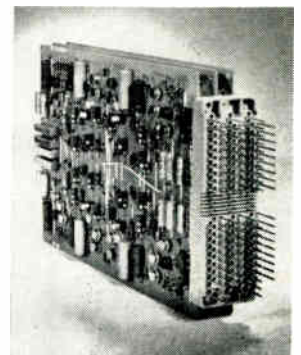


PROGRAMMED WIRE-WRAPPING... 5400 CONTACTS WITH ONE PROGRAM... AMONG MANY, MANY REASONS!

Elco Series 7028 enabled THE NATIONAL CASH REGISTER COMPANY to change from manual to programmed manufacturing without modifying existing plug-in cards utilized throughout the NCR 315 Electronic Data Processing System and its unique CRAM (Card Random Access Memory), which stores up to 8.3 million informational digits, and locates required data in a fraction of a second!

Elco Series 7028 is recessed below insulator surface, eliminated any possible programmed wire-wrapping interference; and additionally provided the proven reliability of Elco VARICON* Contacts, with their fork-like design, 4 coined mating surfaces, "wiping" action and innumerable other production and performance features.

Send for the Elco VARICON* Connector Catalog, Series 7028 information and any other design and engineering information, to learn how your own project problem may be reliably solved in a manner similar to the NCR 315.



ELCO CORPORATION, Willow Grove, Pa. • 215 OL 9-7000, TWX 510-665-5573

Attend Our Connector Seminar at
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EI-09

OCTOBER, 1963

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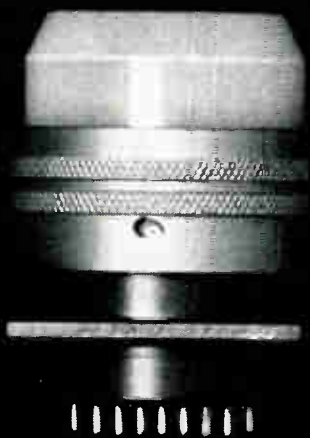
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First we made a Pygmy.

It's a new series of connectors designed primarily for internal use. Quality and dependability are the same as in the bigger ones, despite smaller size.

The Dwarf connector incorporates gold plated contacts with .090 centerline spacing. Numerical contact identification. Uses 24 gage contacts with solder pots which will accommodate 22 gage wire. Shell styles include jam nut mounting receptacles, box mounting receptacles and straight plug assemblies. Contacts are molded into place within a stable high strength dielectric combination insert

Then we made a Pancake.

and shell material. Gasketing at the main joint provides contamination resistance.

Electrical characteristics include minimum flashover voltage 1800 VAC RMS; test voltage 1200 VAC RMS; working voltage 400 VAC RMS; current rating 3 amps; insulation resistance 50,000 megohms; minimum contact engagement .060".

Write us for information on current availability of our Dwarf, Pancake, or Pygmy® connectors, and any specific application. We're in Sidney, New York.

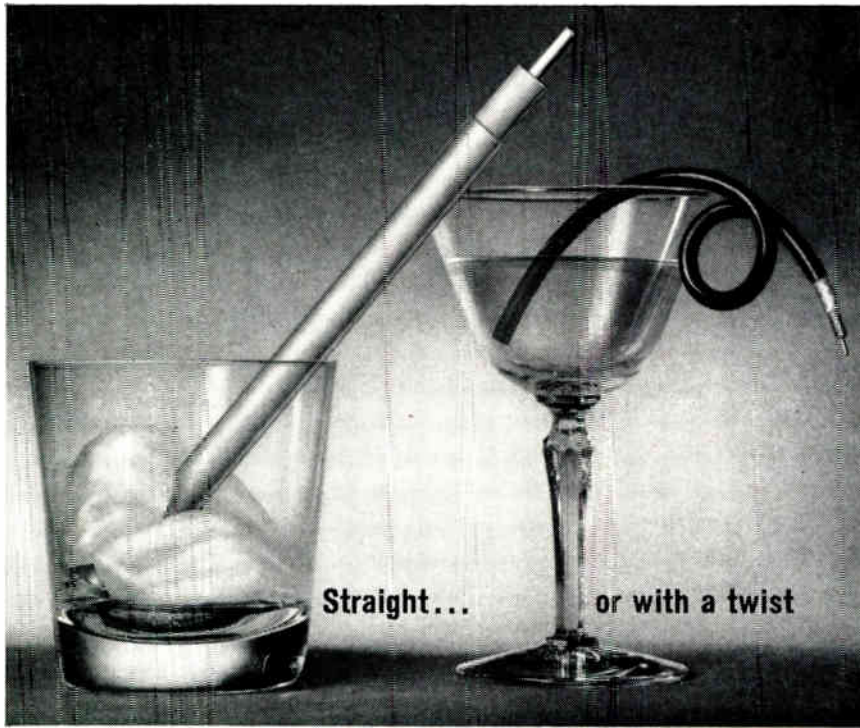
Now what's all this about a Dwarf?

CONNECTORS ACTUAL SIZE

Circle 111 on Inquiry Card

Scintilla Division

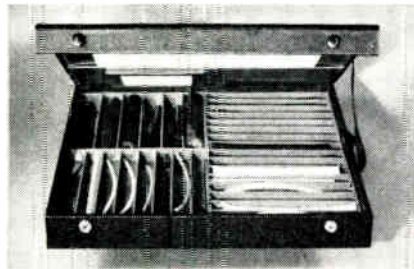




(We can serve you with both!)

Because we engineer and manufacture the most complete line of high frequency cable available in this country, we are in the unique position of being able to offer highly competitive prices and delivery on all your semi-flexible (aluminum and copper tube sheath) coaxial cable, your flexible coaxial cable and triaxial cable requirements. One source for all cable. Let us prove it. Put Times on your bidders list.

Times specializes in transmission system analysis, and offers comprehensive experience in impedance (VSWR) attenuation, electrical and crosstalk problems. And, as always, Times will manufacture cable and assemblies to your precise electrical requirements, including cutting to precise electrical length.



HAVE YOU SEEN THE NEW CABLE-KIT?

Since we have produced virtually every type of standard coaxial cable (over 300) plus thousands of special coaxial and multi-conductor

cables, Times has put together this one-of-a-kind kit, which enables you to see, at a glance, samples of the types of cables we design and produce. It's probable that you may find in it a cable already produced that will meet your exact needs, or be able to select composite construction for a new requirement.

For transmission with critical requirements of attenuation, or attenuation and impedance uniformity, crosstalk or electrical length (phase), we suggest one of the following semi-flexible cable constructions:



● ALUMIFOAM—low loss, 30% better than RG solid dielectric coaxial cable. Aluminum sheath, foamed polyethylene dielectric (50 & 75 ohm).



● ALUMIFIL—low loss, 40% better than RG solid dielectric. Helical filament dielectric (50 & 75 ohm) coaxial cable.



● ALUMISPLINE—lowest loss and best electrical characteristics, 45% better than RG solid dielectric. Splined dielectric (50 & 70 ohm) coaxial cable.



● ALUMISOL—excellent electrical length vs. temperature and uniformity characteristics—better than RG solid dielectric coaxial cable (50 & 75 ohm).



TIMES WIRE AND CABLE
Division of The International Silver Company
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Dept. EI-310

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 Semi-flexible coaxial cable
 Flexible coaxial cable
 I am interested in seeing the Cable-Kit demonstration—have salesman call:

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Company _____

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LETTERS

to the Editor

(Continued from page 168)

"What About the NSPE?—"

Editor, ELECTRONIC INDUSTRIES:

Your editorial of April 1963 states "Many technical societies now serve the electronic industry, but so far they have not sponsored any national programs to develop engineering professionalism."

I would like to call your attention to the National Society of Professional Engineers which has as its goal the provision of the services not met by the technical societies. These services include promoting professionalism, political awareness, community activity, public information, etc. NSPE is engineering's counterpart of the American Medical Association.

However, your point is well taken, and it is indeed true that we have failed to maintain our public image as demonstrated by the fact that the editor of a major engineering magazine does not know of the existence of NSPE.

Philip A. Jarvis
Registered Professional
Engineer

9260 S. W. 70th
Portland 23, Oregon

Ed: We are hardly unaware of the NSPE. But by definition, it represents only professional engineers. There are many, many other engineers—by far the majority—who are not being adequately represented.

"Congratulations—"

Editor, ELECTRONIC INDUSTRIES:

Congratulations on your State-of-the-Art Reference Issue! A real job.

One point we would like to make:

Please change our name and address in the index

From:
MODULAR ELECTRONICS, INC.
521 Central Ave.
Osseo, Minnesota

To:
MODULAR ELECTRONICS, INC.
21 4th St. S. W.
Osseo, Minnesota

Walter A. Gammel, Sr.
President

LETTERS

to the Editor

"State-of-the-Art" Issue —

Editor, ELECTRONIC INDUSTRIES:

I have just finished reading the June 1963 "State-of-the-Art Reference Issue" of ELECTRONIC INDUSTRIES. You are to be congratulated on covering such a broad technical field with completeness and effectiveness.

ELECTRONIC INDUSTRIES has been interesting, informative and a valuable source of reference. Keep up the good work.

I would appreciate receiving eight (8) reprints of the article "Testing without Direct Electrical Connections" by David M. Goodman. These reprints will be distributed to the engineers of our Branch who are working on new and unique testing techniques.

Edward C. Wilgus, Chief
Checkout Design Branch,
Analysis and Design Division,
Directorate of Recon. Engrg.

Aeronautical Systems Div.,
AFSC, USAF
Wright-Patterson AFB, Ohio

"Thanks —"

Editor, ELECTRONIC INDUSTRIES:

I had occasion to call your Readers' Service Department for some information that was difficult to locate. Your Miss Moyer took my call and was instrumental in arranging to provide me with back issues of ELECTRONIC INDUSTRIES so that I might have the information at hand for future reference.

It was refreshing for me to find people in your organization willing to go "the extra mile" when one more or less expects "the quick brush off" when any extra effort is called for in business life today.

May I thank you not only for your helpful magazine but also for the calibre of your personnel.

E. H. Kline
Electronic Maintenance
Supervisor, Dept. 985

UNIVAC Div., Sperry Rand Corp.
P. O. Box 5616,
Phila. 29, Pa.

Ed: We are happy to help when we can. In this case, back issues were available. We are not always so fortunate.



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SR40P1	0-150 ma	40-50
SR50P1	0-150 ma	50-60
SR60P1	0-100 ma	60-70
SR70P1	0-100 ma	70-80
SR80P1	0-100 ma	80-90
SR90P1	0-100 ma	90-100
SR100P1	0-100 ma	100-110
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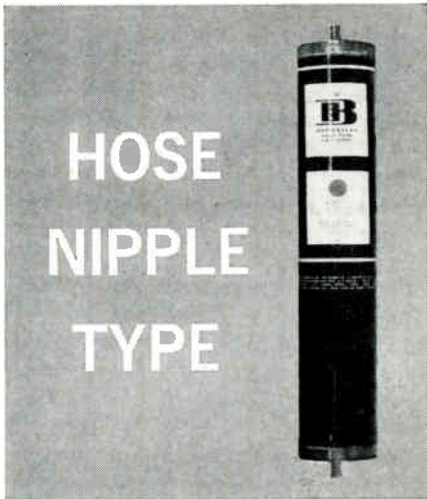


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COMING EVENTS

NOVEMBER

- Nov. 4-6: Northeast Res. & Eng'g Mtg. (NEREM), IEEE; Commonwealth Armory, Boston, Mass.
- Nov. 4-6: Design & Propulsion for Future Aerospace Vehicles Conf., AIAA; Biltmore Hotel, Dayton, Ohio.
- Nov. 6-9: Annual Mtg. of the Plasma Div., APS; San Diego, Calif.
- Nov. 6-9: Mtg., Acoustical Soc. of America; Univ. of Mich., Ann Arbor, Mich.
- Nov. 11-13: Radio Fall Mtg., IEEE EIA; Hotel Manger, Rochester, N. Y.
- Nov. 12-14: Fall Joint Computer Conf., AFIPS (IEEE, ACM, Simulation Councils, Inc.); Conv. Ctr., Las Vegas, Nev.
- Nov. 12-14: Manuf. Automation Show & 7th Conf. on Manuf. Automation, Manuf. Eng. Council, Purdue Univ.; Cobo Hall, Detroit, Mich.

CALL FOR PAPERS

Nineteen Sixty Four Electronic Conference, May 5-7, 1964. Marriott Twin Bridges Motor Hotel, Washington, D. C. Conference is sponsored by the EIA, IEEE and ASQC. Papers will be in the following areas: resistors—fixed and variable; capacitors; connectors, connections and interconnections; printed wiring; materials for components; thin-film devices; micro-miniaturization (excluding silicon integrated devices); conductors and cables; reliability and testing techniques. Three copies of a 500-word abstract should be sent by *Nov. 1, 1963*, to: Dr. John J. Bohrer, Technical Program Chairman, International Resistance Co., 401 North Broad Street, Philadelphia 8, Pa.

Ninth Scintillation & Semiconductor Counter Symp., Feb. 26-28, 1964. Hotel Shoreham, Washington, D. C. Symposium is sponsored by IEEE, AEC and NBS. Papers are invited in the following areas: photomultipliers and image tubes; scintillators and scintillator combinations; semiconductor and special detectors; circuitry and uses; multi-dimensional data acquisition and presentation track imaging (scintillation and spark) complex detector and data processing systems; and radiation detection in space and other special applications. Papers should be 15 min. long. Authors should send title and abstract by *Dec. 1, 1963*, to: W. A. Higinbotham, Chairman, Program Committee, Brookhaven National Laboratory, Upton, L. I., N. Y.

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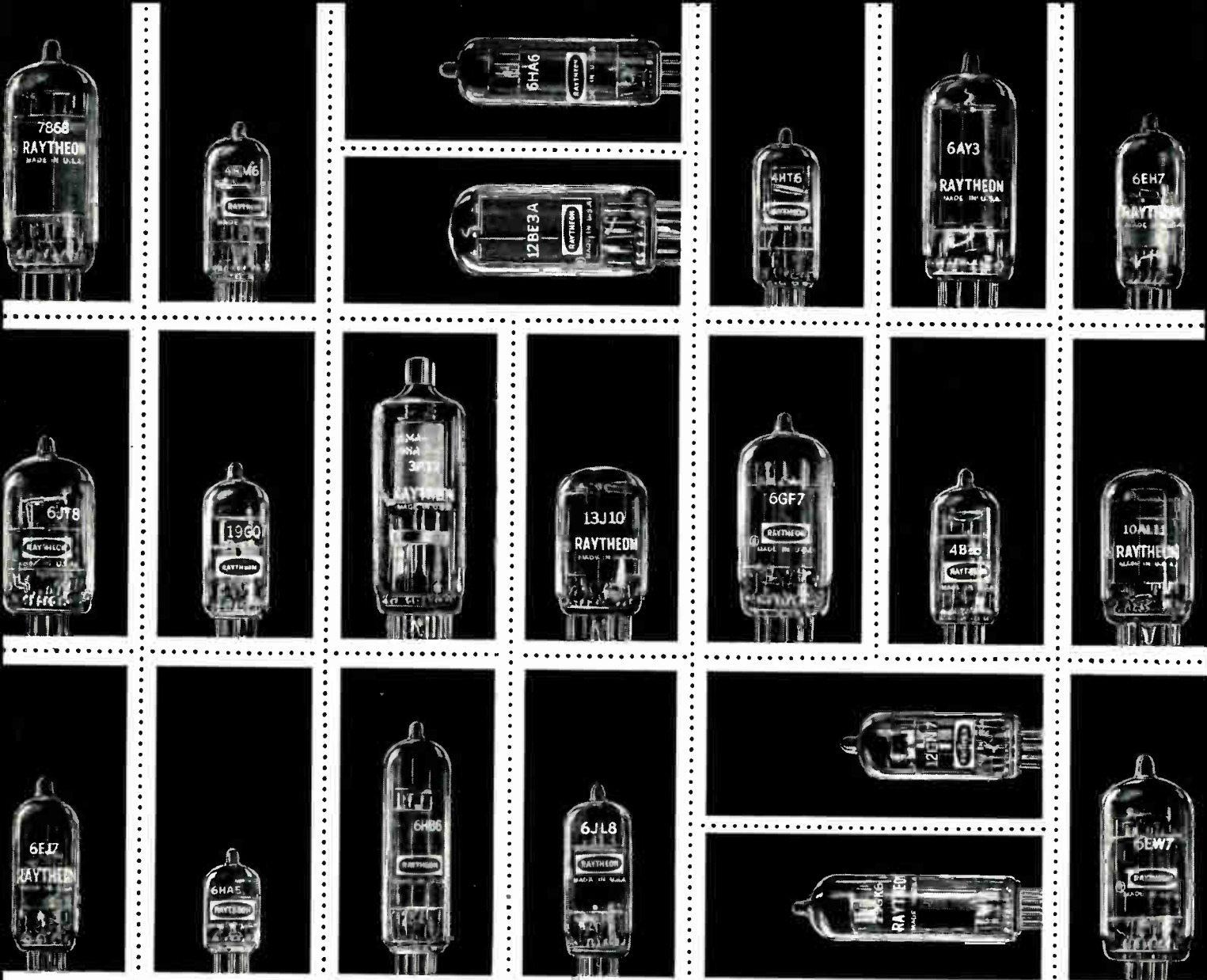
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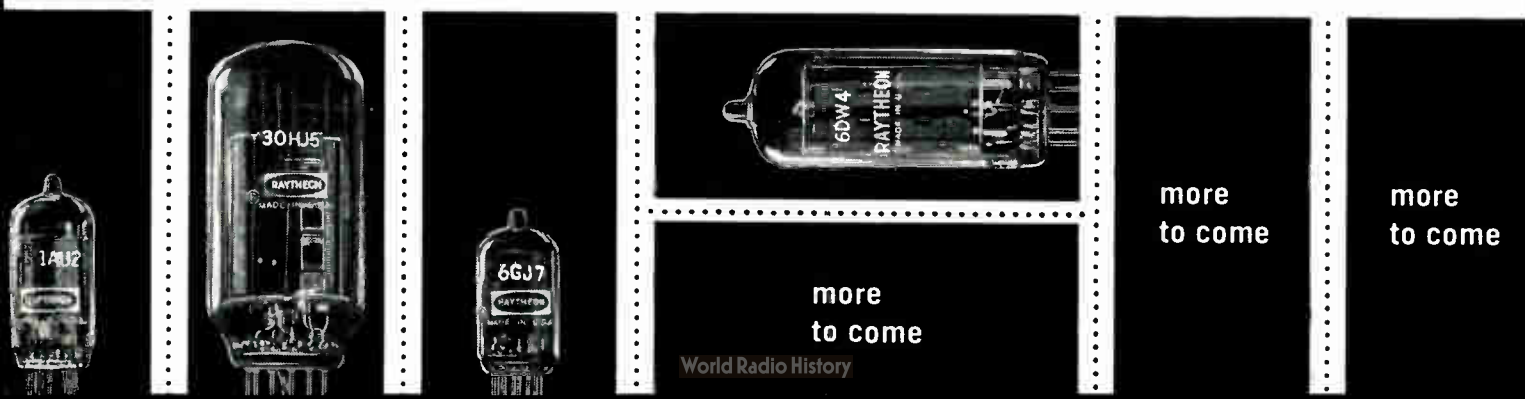
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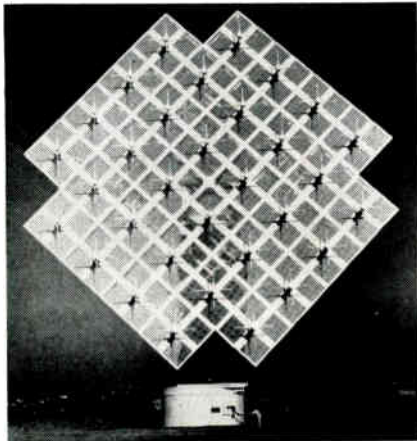
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The GE-235 computer capabilities can be increased with the addition of a high-speed Auxiliary Arithmetic Unit (AAU). The unit is not a peripheral device; it is a computing device having built-in logic and serves as a close-working auxiliary to the basic arithmetic unit. It features "floating-point trapping"; processing is interrupted upon detection of overflow, underflow, and illegal divide. This causes processing to transfer to a connecting program and eliminates special checking provisions in the main program. Computing capacity using the AAU is expressed mathematically as, "a binary number equivalent to a decimal number with 9 significant digits having an exponent range of -77 to +77."

The RCA 3301 REALCOM merges the four primary data-processing areas of scientific, business, real-time, and communication into one system. A design concept, "functional modularity" permits the computer to grow as applications require. An innovation called "scratch pad" memory has an internal speed of 250 nsec. The main-core memory cycle time is 1.75μsec. In one second 160,000 additions or subtractions, 32,000 multiplications, and 18,000 divisions of 8-digit numbers can be performed.

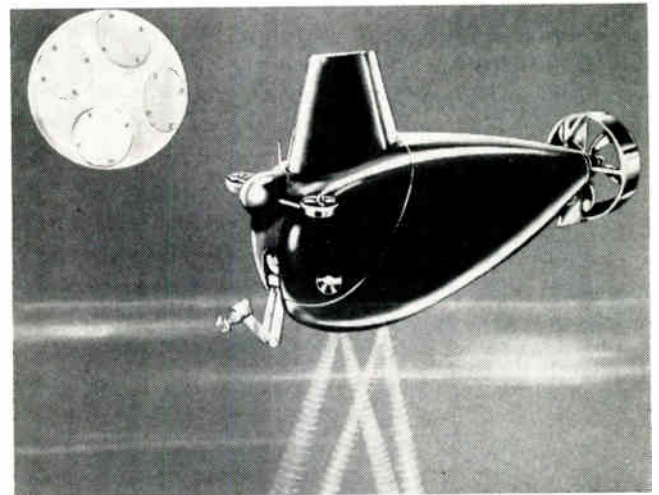
The Army Electronic Command awarded a contract to Sinetics Corp. to develop a family of integrated circuits that operate in the 10mc range. The line of diffused silicon circuits will use diode and transistor logic. Five circuits will be developed: a gate, gate expander, power gate, binary element, and a one-shot multivibrator.

ELECTRONIC SYSTEMS

Five glass ultrasonic delay lines will serve as shift registers in the guidance computer for Gemini. Operating speeds are 1.0 megabit/sec., and delay times are 27.11, 45.11, 50.61, and 110.61μsec. Storage capacity is between 2000 and 2250 bits. Peak drive voltage required is 25v.; output voltage levels range from 500 to 900mv. In operation, a transducer attached to the glass line converts a digital pulse to an ultrasonic signal. The inherent slowness of this signal is used as storage time for the digital pulse; hence, the delay line acts as a memory. When the signal reaches the end of the delay line, an output transducer converts it to an electrical pulse. Developed by Corning Glass.

DOPPLER NAVIGATION

The ALVIN 2-man sub uses JN-400 Acoustic Doppler system developed by Janus Products Inc., Syosset, N. Y. Four beams are directed fore-aft and port-starboard and detected by transducers. If there is any relative motion between vessel and bottom, the freq. received will be different. System determines motion and drift at depths where little is known about current.



The 25A Datatel®, an intermediate-speed data transmission system, sends information over private-line telephone facilities at twice the speed of present telegraph transmission systems, and with more than double the accuracy of intermediate-speed data systems. It is used where communications requirements do not involve large, concentrated amounts of data. Developed by Lenkurt Electric Co., Inc., a sub. of GTF&E.

The Commissariat a L'Energie Atomique, Paris, France, has leased an S-C 4020 high-speed computer recorder from General Dynamics/Electronics-San Diego. Working with an IBM 7090 it will record calculations onto 35mm microfilm or 9½ in. wide photorecording paper. The recorder utilizes electron beams to translate computer output into graphic form. It converts digital language into curves, maps, drawings, complex charts or alphanumerics. The results will appear, in French, on the face of the CHARACTRON® shaped-beam tube.

Time is an independent variable in correlating data with position. Erroneous time readings are of real concern. An error detection and correcting time decoder has been designed for use with the data reduction at Goddard. Time codes, methods of data handling, systems approach to detection, and the complete system are discussed here.

THE DATA REDUCTION FACILITIES AT THE GODDARD Space Flight Center process magnetic tapes containing data received from the scientific satellites. The time code, which indicates the data reception time in Universal Time, is produced by a time encoder located in the tracking station. It is serially recorded on a channel of the tape adjacent to those on which the incoming data are being recorded.

Tracking networks and supporting computer facilities correlate the satellite's location in space with time, and receiving networks and data reduction facilities correlate the satellite's data with time. Since a majority of the data from the satellites thus use time as an independent variable in correlating data with position, erroneous time readings are a source of genuine concern.

* * *

To reduce the time reading errors to a minimum, an error detecting and correcting time decoder has been designed. It is for use with the data reduction facilities at Goddard.

Time Codes

The two time codes adopted for use are the Serial Decimal (SD) time code and the Binary Coded Decimal (BCD) time code.

The Serial Decimal Time Code—the SD time code consists of time data in digits from tens of seconds through tens of hours. Fig. 1 shows this code. The resolution of the serial decimal time code is 1

Error Handling in . . .

TIME DECODING FOR SATELLITE TRACKING SYSTEMS

sec.; however, the resolution can be improved to 1 msec with the use of a linearizing (reference) frequency, which is either 100 kc or 10 kc and is derived from the same tracking station precision oscillator from which the time code is derived. FM is used for recording this signal on tape.

The BCD Time Code—The BCD time code presents time data in digits from seconds through hundreds of days. This includes 4 bits per sec. of "station data" to identify a magnetic tape recording by including, e.g., station identification, satellite identification, the year of recording, etc. The resolution of the BCD time code is 1 msec. because the 1 kc carrier frequency is a part of the code. A binary zero is represented by about three to one increase in the voltage amplitude of the carrier for two complete cycles. A binary One is represented by a similar carrier voltage increase for 6 complete cycles.

Fig. 1 shows the 1 kc coded carrier. The spectrum of the BCD time code includes no significant energy more than ± 400 cycles away from the 1 kc center frequency. Therefore, this code can be mixed with other signals on a single channel of a tape recording to conserve channels. At present, the servo signal, which is 60 cps modulation of 18.24 kc, is mixed with the BCD time code. The decoders previously available, however, did not do a reliable job of decoding this time code, because the signal strength and signal-to-noise ratio have had wide variations among the ensemble of tapes received from the re-

A. Demmerle



P. J. McCeney



T. J. Karras



By **ALAN DEMMERLE**

Head,

PAUL J. MCCENEY

Engineer,

And **THOMAS J. KARRAS**

Engineer,

Special Purpose Equipment Design Sec.
Data Instrumentation Development Br.
Space Data Acquisition Div.
Goddard Space Flight Center, NASA
Greenbelt, Md.

ceiving stations, and the decoders have been unable to cope with these variations.

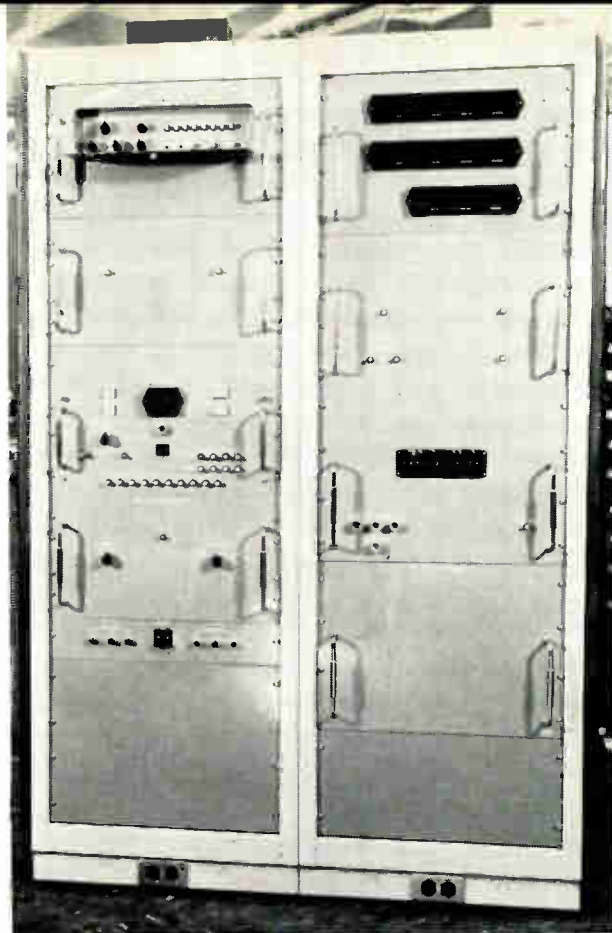
Present Methods of Time-Data Correlation

In the data reduction process at Goddard, the two methods previously used for correlating time with data are the multiple-read-in and the single-read-in methods.

In the multiple-read-in method the decoder collects the time data from the magnetic tape and formats the data as a single time reading: once every 10 sec. for Serial Decimal, or once per sec. for BCD. This reading is updated by 1 kc pulses until another full time reading is collected. The main disadvantage is that any temporary perturbation in time signal appears as an error in the time reading.

In the single-read-in method the operator observes the register display and when it appears to be monotonically increasing, he transfers the decoded time word from the decoder into a register where it is updated with 1 kc pulses. The main disadvantages of this method are that only one time reading is actually correlated with the data, and that potentially valuable data are lost each time the register is reset, since the operator must wait several seconds to be sure that the decoder output is increasing monotonically before setting the updating register.

Fig. 2 shows various possible errors in, and conditions of, a decoder's output. Undetected errors in the time readings associated with data can increase the cost of the data reduction process. In later processing of the data, general purpose computers are used to perform such operations as scaling, converting, sorting, and other special arithmetic or format-



The completed error detecting and correcting time decoder system is shown here in its rack mounted cabinets.

ting operations needed for a specific set of data. If undetected errors in the time data are recorded on the digital magnetic tape, computer time must be spent in searching for these errors. For PFM telemetry, the digital tape is formatted to have a time reading once per frame, which occur at approximately constant time intervals. The computer measures

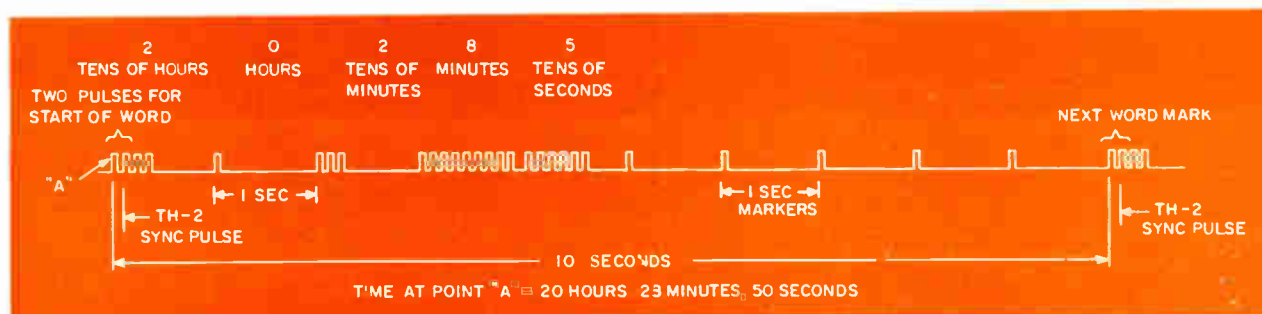
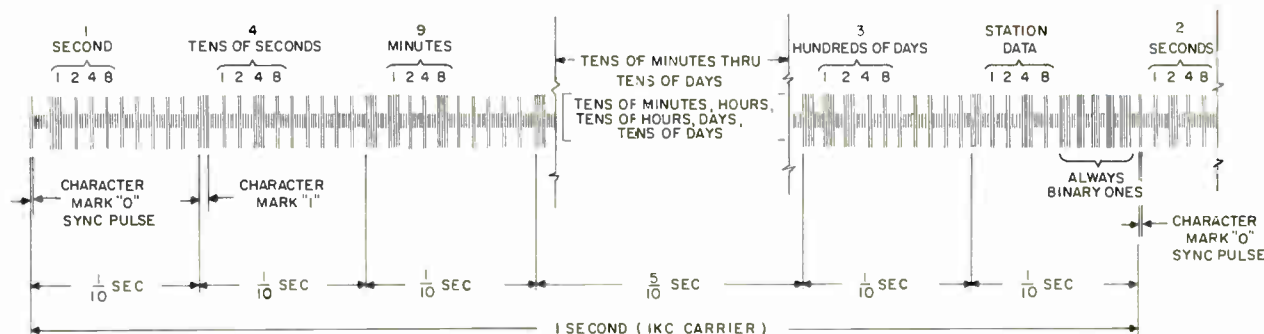


Fig. 1a (above): The NASA serial decimal time code. Fig. 1b (below): The NASA BCD time code.



ERROR HANDLING (Continued)

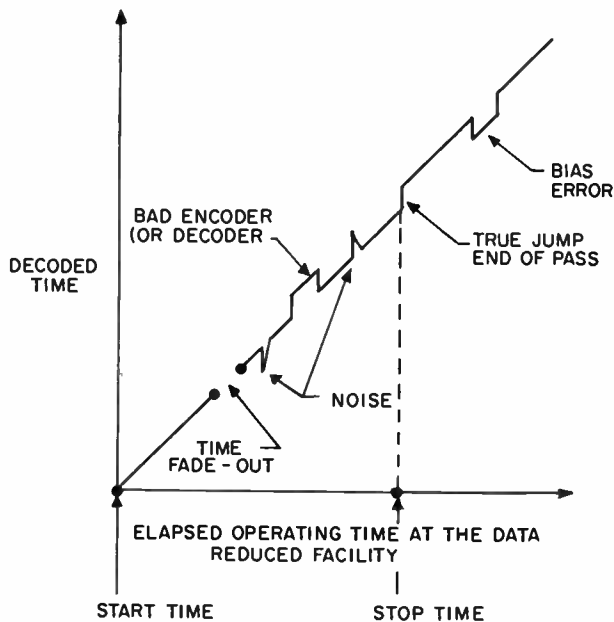


Fig. 2: Possible conditions of a time decoder output.

Table 1

Conditions of the signal arriving in the Data Reduction Facility

- I. The BCD code exists:
 1. It is correct
 2. It is incorrect sporadically
 3. It is incorrect regularly (bias)
- II. The BCD code does not exist:
 4. temporarily
 5. permanently
- III. The SD code exists:
 6. It is correct
 7. It is incorrect sporadically
 8. It is incorrect regularly (bias)
- IV. The SD code does not exist:
 9. temporarily
 10. permanently
- V. The Linearizing frequency exists:
 11. It is correct
 12. It is incorrect sporadic
 13. It is incorrect regularly (bias)
- VI. The Linearizing frequency does not exist:
 14. temporarily
 15. permanently

The conditions can exist in only 8 possible combinations

Category II & IV & V	Category II & IV & VI
" II & III & V	" II & III & VI
" I & IV & V	" I & IV & VI
" I & III & V	" I & III & VI

the difference between two consecutive time readings; and if this difference falls outside certain tolerance limits, an error is indicated.

The Systems Approach

The engineering problem is in choosing and designing a system which, while minimizing operator intervention, optimizes the trade-off of cost-complexity vs. index of confidence in its output readings. The ideal system would be one that could provide correct time readings regardless of errors in the input signal. A more realistic system is one for which the output can be assigned an index of confidence which is a function of the condition of the input signal and the cost and complexity of the system. The final choice of an optimum system depends upon the statistics of the probability of occurrence of any given type of error.

Categorizing Errors

The design of a system which deals with errors requires categorizing those errors. There are several ways to classify these errors, e.g., firstly, those caused by the encoder, decoder, by transmission link; secondly those caused by equipment, or by the operators.

Most useful seems to be the various conditions which can be assumed by the signal at the input to the decoding system. Malfunction of the decoding equipment is equivalent to some of these input signal conditions. With this in mind, the listing Table 1 was prepared.

The other combinations are impossible because categories I & II, categories III & IV, and categories V & VI are mutually exclusive.

An Identification and Correction System

This system detects and identifies errors and corrects certain types of errors. Also, it provides time readings as pure binary numbers which express either the number of elapsed milliseconds of the year, or the number of elapsed milliseconds of the day and the day of the year, as well as the mixed modulus system where time is put on the digital magnetic tape as a BCD number indicating the day of the year, hour of the day, minute of hour, etc. Providing both formats helps eliminate costly conversion time later in the data analysis process.

The time decoding system, which is being built, has been designed to consider: 1. a low signal-to-noise ratio at its input, where noise includes white noise, impulsive noise, and stray modulation; 2. genuine errors in the input signal which may be caused at the encoder; 3. signal fade-out; and 4. decoder malfunction.

There are only 4 combinations of bad input signal in Table 1 which will render incorrect output readings without the system recognizing that its output is incorrect. These 4 combinations are:

1. (3,8) a BCD bias error and a SD bias error where the two bias errors are equal.
2. (3,10) a BCD bias error and no SD code anywhere on the tape.
3. (5,8,11) no BCD code anywhere on the tape, a SD bias error.
4. (5,8,14) no BCD code anywhere on the tape, a SD bias error, and the linearizing frequency missing for very short periods of time.

The seriousness of these limitations, of course, depends upon the nature of the input signal, the frequency of occurrence of the unmanageable input signal combinations, and the consequences of allowing uncorrected errors. After a careful thought, it was presumed too expensive to design features into the system to compensate for these.

There are 3 inputs to the system: 1. the BCD time code, 2. The Serial Decimal (S.D.) time code, and 3. a linearizing frequency.

The following is a brief description of the proposed system (See Fig. 3).

A. Band Pass Filters: These filters were designed to extract the BCD time code from the incoming signal, which can also contain an 18.24 kc carrier with 60 cycles AM for tape speed control. The filters attenuate both the carrier and the servo signal at time compressions of 1, 2, 4, 8, and 16, (i.e., tape

speed-ups). The band width of the 1 kc filter is 800 cycles. These filters are conventional T-type capacitor and inductor low pass-high pass filters.

B. BCD Code Detector: This code detector accepts and adequately deals with amplitude variations of the input signal. It will handle variations of from 2.0 to 13.0 v pk-pk. It also demodulates the time code from the carrier.

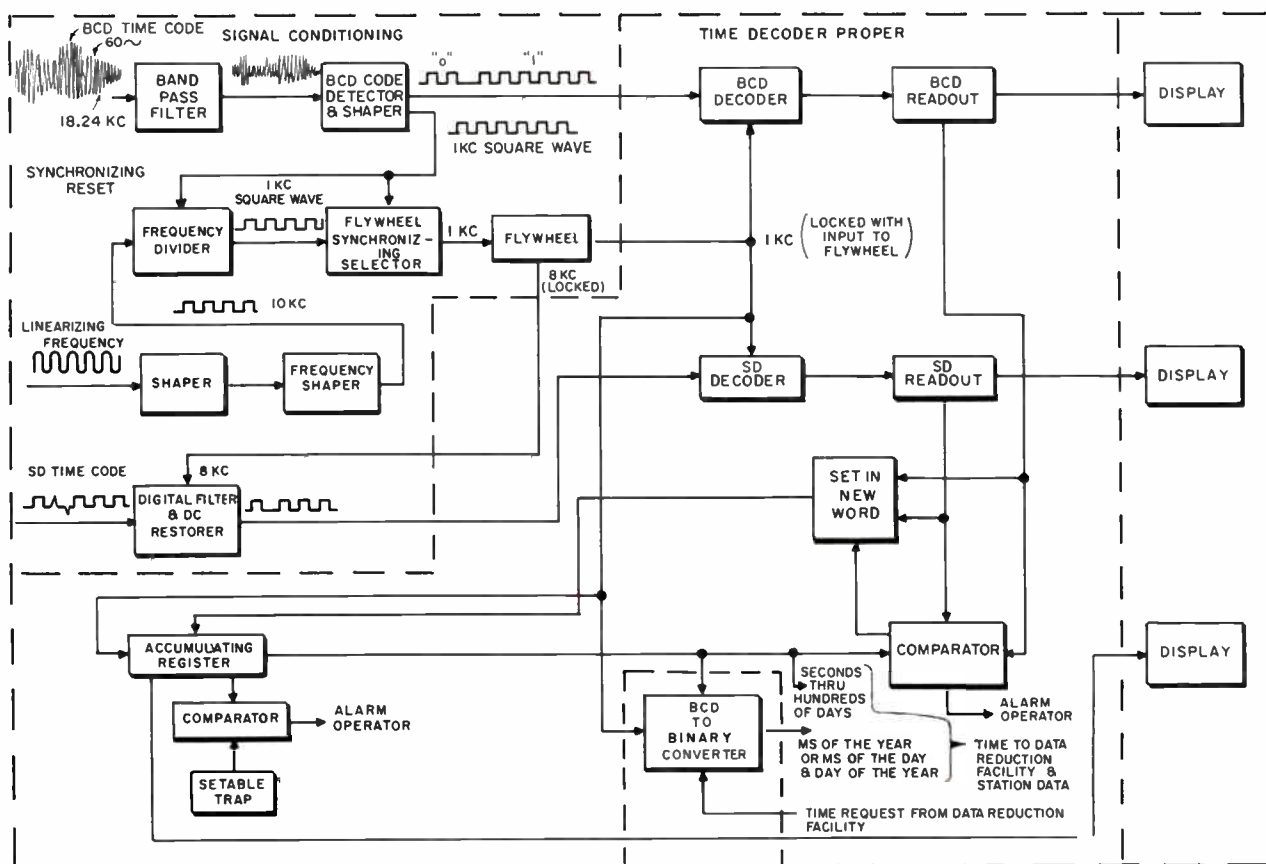
C. BCD Decoder: This unit discriminates between the Ones and Zeros of the BCD time code and presents this decoded time to the read-out circuitry. The BCD decoder contains a One detector circuit, sync shift pulse generator, sync pattern recognizer, sync shift register, logic counter, binary input error detection logic, binary shift register, and a binary word generator.

D. BCD Readout: This unit receives the decoded BCD time word in parallel form from the shift register in the BCD decoder unit and holds each decoded word for display and for making comparisons.

E. Display Units: Each decoded word is displayed to facilitate operation and maintenance. Each display unit contains Nixie™ drivers, binary-to-decimal converter units, and miniature Nixie tubes for display.

F. Shaper, Frequency Selector, Frequency Divider, and Flywheel Synchronizing Selector:

Fig. 3: Block diagram of the time decoder. Note that this unit is broken into sub sections by dashed lines.



ERROR HANDLING (Continued)

Two different "real time" linearizing frequency signals, 100 kc or 10 kc may be available to the time decoder. They are shaped with a Schmitt Trigger circuit. If the input is the 100 kc signal, it is divided down to 10 kc in the frequency selector. If the input is the 10 kc signal, it is passed straight through this selector. The 10 kc out of the frequency selector is again divided by 10 in the frequency divider to produce 1 kc. The frequency divider is reset by the 1 kc carrier from the BCD code detector to assure that synchronization exists between both 1 kc signals entering the flywheel synchronizing selector. This selector supplies 1 kc to the flywheel from the linearizing frequency if that signal is present. If, however, the linearizing frequency fades out, the 1 kc from the BCD detector will automatically be used to drive the flywheel.

G. Flywheel: The purpose of the flywheel is to produce a nominal 1 kc signal which is phase-locked to its input, if there is an input, and to maintain an output at the frequency of the last input if the input disappears. The flywheel has a selectable bandwidth of $\pm 5\%$ or $\pm 10\%$. This means that the standard frequency at the input can vary as much as the selected bandwidth and yet the output of the flywheel will continue to maintain phase-and-frequency-lock with its input. This compensates for input tape stretch, or input tape recorder speed variation, etc. The flywheel also supplies the 8 kc signal to the SD decoder front-end circuitry.

H. Digital Filter and DC Restorer Units: The SD code signal consists of pulses which are 40 to 45 msec wide and occur at a rate of 10 pulses/sec. Such a wide-band signal is susceptible to degradation by impulsive and white noise which makes the reading of this code susceptible to error. Digital techniques are used to extract this signal from the noise. The dc voltage of the base line of these input pulses varies between +0.5v. and -0.5v. A dc restoring circuit is used to assure a constant bias level to the input of the decoder.

I. Serial Decimal Decoder: The decoder is used to find synchronism in the SD time code and present the decoder time to the readout register. It also checks the SD system by way of a word generator.

J. Serial Decimal Readout: This unit receives the SD decoded time word in parallel from the Serial Decimal Decoder and holds this information for ten seconds for display and for making comparisons with the decoded BCD word or the accumulating register.

K. Accumulating Register: The use of an accumulating register prevents possible sporadic errors in either of the decoded time words from being passed to the rest of the data reduction facility. The time, as decoded in either the SD or BCD decoders, is automatically set into the accumulating register at the beginning of each data reduction run and/or when the mode of operation switches between loops 1 and 2. The register is then updated by the 1 kc output of the flywheel. This accumulated time is available as an output and is also sent to the BCD-to-binary converter which presents time (msec of the day and day of the year or msec of the year) to the data reduction facility. The BCD output of the accumulating register is programmable.

L. Comparator and "Set in New Word": The Comparator compares the decoded time with the accumulated time in the accumulating register. It also serves to make comparisons between the serial decimal and BCD decoded time words. The "set in new word" unit operates with the comparator to set a new word in accumulating register when the accumulating register is deemed incorrect. The comparator detects errors in the input signal and errors in the equipment itself, and is, therefore, one of the most basic elements of the system.

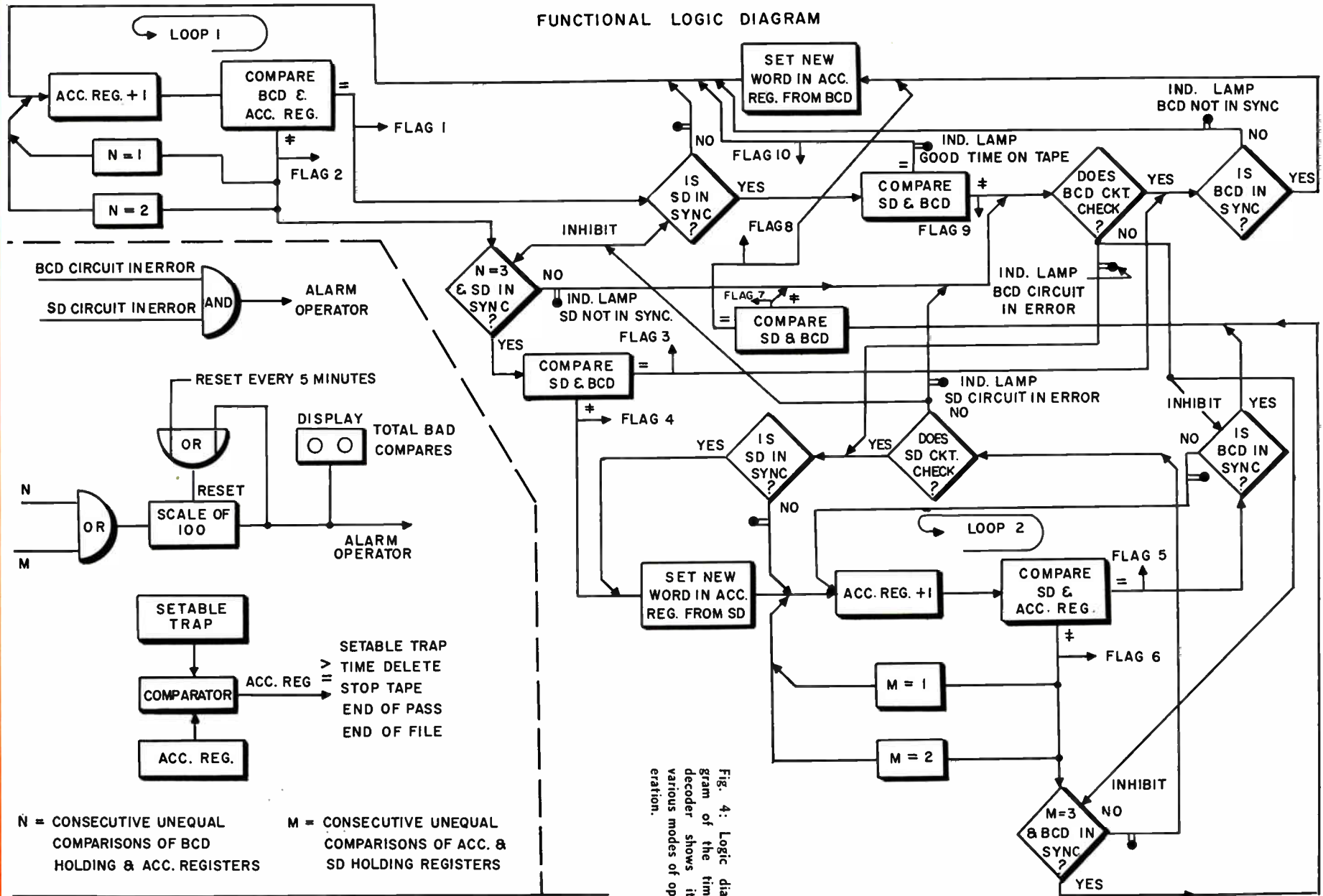
M. BCD-to-Binary Converter: This unit converts the time word in the accumulating register (secs. through hundreds of days) to a binary number representing either msec. of the year or msec. of the day and day of the year. This converted time word is presented to the data reduction facility upon electronic request. The format of this output is programmable.

The converter is designed to make an automatic internal test for component malfunction prior to every conversion. If the automatic test procedure indicates a component malfunction, an error light will warn the operator and the output will be flagged. The light will remain lit until the malfunction is repaired and then it will go out automatically.

N. "Settable Trap": This trap aids the operator in locating a specific time among the ensemble of incoming time words. It consists of a Digiswitch and a comparator. A number is set on the Digiswitch and a comparison is made between this number and the word in the accumulating register. When the number in the accumulating register is equal to or greater than the number on the Digiswitch the operator is alerted.

(Continued on page 188)

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N = CONSECUTIVE UNEQUAL COMPARISONS OF BCD HOLDING & ACC. REGISTERS

M = CONSECUTIVE UNEQUAL COMPARISONS OF ACC. & SD HOLDING REGISTERS

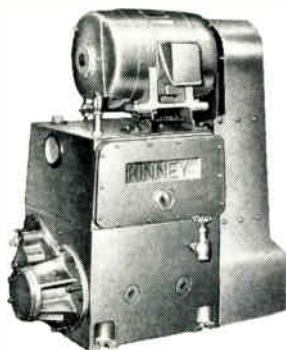
Fig. 4: Logic diagram of the time decoder shows its various modes of operation.

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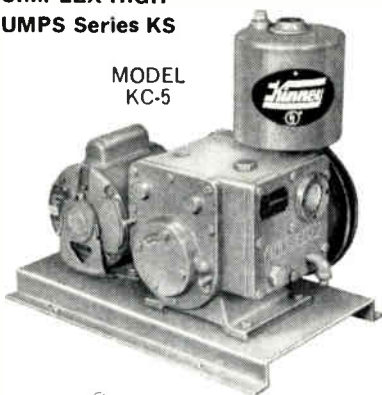
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This decoder makes use, when possible, of the built-in redundancy of having both the BCD and SD time signals available for processing. If only one of these two signals is present, it automatically considers only that one. The decoder automatically checks its internal circuitry, identifies (flags) the class of error which it has detected, can automatically delete the output and alert the operator when the time-density of errors exceeds some present value, alerts the operator and deletes the output at previously known preset times. The feature of alarming the operator at some preset time permits the immediate automatic detection of known times, such as the end of the recording of a satellite pass. This feature is most useful when more than one pass is recorded on one analog magnetic tape.

The system requires no starting procedure or starting point on the data tape. Unlike other time decoders, this system has neither manual single-read-in nor multiple-read-in modes of operation. It performs these operations automatically whether BCD or SD or both time codes are available.

The logic diagram, Fig. 4, of the time decoder shows its various modes of operation. If the system has been reset, either by the system normalizer when

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the power is first turned on, or by pushing the master reset button, operation will begin in loop 1. In this loop, the decoded BCD time word will be compared with the accumulating register. If they compare, flag 1 will be presented to the buffer together with the time word. If they do not compare, flag 2 will be presented to the buffer accompanied by the time word.

In this loop the decoder will also determine if the serial decimal circuit is in synchronism with the incoming serial decimal code. If the serial decimal circuit is in synchronism with the incoming signal, the appropriate part of the incoming BCD time word is compared with the serial decimal time word. If they do not compare favorably (flag 9), the BCD circuit is automatically checked for circuit malfunction.

If the circuit is okay, a check is made as to whether or not the BCD circuit is in synchronism with the incoming BCD time code. If it is in synchronism, a new BCD time word is set in the accumulating register and updated. If there is a BCD circuit malfunction, the BCD circuit operation is inhibited and the decoding function is shifted to loop 2. Another way to shift the decoding function to loop 2 is to have the BCD time word and the accumulating register not agree for a number of consecutive times, where the number is selective. Initially the number has been set for 3 times.

Operation of the decoding function in loop 2 is similar to that in loop 1, except that the SD code is used in place of the BCD code. However, since the BCD loop is the more desirable loop, the decoder will continually determine if operation in loop 1 is possible; and if so, it will shift the decoding function back to that loop.

Conclusions

An error detection and correcting time decoder has been designed for use with satellite data reduction facilities to cope with the large number of erroneous time readings. This decoder is an improvement over the straightforward instance-by-instance time decoding (called multiple read-in) because short-term perturbations in the time code will not produce an incorrect output from the decoder. This decoder is an improvement over a single read-in method of data-time decoding updated by a standard frequency because it continually correlates the time words with the data.

The decoder further decodes both a SD time code and a BCD time code, compares them with each other and with the accumulating register, and "flags" each time reading to show the amount of confidence the experimenter can place in its accuracy. It also has self-checking circuits to reduce the probability that a malfunctioning decoder component will provide an incorrect time reading.

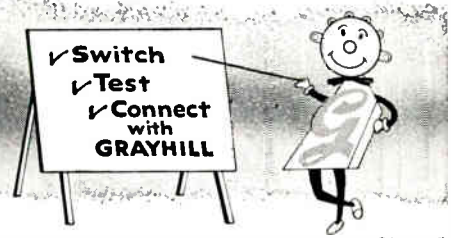


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Reporting late developments affecting the employment picture in the Electronic Industries

EJC REPORTS ON ENGINEER PLACEMENT, ENROLLMENT AND GUIDANCE METHODS

The Engineering Manpower Commission of the Engineering Joint Council is taking issue with the U.S. Employment Service's efforts to increase its professional placement services. Their position is that a "third party" between employer and job seeker on a professional level is neither desirable nor necessary.

The EMC resolution states that graduating engineers should negotiate directly with employers, within the college placement framework.

If the USES expands to the point of displacing normal college placement functions for engineering graduates, the best interest of the students, employers, and professional societies will not be served, says the Commission.

A similar resolution was passed recently by the Scientific Manpower Commission.

In other activity, an EMC subcommittee surveyed various guidance publications and practices.

In addition to upgrading the public image of engineering, the subcommittee recommends joint effort by professional and technical societies to produce one and only one guide booklet, supplemented by an official list of additional materials published by private sources, colleges and industries.

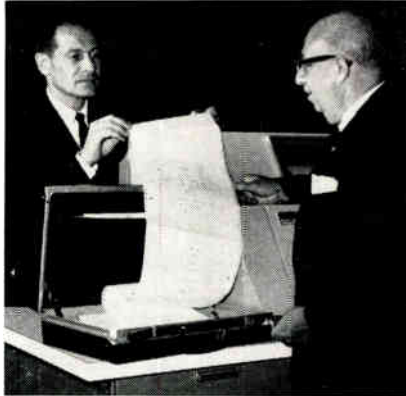
The committee believes that the sheer weight and diversity of material now placed in the hands of high school students tend to defeat its own ends.

In another report, recently completed, the EMC points out that large numbers of well-qualified students are dropped out of engineering schools. High attrition rates cause disillusionment, which reacts against engineering and is one of the principal causes of declining freshman enrollments.

Students, according to the report, ask themselves, "Why take engineering if the odds are stacked against you?"

Engineering deans were asked to comment on the problem by Dr. Arthur

ELECTRONIC BRIDGE DEALER



R. M. Bloch (l), VP, Honeywell Electronic Data Processing, and R. L. Frey, Editor, American Contract Bridge League "Bulletin," check hands Honeywell 800 computer dealt ACBL members at recent tourney. Computer also scored, but did not play or bid. A 100% accurate scoring program was called for, since each team's score depends on the scores achieved by all other teams.

F. Bronwell, dean of engineering, University of Connecticut, and chairman of a Commission subcommittee. The report, based on the comments, concludes that there are effective ways of reducing student attrition if colleges face up to the problem. Suggested remedies are:

1. More effective pre-selection and guidance to trim number of weaker students.

2. Greater curricular flexibility for freshman to allow for variations in academic backgrounds—to help the faltering but conscientious student.

3. Positive program of tutorial help to lift the student over initial hurdles.

4. Experiments on more effective counseling methods. Most students now do not seek out counselors.

5. A more conscientious program for engineering freshmen and sophomores to develop a sense of identification with the profession and a feeling of engineer pride.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 196.

TECHNICAL RECRUITING TAKES DOWNWARD SLOPE IN JULY

A sharp downtrend in demand for technical people was seen in July. The Engineer/Scientist Demand Index showed 84.9, down 13.5 from June. This is the lowest figure for July in the history of the index.

The drop is part of a steady decline that began in February, marked by a slight upturn from 94.8 in May to June's 98.4. The July figure is the lowest since December, 1960. It is more than 30 points below last year's level.

Causes for this steady downtrend and sharp drop during July are not clear. In part, the usual mid-summer break in demand for technical people is a factor, with the spotlight on field interview trips.

NSPE SECTION PUBLISHES PRIVATE PRACTICE INDEX

A compilation of material on consulting engineering called "Professional Index of Private Practice" has been published by the Professional Engineers in Private Practice, part of the National Society of Professional Engineers.

The Index is in eight sections including Ethics, Fees, Competitive Bidding, Contracts, NSPE Policies, Organization of the Functional Sections, Professional Liability Insurance, and Federal Laws Affecting the consulting engineer.

CHARITY OFFERS EDP CLASS TO HIGH SCHOOL QUITTERS

A program of on-the-job training in electronic data processing for high school dropouts was announced by Altro Workshops and the Association of Data Processing Services Organization (ADAPSO) in New York City. The program provides training in computer operation, key punching, and related EDP techniques. The program is being conducted by Altro, a non-profit rehabilitation agency affiliated with the Greater New York Fund.

TECHNICAL WRITING: SUPERSTITION AND FACT

There is considerable disagreement throughout the engineering community as to what constitutes a technical writer.

While some personnel managers seek a pigeon-hole combination of graduate engineer and professional writer, another camp observes that the ideal man is simply a writer who understands the basic principles of science. Here are some comments on the matter.

A CHARACTERISTIC OF OUR SOCIETY is its preoccupation with measurement and classification. Almost as soon as the need for a new breed of specialist is recognized, we begin searching for a conventional label to describe his job.

The rub is that many of these labels are misnomers. But, human nature being what it is, it is easier to cling to the misnomer than it is to rename the job.

The term "technical writer" is just such a misnomer. Subject matter may be technical, but the primary purpose is the same for all writers—to communicate ideas.

Most technical writers have sought professional acceptance by emphasizing the word "technical." Because the space age has so enhanced the prestige of science and engineering, the temptation to line up under the scientific-technical banner is almost irresistible.

There is nothing really wrong with this little fiction, except perhaps the consequences. Many personnel recruiters have accepted this technical writer as "just another kind of engineer." They have accepted it primarily because, like most of us, they don't really know what a technical writer is or does. And besides, it limits the search to ME or EE degree holders.

Closed Profession Challenged

Fortunately, this tendency toward a closed profession is being challenged. William Gilman in his book "The Language of Science" has this to say: "Whether the technical writer comes from the science or English corner of the campus matters less than his having a reasoning mind and ability to explain. Here, then, is a new specialty which is not so highly specialized after all. It isn't so much being 'strong in science and weak in English,' or vice versa, as having what a good writer and a good scientist share—awareness of the reader and willingness to work for clarity."

If Mr. Gilman's viewpoint is correct, then why

haven't more people accepted it? The opposing argument can be reduced to the following statement: any writer not professionally trained in the field in which he is writing cannot do a thorough and accurate job of presenting information because he must depend on others to check the technical accuracy of his writing.

Mistaken Idea of Tech Writer

This assertion is based on an erroneous conception of technical writing. Usually the people who offer this argument see the technical writer as one who refines a batch of raw engineering data sheets into polished technical documents. This individual usually writes instruction books and proposals exclusively. Most want-ads specify this kind of person. The trouble is that instruction books and proposals are only two of the many facets of technical writing. Ignored are such chores as editing symposium presentations, converting research findings into reports and signed articles, editing technical house organs, and preparing press releases and speeches.

A good share of industry's technical writing is not original work by the writer. It is instead a professional give-and-take relationship between a technical writer and an engineer with the writer assisting the engineer in documenting his ideas and the engineer checking the work for technical accuracy. Under these circumstances the technical writer is 90% reporter and 10% author.



By **ROGER M. D'APRIX**

Light Military Electronics Dept.
General Electric Co.
Utica, N.Y.

Must Recognize Reporter Role

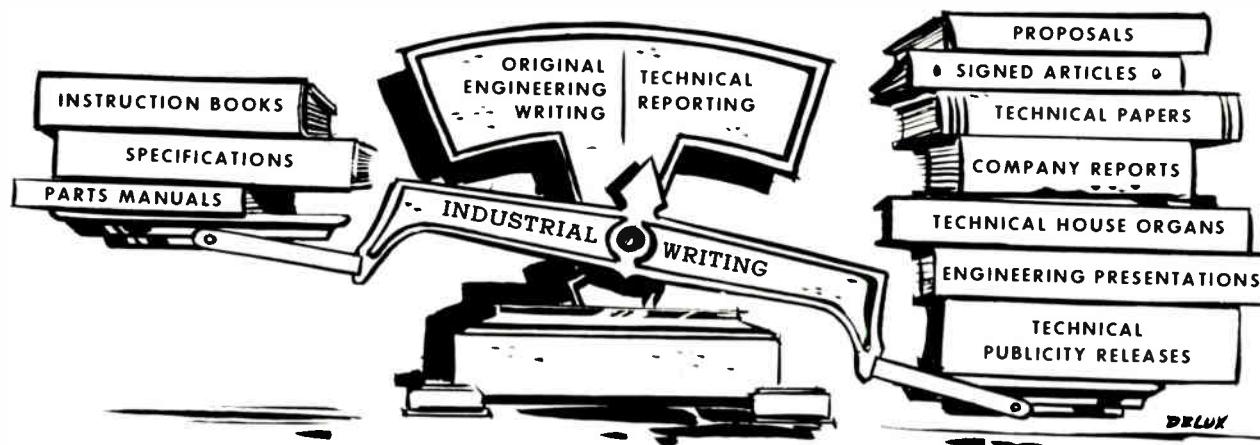
The technical writer must be aware of his role as a reporter. Today, more than ever before, the technologist, because of the demands and complexity of his work, finds it difficult to communicate with the layman, or even with fellow engineers in different specialities. As a result, he finds himself living and working only with those "who speak the same language." Here is one important area where the technical writer contributes to the information exchange.

In this relationship the writer's own technical background is important only so far as it permits him to understand the engineer's intent. Indeed, in some in-

neers who write well enough to do it for a living, and of the few who are good enough, writing generally plays second fiddle.

Another reason is that experience shows these twin qualifications do not necessarily guarantee good technical writers. This is more a question of the broadness of the writer's responsibilities than it is of the writing inadequacies of transplanted engineers.

Most technical writers today are jacks-of-all-the-writing trade. Besides the familiar instruction books and proposals, they are frequently asked to edit technical reports, symposium papers, signed articles, engineering presentations, and other writings.



Most industry technical writing today is technical reporting (right scale) rather than original engineering writing (left).

stances this background can even be a liability, as in the case when the writer chooses to question the engineer's work, until empathy gives way to open hostility.

Although want ads for technical writers lead one to believe that industry is hiring only experienced engineers with a flair for writing, this is not really the case.

In one survey of technical writers reported at last year's Professional Group on Engineering, Writing and Speech symposium, 31 of some 82 respondents did not have a college degree. Of the 51 with degrees, 18 were EE's and 7 had assorted "hard science" degrees for a total of 25 technical backgrounds. The remaining 26 respondents had degrees in the humanities.

Engineer-Writer Hard to Find

A good reason for the discrepancy between the want-ad stereotypes and the actual hires is that the stereotypes are hard to come by. Engineering and writing are opposite interests. There are few engi-

Such responsibilities imply a broad, flexible person whose chief talent is conveying ideas clearly. Fortunately, or unfortunately, there is no *one* background—or degree—that will produce such a person. We should not perpetuate the myth that there is.

In practice, the writer's broad responsibilities result in some interesting problems. Consider the engineer-writer relationship. At best, this is an area fraught with potential misunderstandings and resentment. At worst, it is open conflict.

Bears Considerable Responsibility

A technical writer bears considerable responsibility for the content and style of handbooks and proposals. In this rather formal relationship, however, in which the engineer supplies raw technical material and the writer translates it into printed pages, both parties are able to preserve a degree of anonymity even within the organization.

But an engineering presentation, or a signed article, is another matter. The engineer, besides giving
(Continued on page 197)

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TECHNICAL WRITING (Concluded)

birth to his raw material in long, painful labor, will forever be *personally* identified with both content and style.

Under these circumstances, he is generally more resistant to the technical writer's changes. Besides his skill as a technician, the technical writer must now become a specialist in human relations.

Another problem for the technical writer is orienting his own style to the varied kinds of material he is called on to write. There is a vast difference in acceptable style and tone for the *Journal of the Acoustical Society* and for a management presentation to a group of visiting school teachers. Yet the writer may very well work on both kinds of material in the same day, with a section of a proposal thrown in.



Want-ad stereotype of a technical writer suggests a combination of Ernest Hemingway, Werner Von Braun, Norman Rockwell.

Writer Must Analyze, Observe, Perceive

What is needed is a man acquainted with the broad principles of science, one who can analyze, observe, and perceive scientific relationships. A thorough knowledge of the theory and application of communication principles is also essential; these are the writer's tools. Beyond this there should be no neat pigeon-hole for his job description.

The only real measure of a tech writer's success is his ability to communicate technical ideas to his audience. If he cannot—regardless of his background, regardless of his degree—he is not a technical writer.

Admittedly, this pragmatic definition does not make the personnel specialist's job any easier. But anything less inclusive than this will rule out thousands of effective technical writers needed desperately to help resolve the rapidly developing crisis in technical communication.

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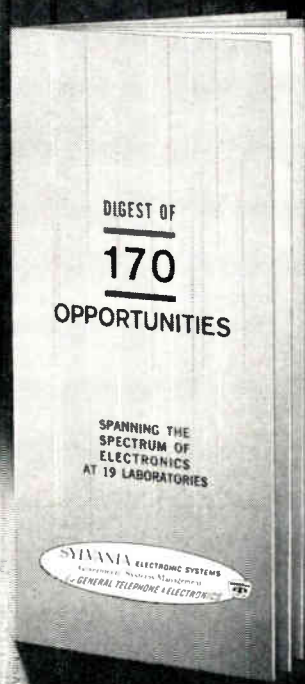
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The diversity of professional manpower requirements described in this "Digest" include: research, design, development, systems engineering, advanced research and program management. They cover the areas of communications systems; data processing and display; detection, tracking and missile defense systems; electronic warfare; and navigation, intruder warning and reconnaissance systems.

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EDITOR'S MAIL BOX

'OUCH' TOLERANCE and personality are now under scrutiny by Republic Aviation psychologists. If you don't like dentist's chairs, chances are you won't like a ride to the moon either. Republic's Dr. Julius Peters reports a relationship between ability to endure pain and the limited use of the senses. Dr. Peters said findings tend to refute the theory that the man most sensitive to pain could best cope with reduced sensory environment in a space capsule. He concludes that some persons have highly developed endurance to pain or any other abnormal situation, and further study could provide valuable criteria for astronaut selection.

TWINKLE-LESS STARS ain't the job of engineers of Westinghouse Baltimore Defense Center at Lakehurst Naval Air Station, but they are working on a way to take "twinkle" out of Echo II when orbited by NASA later this year. This "twinkle" is caused by random reflections of radio and radar waves from Echo's skin. If the 135-foot diameter varies more than two inches, returning signals become distorted and unusable. If the signals are unclear, experiments using Echo II as a passive, reflecting satellite will be worthless.

YOU DID IT when you were a kid—balance an upright broom on your hand. A machine called MADALINE can do it, too. So, there! A simple but brainlike system of Multiple ADaptive LInear NEurons, MADALINE does it by electronically observing how a human does it and then copying his actions. Only a year and a half old, MADALINE is the brainchild of Bernard Widrow and his research team at Stanford. MADALINE's raison d'être—to demonstrate that a teachable machine is possible.

RADIO BIRD WATCHERS of the Montana Fish and Game Department around Shonkin, Mont., can track their sharp-tailed grouse with mounted miniature transmitters. FCC has waived a couple of rule sections concerning call letters and physical control of transmitters. Only six of the tiny transistor units will be used at a time. Each will operate on a different frequency, one for each bird. With two or more receivers and triangulation methods, birds can be pin-pointed.

REFLEX MACHINE REMEMBERS 4800 DIFFERENT PATTERNS

CONFLEX I recognizes 4800 different patterns, including pictorial displays, letters, numbers and geometric patterns. Test patterns to be learned are viewed with a 35mm slide projector or manually-fed negatives. The value assigned a test pattern is called stimuli.

Particular sets of stimuli are assigned to particular classes which are indicated by various combinations of responses that register as output. The system can be trained to classify a large number of stimuli which then are placed in any number of different

classes.

Once trained, the system will classify—with 99.6% accuracy—any stimulus it has seen before. Unit was built by Scope Inc., Falls Church, Va.

INDIANS OK NEW PLANT

A building-and-loan agreement for more than \$1 million, including a 40,000 sq. ft. electronics plant at the Laguna Indian Reservation, Laguna, N. M., has been signed between Burnell & Co., Inc., Pelham, N. Y. and the Pueblos of Laguna.

U.S. AEROSPACE R&D IS AID TO INDUSTRY, STUDY FINDS

Government - sponsored missile and space research has benefited the commercial side of industry and the benefits will increase according to a study by the University of Denver.

The study findings will help in accelerating transfers of technology from NASA research programs to the commercial sector of the national economy by identifying extent and ways in which past transfers have been made. The survey showed 127 actual transfers and 58 potential transfers.

Some facts revealed in the study are: transfers from government-sponsored R&D in terms of technology are the most important contribution, and space-related R&D stimulates basic and applied R&D of improved materials, processes and techniques, plus new test and laboratory equipment.

The study also showed that R&D output contributed to cost reduction in both commercial manufacturing and fabrication methods.

COMPACT TRANSPONDER GIVES RE-ENTRY COMMUNICATIONS

A compact transponder, called Azusa C-T, and made by General Dynamics/Astronautics has succeeded in communicating through the ionization layer surrounding a space vehicle on re-entry.

The Azusa C-T, mounted in the missile, transmits at 5,000 MC. It is only 9 x 9 x 4.7 in., weighs but 21 lbs. It reportedly performed without failure on over a dozen recent missile tests from Cape Canaveral.

Signal exchange between transponder and Azusa ground station at the Cape provides data to predict vehicle re-entry and impact. Before this, position and velocity for range safety and orbit are determined.

GERMAN TRANSMITTER WILL WORK WITH RELAY, TELSTAR

The German Government will buy a portable space communications station that can work with both Relay and Telstar. ITT Federal Laboratories, Nutley, N. J., will supply it for the German Post Office Dept.

The station is to have two transmitters, one for Relay and one for Telstar. It will be able to handle 12 two-way voice channels, facsimile, multi-channel, teleprinter and high-speed data transmission.

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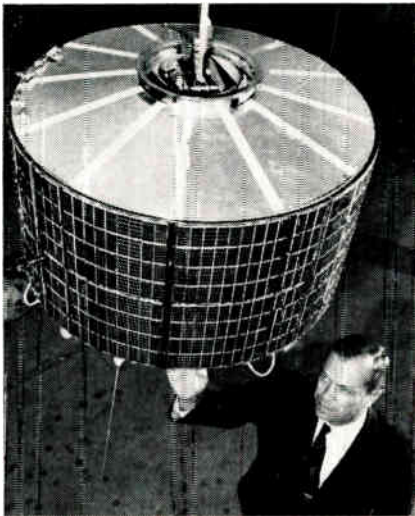
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WORKHORSE SATELLITE



Syncom 2, first synchronous satellite now hovering 22,300 miles out in space, has logged more message time than all other satellites combined since it was orbited nearly three months ago. It has been receiving and transmitting an average of 15 hours a day. With Syncom above is Dr. Allen E. Puckett, Hughes Aircraft exec.

AF, SPERRY CONTRACT SEEKS VERSATILE RANGE CENTER

Range control equipment to permit simultaneous countdown for two missile launches and global range support of another orbital vehicle is now on the design board for the Air Force, according to a contract awarded to Sperry Piedmont Division of Sperry Rand Corp.

Plans call for about 64 men at 137 electronic consoles in a new Range Control Center at Cape Canaveral to be able to control simultaneously 800 range instrumentation status displays, four missile trajectory plots, three impact prediction plotters, three separate countdown and timing systems and a network of communications to direct the operations of ships, planes and range instrumentation stations along the 10,000-mile Atlantic Missile Range.

The Center will have command and control equipment needed for worldwide activities in support of missile, orbital and deep space launchings from Cape Canaveral.

Equipment will provide visual display of the state of all range instrumentation systems including radar, telemetry, optics, instrument ships, aircraft, and recovery forces along the entire Range.

Thirty-four TV monitors and a number of cameras will allow operators to monitor launch pad operations, meteorological display, in-flight missile performance, and other remote displays.

FAILURE STUDY INDICATES CONNECTORS MORE RELIABLE

A recent study shows that high-performance electrical connectors compare favorably with other electro-mechanical parts in failure rate.

The study, by a leading aircraft maker and offered by Amphenol-Borg Electronics Corp., evaluated field failures on commercial jet aircraft for 11 months. The study showed connectors meeting Mil Spec MIL-C-26500 failed at a rate of 0.048 failures per million hours.

The comparison was with compo-

nents such as diodes (0.564 failures per million hours), wire wound resistors (0.087 pmh), power relays (0.3 per million cycles), germanium power transistors (0.6 pmh), and ceramic capacitors (0.02 pmh).

Also covered in the study were connectors meeting MIL-C-5015 and MIL-C-26482 specs. Failure rate for MIL-C-5015 was about 10 times higher than that for MIL-C-26482 units.

MIL-C-26482 had failure three times higher than MIL-C-26500.

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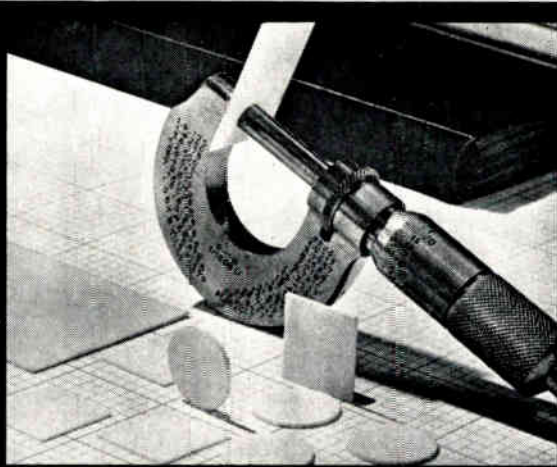
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8 Poles in a Display Switch? 500,000 Operations?



A WESCON Design
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TWO COMPANIES INK HYBRID COMPUTER PACT

Joint marketing and systems engineering in designing, making and installing large hybrid computing systems have been disclosed by Packard Bell Computer and Computer Products Inc.

Both firms point out that the growth of hybrid computing uses require a more intimate combination of the analog and digital elements of the computing system than has been available.

Equipment most likely for hybrid systems are Computer Products Mark III Analog Computer and Packard Bell's PB440 Digital Computer.

RCA DEVELOPS VIDEOSCAN OPTICAL CHARACTER READER

RCA has developed an optical character reader that combines the scanning ability of the TV vidicon tube with the data handling capacity of the RCA 301 computer.

Called Videoscan, it picks data off up to 90,000 printed documents an hour by multiple scanning of printed characters. The data is then put in computer code and fed to the computer.

The system processes accurately such documents as gas and telephone bills, insurance premiums, tax notices and magazine subscription blanks. Processed documents can be from 2.5 to 8.5 in. wide, 2.5 to 4 in. high, and from .003 to .01 in. thick. Documents 4 in. wide or less can be handled at 1,500/min.

X-RAY-SENSITIVE TV MAY AID INDUSTRIAL TESTERS

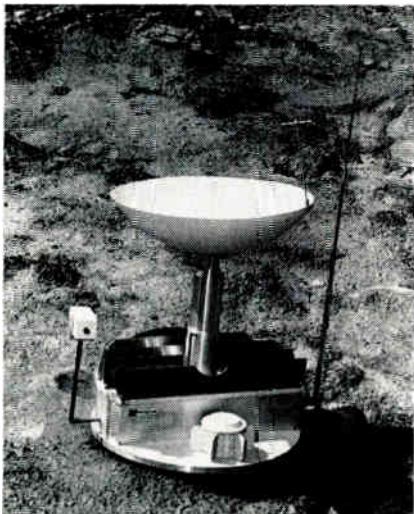
An X-ray-sensitive vidicon TV system developed by Picker X-ray Corp., Cleveland, Ohio, promises to aid industrial component testers.

The TV system has a scanning rate of 830 lines/frame, helped by a 20 mc/sec. bandpass. This compares with the 525-line scan rate and 4.4 mc freq. response for standard broadcast TV.

The unit has a fixed-potential beryllium window 250 kv. X-ray tube with 0.7mm. focal spot. Focal spots of 0.3mm. are available with beryllium-window 150 kv. equipment.

Radiation passes through the component inspected, a $\frac{3}{8} \times \frac{1}{2}$ in. opening in a lead shield, a beryllium window and a photocathode that converts the X-rays into electrical charges. These are picked up by a scanning beam.

MOON PACKAGE



Westinghouse Defense Center designed this model of a lunar logistics system communication payload. The package is intended to make the arrival of Apollo astronauts safer and their work more useful. It may be on stand-by on the moon for a year; it would relay voice and television messages from lunar vehicles back to earth.

ASTRONAUT SPACE TRAINER

A dynamic trainer at the Manned Spacecraft Center, Houston, Tex., gives Gemini astronauts and Apollo candidates practice in docking and rendezvous-ing with another orbiting object. The trainer consists of two vehicles: the Gemini cockpit in which two astronauts can perform a rendezvous "mission" at the same time, and the Agena target vehicle.

The trainer has 6 degrees of freedom. The Agena "vehicle" has 100 ft. travel longitudinally, and ± 16.5 ft. vertically. The Gemini "spacecraft" has ± 24 ft. travel laterally, and pitch, roll and yaw capability to $\pm 45^\circ$.

Air bearings on the trainer give the two vehicles minimum friction and maximum smoothness during "response" to pilot control.

FLAME-RETARDANT LAMINATE

A copper-clad laminated plastic—Fireban 600—with built-in flame-retardant properties has helped RCA upgrade the quality of printed wiring boards and shave production costs.

Taylor Corp., Valley Forge, Pa., produces the glass-base epoxy-resin laminate—equivalent of NEMA Grade G-10—which has supplanted Grade G-11 primarily because of cold punching and machining operation advantages.

The less brittle quality of Fireban 600 is attributed by Taylor to the resin system it employs in the laminate's manufacture.

Where ya' going mister?

To Temco Electronics, son. At Temco, talented scientists and engineers know the excitement of creativity, the satisfaction of personal and professional advancement and contribution in a growing electronics organization . . . an organization designing and developing systems, components and specialized devices in the areas of communications and data handling, instrumentation, telemetry, tracking, guidance, automatic controls and support systems. ■ In 1961, Ling-Temco-Vought combined the staff and facilities of Vought Electronics, a division of Chance Vought Corporation, with Temco Electronics, a division of Temco Electronics and Missiles Company. First as Vought Electronics and now as Temco Electronics, this LTV division has experienced a growth in sales averaging approximately 40% per year. This success is directly attributed to Temco's technical competence, aggressive management and extensive research and development efforts. ■ Temco Electronics has a personal challenge for you. Your investigation of the following openings plus many others is invited.

RADAR TERRAIN SENSORS Requires full design knowledge of advanced airborne radar systems and components of such systems. Will have full design responsibility.

RECEIVERS Design engineers experienced in design of solid state and electron tube high performance receivers. Experience desirable in receiver circuit design for the VHF & UHF range, computer and decision making type logic circuitry. Information theory, probability of detection and false alarm capability.

ELECTRONIC SUPPORT SYSTEMS Design engineers for requirements analysis and design of all types of

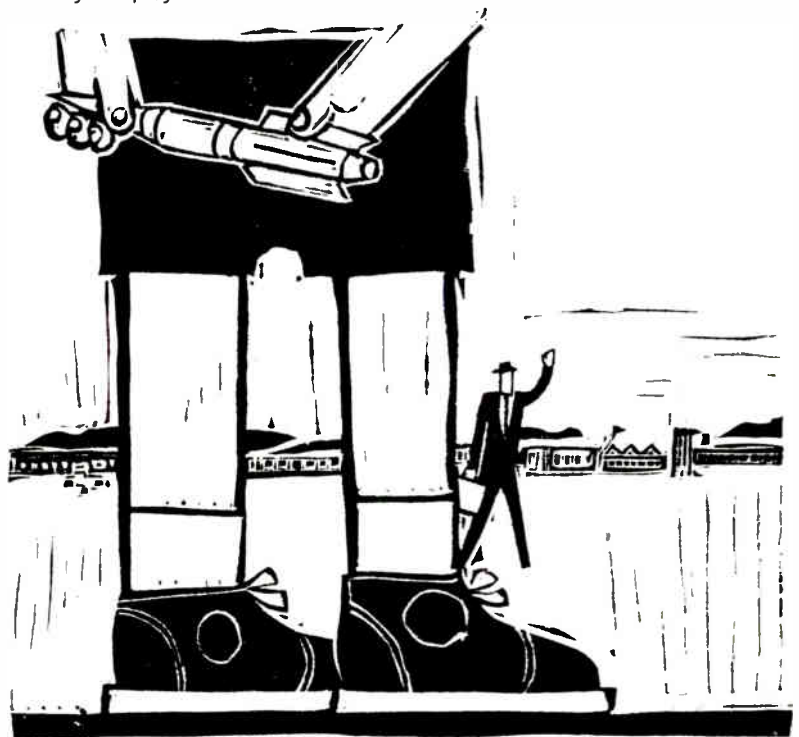
electronic support systems and automatic check-out equipment.

TRANSMITTERS Transmitter design specialists in UHF-VHF power amplifiers. Both high and low power linear amplifier experience desirable.

AUTOMATIC CONTROLS Electronics systems engineers experienced in servo systems analysis and design or digital or analog computer techniques. Also assignments in solid state transistor circuitry design.

DISPLAY SYSTEMS Electronics engineers to perform systems concept design. Should be familiar with digital logic design, servomechanisms, solid state circuit design and analog computer techniques.

For complete information on Temco Electronics and career assignments, write to B. G. Hickey, Dept. B-103, P. O. Box 6118, Dallas 22, Texas. An equal opportunity employer.



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N.Y. LASER FIRM OFFERS NEW HIGH-POWER LINE

A series of light, compact, low-cost, high-power laser units with separate power supplies are offered for purchase or lease by Boston's Maser Optics, which claims the broadest line of high and low power lasers on the current market.

High-power pulsed lasers from Maser Optics are rated from 20 to 300 joules output, and range in price from \$3500 to \$15,000. Compact laser heads are hand portable and are easily accessible for adjusting. The 300-joule units include light weight multicavity laser heads. Power supplies, 3 to 5 KV, are priced \$3500 to \$30,000.

MAG. TAPE BIBLIOGRAPHY

A revised Bibliography of Magnetic Recording, covering years 1954 to 1961 inclusive, has been published by Kinologic Corp., Pasadena, Calif.

The 20-page bibliography list 762 papers and articles from more than 120 technical journals—foreign and domestic. Complete names and addresses of cited journals, and a separate cross-index of 626 authors are included.

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<p>0.25% ACCURACY 10 IN/SEC Pen Speed 1 MV/IN- 10 V/IN Sensitivity</p>	<p>0.05-2 IN/SEC Time Base Zener Reference Voltages Electric Pen Lift</p> <p><small>HR96 Without Time Base, Zener Reference Supply and Pen Lift \$725</small></p>
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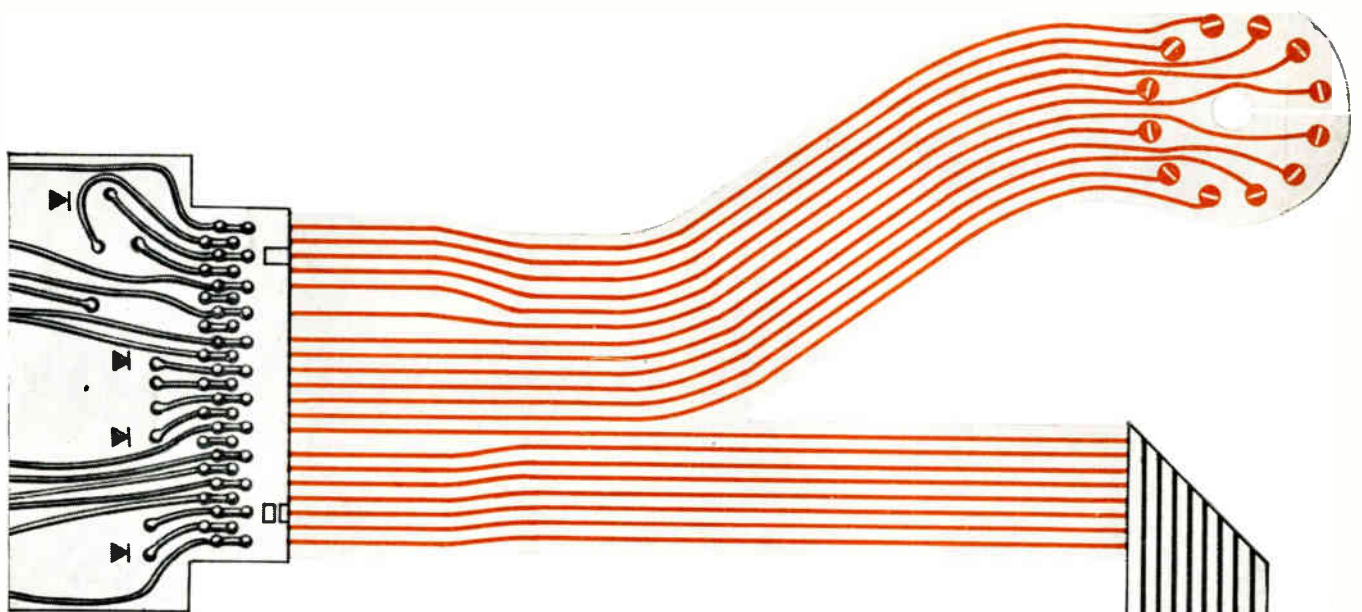
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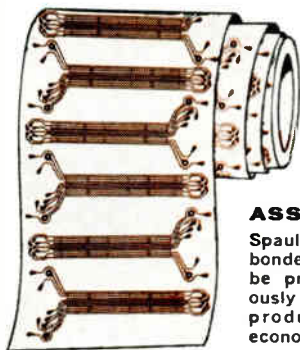
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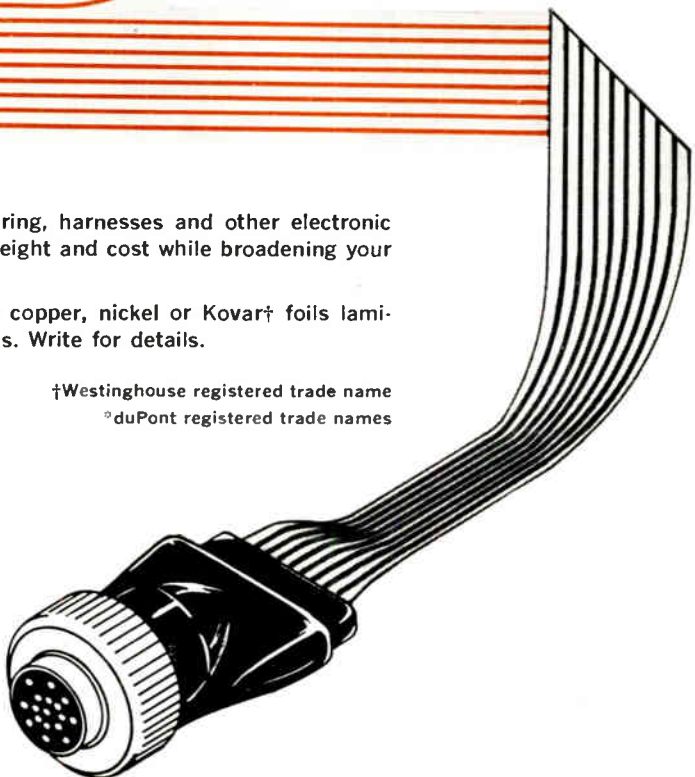
Available in combinations of copper, nickel or Kovar[†] foils laminated to Mylar* or Teflon* films. Write for details.

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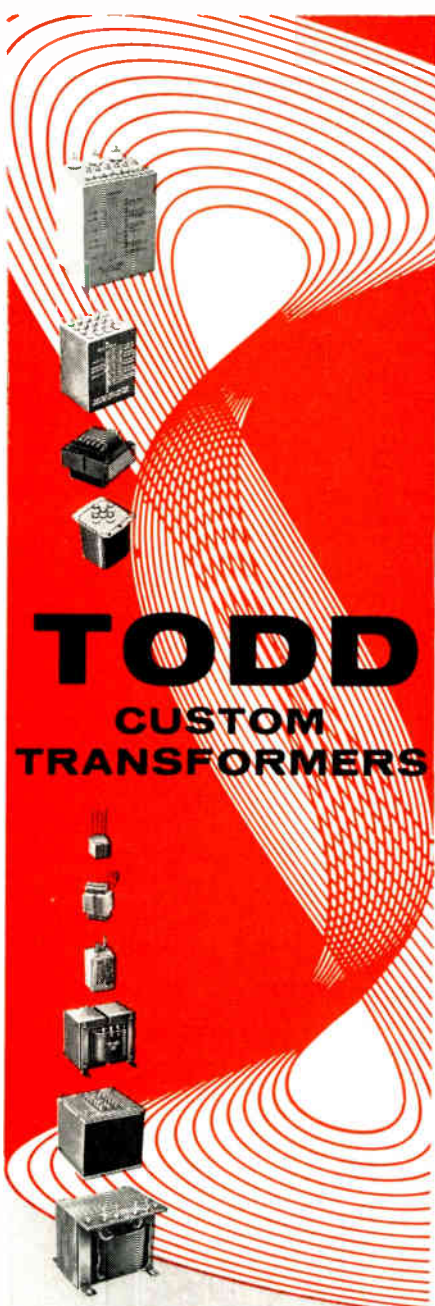
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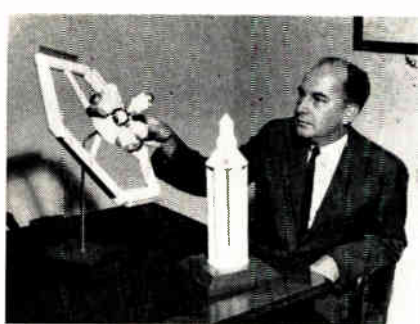
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SPACE STATION



Rene A. Berglund, Chief, Space Vehicle Design Branch, Space Technology Division, MSC, is shown with models of the award winning space station concept he designed. Berglund received a \$400 award from NASA Inventions and Contribution Board. The circular model represents modular space station concept erected in space. The other model denotes a space station ready for launching.

NEW VIDEO MONITORS OFFER APARTMENT HOUSE SECURITY

A multi-purpose video protection system called "Videosentri" with applications in scores of areas has been announced by Industrial TV Utilities, New York City.

The Videosentri features a hi-definition vidicon camera and a proprietary video distribution technique with hi-definition, low-cost, eight-inch monitors. Two series of video systems are available.

One system, designed specifically for multiple dwellings, provides a hi-definition camera for mounting in lobby directory panels. When a visitor presses a call button he is unknowingly revealed instantly on the tenant's eight-inch monitor.

The other system is for commercial houses, industrial plants, security zones, distribution points, shipping docks, warehouses, and other places where a number of guards are needed.

TV SERVICE EXPANDING

Color TV will result in the servicing industry assuming a larger role in the home entertainment industry in coming years, predicts R. W. Saxon, president of RCA Sales Corp.

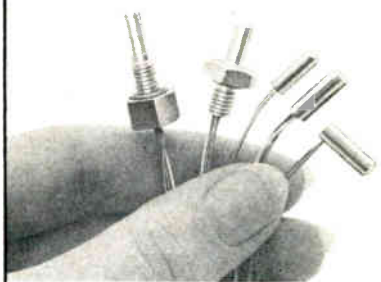
He stressed the need for a healthy and vigorous independent service industry to be ready for the expansion of color television and the "new products taking shape in laboratories."

He said that independent servicemen now account for more than 94% of the service business on RCA TV sets. The independent servicing industry handles 99% of the retail TV industry's servicing requirements, he added.

PLATINUM RESISTANCE THERMOMETERS

(FOR EVERY APPLICATION)

MINCO'S S31 PRECISE TEMPERATURE SENSORS ARE AVAILABLE IN 15 MODELS



ACTUAL SIZE
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1. Precision, strain-free, platinum sensing element.
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4. Repeatability accuracy better than 100 parts per million (0.03°C).
5. Available with 0°C resistance of 470 ohms, 100 ohms, or 50 ohms; calibrated within $\frac{1}{4}\%$, $\frac{1}{2}\%$, or 1% of nominal value.
6. Measured 0°C resistance value (to 5 places) supplied with individual units.
7. 3-wire termination for lead resistance cancellation.
8. Models with 0°C resistance of 470 ohms are stocked for immediate shipment, other models 4 weeks.
9. Prices range from about \$146 to \$52, depending on quantity and calibration specified.
10. Patents Pending.

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Circle 137 on Inquiry Card

ELECTRONIC INDUSTRIES Advertisers - October 1963

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NEW



PULSE CURRENT GENERATOR

- Rise and fall time: 10 nsec to 5 μ sec
- Output current: 0.1 amp to 1 amp
- Output impedance: 10K ohms minimum
- Frequency: 20 mc maximum
- Duty cycle: up to 80%
- Back voltage: \pm 50 volts

3C positive and negative Pulse Current Generators, featuring variable rise/fall times between 10 nanoseconds and 5 microseconds, convert programmed sync pulses from digital program generators, including 3C's 20 megacycle Digital Program Generator, into stable, variable parameter current pulses for investigation and test. They also incorporate internal triggering and sync output provisions, allowing one or more instruments to operate without program source. Combination of either the Negative Current Generator, Model 2031, or the Positive Current Generator, Model 2032, with Timing/Power Unit, Model 2030, forms a completely self-contained Pulse Current Generator providing trigger control, delay, sync, width, output shaping, and output amplitude controls. Input power required is only 115 volts. In addition, the instrument provides two special features: an output back voltage adjustment and output analyzer circuits. Combined, these allow high cycles with complete safety. Applications include:

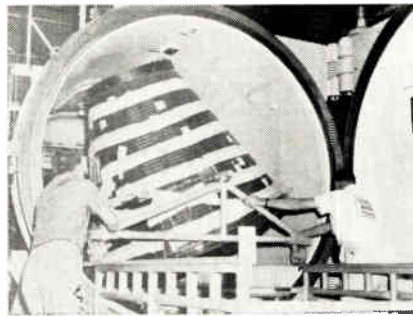
- Routine core memory exercising, test, and device development.
- Advanced storage device development including twistor, small core multi-aperture cores, thin films, high speed tape and drums.
- Serial delay line development and test including RZ and NRZ acoustic glass delay lines, quartz, magnetostrictive and filament lines.
- Research in Cryogenics.
- Development of magnetrons and devices requiring short duration high energy pulses.

Light-weight, portable 3C Pulse Current Generators function comfortably as either general bench-type laboratory instruments or as component elements within larger test systems to meet a broad range of magnetic and solid state test and development requirements.



COMPUTER CONTROL COMPANY, INC.
OLD CONNECTICUT PATH, FRAMINGHAM, MASS.
2251 BARRY AVENUE, LOS ANGELES 34, CALIF.
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SPACECRAFT HANDLERS



Putting spacecraft in "space" is almost routine with these NASA Manned Space Ctr. engineers. Here they roll Mercury model into vacuum chamber at Houston facility, to test environmental control system. ECS is life - sustaining system within craft. It cannot produce weightlessness, but it can evacuate air pressure to space levels. Heat pads on craft simulate solar heating.

TELSTAR RECOVERY BEARS OUT WESTINGHOUSE STUDY

The recovery of Telstar confirms a recent study of the failure of electronic devices recently conducted by Westinghouse for the AF Rome Air Development Center.

The Westinghouse study, though unrelated to the Telstar project, explains transistor failure due to surface charge, and says the transistors recover when the charge leaks off or is removed.

Westinghouse scientists, beginning in July, 1961, found the temporary failure of a transistor due to a charge from ions on its surface has several causes: Transistor surface charge may result from space radiation effects, electrical discharge, static charging of a transmitter by a nylon-clad assembler, transmitter exposure to ultraviolet light, or even in some cases from transient pulses during operation.

PILOT TO MAKE COLOR TV

Pilot Radio Corp will produce color television receivers this fall in a new \$2,000,000 plant.

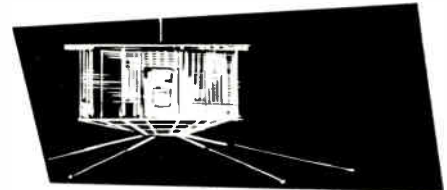
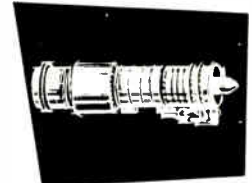
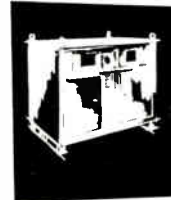
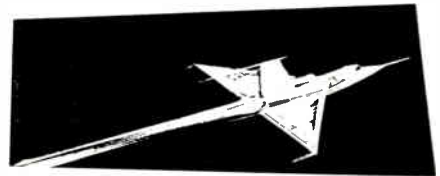
Color sets will be incorporated in Pilot's expanding line of stereo consoles.

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LAVELLE AIRCRAFT CORPORATION
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TWO NEW PULSERS FROM hp—WITH TWIN PERFORMANCE INNOVATIONS:



Custom-designed nanosecond pulses

With the hp 215A: Positive or negative pulses to 10 v into 50 ohms with rise and fall times less than 1 nsec. Width continuously adjustable to 100 nsec. Continuously adjustable internal triggering 100 cps to 1 mc, external 10 cps to 1 mc, with selectable slope and level, single pulse. Trigger output 140 nsec advance to 10 nsec delay with respect to output pulse. Pulse bursts with gated input, 1 v to turn on. Price, \$1875.

Controlled, specified pulse shape! No need to monitor the pulse from this new generation of Hewlett-Packard pulsers. Pulse shape is so carefully controlled that it can be specified under all operating conditions!

Constant 50-ohm source impedance absorbs reflections from the external load, bans secondary reflections from the pulser. Monitoring is unnecessary.

Scope-type triggering, pulse gating. No amplifiers or inverters needed for external triggering—you can select your external trigger slope and level. The gated feature provides pulse bursts for maximum versatility!

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

HEWLETT-PACKARD COMPANY

1501 Page Mill Road, Palo Alto, Calif. 94304, (415) 326-7000. Sales and service in all principal areas. Europe, Hewlett-Packard S.A., 54 Route des Acacias, Geneva, Switzerland; Canada, Hewlett-Packard (Canada) Ltd., 8270 Mayrand St., Montreal, Que.



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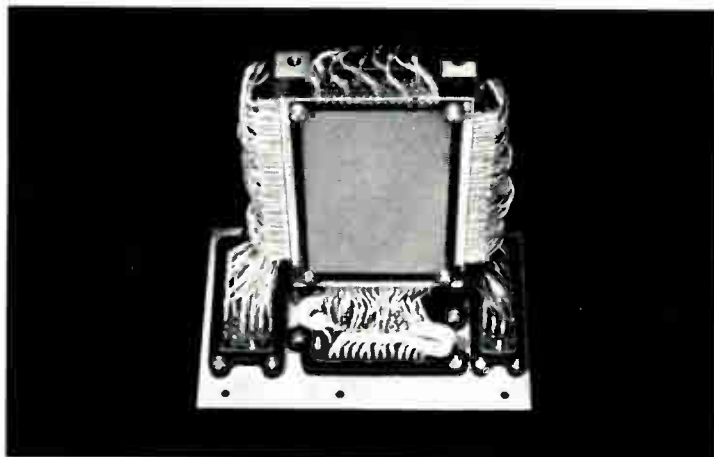
Power-packed 200 watt pulses

With the hp 214A: Positive or negative pulses to 100 v into 50 ohms (2 amps) at rep rates to 1 mc. Rise times 10 to 15 nsec. Pulse width continuously adjustable to 10 msec. Internal triggering, 10 cps to 1 mc continuously adjustable, external, dc to 1 mc, level and slope selectable. Gated feature for pulse bursts, double pulse, single pulse, square wave capabilities. Ideal for high current applications. Price, \$875.

Ask your Hewlett-Packard field engineer for a demonstration of the pulse generator that will best fit your requirements.

NEW RCA ADVANCES IN FERRITE TECHNOLOGY EXTEND MEMORY STACK CAPABILITIES

RCA offers Wide-Temperature-Range Stacks... Microferrite Stacks... Temperature Controlled Stacks
... Conventional Memory Stacks... in virtually any configuration to meet today's computer demands

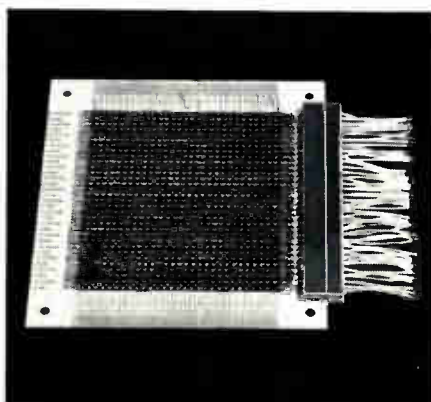


RCA's versatile line of memory stacks now includes sizes from 256 words by 8 bits to 16,304 words by 32 bits, with ferrite cores from .030" to .080" O.D. for system speeds as fast as 375 nsec.

RCA stacks can be supplied in a wide range of configurations and operating characteristics to meet your design needs, including types designed to meet stringent environmental specifications for shock and vibration. In addition, you can select from a broad range of plane constructions—new molded epoxy, phenolic, and printed-circuit types, or aluminum types designed to meet MIL specifications. All RCA stacks are 100 percent dynamically tested to assure dependability under actual operating conditions.

RCA WIDE-TEMPERATURE-RANGE STACKS COVER 80°C SPAN

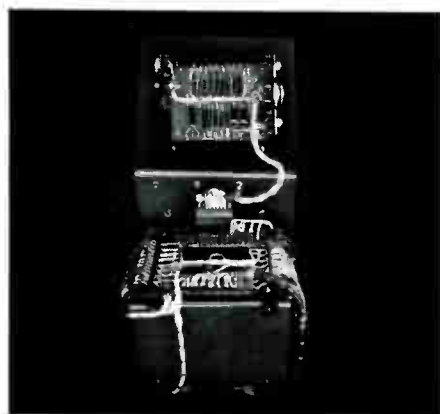
New RCA wide-temperature-range ferrite cores permit the construction of planes and stacks that operate over any 80°C range within the limits of -60°C to +125°C without peripheral temperature-control equipment. In those applications where small size, minimum weight and reduced peripheral equipment are required, these devices can help you achieve vital space and cost savings.



RCA'S EXCLUSIVE MICROFERRITE STACK ACHIEVES 65 nsec. SWITCHING

New RCA microferrite memory stacks complete a full read/write cycle in 300 nano seconds with less than 350 ma driving current and bit outputs of 50mv.

These revolutionary word-address systems, using proved ferrite cores, achieve packing densities to 2,000 bits per cubic inch. Available in multiples of 32 words by 32 bits.

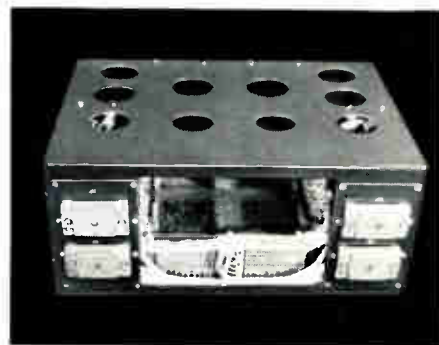


RCA CONTROLS STACK TEMPERATURE TO WITHIN $\pm 2^\circ\text{C}$ OVER A 120°C RANGE

RCA Memory Stacks, temperature-controlled within $\pm 2^\circ\text{C}$ are designed to meet MIL Specifications. Available in conventional or high density packages, these stacks can be utilized where specifications call for conventional core operation over extreme temperature ranges (up to a 120°C span).

RCA CONVENTIONAL MEMORY STACKS MEET LOW-COST REQUIREMENTS

RCA conventional memory stacks may be used where temperature extremes are not a critical problem, but where RCA's high quality and reliability are required at lowest possible cost. Hundreds of these stacks are now in use with an outstanding record of reliability.



Service: Your local RCA Field Representative is prepared to provide a completely coordinated application service, covering ferrite cores and memory systems, and semiconductor devices. Call him today. For further technical information, write RCA Electronic Components and Devices, Memory Products Department, Section FJ10, 64 "A" Street, Needham, Mass.



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