

# ELECTRONIC INDUSTRIES

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TECHNIQUES OF INTERCONNECTION

- Soldering • Welding
- Crimping • Solderless Wrap

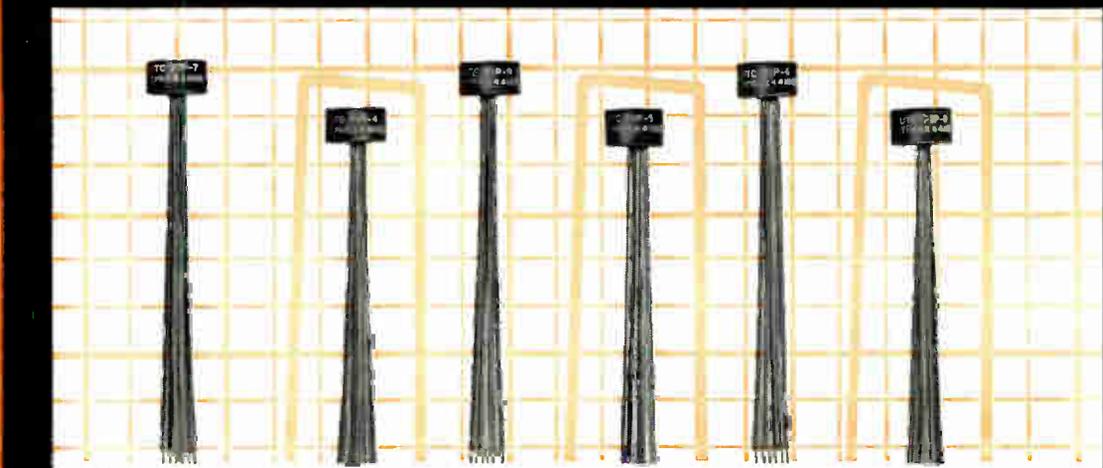
MAY 1964

World Radio History



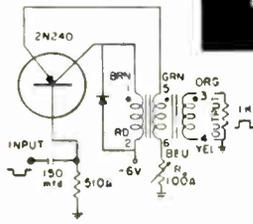
# NEW PIP SERIES

## ULTRAMINIATURE TRANSISTOR PULSE TRANSFORMERS



UNITS SHOWN ACTUAL SIZE — IMMEDIATE DELIVERY FROM STOCK

TRANSISTOR TEST CIRCUIT



All units individually checked and adjusted, in transistor circuit illustrated, to parameters in table.

### DEFINITIONS

**Amplitude:** Intersection of leading pulse edge with smooth curve approximating top of pulse.  
**Pulse width:** Microseconds between 50% amplitude points on leading and trailing pulse edges.  
**Rise Time:** Microseconds required to increase from 10% to 90% amplitude.  
**Overshoot:** Percentage by which first excursion of pulse exceeds 100% amplitude.  
**Droop:** Percentage reduction from 100% amplitude a specified time after 100% amplitude point.  
**Backswing:** Negative swing after trailing edge as percentage of 100% amplitude.

- RUGGED—COMPLETELY METAL CASED
- Manufactured & Guaranteed to MIL-T-21038B
- 5/16" Dia. x 3/16" Ht.; Wt. 1/20 oz.
- Ratios—4:4:1 and 5:3:1
- Anchored leads, withstands 10 lb. pull test
- Printed circuit use, plastic insulated leads
- Can be suspended by leads or clip mounted

Type No.	APPROX. DCR. OHMS			BLOCKING OSCILLATOR PULSE					COUPLING CIRCUIT CHARACTERISTICS						
	1-Brn 2-Rd	3-Org 4-Yel	5-Grn 6-Blu	Width μ Sec.	Rise Time	% Over Shoot	Droop %	% Back Swing	P Width μ Sec.	Volt Out	Rise Time	% Over Shoot	Droop %	Back Swing	Imp. in/out*
<b>RATIO 4:4:1 MIL TYPE TP6RX4410CZ</b>															
PIP-1	.18	.20	.07	.05	.02	0	0	37	.05	9	.018	0	0	12	50
PIP-2	.47	.56	.17	.1	.025	0	0	25	.1	8	.02	0	0	5	50
PIP-3	1.01	1.25	.37	.2	.03	2	0	15	.2	7	.035	0	0	5	100
PIP-4	1.5	1.85	.54	.5	.05	0	0	15	.5	7	.06	0	0	0	100
PIP-5	2.45	3.1	.9	1	.08	0	0	14	1	6.8	.15	0	0	5	100
PIP-6	3.0	3.7	1.1	2	.10	0	0	15	2	6.6	.18	0	2	10	100
PIP-7	4.9	6.05	1.8	3	.20	0	0	14	3	6.8	.20	0	2	10	100
PIP-8	8.0	9.7	2.9	5	.30	0	0	3	5	7.9	.22	0	13	25	200
PIP-9	13.1	15.9	4.7	10	.35	0	5	12	10	6.5	.4	0	15	20	200
PIP-100	Transistor pulse transformer kit, consisting of PIP-1 thru PIP-9 in plastic case.														
<b>RATIO 5:3:1 MIL TYPE TP6RX5310CZ</b>															
PIP-10	.55	.41	.15	.1	.01	0	0	20	.1	8	.01	0	0	5	140 50
PIP-11	2.9	2.2	.82	1	.02	4	4	6	1	6.6	.05	0	6	12	280 100
PIP-12	9.4	7.1	2.6	5	.05	0	12	12	5	8	.09	2	12	25	560 200

\* Input winding leads Brn-Rc (1-2); output winding leads Org-Yel (3-4); leads Grn-Blu (5-6) open.

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## EDITORIAL:

**ELECTRONIC  
INDUSTRIES**

The STATE-OF-THE-ART Magazine  
for Electronic Engineers

# LET'S SELL OUR CAPABILITIES TO OTHER INDUSTRIES

SPENDING FOR MILITARY HARDWARE has leveled off and will decline in the years ahead. Many electronic manufacturers, dependent on defense production, must find new markets if they are to survive.

Last October, in our lead editorial, we wrote "American Industries Are Our Greatest Challenge." We believe it vital that the industry develop a bold new approach to meet this problem.

We suggest that what is urgently needed now is a marketplace to bring the vast array of electronic capabilities to the attention of other industries. Specifically, there is a need for a permanent "Electronic Capabilities Center." It should be a place where manufacturers in other fields could come to find out how we can do it better for less. It should be strategically located — include systems, equipment and component exhibits. A competent consulting staff would be available to discuss each manufacturer's problems on a confidential basis. It would become the liaison center between ourselves and other industries!

Electronic manufacturers who have tried to explore new commercial and industrial markets discover quickly that selling to industry is entirely different from selling to the government. Design concepts are not the same. New marketing and distribution problems must be solved. As a result, many companies have found it difficult to convert their skills and their thinking to industrial markets.

When we try to consider the requirements of other manufacturing industries it becomes apparent quickly that we really don't know what specific electronic products or systems they need. We have few directly adaptable products available now. The development of acceptable and needed devices is going to take some time and effort.

The establishment of an industrial Electronic

Capabilities Center immediately raises questions of financial and administrative support. It is obviously not possible to provide a detailed operational blueprint at this writing.

Responsible organizations serving the electronic industries should join together now, pool resources, and establish an investigative committee. ELECTRONIC INDUSTRIES would be happy to cooperate and lend its support to such a program.

Some suggested participants: the Electronic Industries Association, the National Electrical Manufacturers Association, the American Standards Association, the Aerospace Industries Association and the Institute of Electrical and Electronic Engineers. Further support or assistance might also come through the National Association of Manufacturers as well as the Department of Defense and the Department of Commerce.

There are similar type establishments already in existence. In New York City, for example, the Architects Building Housing Center devotes several floors of show rooms and exhibits to be studied by visiting builders. In Washington, D. C., the National Housing Center occupies an entire building. The Defense Department, when it needed to develop new sources, sponsored material exhibits in various cities.

As publishers, we have studied other industries and reported in depth on their needs, and the opportunities to sell electronic equipment. But there is no substitute for the face-to-face exchange of ideas, especially when the specific equipment and components can be seen and demonstrated. An "Electronic Capabilities Center" is the ideal place for this exchange.

We believe one or more "Electronic Capabilities Centers" are needed urgently by our industry now.

We shall welcome your suggestions and comments.

*Bernard F. Osburn*

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## COVER

This striking design illustrates the deformation of wire in a crimped connection. The unusual pictorial treatment was supplied by AMP Inc., Harrisburg, Pa.

\*STATE-OF-THE-ART: up-to-the-moment capability in each area of electronic technology



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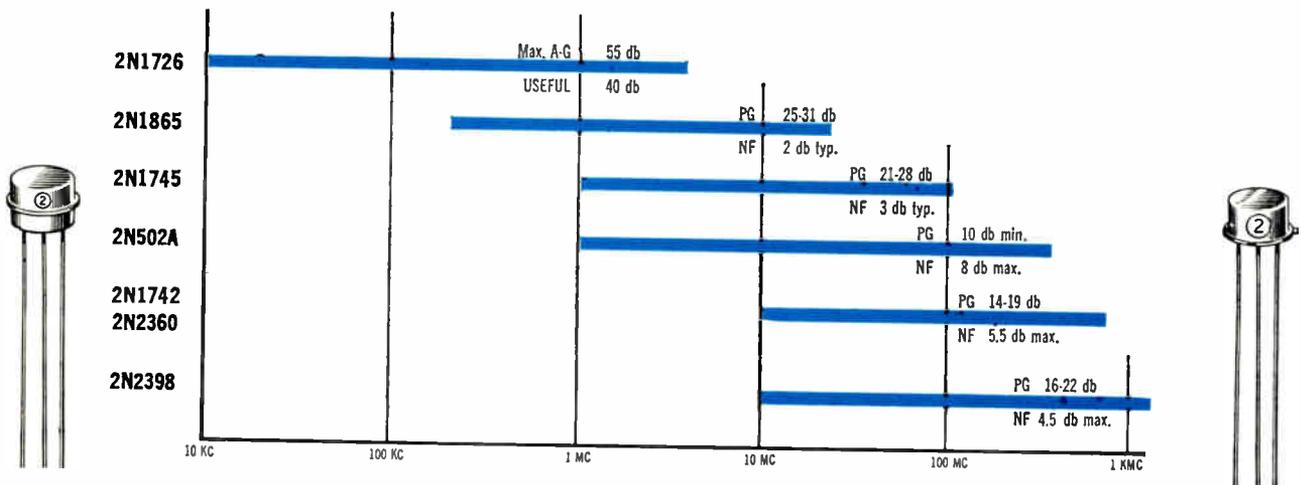
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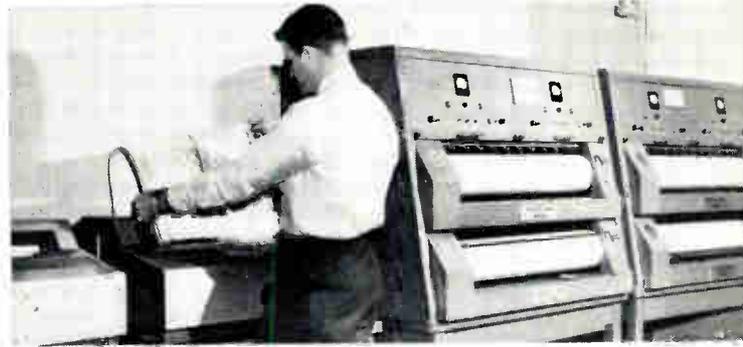
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**FACSIMILE IS COMING OF AGE****38**

This communications medium, from a seed sown more than a century ago, has been a "sleeping giant." No longer the grand wonder, it is still more than a lab toy. Recently becoming electronic, facsimile may have the greatest potential in business and high-speed data reduction, and using telephone lines.

**HERMETICALLY SEALED CONNECTOR****72**

What will hermetically sealed connectors do or not do? What can be expected of them as opposed to other connectors? How are they affected by temperature, humidity, pressures, thermal and physical shock, etc. These and other pertinent questions are answered here.

**TRAINING ENGINEERS  
IN COST-CUTTING TECHNIQUES****156**

Incentive contracts are here—and so is the mandatory and growing need for engineering economics, once a wistful experiment. A contractor must keep down engineering design costs or he may be an "also ran" in contract negotiations. GE suggests training engineers in engineering economics as a likely answer.

**GUIDE TO TODAY'S CIRCUIT  
INTERCONNECTIONS****48**

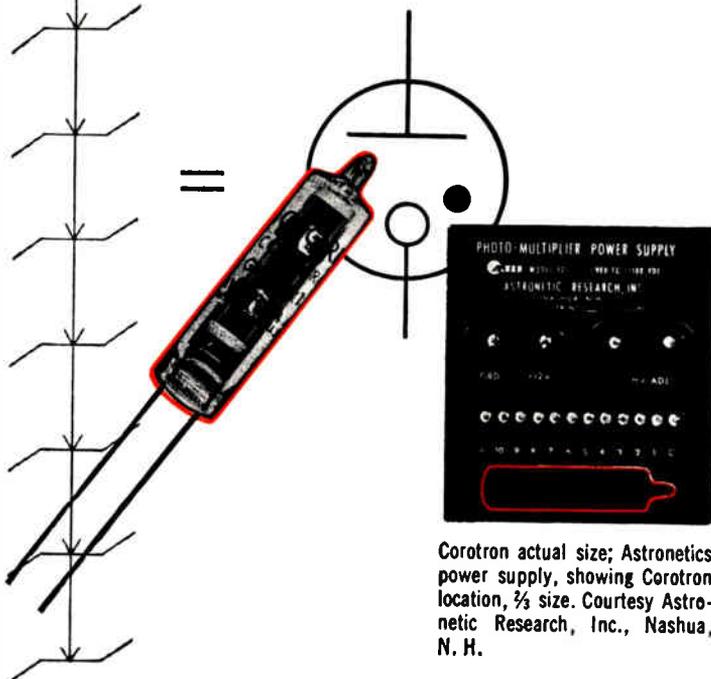
The major types of interconnections are crimping, solderless wrap, soldering, and welding. Each has certain advantages, as well as problems. This article describes both, and includes information on where to purchase the devices and machines.

**DESIGN FOR A DATA EXCHANGE SYSTEM****86**

The automatic exchange system described here is a broadly applicable real-time message switching and information processing system. It can operate in the store and forward mode and/or it may be integrated with circuit switching equipment. The system represents a step forward in the application of computer methods to communications.



# NEED A 3000 VOLT ZENER DIODE?



Corotron actual size; Astronetics power supply, showing Corotron location, 1/2 size. Courtesy Astronetic Research, Inc., Nashua, N. H.

You could string together several hundred zeners. Or you could specify *one* Victoreen Corotron. It is the gaseous equivalent of the zener with all the advantages of an *ideal* HV zener diode.

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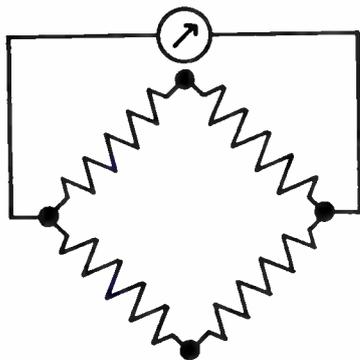
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thorization.

# 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-feet.

**Step 7.** Resistivity of cable in ohms-per-feet 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.

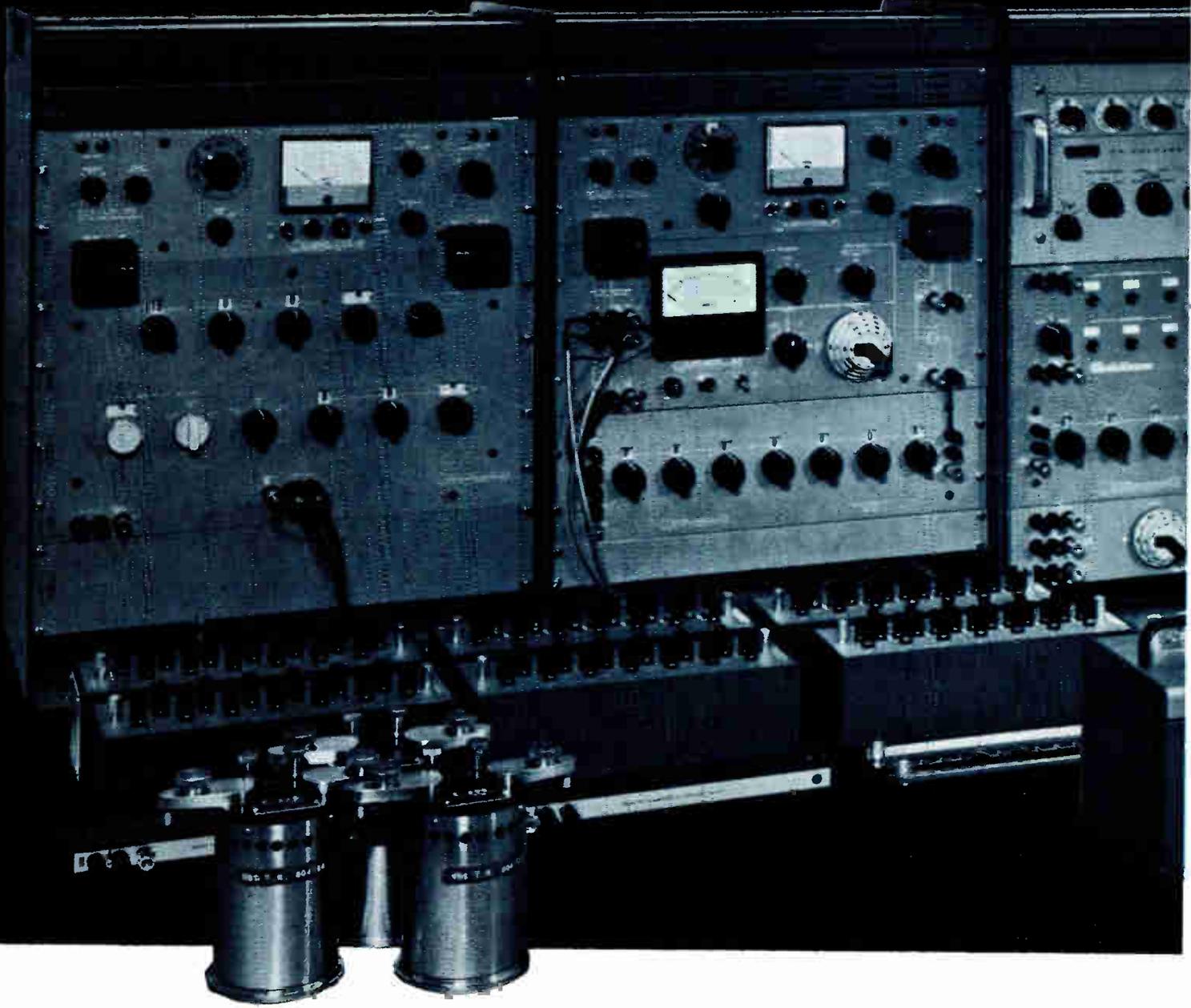
**Step 2.** See opens, shorts, or impedance variations the instant they occur; read distance to fault directly in feet from the pip on the scope.

*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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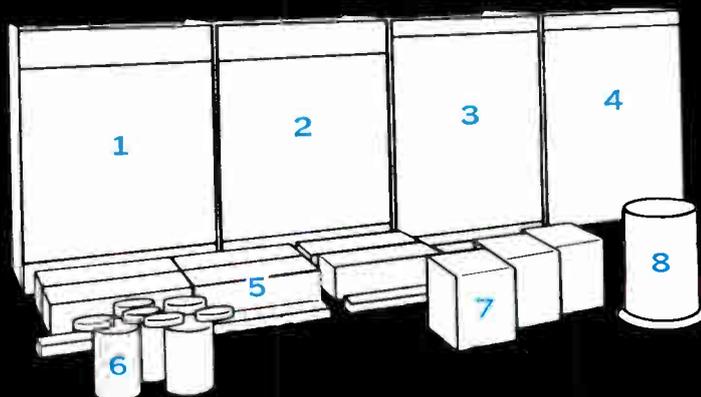
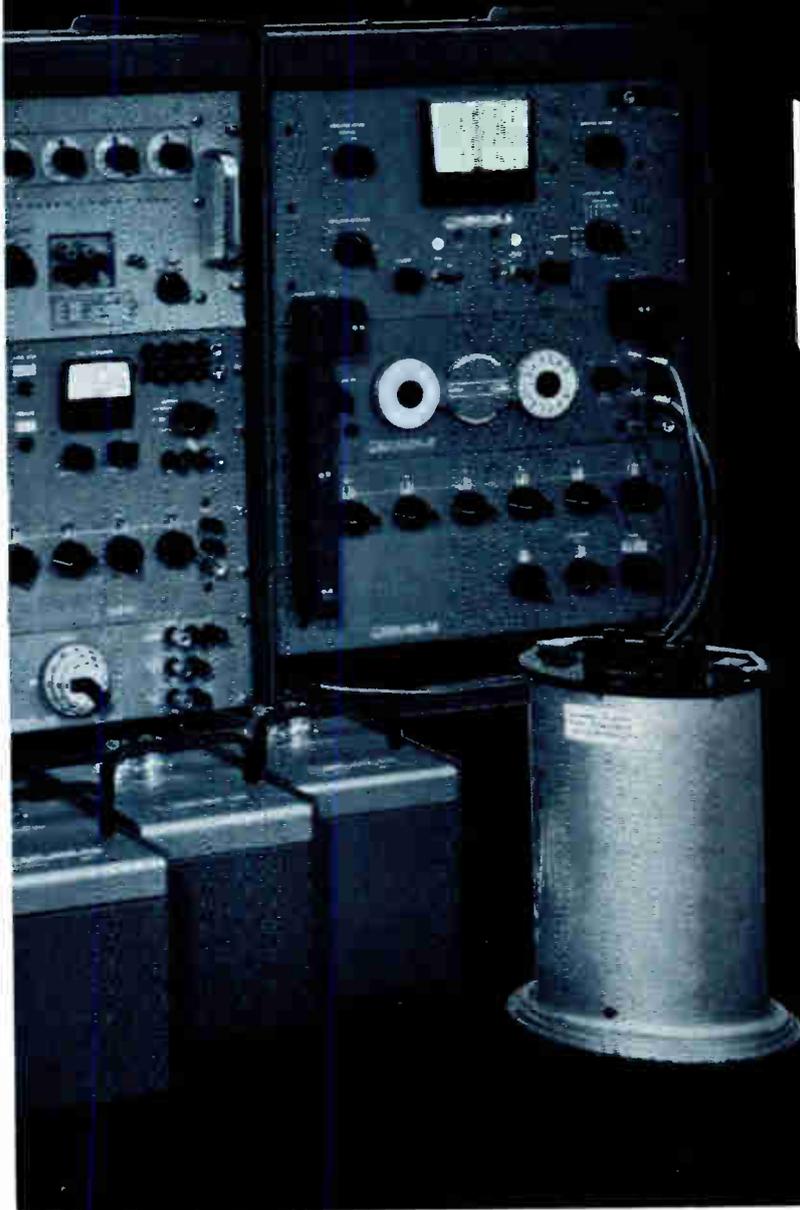
The ESI Calibration Console illustrated above is more than a collection of excellent measuring instruments. It is a complete, self-sufficient laboratory for dc and audio frequency measurements.

This is the metrology package which was recently purchased by the United States Air Force to improve the capability and efficiency of its

## **TRACE**ABILITY

world-wide network of Precision Measurement Equipment Laboratories. Traceability for the entire network is directly insured by the Heath Inertial Guidance and Calibration Group, Newark, Ohio.

This integrated instrumentation, adopted by the Air Force after a careful review of competitive proposals, typifies ESI's "Systemetrics" approach to the precision measurement needs of modern science and technology. It is available to you as the ESI Model 51 Calibration Console.



#### ESI MODEL 51 CALIBRATION CONSOLE

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- (2) Model 791 Ratio Measuring System
- (3) Model 731 DC Ratio and Voltage
- (4) Model 242 Resistance Measuring System
- (5) Model SR 1010 Resistance Transfer Standards and Accessories
- (6) Precision Reference Resistors
- (7) Model SC 1000 Capacitance Standard
- (8) Standard Voltage Reference

Fundamental to the "Systemetrics" concept is the selection and application of the most precise measurement techniques and the implementation of these techniques by stable reference and transfer standards to provide direct traceability to the National Bureau of Standards. These standards permit the accurate calibration of the console in your own laboratory or on the production line with simplicity, efficiency and economy. ESI automatic data logging can be added to speed measurements in high reliability test programs.

The ESI "Systemetrics" concept, also includes instruction material, technical reports, engineering bulletins and application data correlated to insure optimum results.

The same capabilities which enabled ESI to develop the Air Force Calibration Console are applied in a complete line of advanced instrumentation ranging from individual standard resistors to complete measurement systems.

For additional information, request ESI "Systemetrics" data and bibliography of current technical literature. For immediate service, our instrument engineer, John Healey, is as near to you as your telephone. Just check your local directory and call him.



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Analyzing current developments and trends affecting the State-of-the-Art of technologies throughout the electronic industries



### OVER THE ROOFTOPS ON A LASER BEAM

Voice via 10-kc channel over helium-neon laser beam. The 3.3-mile path is between ITT Industrial Laboratories plant and a Ft. Wayne, Ind., building. Transmitter uses Brewster windows and confocal optics coupled with a collimator and 2-inch aperture lens. Receiver is an 8" cassegrainian telescope with an ITTIL multiplier phototube.

**SUPERCONDUCTING GENERATORS** at Westinghouse Research Laboratories are only four inches in diameter but turn out more than 800 amperes. The generators energize large superconducting magnets. Westinghouse engineers report that the generators produce high current with nearly 100% efficiency. The tiny generators are immersed in liquid helium along with the magnet. This eliminates the need for large exterior generators and fat non-superconducting cables. In one generator, the plates, usually lead or niobium, are arranged in a circle, connected by superconducting wire. Small "exciting" superconducting magnets rotate close to and parallel to the plates at about 100 rpm within a 4-in. circle. The magnets create magnetic field and also make "holes" of normal-behaving metal through the plates. Magnetic lines of force pass through "holes." Lines sweep past superconducting wire, creating current. Another version of the generator has three fixed magnets fed by ac, which creates a rotating magnetic field through the "holes." This makes it a superconducting dc generator with no moving parts.

**MULTIPLATE RADAR ANTENNA**, designed by the Air Force Office of Aerospace Research, will be 10,000 times more sensitive than the 84 ft. radio/radar units now widely used. The flat multiplate antenna will discern details on the moon with angle resolution of one minute of arc. The antenna will consist of 500 flat plates, 20 ft. square, in four elliptical areas around a 1,000-ft. tower. Each plate will be adjustable. A computer will determine proper tilt and center height of each plate. Antenna can be any arbitrary size.

**AUTOMATED INFORMATION SYSTEM**, developed by Astronautics Division of General Dynamics Corp., is now being used by engineers to improve reliability in Centaur space craft. The new system employs a computer to search volumes of technical data and to provide answers in minutes that once required weeks to locate. The GD automated fact-finding method is now being expanded for use on the Atlas launch vehicle. With access to some 835,000 items of technical data on Centaur, engineers can trace history of any failure category, determine whether current part failure is isolated or part of a pattern carried on since Centaur began three years ago. Key feature is not hardware but method used to store and retrieve data.

**SUN-PUMPED LASER OSCILLATION** using neodymium-doped glass has been continuous at 30°C, according to American Optical Co. The system consists of a two-foot parabolic mirror used with lenses of special design that concentrate the Sun's energy collected on a spot 2.8 mm in diameter. A reflecting cylindrical cavity containing a 30 mm long laser rod is placed at the focus. The rod is silvered at both ends, and consists of a 0.1 mm diameter neodymium-doped glass core. The core is covered with clear glass to 1 mm over-all diameter. Power output is about 10  $\mu$ w.

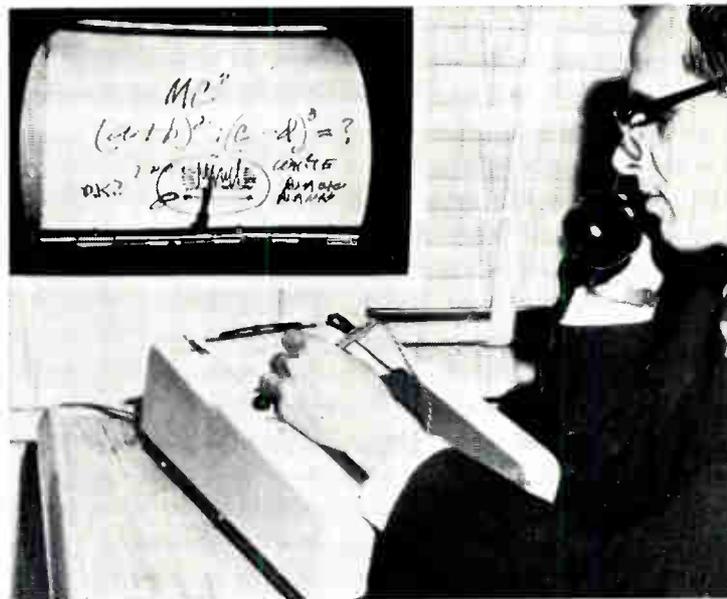
**MULTIPLIER-AMPLIFIER FUNCTIONS** have been combined in one transistor at Thompson Ramo Wooldridge. Three new VHF and UHF all-transistor power amplifier-multipliers with power ranging from 4 to 10 watts and frequencies as high as 580 mc use special circuits that employ transistors in the final amplifier stage. One unit is a power source that converts 400 mw at 210-290 mc to a minimum of 4 w output at 420 to 580 mc. Output is across any 20 mc portion of the 210-290 mc band. A second unit is a VHF power amplifier operating over any 10 mc portion of the band. Output is 5 w, with 11 db power gain. The third unit is a 10 w power amplifier with 14 db power gain, and 25% efficiency at 10 mc portion of the 210-290 mc band. All units use 28 to 40 volts dc.

**NEAR PERFECT CRYSTALS** have been produced by a new fundamental crystal growth, discovered by metallurgists at Bell Telephone Laboratories. The technique is called vapor-liquid-solid (VLS) mechanism. Bell scientists R. S. Wagner and W. C. Ellis report that the technique has great promise for semiconductor, laser, piezoelectric, and magnetic devices; all need precisely grown crystals. VLS growth occurs when a droplet of a saturated solution of a crystalline material and an impurity receives atoms from a vapor.

**OPTICAL HETERODYNE RADAR** being developed by Sperry Rand Electro-Optics Group to exploit the full potential of the laser. Power, narrow band width, phase stability and narrow beam angle are being combined in a three-laser, optical heterodyne system operating at  $1.06 \mu$ . Sperry engineers say this combination will enable laser radars to reach sensitivities and ranges beyond existing systems. Key to the Sperry development is the mating of power and coherence in the transmitter and ultra-sensitive, low noise detection in the receiver. A prototype transmitter is being built around tandem operation of a highly coherent gas laser local oscillator and a pair of solid state laser amplifiers. Heart of the receiver is a tiny Sperry-developed diode detector; the device functions both as an optical heterodyne signal mixer and as a low noise, nondegenerate parametric amplifier. Materials being studied include neodymium-doped calcium and strontium tungstate.

### NEW SUBROC CONTROL SYSTEM

U.S. Navy fire control technicians operate new Underwater Fire Control System Mk 113, produced by General Precision Information Systems Group. The Mk 113 is a principal part of revolutionary new missile for SUBROC antisubmarine weapon system. Technicians operate attack-control console and check target data analyzer.



### LONG-DISTANCE 'BLACKBOARD'

A device to transmit handwriting on telephone voice circuits has been developed by General Telephone & Electronic Corp. Object is long-distance telephone lectures to students. Transmitted handwritten 'blackboard' notes are reproduced on a closed-circuit TV system. The device, Electrowriter, both transmits and receives.

**HIGH-SPEED TRANSMISSION** of black and white facsimile over a 240 kc channel is now possible, according to Bell Telephone Laboratories. A new system sends up to 16 typewriter-size pages per minute. Definition is 100 lines per inch. System uses a communications channel equal in bandwidth to 60 voice circuits. System is potentially able to send digital data at 200,000 bits per second. Current facsimile sending rate is one-sixth of page per minute at 100-line/inch definition. Changes in black and white are somewhat infrequent in most copy. This allows the system to use strong 3.92  $\mu$ sec. pulses while keeping average transmitting power to a tolerable level.

**ELECTROCHEMICAL NEURONS** may be the basis of a new logic computer capable of functioning "like a human brain" according to Space-General Corp. engineers. Robert M. Stewart, director of S-G Applied Research Laboratory, said that the neuron is based on the immersion of steel in nitric acid which puts out electric characteristics similar to animal nerve impulses. When a steel ball network is put in acid, electrochemical reaction forms a semi-stable, inert membrane. If the membrane is disturbed, surface waves are produced similar to those in human nervous system. S-G physicists used iron and silver wires to make an artificial nerve cell with "inhibition," believed to be the key to a logic computer. In its ultimate form, the computer might contain 10 billion or more parts per cubic foot, said Mr. Stewart. It would be as small as a human brain, start as a "baby" and mature with external stimuli.

(More RADARSCOPE on Page 12)

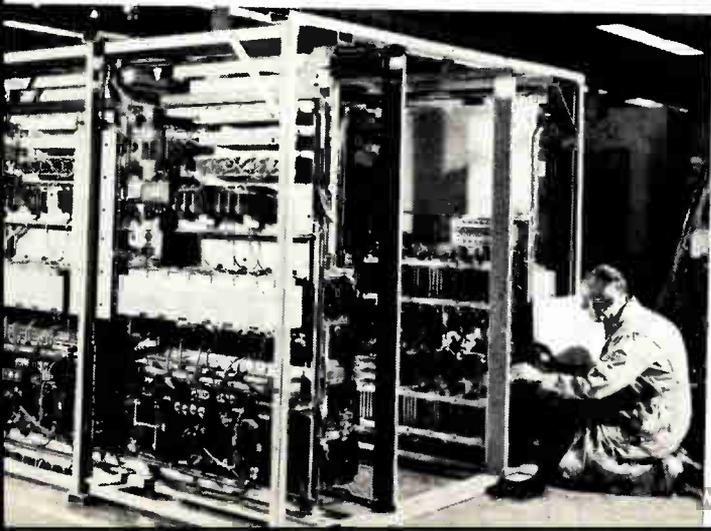
**3-D OCEAN FLOOR SONAR SCANNER** is being tested by Westinghouse. Towed under water, transistorized sonar scans ocean floor with hf sound waves. Reflected beam appears as sharp, clear image on surface TV. Pictures are recorded on sensitive paper. Developed for Office of Naval Research, the system views bottom at right angles to tow direction at up to four knots. The system is towed from 200 to 400 feet above floor at depths down to 20,000 feet. Two sets of sonar transducers scan the floor out to 1200 feet on both sides.

**LASER BEAM DEFLECTOR** has been developed by IBM. "High-speed directional control of a laser beam is now possible" with an experimental device for deflecting light to precise locations on any surface. Called a digital light deflector, the device uses laser light to project letters, numbers or other images at high speed to exact positions. In operation, laser light is passed through pairs of crystals which deflect the beam. Each added pair of crystals doubles possible directions.

**EXPANSION OF R-F SPACE** for communications can be gained through little-used millimeter-wave regions, reports a General Telephone & Electronics scientist. Dr. Gerhard Weibel, of GT&E, reports that a single millimeter wave channel has much greater capacity than a microwave channel; also, it is not affected by weather as are laser beams. Millimeter waves lie in the spectrum just above microwaves and somewhat below lasers—between 30 gc. and 300 gc. Theoretically, Dr. Weibel said, a millimeter wave can carry 10,000 or more voice channels. This is about 10 times the operating capacity of a microwave system.

#### STATIC FREQUENCY INVERTER

Built by Allis-Chalmers for use in setting up a national nuclear attack warning system using standard power lines, this 200-kva static frequency inverter converts 60 cycle ac to 210 cycle ac. Made for the Office of Civil Defense of the Department of Defense, it will be part of NEAR (National Emergency Alarm Repeater).



**HEAT-RESISTANT COMPONENTS** are being developed by NASA, reports Homer E. Newell, associate administrator for NASA's Space Science and Applications. Mr. Newell says that such components will be directly applicable to radios and TV receivers. Their longevity has been seriously reduced by their own generated heat. This new approach, said Mr. Newell, is being taken since certain reliability needs cannot be met by present state-of-the-art devices.

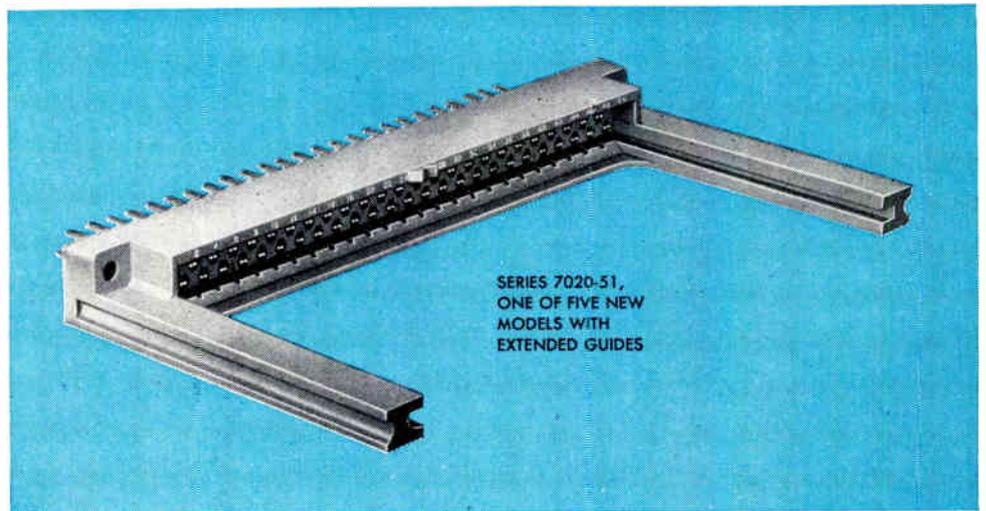
**PHOTOELECTRIC METHOD** for measuring absolute intensities of visible and near-visible light sources has been developed by University of California Electronic Research Laboratory for the Army. The method is said to be reasonably accurate in measuring relative intensities of spectral lines. To establish measurement standards, researchers used a tungstenstrip lamp as a source of known brightness. Response of a Jarrell-Ash spectrograph used with a photomultiplier was measured over the range of 3500 Å to 11,000 Å. No measurements were made down to 2000 Å because a tungsten lamp with a quartz window was not available.

**COHERENT GREEN LIGHT SOURCE** has been produced by Laser Systems Center of Lear Siegler, Inc. The unit was built for the Naval Ordnance Laboratory to be used for underwater and photochemical research. According to Lloyd Cross, Director of the Laser Systems Center, researchers now have the laser beam they need for underwater experiment. Red light lasers are not as useful underwater. Lloyd reports that the green light is produced by projecting a beam from a neodymium-doped glass laser into a non-linear crystalline material. Beam width is about one milliradian. Pulses are less than 0.1 μsec.

**PARAMETRIC AMPLIFICATION** at 35 gc with a 29-gc pump has been achieved by LFE Electronics, division of Laboratory For Electronics, Inc. LFE's microwave laboratory had built a two-idler breadboard parametric amplifier which had a power gain at 13.9 gc using a 9.3-gc pump. The underlying theory is that additional idlers can reduce the noise figure as well as the pump frequency. Otis C. Ferrell, general manager of LFE, foresees new parametric techniques extending soon into the 100-gc range and development of all solid state microwave receivers. Another use might be in low-noise microwave-to-IF down-conversion providing stable power gain.

(More RADARSCOPE on Page 14)

# UNCOMMONLY CLEVER SOLUTION TO A COMMON 'DISCONNECTION' PROBLEM



## NEW ELCO VARICON\* CONNECTOR FAMILY WITH EXTENDED, INTEGRALLY-MOLDED PRINTED CIRCUIT CARD GUIDES!

Printed circuit cards often appear to have a cunning all their own. They wiggle, waggle and wobble when everything else stays put; and sneakily, silently disconnect themselves . . . and boinggg . . . there goes your entire system! What's to do about it? Specify the new ELCO VARICON\* Connectors, with their uncommonly clever, integrally molded, extended guides which hold  $\frac{1}{16}$ " module cards rigidly in position against thumps, bumps and vibrations. Five models are available for countless application variations: with one-piece polycarbonate insulators, and mounting holes to add to the rigidity and to simplify the mating. Depending on the model, you may specify miniature or subminiature contacts, in 14, 17, 33, 36 and 51 contact sizes, with tail-end terminations for virtually every wiring technique. And all—mind you—with the added operational assurance of the world's most reliability-proven contact—the ELCO VARICON\* Contact! For further information—or design-engineering and production assistance, simply call, write, wire or TWX us.

if it's new . . . if it's news . . . it's from



\* TRADE-MARK

MAIN PLANT AND OFFICES: Willow Grove, Pa., 19090, 215-659-7000, TWX 510-665-5573 • ELCO PACIFIC, W. Los Angeles, Cal., 90064 • ELCO MIDWEST, Chicago, Ill., 60645 • Also Representatives, Subsidiaries, Licensees Throughout the World.

ELECTRONIC INDUSTRIES • May 1964

Circle 4 on Inquiry Card

13

# International Rectifier

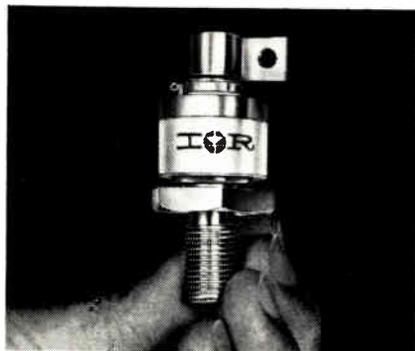
SEMICONDUCTOR DESIGN DATA 

## How to Build Better Circuits without Really Straining – Using International Rectifier Controlled Rectifiers and Miniaturized High Voltage Silicon Rectifiers

Who's afraid of ambient heat and cold? Not the user of IR's always-dependable off-the-shelf switching devices! For instance, you can eliminate forced air cooling with a new series of 70 ampere, 25 to 400 volt PRV silicon controlled rectifiers. They operate reliably in ambient temperatures from  $-65^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$ . That's an increase of  $25^{\circ}\text{C}$  in each direction!

Troubled with voltage spikes in your ac or dc circuits? Install IR's 35 ampere (55 ampere RMS) epitaxial SCR's. They're designed to handle non-repetitive surges up to 700 amperes and have built-in protection against high transient voltages. This new series is rated for 600 to 1300 volts PRV. Write for Bulletin SR-361.

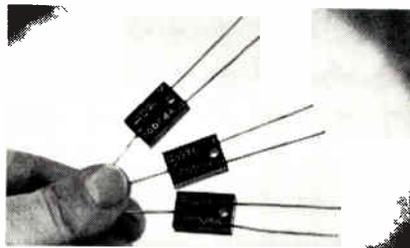
You'll be glad to learn we've got a variety of special parameter 16 ampere SCR devices for those problem-child circuits... 200 and 250 PRV units featuring maximum turn-off time of 12 microseconds, reverse recovery not exceeding 3 microseconds and gate recovery under 11.8 microseconds. 600, 700 and 800 volt PRV (2N690, 691, 692) SCR's have been added to that popular 2N681-689 series. Write for Bulletins SR-351 and SR-366.



### Pack 'em In Like Sardines!

These 70 ampere SCR's feature flag terminals for closely packed circuitry. Although they measure less than  $1\frac{3}{4}$ " above the seating plane, they span a wide, wide voltage range. Diffused alloy SCR's range from 25 to 800 volts, epitaxial types from 600 to 1300. One epitaxial series provides specified maximum reverse avalanche voltage. We'll be glad to help you decide where they'll fit comfortably in your circuitry. Just ask!

INTERNATIONAL RECTIFIER CORPORATION 233 Kansas St., El Segundo, California



### To "Cram a Barrel of Power into a Thimble," Rely on IR High Voltage Technology

Each miniaturized device shown above replaces several rectifier devices in applications calling for positive or negative output, full wave center taps and OR gates. PRV ranges from 200 to 2000 volts, 350 to 2600 transient. Current ratings, at  $50^{\circ}\text{C}$  ambient, reach 1.8 ampere. They combine nicely in single-phase bridge or polyphase rectifier circuits.

Where space is critical and voltage high, IR helps you trim the fat with 0.9 ampere miniaturized silicon rectifiers with PRV ratings from 400 to 2000 volts (600 to 2600 transient). In many applications, you'll find they handily eliminate bulkier circuits and mercury vapor tubes. A wide range of characteristics provides true modular flexibility of design.

Our extremely compact, large output single-phase, full wave bridge rectifiers each perform functions that once required four individual diodes. Rated from 200 to 1000 volts PRV (350 to 1250 transient), they put out as much as 1.8 ampere average dc. Write for Bulletins SR-232-235.

Want 8000 volts per inch? IR's compact encapsulated sticks offer a PRV range from 2 kv to 75 kv, with 0.2 to 1 ampere output. They measure only 0.5" to 1.0" square by 1" to 15" long! You'll find them mighty useful in radar pulse modulators, electrostatic precipitators and radio power supply units.

### "What's Your SCR IQ??"

To find the answers to this and many other pertinent questions on controlled rectifiers, write for your copy of our SCR fact round-up, "What's Your SCR IQ?"

# RADARSCOPE

INTEGRATED CIRCUIT PARAMETERS and thermal design are part of a two-phase study by Motorola in behalf of the Navy. Joint goals of the study are definition of integrated circuit thermal parameters and establishment of thermal techniques for both I/C devices and systems. One phase will consider thermal aspects of semiconductor and thin-film integrated circuits. Cordwood modules will be studied. Thermal design practices will be surveyed, EDP analyses run, and instruments devised. The other phase will deal with multi-circuit networks.

### BIGGER COLOR TV TUBES

are apparently on the way. RCA is working on a new 25-inch 90-degree rectangular color CRT. It is expected to go into pilot production before mid-year. The tube will have a new type of envelope especially designed for color. Limited quantities of the new tube may be available to TV set makers later in the year. The company is expected to produce some 1.3 million color tubes in 1964. Nearly all will be standard 21-inch round type.

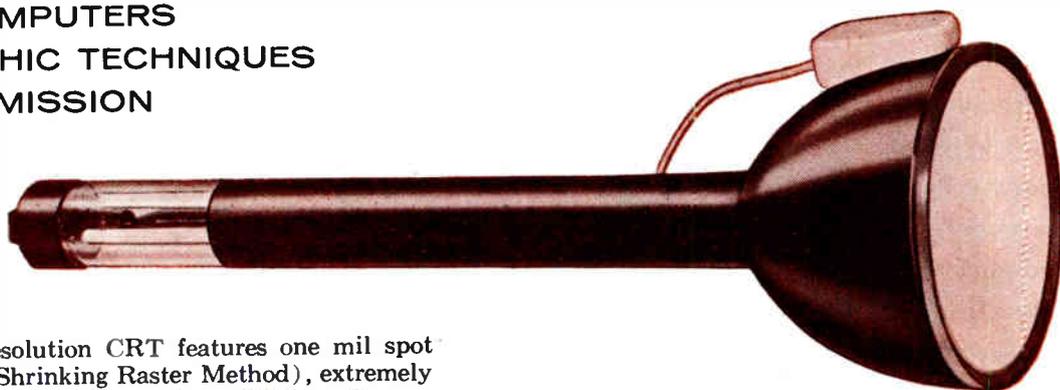
### HIGH-POWER LIGHT SOURCE,

using solid state diodes of both coherent and incoherent light output is being developed for the Air Force by Sperry Rand Corp. The source will be continuous wave, with electroluminescent radiation for avionic system application. Sperry scientists are studying properties of indium arsenide and mixed crystals of indium gallium arsenide. The crystals emit infrared light. A key area of study, according to Dr. Roger Newman, head of Sperry's solid state research, is high-power, c.w. output from reliable, long-life devices that can operate at temperatures much higher than the  $77^{\circ}\text{K}$  needed for existing diodes.

# RAULAND *FLYING SPOT* SCANNER

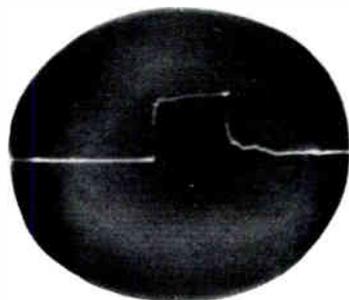
## APPLICATIONS UNLIMITED

- RADAR • COMPUTERS
- PHOTOGRAPHIC TECHNIQUES
- FILM TRANSMISSION



Rauland's 5" High Resolution CRT features one mil spot size (measured by the Shrinking Raster Method), extremely fine grain screen with low phosphor noise and flat non-browning face plate, ground and optically polished. Applications are limited only by the imagination; write for complete technical specifications.

# ULTRAFAST SCAN CONVERTER STORAGE TUBE



Photograph of a 24 nanosecond transient pulse as displayed on an ordinary television monitor.

Rauland's ultrafast Scan Converter Storage Tube records and stores transient phenomenon with pulse rise times of less than a nanosecond. The R6253 tube permits slow scanning techniques to be used for the relay of transient pulse data over narrow band systems. The pulse may also be recorded by conventional means — on magnetic tape, transmitted over inexpensive telemetry links, over communication cables, displayed on an ordinary television monitor and photographed using "box camera" exposure time. Relay or recording of pulses can be simultaneous with visual observation. It utilizes a distributed deflection system for the writing side and either magnetic or electrostatic deflection for readout of high speed phenomenon.

 <p><b>SCAN CONVERTER STORAGE TUBES</b></p> <p>Resolution Capability of 1000 TV lines. Erase Capability of 2 seconds or less. Any combination of electrostatic or magnetic deflection is available.</p>	 <p><b>FLAT FACE DISPLAY TUBES</b></p> <p>Rauland's flat face tubes (16", 22", 24") minimize parallax error. Resolution capability of 1000 TV lines at a brightness of 100 foot-lamberts. We will suit your specific requirements with any type of radar display tube in any size with any type phosphor or gun.</p>
--	---



**The RAULAND Corporation**

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**SAVE \$2.00\*  
PER RELAY  
AND GET  
EXTRA  
CONVENIENCE  
TOO!**

**WIRE  
THIS**



This precision-built socket starts you off to a savings of nearly \$2.00\* per installed LS telephone-type relay when you specify our relay-socket-cover combination instead of a similar relay with factory-wired, octal-type plug. Also (1) you have the convenience of a plug-in component, and (2) you can use a relay having more contacts than octal-type plugs will accommodate.

Two sizes of sockets are available. The 16-pin smaller one (1.39" x 1.71") accepts relays with contact arrangements from 1 Form C to 4 Form C. The larger 28-pin one (1.39" x 2.11") will take relays with contact arrangements up to 8 Form C. Each size socket has four coil terminals for single or dual coil relays.

*\*Approximate. Based on single lot price. Savings depend on contact arrangements.*

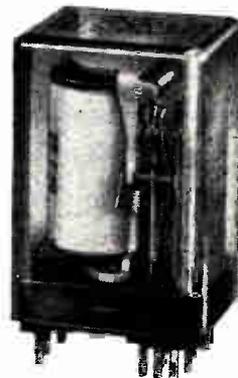
**PLUG  
RELAY IN**



Plug the LS into the socket . . . just as you would a vacuum tube. The relay's tab terminals mate snugly with the socket, will hold the relay in place under normal conditions. When the relay is mounted horizontally, or when vibration is a problem, two banana plugs or two machine screws may be used.

A choice of cadmium or gold plated socket terminals is available . . . and the pierced solder terminals are designed also for AMP-78 taper tab connectors.

**SLIP ON  
DUST COVER**



The transparent, high impact, high temperature resistant dust cover fits over the socket nearly flush with the chassis. Covers as well as sockets of either size may be purchased separately. With socket and cover, the LS relay is designated the LSP . . . a sparkling addition to this series of reliable telephone type relays.

Here is a neat, modern, cost-reducing approach to using the reliable, versatile LS relay. Better send for complete information today.

### LS SERIES ENGINEERING DATA

#### GENERAL

**Description:** Medium coil telephone type relay with bifurcated contacts.

#### Time Values:

AC: Operate: 3 to 15 milliseconds.  
Release: 3 to 15 milliseconds.

DC: Operate: 5 to 50 milliseconds.  
Release: 5 to 140 milliseconds.

Precise time values depend upon coil power and contact arrangement.

Operate and release time delay slugs and fixed or adjustable residuals are available for DC relays.

**Expected Life:** 100,000,000 mechanical operations minimum.

**Contacts:** 100,000 operations minimum at rated load.

**Temperature Range:** -55°C to +85°C standard (+105°C available on special order).

**Weight:** Approximately 3¼ ozs. (open).

#### CONTACTS:

**Arrangements:** AC: Up to 12 springs (6 per stack-4 movables). DC: Up to 24 springs (12 per stack).

**Material:** ¼" dia. twin palladium is standard for bifurcated contact arms.

Gold-alloy, other contact materials, and single contacts are available for specific applications.

**Rating:** AC: 4 amps @ 115 volts AC, 60 cycle resistive (open relay @ +25°C).  
DC: 4 amps 28 volts DC resistive.

#### COILS:

**Voltage:** AC: To 230 volts 60 cps.  
DC: To 220 volts.

**Resistance:** DC: 55,000 ohms maximum.

**Power:** AC: 4.37 voltamps.  
DC: 65 milliwatts per movable arm

minimum, 5 watts maximum @ +25°C.  
**Duty:** Continuous.

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STANDARD P&B RELAYS ARE AVAILABLE AT LEADING ELECTRONIC PARTS DISTRIBUTORS



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World Radio History

Circle 7 on Inquiry Card

# COMING EVENTS

## MAY

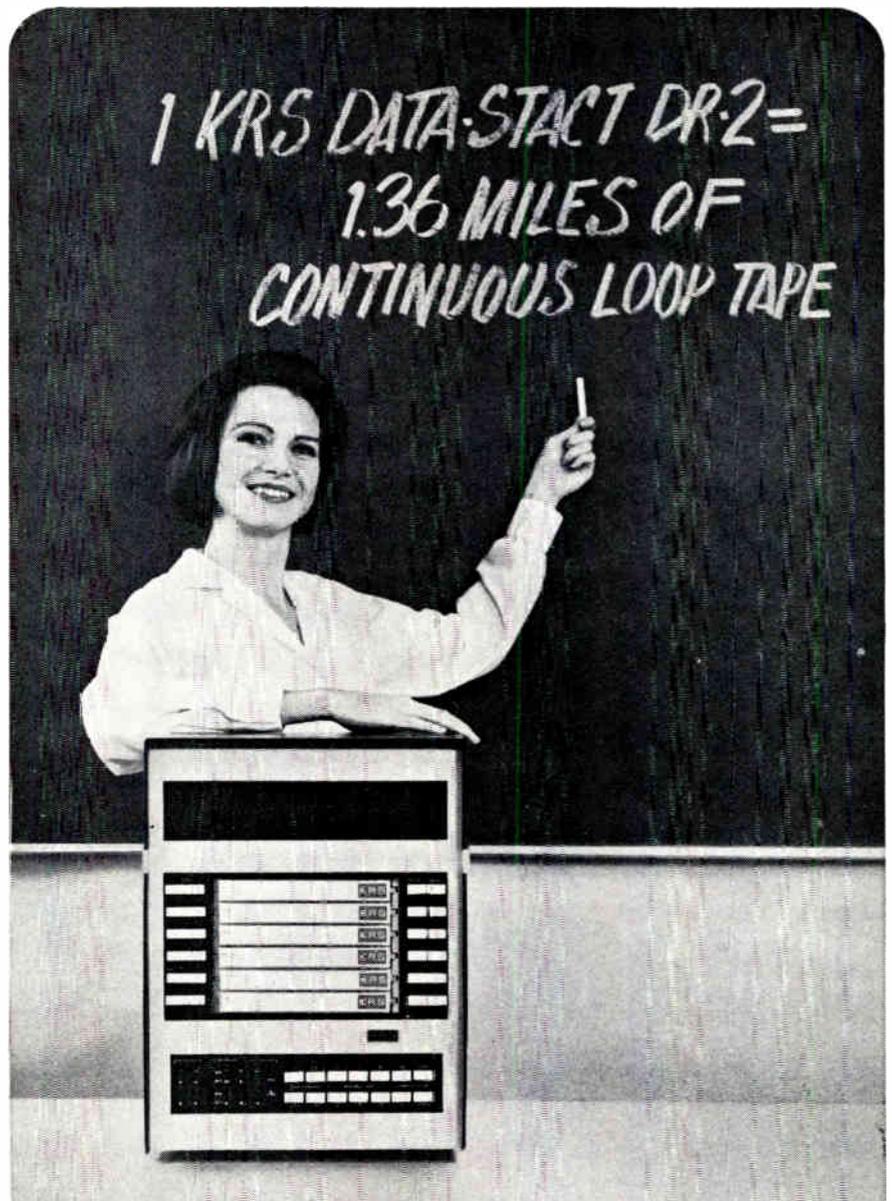
- May 11-13: **NAECON** (Nat'l Aerospace Electronics Conf.), PTG-ANE, Dayton Sec., AIAA; Biltmore Hotel, Dayton Ohio.
- May 11-14: **Design Eng. Show & Conf.**, ASME; McCormick Place, Chicago, Ill.
- May 18-20: **7th Nat'l Power Instrumentation Symp.**, ISA; Denver Hilton Hotel, Denver, Colo.
- May 18-20: **Electronic Parts Distributors Show**; Conrad Hilton Hotel, Chicago, Ill.
- May 19-20: **Nat'l Appliance Technical Conf.**, IEEE; Ben Franklin Hotel, Phila., Pa.
- May 19-21: **Int'l Symp. on Microwave Theory and Techniques**, PTG-MTT; Int'l Inn, Int'l Airport, Idlewild, N. Y.
- May 20-22: **Pulp & Paper Industry Conf.**, IEEE; Netherland Hotel, Cincinnati, Ohio.

## JUNE

- June 1-5: **Nat'l Plastic Conf.**, SPI; Commodore Hotel, New York, N. Y.

### '64-'65 Highlights

- WESCON**, Western Electronic Show and Conv., Aug. 25-28, IEEE, WEMA; Sports Arena, Los Angeles, Calif.
- Nat'l Electronics Conf.**, Oct. 19-21, IEEE, et al; McCormick Place, Chicago, Ill.
- NEREM**, Northeast Research & Eng. Mtg., Nov. 4-6, IEEE; Boston, Mass.
- IEEE Int'l Conv.**, Mar. 22-25; Coliseum & New York Hilton, New York, N. Y.
- June 8-10: **Symp. on Quasi-Optics**, PIB-IEEE; Statler-Hilton, New York, N. Y.
- June 8-11: **Systems Engineering Exh.**; New York Coliseum, New York, N. Y.
- June 9-11: **Applied Mechanics Conf.**, ASME; Univ. of Colorado, Boulder, Colo.
- June 11-12: **8th Nat'l Product Eng. & Production Conf.**, PTG-PEP; Pratt Institute, Brooklyn, N. Y.
- June 14-18: **Mtg.**, American Nuclear Soc.; Sheraton Hotel, Philadelphia, Pa.
- June 16-18: **Int'l Conf. on Precision Electromag. Measurements**, IEEE, NBS Boulder Labs.; Boulder, Colo.
- June 21-26: **67th Annual Mtg. & 16th Material Testing Exh.**, ASTM; Conrad Hilton Hotel, Chicago, Ill.
- June 23-25: **6th Nat'l Symp. on Electromagnetic Compatibility**, PTGEC/IEEE; Los Angeles, Calif.



A good fact to remember! One 60-pound KRS DATA-STACT™ DR-2 is equal to almost any instrumentation record/reproduce function you could give it between DC and 100 kc. And, it's the only Cartridge Instrumentation Recorder able to log 1 1/3 miles of two-channel data without reloading.

**SIX RECORDERS IN ONE** It's true! Each DATA-STACT DR-2 Recorder operates a stack of six KRS STACTape™ Cartridges. Each cartridge holds a two-channel, 1,200-foot continuous-loop roll of 1/4-inch tape. Used sequentially, they provide 7,200 feet of two-channel data-logging capacity at any one of six selectable tape speeds. Operated simultaneously, they can record up to 1,200 feet of 12-channel data.

**NO MECHANICAL ADJUSTMENTS** Extreme simplicity of the DATA-STACT DR-2 Recorder eliminates the critical parts that cause adjustment headaches. All-solid-state circuitry contributes to its exceptional reliability. Complete system price range from \$2,500 to \$10,000.

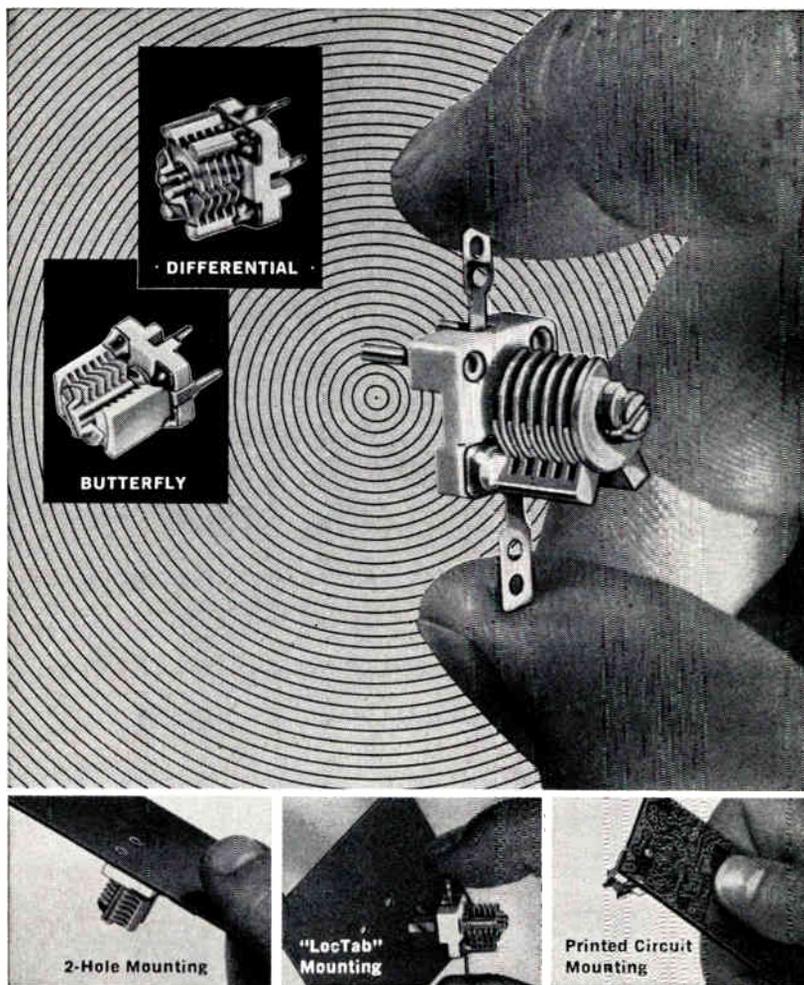
For more facts on KRS DATA-STACT DR-2 Cartridge Instrumentation Recorders, write for Instrumentation Div. Bulletin DR-2. Dept. E.1., KRS Electronics, 4035 Transport Street, Palo Alto, California



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Cut costs — save valuable space with these

# SUB-MINIATURE “U, UA, and UB” AIR VARIABLES



**Precision machined for high reliability—exceptional mechanical stability!**

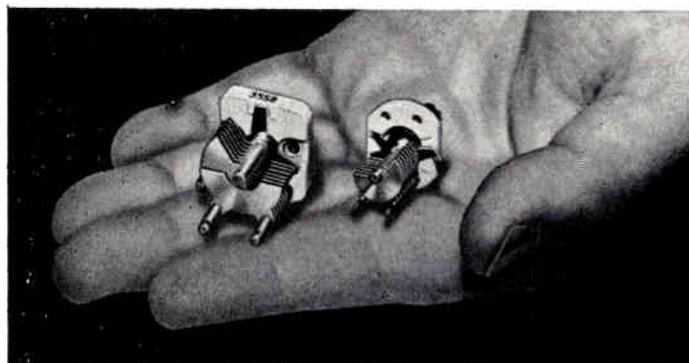
- HIGH “Q” — GREATER THAN 1500 AT 1 MC! • HIGH TORQUE-TO-MASS RATIO — 2½ TO 10 INCH OUNCES!
- LOW TEMPERATURE COEFFICIENT — PLUS 26 ± 20 PPM/° C!

Cut costs—improve performance—save valuable space with these sub-miniature air variable capacitors! Type “U” requires less than 0.2 square inch for chassis or panel mounting — Types “UA” and “UB” require less than 0.23! No special tools required for installation — slotted rotor shaft accommodates large screwdriver. Rotors and stators precision machined from one piece of solid brass — provide outstanding mechanical stability. Units offer high “Q” (greater than 1500 at 1 mc.), high torque-to-mass ratio, and low temperature coefficient — provide absolute freedom from moisture en-

trapment found in trimmer capacitors of the enclosed or solid dielectric type.

All metal parts are silver-plated — ceramic is steatite Grade L-4 or better. Exceptionally uniform delta C and voltage characteristics . . . voltage breakdown ratings available to 1300 volts DC. Single Section types available in three fast, easy mounting styles: “Loc-Tab”, Printed Circuit and Two-Hole — Differential and Butterfly types available only in Printed Circuit mounting styles. Tuner (coil-capacitor) assemblies available in production quantities to your specifications.

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◀ **TYPE “M” AND “S” MINIATURE CAPACITORS** — Slightly larger than the “U” and “UA” Types, still excellent for use in compact equipment. Soldered plate construction, heavily anchored stator supports. DC-200 treated steatite insulators. Plates are nickel-plated brass. Available in Single Section, Butterfly, and Differential types with straight, locking and screwdriver shafts. “S” also available in Dual type.

**DALE****RELIABILITY**TOTAL CAPABILITY IN  
PRECISION RESISTANCE

• G Series has silicone coating affording excellent environmental protection.

• HG Series has special aluminum housing with "flat top" design for quick, easy identification of size, value and tolerance.

## Another Dale "first"...G & HG Series set new power-performance records with BeO cores

Dale's pioneer use of beryllium oxide cores gives G and HG resistors a big edge over conventional precision power resistors. The reason is beryllium oxide's outstanding thermal efficiency when compared with the commonly used core materials, aluminum oxide and steatite (see chart). This allows G and HG resistors to meet all the requirements of applicable Mil. Specs. for conventional wirewounds, *but at wattage ratings which are from 1.4 to 3 times higher.* As a result, you get:

- **Better stability** at conventional ratings
- **More power in the same space**—1.4 times for the G series and 2-3 times for the HG series
- **The same power in less space**

It all adds up to two lines of resistors which give you unmatched ability to meet engineering requirements both from a packaging and a reliability standpoint.

### SPECIALS—ASK US

We have produced more than 400 special modifications from a single resistor. Special configurations, networks—just name it and we'll go to work.

Write for Catalog A



## DALE ELECTRONICS, INC.

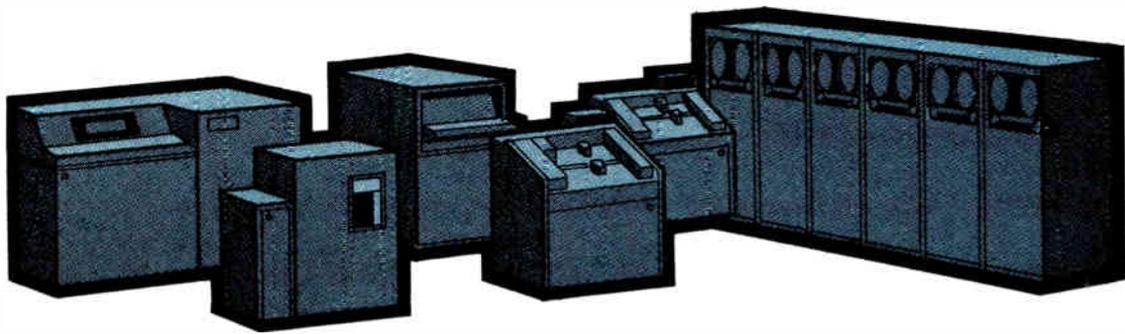
1304 28th Avenue, Columbus, Nebraska

A subsidiary of THE LIONEL CORPORATION

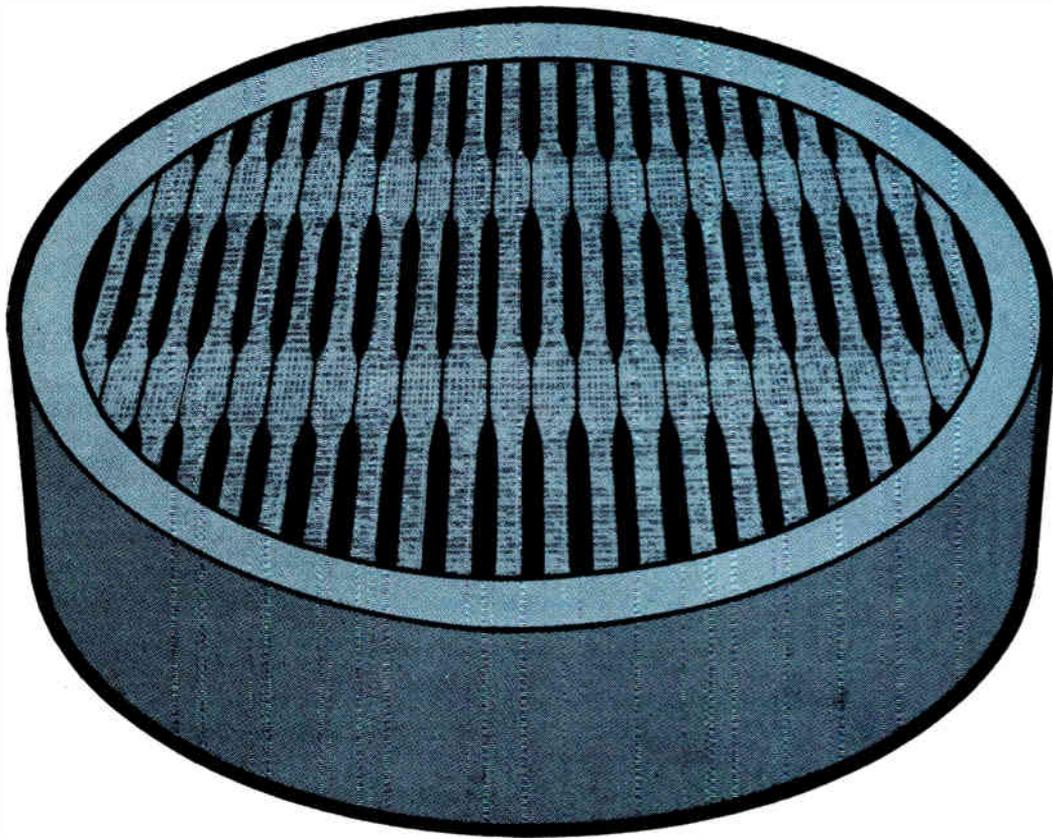
Also Sold by Dale Electronics Canada, Ltd., Toronto, Ontario, Canada



Core Conductivity at 275° C				$\frac{\text{BTU-Ft}}{\text{Ft}^2\text{Hr}\cdot\text{°F}}$	
ALUMINUM—130					
BERYLLIUM OXIDE (BeO)—64					
STEEL—33					
ALUMINUM OXIDE—8					
STEATITE—1.5					
TYPICAL SPECIFICATIONS					
DALE TYPE	EQUIV. MIL. TYPE	DALE RATING	MIL. RATING	BODY DIMENSIONS	RESISTANCE RANGE
G-1	—	1 watt	—	.250x.078	1 ohm—3K ohms
G-6	—	6 watts	—	.625x.250	.1 ohm—35K ohms
G-15	RW-68	15 watts	8 watts	1.781x.375	.1 ohm—240K ohms
HG-5	—	15 watts	—	L. W. H. .60x.334x.32	.1 ohm—20K ohms
HG-10	RE-65	20 watts	10 watts	.750x.425x.375	.1 ohm—35K ohms
HG-25	RE-70	35 watts	15 watts	1.062x.550x.542	.1 ohm—75K ohms
MAJOR ENVIRONMENTAL SPECIFICATIONS				G Resistor Specs. based on MIL-R-26	
LOAD LIFE: 1% Max. $\Delta R$ in 1000 hours at full power				HG Resistor Specs based on MIL-R-18546	
OVERLOAD: .5% Max. $\Delta R$ under 3, 5 or 10 times momentary overload per applicable Mil. Spec.				Models shown are typical: 10 resistors in full G line, 4 in full HG line	
OPERATING TEMPERATURE: -55°C to +275°C				Tolerances: 3%, 1%, .5%, .25%, .10%, .05%	



**IF YOU DON'T LIKE TO COMPROMISE ON ELECTRONIC COMPONENTS**



### **SELECT AN UNCOMPROMISING FILTER**

It doesn't take much to discombobulate the most carefully conceived and manufactured electronic units. A couple of ten-micron dust particles floating around in a computer can butcher astrophysical equations as surely as a monkey wrench. That's why it's a good idea to talk to an Air-Maze engineer about the right kind of air filter. Round or rectangular, oil-wetted or dry, with or without RF shielding, he will show you how to make the filter an integral part of the unit. He's got the filter that allows proper cooling without compromising the reliability of the system. For more detailed information, write or call Rockwell-Standard Corporation, Air-Maze Division, Cleveland 28, Ohio.



**AIR-MAZE FILTERS ARE PRODUCED BY ROCKWELL-STANDARD CORPORATION**

**VALUE OF COMPONENT SHIPMENTS DOWN**

Shipments of electronic components from U. S. firms in the third quarter of 1963 were up 1.8% in volume but down 6% in value from the preceding quarter reports the Department of Commerce, Business and Defense Services Administration.

Value decline, reports BDSA reflected competitive price pressure. Defense shipments were off 8.9%; non-defense, 5.1%. Reduced value of sales was characteristic of virtually all major categories of electronic items surveyed throughout the industry except for complex components.

**AEROSPACE FIRMS URGED TO CONVERT, 'GO CONSUMER'**

Stockholders and Congressmen are urging electronic firms to transform aerospace/defense technology into commercial and industrial products.

So far, DOD and NASA report that the so-called by-products ("spin-off" or "fall-out") from defense/aerospace work largely has been technology rather than products.

NASA's Office of Technology Utilization is putting out a series of technical bulletins to acquaint industry with innovations from aerospace. Western Electronic Manufacturers Association (WEMA) is supporting the proposed Office of California Development. This state agency will try to help California firms to convert to civilian production.

**CPFF DEALS AT 35% IN 1963, INCENTIVE SALES STILL SMALL**

The Renegotiation Board reports that in Fiscal Year 1963 the cost-plus-fixed-fee (CPFF) sales represented an important part of negotiable defense contracts. Incentive contract sales still are relatively small.

CPFF contracts with DOD represented 35.4% of all renegotiable sales. Other sales, representing 18.5% of total renegotiated, included incentive, price redetermination, and time and material contracts.

**LASERS TO REMAIN A 'FIELD' RATHER THAN 'MARKET'**

Marketing men observe that lasers will continue to represent a field rather than a market so long as they generate more publicity than profits.

Estimates are that the Federal government is pumping about \$30 million yearly into laser research. This figure is possibly matched by another \$30 million from industry.

**WEMA SURVEY FORECASTS FACTORY SALES PLATEAU**

Electronic industry growth along the West Coast of the U. S. appears to have stalled on a plateau that will carry through 1964, according to the Western Electronic Manufacturers Association (WEMA).

In a survey, taken yearly by WEMA, figures indicate that consolidated sales of western companies this year will show no significant gain over the 1963 record of \$3.875 billion.

Burgess Dempster, WEMA president, and president of Electronic Engineering Co. of California, Santa Ana, pointed out that despite the general levelling-off, a majority of the companies are forecasting increased sales for the year.

"The aggregate growth in the West, however, is offset by considerable downturns foreseen by one out of four companies," he said.

Dempster attributed the slowdown to lagging U. S. military expenditures in the western states. "The companies experiencing the biggest sales dips are those which are most dependent on government contracts," he declared.

He explained there have been no major projects awarded to the West by

the Department of Defense or the National Aeronautics and Space Administration since Apollo in 1962.

"On top of reductions in the defense dollar," Dempster said, "we are faced with changes in government buying policies which increase costs, and pressures to 'spread the work' which tend to direct business away from our area."

While 1963 sales volume in the West was up 8.1% over the 1962 level of \$3.585 billion, year-end employment in the industry was off 4,800 from the 255,000 people employed at the end of 1962.

The WEMA president is confident that the West will re-establish its growth curve in 1965 and, possibly, by the latter part of this year.

**COLOR EXPECTED TO BOOST TV SALES TO \$2 BILLION**

Color Television will boost TV receiver industry over the \$2 billion retail sales mark for the first time in history in 1964, an RCA executive predicted.

Jack M. Williams, Vice President, Advertising and Sales Promotion, said that the industry's normal annual sales standard has been revised upward to 8 million units owing to the growth of color TV coupled with the continued strong movement of black-and-white receivers.

Noting that the TV receiver field historically had operated under a normal sales rate of 6 million plus sets a year through 1962, Mr. Williams said the full breakthrough came in 1963 when more than 8 million sets were sold for the first time.

Another 8 million plus year is expected for 1964.

**PROFIT SQUEEZE CONTINUES FOR PRINTED CIRCUIT FIRMS**

Profit squeezing continues in the printed circuit industry, reports the Institute of Printed Circuits. The Institute says that a recent survey shows that average profits in 1963 were about 1.5% of sales after taxes. Sales reported by independent makers of PC boards were up about 3% in 1964.

In retrospect, the Institute feels that a degree of stabilization has hit the printed circuit industry. Sales have grown only slightly in recent years. The profit picture has remained depressed. In 1960, profits were 3.2% after taxes; in 1961, they were 1% after taxes. Under the same conditions profits in 1962 were 2.9% and in 1963 they were at 1.5%.

**WESTERN ELECTRONIC INDUSTRY DATA**

Comparison of Factory Sales and Employment for 1962 and 1963

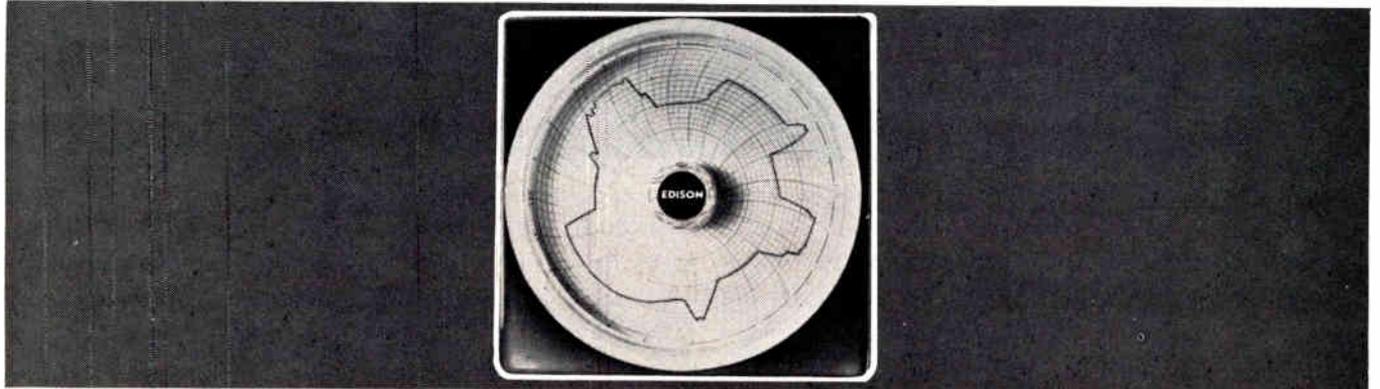
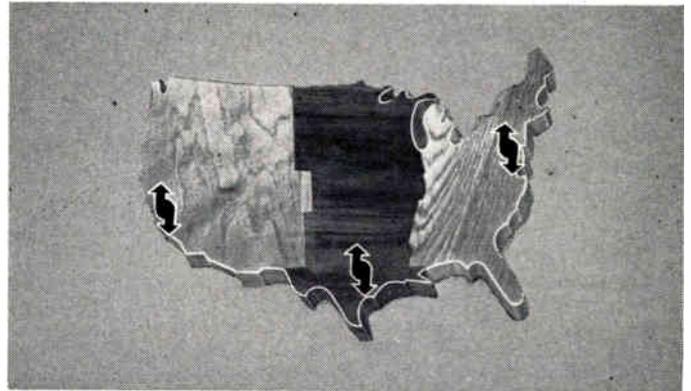
	Employment	Factory Sales
<b>LOS ANGELES</b>		
1962	159,000	\$2,120,000,000
1963	152,000	2,300,000,000
<b>SAN FRANCISCO BAY AREA</b>		
1962	49,000	760,000,000
1963	48,500	800,000,000
<b>ARIZONA</b>		
1962	12,500	190,000,000
1963	15,100	220,000,000
<b>SAN DIEGO</b>		
1962	11,800	185,000,000
1963	11,800	185,000,000
<b>NORTHWEST</b>		
1962	11,200	165,000,000
1963	11,200	175,000,000
<b>BALANCE OF THE WEST</b>		
1962	11,500	165,000,000
1963	11,600	175,000,000
<b>WESTERN TOTALS</b>		
1962	255,000	3,585,000,000
1963	250,200	3,875,000,000
<b>U. S. TOTALS</b>		
1962	1,010,000	13,600,000,000
1963	1,040,000	15,200,000,000

Source: Western Electronic Manufacturers Association. Western states as classified by WEMA includes the 11 states of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming.

# The right way to buy... call ARCO!

... Exclusive supplier of OMNICORDER Chart Recorders to the electronic industry in U.S.A., backed by regional headquarters strategically located to serve key industrial electronic areas. And Arco is as close as your telephone, serving OEM, and government markets. All products manufactured or distributed by Arco are guaranteed to meet

or exceed MIL specs wherever applicable, and are fully warranted by Arco and its suppliers. You're buying right—for prototype or production — when you buy from Arco. For more information wire, write, phone or TWX. Prove it to yourself the next time you look for quality products like . . .



## The writer to specify... OMNICORDER®

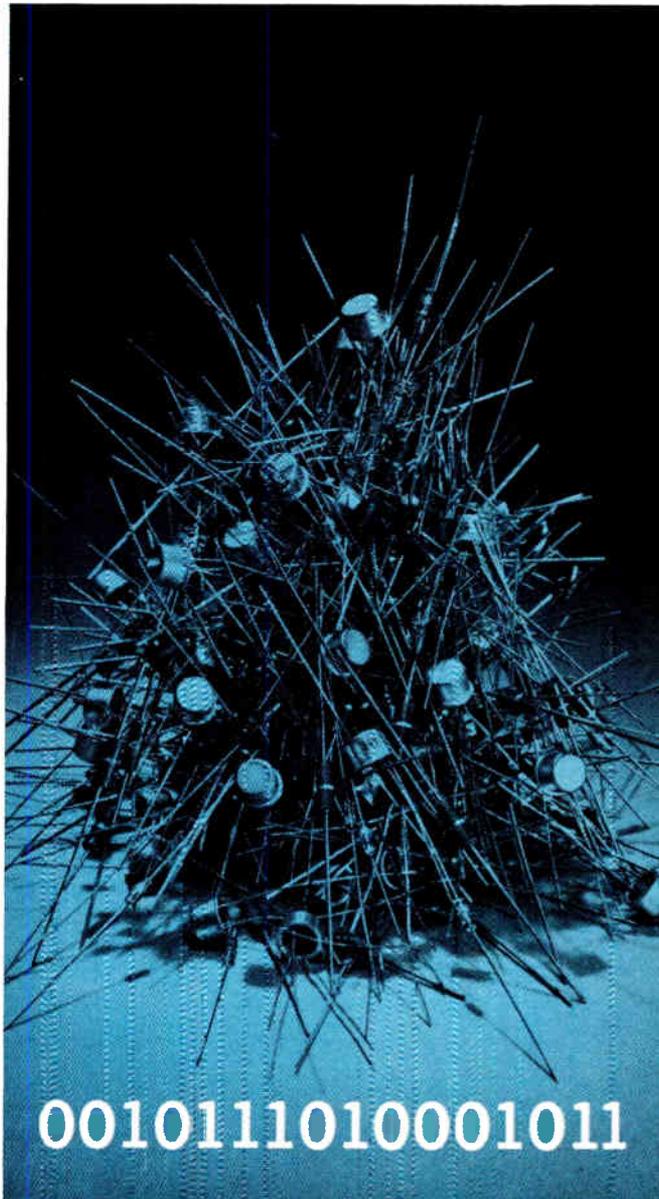
... manufactured by the Instrument Division of Thomas A. Edison Industries. OMNICORDER is reliable and precise, a unique development in inkless chart recorders, monitoring any variable that can be converted to an electrical signal. Its rugged exactness is packaged no larger than a conventional panel meter, and will provide accurate measurements for periods of 1, 7, or 30 days . . . or 1, 7, or 30 hours. A full

range of OMNICORDER measures and records AC or DC currents or voltages, temperatures, or other variables through the use of the proper transducers. OMNICORDER may also be ordered to fit particular requirements wherever necessary. Your Arco Sales

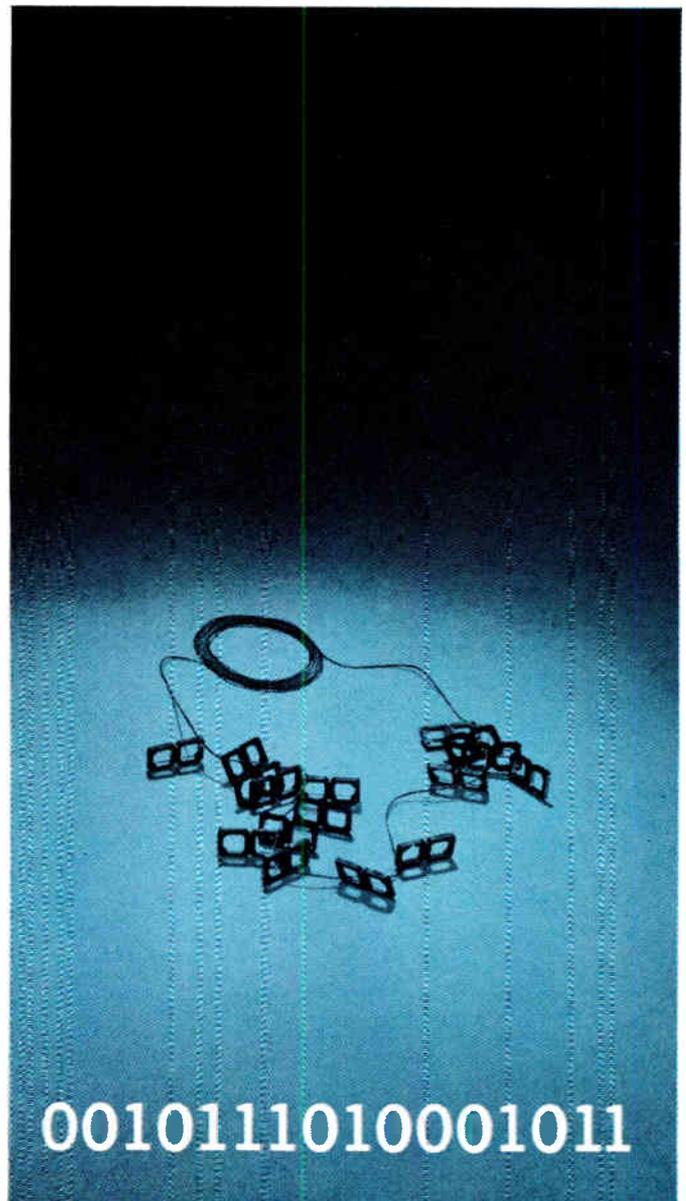
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0010111010001011



0010111010001011

## Check the bits, the same, aren't they, but, does your **BINARY SEQUENCE DETECTOR** know this?

There is a mountain of difference between the ordinary binary sequence detector (left) that uses a whole pile of transistors, diodes, resistors and capacitors and the AMP-MADNETIC\* Binary Sequence Detector that just uses ferrite cores and wire. That's a *big* difference when you think of how one component failure or malfunction can affect a binary lock.

And that's only *one* of the big differences! Our Binary Sequence Detector offers others. For instance:

- No standby or non-operating power is required, even to retain *memory* of lock word.
- No shifting or chance of accidental alteration of lock word—it's wired in.
- Checks for proper "key" by testing each sequence—can also be modified into a "word" detector.
- Rejects simultaneous application of "1" and "0".
- Operation assured over a temperature range of  $-50^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$ .

Want to see what the difference really is? Then try our evaluation unit... a 16-bit Binary Sequence Detector complete with drivers... you jumper in your "lock" word... unit tests every sequence of  $2^{16}$  combinations.

Here are the vital statistics:

AMP Part No.: **396978-1**  
 Voltage Range: **+24 V DC to +32 V DC**  
 Temperature Range:  **$-50^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$**   
 Average Current at 1 KC Bit Rate: **40 ma.** maximum @ 28 V  
 Average Current at Rest: **0 ma.** @ 28 V  
 Information Input: **+5 V** (minimum) for  
                                   5 $\mu$  seconds into 1 K  $\Omega$  load  
 Output Pulse: **+5 V.** for Correct Sequence  
 Signal-to-Noise Ratio  $\geq$  **15 to 1**  
 Load Impedance **250  $\Omega$**  minimum

If you're dealing with electronic locks, command and control circuits, or segments of multiple event fixed time programmers, you'll want to get the different story on our Binary Sequence Detector. Our evaluation unit will do just that. Write today for further information.

\*Trademark of AMP INCORPORATED



A-MP\* products and engineering assistance are available through subsidiary companies in:  
 Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

# ELECTRONIC SNAPSHOTS . . .

The Changing  
STATE-OF-THE-ART  
in the electronic industries

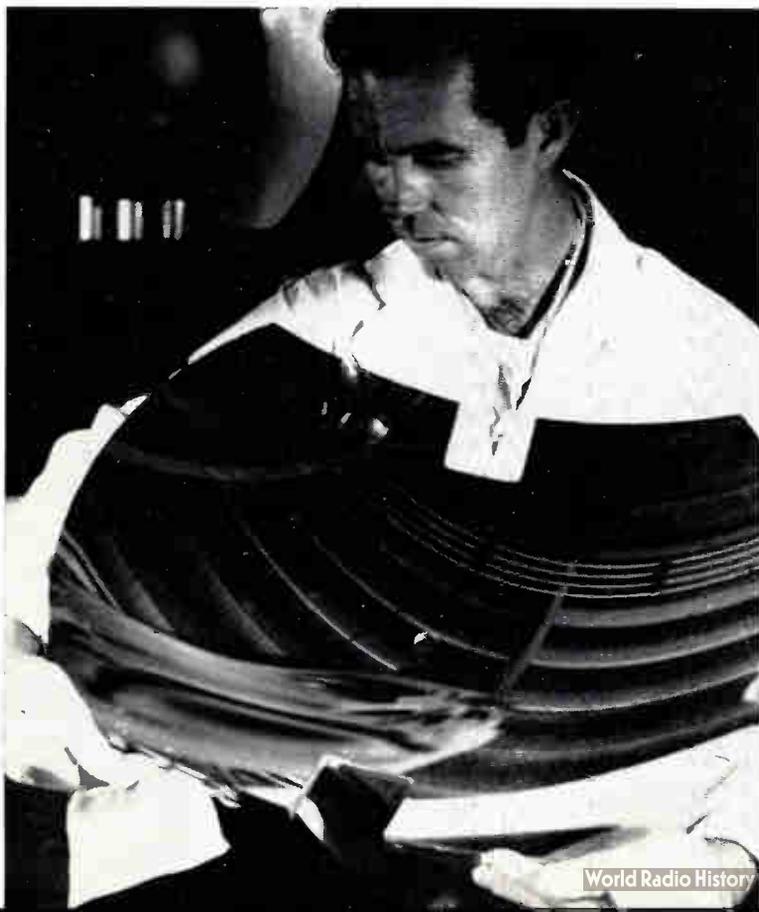
## INSPECTION

Bill Peddie and Katherine Leach of Key Resistor Corp. (Gardena, Calif.) use Packard Bell closed circuit TV to inspect hermetically sealed resistors. The prior method was to take 35mm pictures of each resistor and then inspect them at a one to one ratio.



## ELECTROFORMED

Reflector (below), developed by Electro-Optical Systems, Inc., Pasadena, Cal., undergoes final plant inspection. Initially devised for spacecraft, the mirrors will be used to reflect both visible and infrared light for the searchlight of the Army's M-60 tank. Built by an electroforming process, mirrors of a similar type were used in spacecraft power systems.



## MATERIALS STUDY

Specimen to be made into a diamond by machine is contained in a small heater tube in a pyramid of soapstone in the man's left hand. Pyramid is compressed between four anvils and, under high pressure, the soapstone flows to seal the compression chamber. Fourth anvil is ready to be placed in position. Machine's real task is to study ultra-high pressures and their effects on materials. Scientists hope to find materials for transistors and other devices. Machine was developed by a British affiliate of the IT&T Corporation.

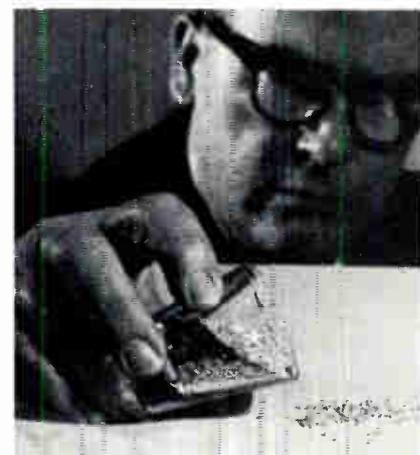
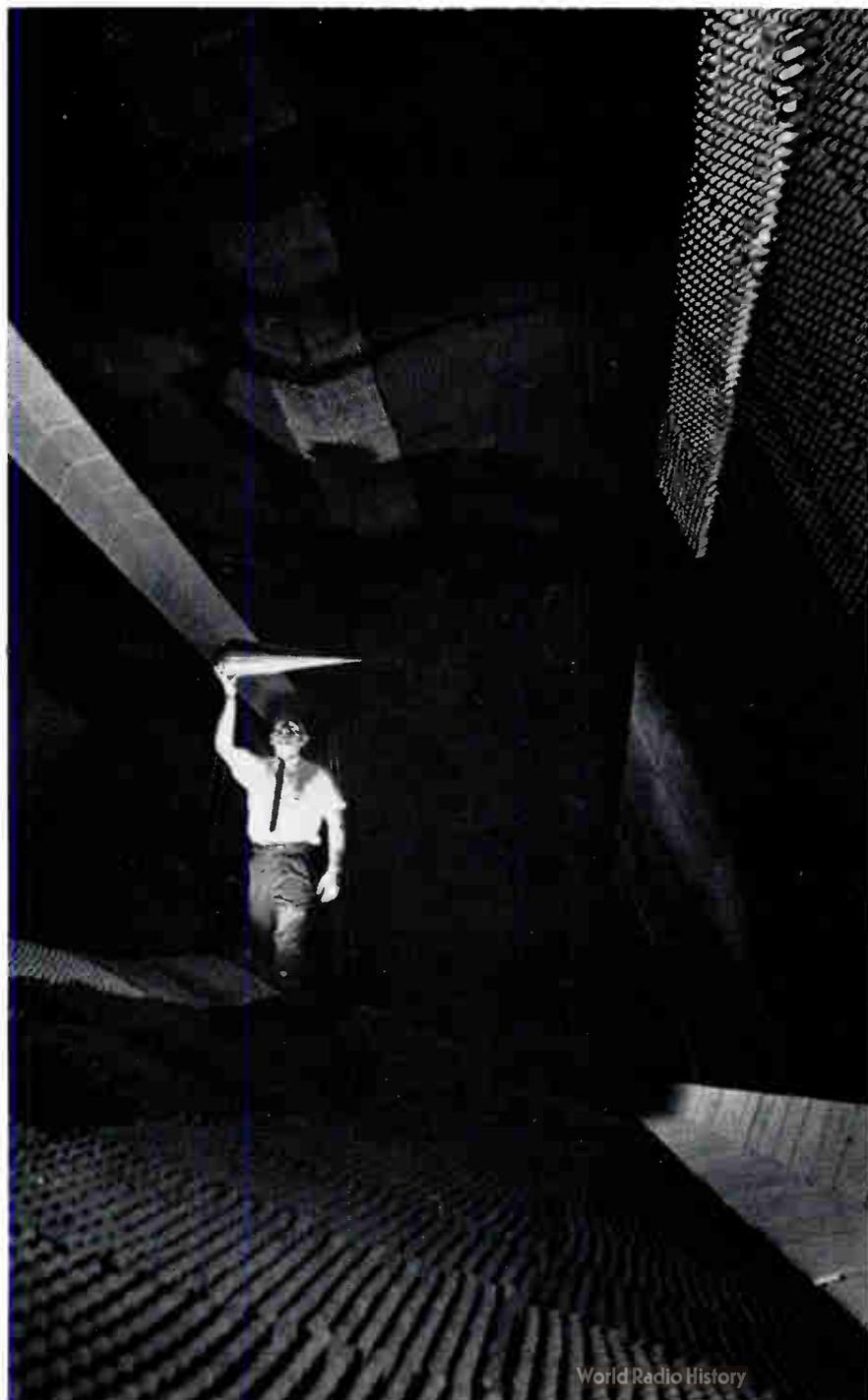
### HAND-HELD RADAR

Military observer shows new General Dynamics/Electronics' (San Diego, Cal.) Hand-Held Radar. It is a solid-state FM-CW system. The system detects moving targets and warns operator via audio signals through earphones.



### ACCURATE MEASUREMENTS

Designs of re-entry vehicles that cannot be detected by radar are evaluated in this microwave anechoic chamber at Douglas Missile & Space Systems Division in Santa Monica, Cal. Chamber is lined with carbon-impregnated sponge rubber baffles which almost totally absorb stray radar signals permitting accurate measurements of the energy reflected by test specimens. Here, engineer R. S. Thomason positions a scale model used in experiments.



### DIFFUSED-JUNCTION

"Microglass" diodes, developed by Hughes Aircraft Co., Newport Beach, Cal., are designed for use in computers, missiles and space systems. These diffused-junction diodes feature a double-glass hermetic seal to insure high reliability. Ten types are offered.



Patent Pending

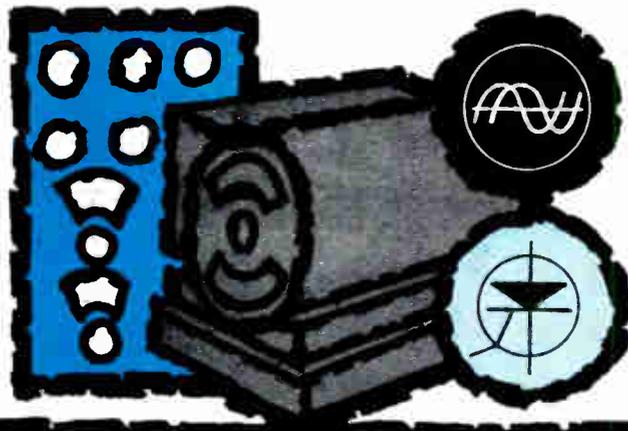
## NOW—ANYONE CAN MAKE ACCURATE HEAT SINK THERMAL EVALUATIONS!

1. **CONNECT HEATING AND SENSING PROBE** to the semiconductor heat sink to be evaluated.
2. **SET TEMPERATURE DIAL** to the desired semiconductor case temperature and allow 2 to 4 minutes for temperature stabilization.
3. **READ DIRECTLY IN WATTS**, the power dissipation of the semiconductor with heat sink. The result is an accurate, dependable evaluation.

The ability of the IERC Heat Transfer Meter to consistently verify the results of our own sophisticated thermal test equipments used in the development of IERC heat-dissipating devices, is offered as a most valuable time and cost-saving tool for design engineers, components and standard groups, as well as thermal design laboratories.

We invite your inquiry for Model 5900 IERC Heat Transfer Meter data and information on additional applications. Address requests to IERC Division, Dept. 59, 135 W. Magnolia Blvd., Burbank, Calif.

**IERC**  **D I V I S I O N**  
**INTERNATIONAL ELECTRONIC RESEARCH CORPORATION**  
*a subsidiary of Dynamics Corporation of America*



# silicon controlled rectifiers

**2N2573-2N2579 SERIES**

**TO-41**



**2N681-2N689 SERIES**

**TO-48**



**FROM THE LEADING MANUFACTURER OF SILICON POWER DEVICES**

Backed by years of advanced research and successful new developments in the silicon power field, we are now producing these popular SCR series—2N681 through 2N689 series in the TO-48 package, and the 2N2573 through 2N2579 series in the TO-41 package. □ These all-diffused Silicon Controlled Rectifiers have the same rugged construction features that are built-in to our highly acclaimed transistor line. The rigid post and clip construction provides an element of rugged reliability and mechanical capability that is unequalled in the SCR field. The post is anchored at both ends and connects the terminals to the pellet.



In addition, these devices exhibit the desirable feature of having a positive temperature coefficient for the forward breakover voltage ( $V_{B0}$ ) characteristic, with the minimum  $V_{B0}$  guaranteed at  $T_c = -55^\circ\text{C}$ . □ For regulated power supplies, power inverters, and motor control circuit design requirements, here are high reliability silicon controlled rectifiers at competitive commercial prices. □ If desired, they are also available in the familiar TO-3 package. □ For more information contact:

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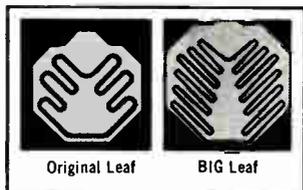
# First we had the Leaf. Then the BIG Leaf.



## Now we have the Leaf-Let.\*

The addition of the new Leaf-Let™ configuration makes our silicon planar epitaxial transistor line just as broad as the list of applications for silicon devices. From high-frequency low-power to high-frequency high-power (and everywhere in between) we have the right NPN epitaxial transistor for the circuit.

Our new Leaf-Let (for Little epitaxial transistor\*) transistors are designed for high speed switching, DC amplifier and VHF communication applications. The use of the new Leaf-Let configuration results in excellent high frequency response, improved Beta linearity and greater reliability because of larger bonding areas, compared to conventional high frequency planar configurations. Typical values for the Leaf-Let



are: High Current Gain—Bandwidth Product,  $f_t = 300$  mc minimum at  $I_C = 20$  mA,  $V_{CE} = 20$  V,  $f = 100$  mc; Low Collector Saturation Voltage,  $V_{CE(s)} = 0.4$  V maximum at  $I_C = 150$  mA,  $I_B = 15$  mA; High Collector-to-Base Voltage,  $V_{CBO} = 60$  V minimum at  $I_{CBO} = 10$   $\mu$ A; Low Collector Cutoff Current,  $I_{CBO} = 0.01$   $\mu$ A maximum at  $V_{CB} = 50$  V; Low Output Capacitance,  $C_{ob} = 8$  pf maximum at  $V_{CB} = 10$  V,  $f = 1$  mc.

The Leaf-Let, like the rest of our Leaf® line, is immune to "purple plague" since we use aluminum alloy lead wires in bonding to the aluminum base and emitter contact areas.

The 2N2217-2N2222 and the newer 2N2217A-2N2222A are some of the type numbers featuring the Leaf-Let configuration.

If you'd like more information on our Leaf-Let, a list of other Leaf-Let 2N numbers, or on the rest of our silicon planar epitaxial transistor line, contact your nearest Bendix sales office.

## Bendix Semiconductor Division

HOLMDEL, NEW JERSEY



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# WHAT'S NEW

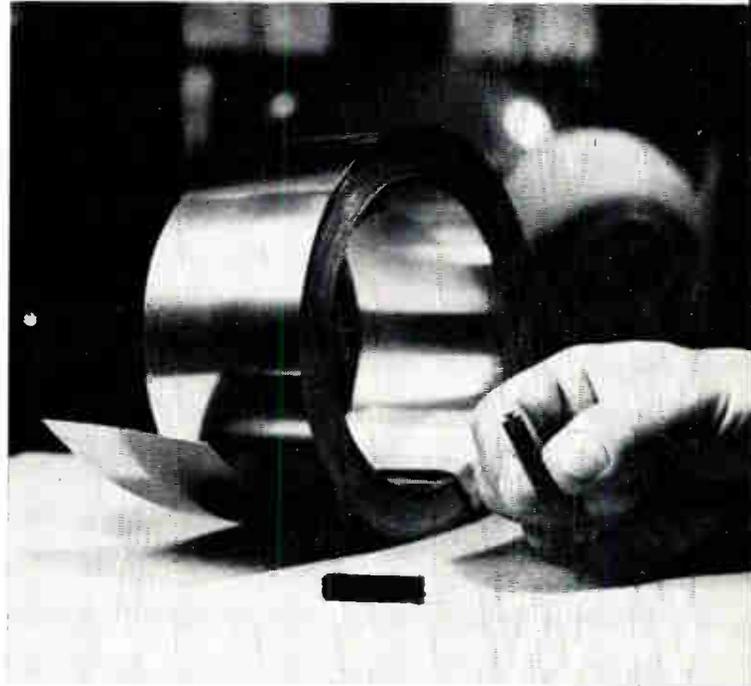
## MAGNETIC ALLOY

A NEW ALLOY of the cobalt-iron-vanadium family has been developed at Bell Telephone Laboratories. It has been named Remendur because it is capable of very high values of remanence up to 21,500 gauss.

The new alloy is slated for use in commercial telephone and military switching systems. One of these uses is the magnet of the ferreed crosspoint switches to be used in new Bell System electronic central offices.

Remendur's high residual induction makes possible the use in the ferreed of permanent magnets with very small cross-sections.

Remendur has a square hysteresis loop, a temperature-stable coercive force of the value desired in the range of 20 to 60 oersteds, essentially isotropic or non-directional magnetic properties, and a high Curie temperature. The alloy — though quite hard — has enough malleability and ductility to permit it to be processed into thin foils, fine wires, and narrow ribbons. It has a high elastic modulus, an expansion coefficient to match glass, can be readily electroplated, and responds to a simple heat treatment.



New magnetic alloy can be rolled as thin as a human hair. One pound of the alloy (called Remendur) will make over 2000 ferreed switches similar to the one shown in the photograph.

## INTERCONNECTION DEVICE

A NEW INTERCONNECTION DEVICE has been announced by Cinch Manufacturing Co., Chicago, Ill. Called Preskam, it permits increased contact density and reliability in the interconnection of etched circuit boards. The system is covered by patents pending.

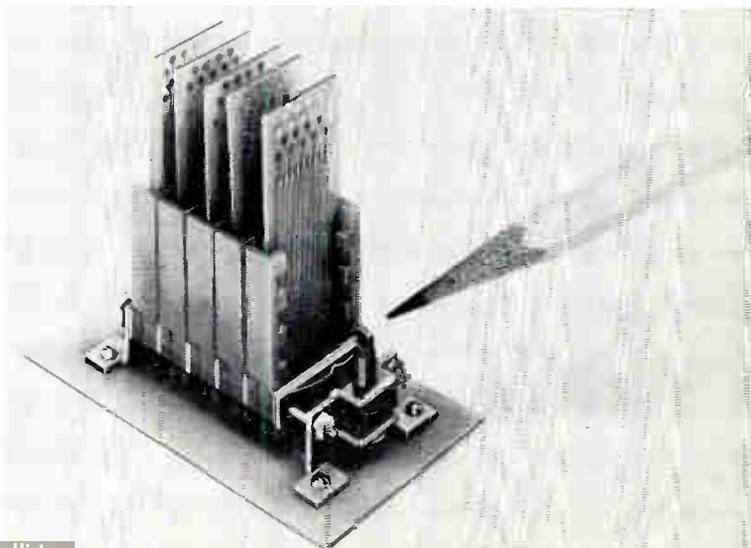
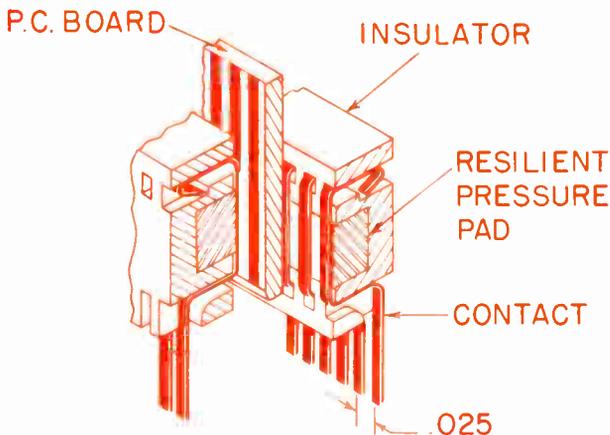
It uses a cam-actuated insulating bar to provide contact with the PC boards by external clamping, after the board is inserted into the device. A resilient material recessed in the insulating bar, behind the connector contacts, applies pressure over the entire

length of the contact surface. Thus, electrical contact is made over its entire length.

Contact forces in normal PC connectors are limited by insertion and withdrawal forces, and by the amount of contact "drag" on the board terminals. These limitations do not exist in the Preskam. Here, the contact pressure is not applied until after the board has been inserted in the connector. Thus, higher contact pressures can be achieved.

Preskam is now being produced with 0.025 in. centers. Contacts are of gold plated, copper base alloy. Insulating members are made of Lexan, and neoprene is used for the pressure materials. Other materials can be used to meet specific environmental conditions.

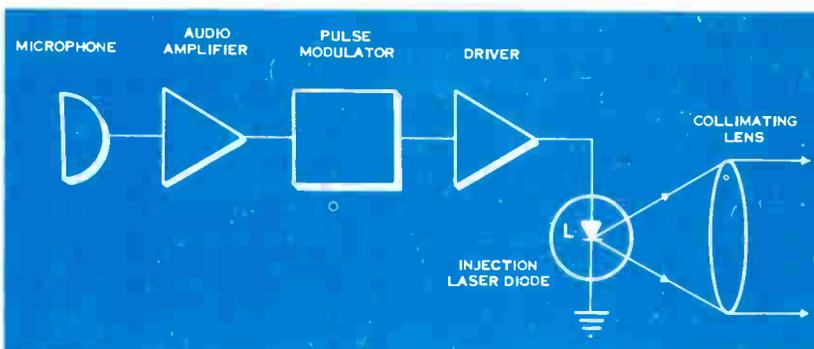
Cutaway (l) shows Preskam connector and P. C. board in locked position. Resilient pressure pad keeps contact flat against P. C. board circuit. Typical system assembly (r) of five P. C. boards. Cam lock mechanism (indicated by pencil point) is in locked position. Dummy boards are used for illustration.



# WHAT'S NEW

## COMMUNICATION LASER

Voice signal is boosted by audio amplifier and converted into a pulse train at modulator. Each pulse causes a pulse of coherent laser light to be emitted from the laser. Lens collimates light into a narrow beam and it is sensed at the ground.



AN EXPERIMENTAL VOICE COMMUNICATION SYSTEM, using a laser beam, is being developed by the IBM Federal Systems Division for NASA.

The pulsed-laser system will first be tested point-to-point at ground level. Later aircraft-to-ground communications will be tried.

In the flight test, tracking radar at the ground receiving station will lock onto the aircraft and cause the nearby optical receiver to point directly at the aircraft. This receiver consists of a light-collecting reflector system, a photomultiplier, and a powerful pulsed-laser beacon. The airborne transmission system, which consists of a box-shaped transmitter mounted on a ball and socket swivel near an air-

craft window, will be manually aimed at the beacon source.

When the operator has the beacon centered in his sighting crosshairs, he can begin voice communication. Circuits within the laser transmitter modulates his voice into a series of electrical pulses. The connected laser device converts these pulses into a beam of pulsed infrared light. This beam, made narrow by special focusing lenses, is detected by the ground receiver. The receiver then converts the light into electrical pulses and demodulates it to voice.

The airborne transmitter uses a gallium-arsenide injection laser. This laser can operate at near room temperature. No cryogenic cooling is needed.

## CONNECTOR CONTACT

A DOUBLE-READOUT TAPER-PIN CONNECTOR featuring a new cheaper, but more efficient, contact has been announced by Hugh H. Eby Co., Phila., Pa. Costs of each connector were cut by 43% through the design of a one-piece, three-fingered contact. Many operations such as screw machining, riveting and brazing were eliminated from the production process.

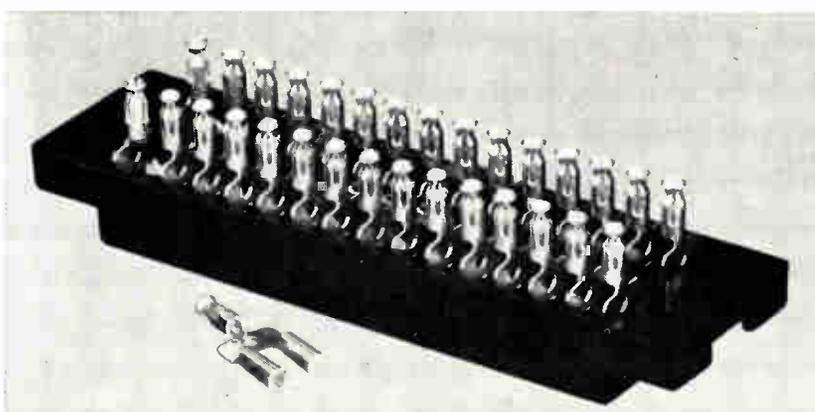
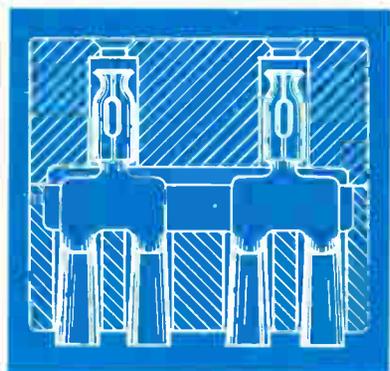
With the new contact, retention forces can be held to high requirements using a light gauge split-barrel. Also, contact reliability is considerably improved with the one-piece design. Formerly the connector used a

Cross-sectional view (I) shows how split barrel taper-pin contact is seated in a double-readout card edge connector. View at right shows how taper-pin contacts are arranged in a 30-pin connector. Top half of connector is removed to show contact arrangement. An individual contact is also shown.

3-piece contact consisting of two screw-machined barrels riveted and brazed to a top member. The straight walls of these barrels could not conform to the contours of the taper pins and thus contact was effected only at restricted points along the surface of the pins.

The Eby split-barrel taper contact conforms to irregularities in the taper-pin, which, in addition to its tapered shape, insures maximum surface area contact. It is this conforming contact design which is also the basis for the high retention values which are achieved.

The one-piece contact is made of 0.014 in. silver-plated beryllium copper. Forming of the taper shape in the progressive stamping die must be held highly uniform. Each section is made to tolerances of  $\pm 0.0001$ . (More What's New on page 160)





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OVER ►

# Siemens ferrite pot cores for adjustable, high-stability, high-Q coils



Pot cores meet the most critical requirements for filters used in multiplex and other carrier-frequency applications because of these advantages: easy adjustment to precise inductance, high stability, high Q, low distortion, and self-shielding that allows compact component density without regeneration or coupling.

In addition, Siemens pot cores offer uniform electrical characteristics month after month... made possible by Siemens' unique manufacturing controls.

**Wide range of materials** provides optimum properties for frequency ranges up to 40 mc for oscillating and filter coils... up to 400 mc for transformers.

**Wide range of sizes.** Diameters range from 0.22 to 2.75" including all International Standard Sizes. Most of the widely used sizes between 0.43" and 1.41" diam. are available for immediate shipment from stock at White Plains, N.Y.

**Stability.** Less than 0.2% change in permeability in 10 years at temperatures up to 70°C for typically gapped cores used in filter coils.

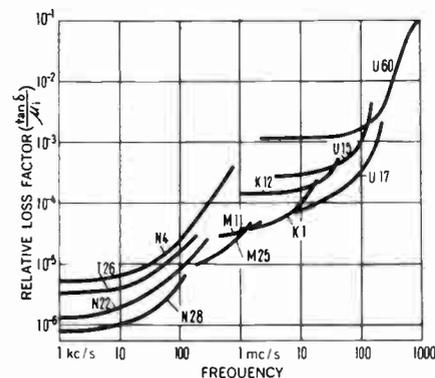
## Frequency ranges, temperature coefficients:

Application	Ferrite Material	Initial Permeability	Frequency range mc/s	Rel. Temp. coeff. * $\frac{\Delta \mu}{\mu}$ in ppm/°C at 20°C...60°C
Coils for filters and oscillating circuits	N 28	2000	up to 0.1	0.5-1.5
	N 22	1100	up to 0.3	0.8-2.0
	M 25	550	0.2-1.6	1.0-3.0
	K 1	80	1.5-12	1.0-6.0
Transformers	T 26	2000	up to 0.3	0.5-3.0
	T 7	2000	up to 100	0-4.0
Wide-band transformers	N 22	1100	up to 10	0.8-2.0
	T 7	2000	up to 100	0-4.0
	K 1	80	up to 400	1.0-6.0
	N 28	2000	up to 0.1	0.5-1.5

\*The temperature coefficient of a gapped core can be calculated as follows:  $TC_g = \frac{TC}{\mu} \cdot \mu_g$

**Temperature coefficients** are closely controlled, and with complete data available. (Siemens "Styroflex" polystyrene capacitors are widely used for temperature-compensating with pot cores.)

**High Q value,** with high stability, is typical. For example, a 26 x 16 core of N22 or N28 material  $A_L$  315 at 100 kc shows a Q value of approximately 950. (Under special measuring



conditions with limitation of current, Q value is beyond 1000.)

**Complete line of "hardware"** includes coil formers with one to four sections, mounting assemblies for chassis or printed circuits, adjustment devices and keys. Formers are made of Makrolon (up to 125°C) and polystyrene.

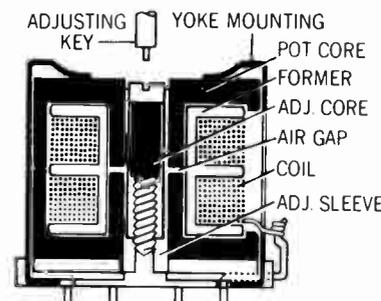
## $A_L$ values (mH/1000 turns) of ferrite materials for some typical pot-core sizes

$A_L$  values in parentheses are for pot cores without air gap. (1)  
Tolerance:  $\pm 3\%$  unless indicated otherwise.

Dimensions in mm diam. x ht. (2)	Dimensions in inches	Type	Ferrite materials					T 26		N 30
			K 12	K 1	M 25	N 22	N 28	Tol.: $\pm 5\%$	Tol.: $\pm 10\%$	
7 x 4	.28 x .16"	B 65 511				100 (700)			160 250 (1000)	(2000)
9 x 5	.35 x .20"	B 65 521 (2)	46	25 (95) 40	40 63	63 (850) 100	100 160		250 (1200)	(2500)
11 x 7 standard	.43 x .28"	B 65 531	46	25 (115) 40	40 63	63 160 100 (1200)	100 160		400 (1600)	(3200)
14 x 8 standard	.55 x .31"	B 65 541	20	40 (140)	40 100	40 160 100 (1500)	100 315 250 400	250	400 (2100)	(4200)
18 x 11 standard	.71 x .43"	B 65 651	25	25 (180) 40	40 63 100	63 250 100 (2000) 160	160 315 250 400	400	630 (2800)	(5600)
22 x 13 standard	.87 x .51"	B 65 661		40 (220) 63	100	100 315 160 400 250 (2600)	250 400 315	630	1250 (3800)	(7000)
23 x 17	.91 x .67"	B 65 571		40 (270) 63	63 100	160 400 250 (3300)	400 500	400 630	1250 (4900)	(9000)

<sup>1</sup>Used for chokes and transformers in which losses and variations in permeability are of secondary importance.

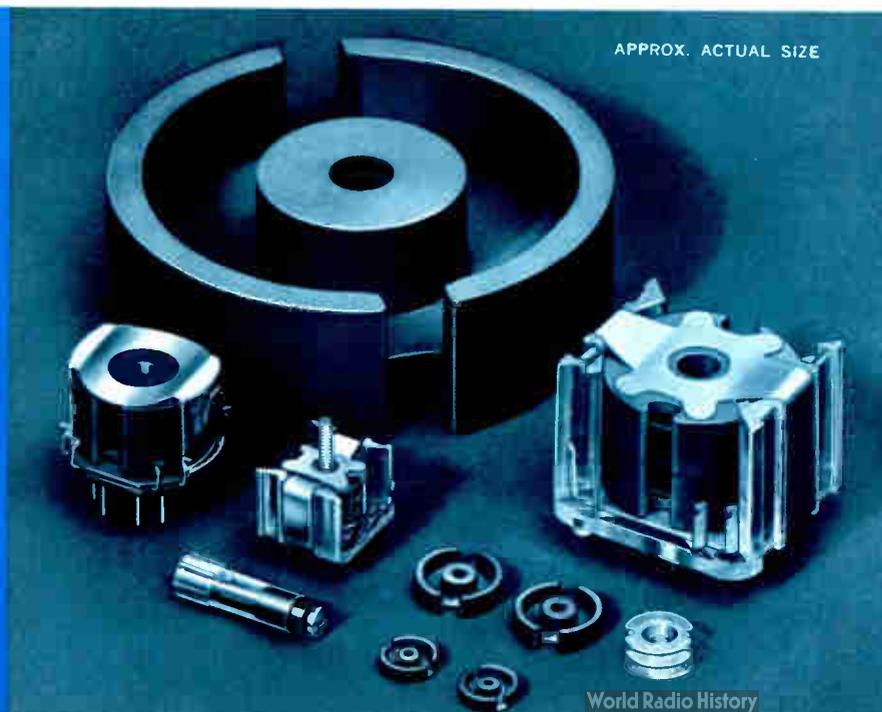
<sup>2</sup>Sizes up to 70 x 42 mm are available. Data on request.  
<sup>3</sup>Available only in tolerance  $\pm 5\%$ .



Other Siemens ferrite products include E cores, cylindrical and tubular rods, and recording heads. "Transfluxors" are available in a variety of shapes and materials for all types of logic circuits. Also switching and memory cores and complete matrices. Data available on request.

Siemens ferrite pot cores and Transfluxors are distributed by William Brand Electronic Components, Inc. and are available from leading sales representatives throughout the U.S.

**CIRCLE 96 ON READER SERVICE CARD**

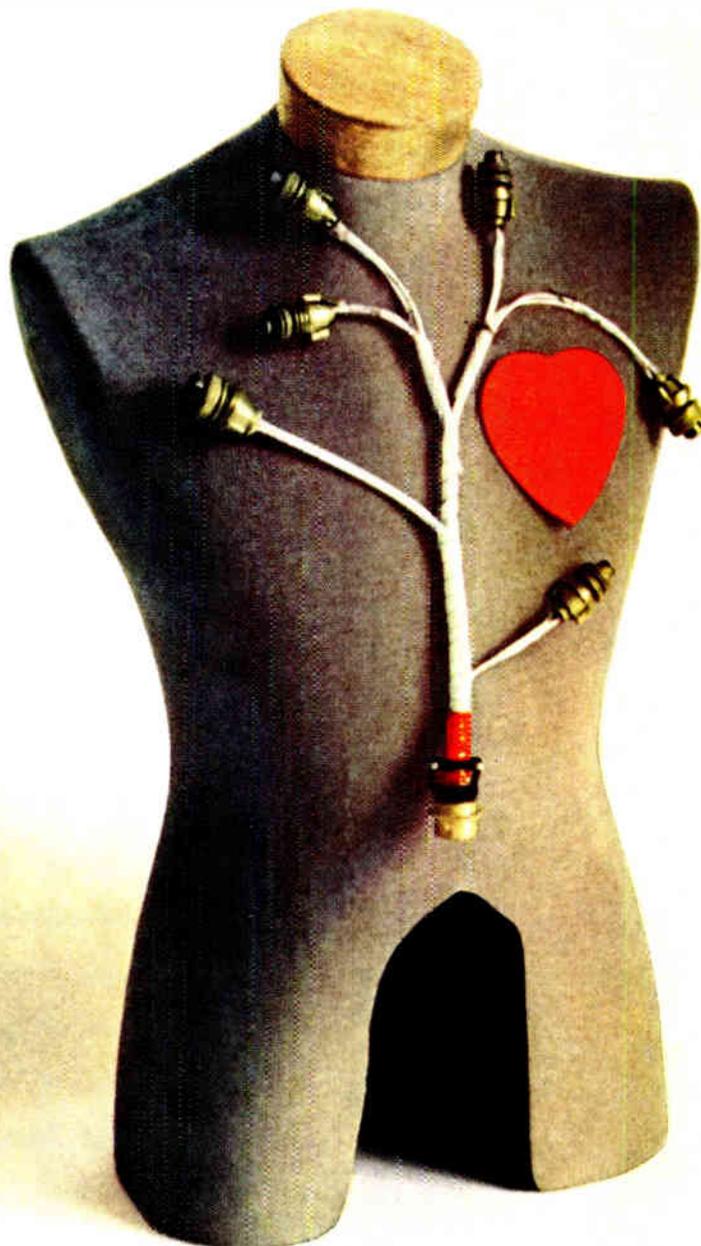


Siemens components available: Ferrite pot cores, Transfluxors, memory cores and matrices, capacitors (electrolytic, polystyrene, metallized plastic, metallized paper), deposited film resistors, semiconductors, R. I. meters and screened cabinets.  
Distributor for these electronic components

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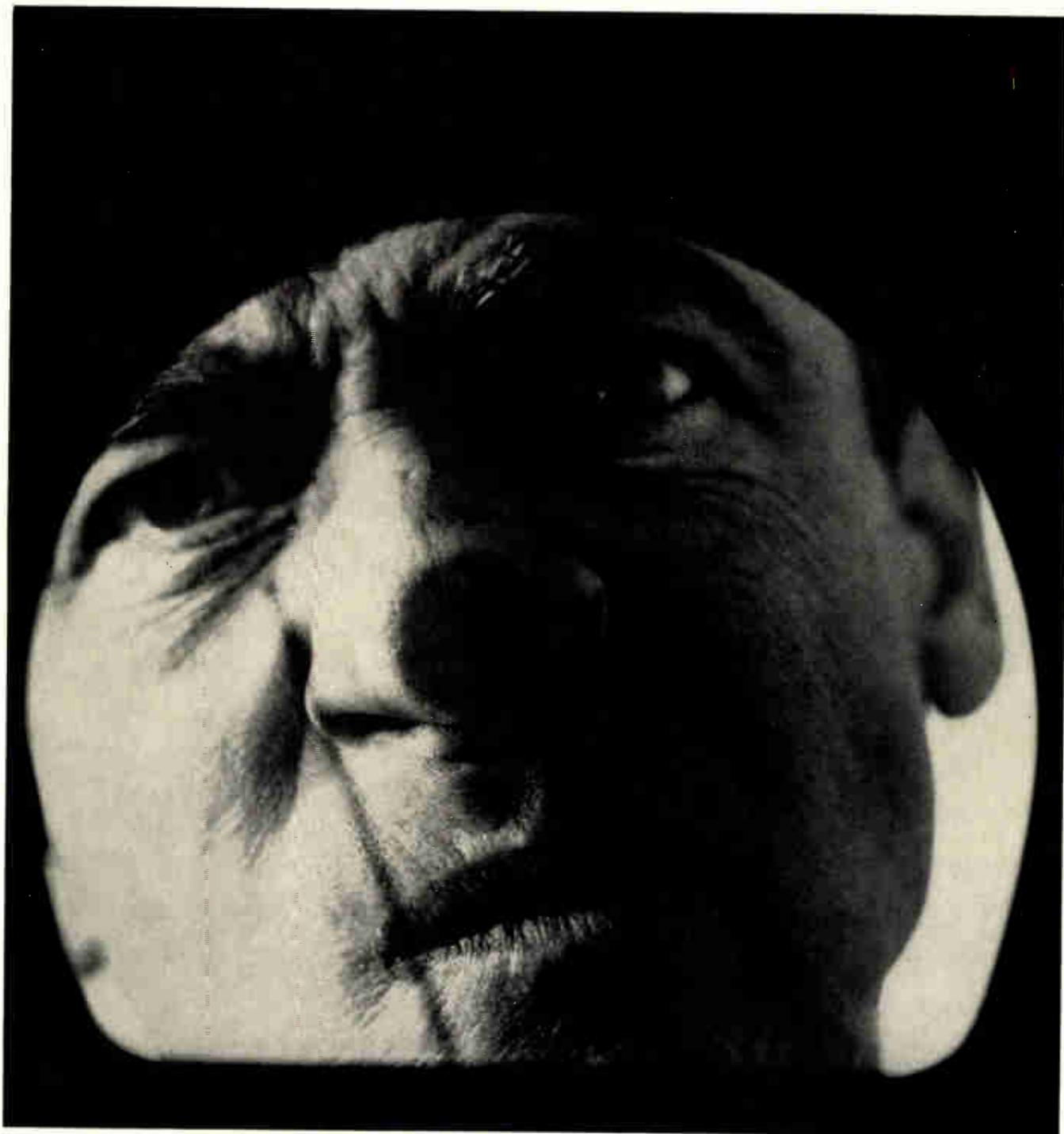
Like the complex interstage harness assemblies that are the backbone of Minuteman. Like shear-off disconnect assemblies on interceptor missiles. And cost-saving plug-in assemblies for communications systems.

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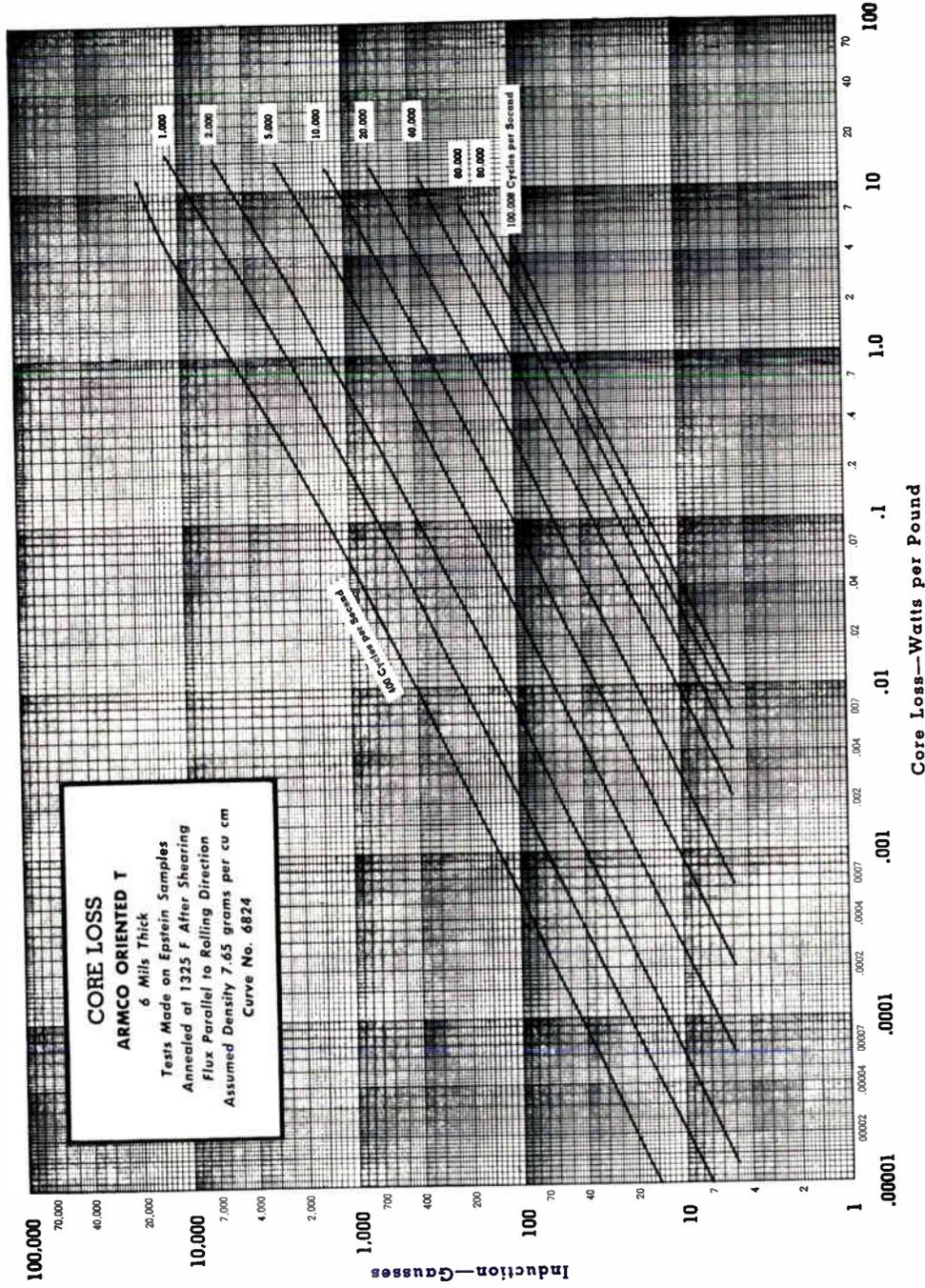


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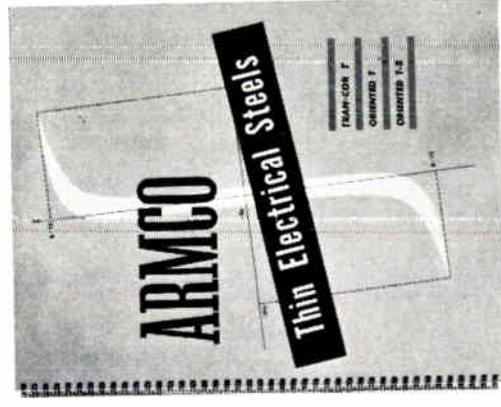


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# FACSIMILE IS COMING OF AGE

This communications medium, from a seed sown more than a century ago, has been a "sleeping giant." No longer the grand wonder, it is still more than a lab toy. Recently becoming electronic, facsimile may have the greatest potential in business and high-speed data reduction, and using telephone lines.

ONE OF THE OLDEST, yet newest means of electronic communications is the electronic facsimile system. It transmits information graphically or pictorially by wire or radio circuits.

In April 1963 ITT's Industrial Laboratories for the first time used gallium arsenide diodes to transmit electronic facsimile signals. This experimental data transmission was described as the "forerunner of a line of laser-type products and systems now under development." But facsimile itself, originally electrical and later electronic, dates back to a patent issued to Alexander Bain in 1843!

In the century since Bain's patent was granted, facsimile has been largely a laboratory curiosity. Around the 1920's and 1930's, facsimile became a publications and communications tinkertoy. Concurrently, and up to the present, facsimile has been used chiefly for weather map transmission. It also has been coming into broader commercial and industrial use.

Yet the history of electronic facsimile, at best, is both checkered and promising. In the 1930's facsimile was dubbed a "coming wonder." In the 1940's it was called both a "stepchild" and a "Cinderella." In the 1950's *The New York Times* called facsimile a "communications infant." And, now, in the 1960's, it is called a "sleeping giant" by the Electronic Industries Association (EIA). Most appropriately, facsimile seems to have been "always a bridesmaid, but never a bride." This opinion is based upon this writer's personal experience as a programmer and promoter of Hogan electronic facsimile back in the mid-1940's when most people regarded a facsimile as a "box-top" copy.

Despite its wavering history, electronic facsimile has been making progress in limited spurts. The biggest backer of facsimile is the U. S. Government, and broadest users are the Army Signal Corps, Navy,

Air Force, National Aeronautics and Space Administration, Federal Aviation Agency and, most important, the U. S. Weather Bureau.

These agencies mainly have funded and used facsimile's unique capabilities to send words, diagrams, blueprints, signatures and pictures between two points, both in war and in peace. A facsimile machine scans a black and white or color page, in a succession of parallel lines. It detects the changing light intensity of this copy through a scanning photoelectric cell. When the machine detects black, it generates a voltage. When it detects white, it generates a voltage of the opposite polarity. Thus, an electrical replica of all variations from black to white gradually reproduces the original matter, line-by-line.

## Total Market Unknown

Nobody really knows how big the electronic facsimile equipment market is. At best, it is perhaps somewhere between \$50 and \$100 million. The biggest and most profit-making user of electronic facsimile is the Western Union Telegraph Co. It has installed about 40,000 Deskfax recorder-transmitter

By **SIDNEY FELDMAN**

Associated Editor  
ELECTRONIC INDUSTRIES

Bell Telephone's 602A Data-Phone set allows facsimile sending on voice-grade regular phone lines. Now in production, Data-Phone can send maps, charts, drawings and documents by phone to any other Data-Phone throughout the nation.





Air Force technician and communications center specialist loads a map for transmission on the Strategic Facsimile network provided by Western Union to speed up-to-minute high altitude weather information to SAC bases throughout the country.

units which annually carry some 50,000,000 telegrams between customers' offices and company central offices. WU also has built special facsimile communications networks, discussed here later. The Bell System also has long been interested in facsimile transmission.

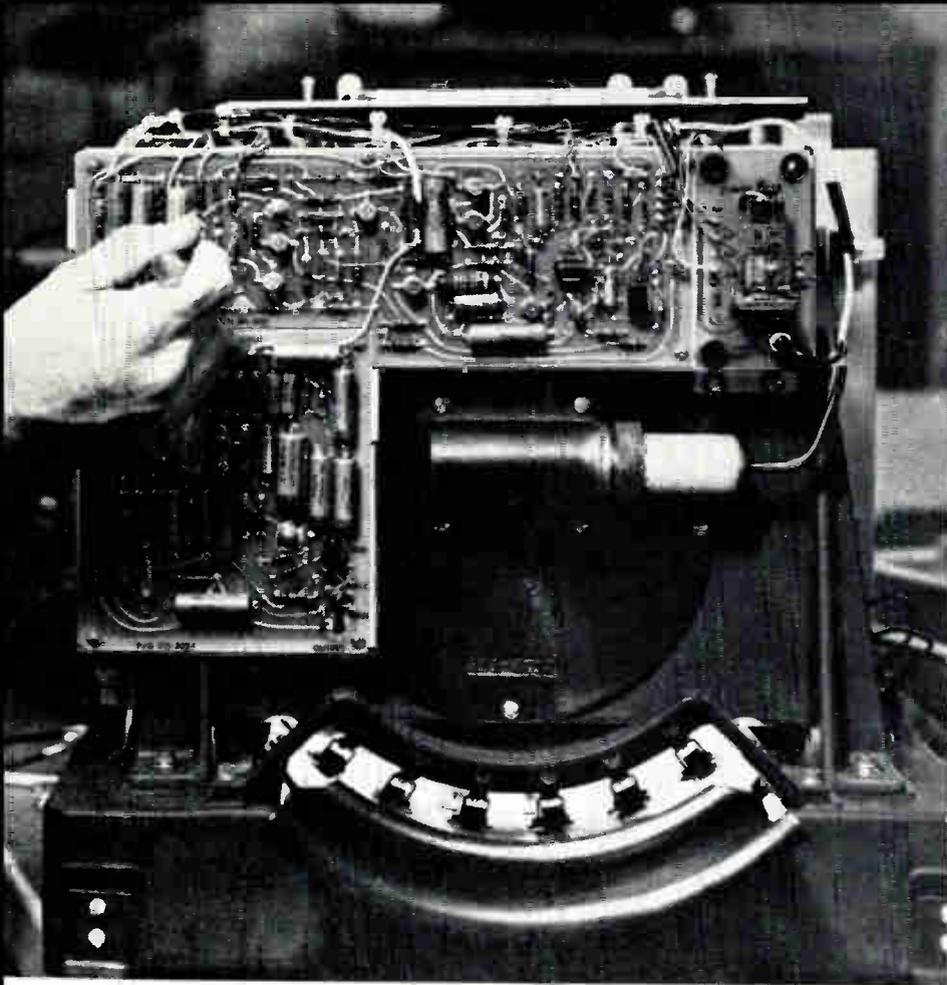
Paradoxically, in the 1960's it somehow remains for electronic facsimile to be "rediscovered" and promoted—all over again. Last December, EIA's Industrial Electronics Division sponsored an organizational meeting of its new Facsimile Section. An EIA release cited George Rich of Xerox Corp., who said "the U. S. public knows practically nothing about facsimile equipment and processes or about the opportunities presented by the industry."

This Facsimile Section gave special guideline instructions to the corresponding Facsimile Engineering Committee (TR-29), which had been organized several months earlier. This group appointed an Engineering Advisory Committee to help form stand-

ards for facsimile equipment operating in the higher base-band frequencies of AT&T and the new Western Union switched-network. Standards are needed to enable all facsimile machines to use common communications facilities to "talk to each other." EIA's new facsimile groups exemplify a rebirth of interest of certain electronics companies in further advancing electronic facsimile markets. The Facsimile Section enables the equipment industry to present a united view in EIA functions, such as marketing services, engineering standards, and related activities.

EIA's Facsimile Engineering Committee is headed by Ken McConnell, of Adler Westrex, a division of Litton Industries, Inc. His group works with the Institute of Electrical and Electronic Engineers' Facsimile Committee 9 (stands) which is revising the old *IRE Facsimile Test Chart* copyrighted in 1955. The new chart, which may be available later this year, will be distributed through EIA.

Chairman of the EIA Engineering Advisory Com-



## FACSIMILE (Continued)



First completely transistorized facsimile transmitting system. The Fairchild Scan-A-Fax uses printed circuitry throughout. The Scan-A-Fax unit (above) accepts all types of copy and visual matter. It has ability to automatically run up received copy to display easel for immediate removal. This feature eliminates four to five minute wait for copy to come from the recorder unit at recording speed.

mittee is Walter M. Graham of TELautograph Corp., of which Hogan Facsimile is a fully-owned subsidiary. Other members are T. E. Lindsay, of Bell Telephone Laboratories, George Rich of Xerox, and G. H. Ridings of Western Union.

### Suggests Bright Future

All of these newer and more current activities in the facsimile field suggest a brighter future. However, electronic facsimile also has past problems and difficulties.

Possibly the harshest, yet most realistic estimate of electronic facsimile in recent decades was stated around 1946 by Colonel "Bertie" McCormick, inventor, crusader, and publisher of "The Chicago Tribune." He quashed other newspaper publishers' cherished dreams of bypassing printing presses and delivery trucks by "delivering home newspapers by electronic facsimile." Instead, he predicted facsimile "would serve isolated men in penal colonies and lonely sailors on the high seas." What the colonel was saying was that electronic facsimile could succeed commercially, but not for consumer home use. To this day, his estimate is still being borne out.

Electronic facsimile had been held back from many commercial and industrial applications for varied and still-debated reasons. Technically, these may be summed up as: (a) receiving-sending equipment was

too bulky and too costly; (b) conflicting systems, one using moist electrolytic paper and the other using dry, chemically-coated paper; (c) need for broad-bandwidth communication channels which increased transmission costs, compared to the less costly narrower communications bands required for voice, telegraph and teletypewriter.

One management critic of the facsimile business, who "lost his shirt" but not his head, offered suggestions. "Take facsimile out of the engineering field," he urged. "Through objective redesigned, proper marketing, and consumer education, bring it into the business office where it belongs." This critic insisted that home facsimile broadcasting was remote. He did anticipate a great "untapped potential" for facsimile equipment among the several thousand users of "full-period telephone talking circuits." And he suggested "widespread use" of facsimile over private microwave facilities, provided the Federal Communications Commission approved.

### Too Few Channels

One of facsimile's biggest continuing problems was inadequate transmission channels, at commercially attractive rates. Noisy circuits blur pictorial transmissions by facsimile. So, for a while, a few available static-free FM broadcast frequencies were used. Telephone lines had limitations.

Facsimile was limited to the confines of private or leased-line telephone networks. Such service was very expensive for low volume or multi-location users, since they could communicate only with other private line stations. Data-Phone service opened a less-costly alternative to using private lines. Anyone with a facsimile machine compatible with the data set now can dial anyone else with similar equipment to send copies of documents at regular local or long distance telephone rates.

Yet this Data-Phone era dawned partly because of the coming of the computer, and partly because the FCC in 1959 opened microwave frequencies to the general business community. The microwave market, once limited to U. S. Federal Agencies and right-of-way companies, such as pipelines and railroads, now was wedged open. It came press radio, transportation, and a host of industrial companies. However, private microwave offered these private firms too much, too soon, at too high a cost. Few private companies had sufficient voice, computer or even electronic facsimile volume to justify the high price of private microwave.

In response to this threat, AT&T countered private microwave competition by increasing its own microwave and other facilities, and offering special rates and services. These "telephone channel packages" for voice and/or business machines include Telpak and WATS (Wide Area Telephone Service).

Here Data-Phone sets were developed for business machines, particularly computers as well as electronic facsimile equipment, to "chat" by telephone. EIA's technical facsimile committees are helping to form standards for facsimile equipment operated in the higher base-band frequencies, such as those in the range of Telpaks A3 and C3. EIA's Engineering Advisory Committee also is considering need for possible standards for the new Western Union switched-network, a four-wire system for terminal equipment.

### Key to Facsimile Success

A real key to future business success of facsimile operations is found in Bell Telephone System's 602A Data-Phone set, introduced late in 1962 and product-tested in several parts of the U. S. in 1963. This new data set made possible facsimile transmission over the regular dialed-up telephone network. AT&T's administrator of data communications planning, Harvey J. McMains, said, "This development now makes it possible for a much larger segment of the business community to send facsimile material in a more economical and efficient way, providing a new dimension in business communications."

Another factor underlying the current re-awaken-

ing of the facsimile giant is the rise of the photocopy machine business. Such machines are "revolutionizing" office operations by enabling office personnel to "print" countless cheap, rapid, good quality photocopies of office letters, documents, and other paperwork. General office procedures now are organized to use multiple copies of such papers. The next natural step is for some of these copies, as well as original documents, illustrations, microfilm or computer print-outs, to be reproduced *and* transmitted simultaneously by electronic facsimile equipment using telephone lines.

Actual and potential electronic facsimile customers are legion. Banks, sales organizations, manufacturers, publishers, advertising agencies, missile and aircraft makers, department stores, government agencies, and various service agencies from wholesalers through broadcasting networks are already using such systems.

Defense and aerospace government contractors have used such systems dramatically, sending varied reports, blueprints, and engineering drawings between plants and sub-contractors, to DOD and NASA offices around the U. S. Facsimiles of microfilm records, for example, were transmitted 1,500 miles to Atlas missile sites by General Dynamics/Astronautics in San Diego, Calif., via a Micro-Com system developed by Alden Electronic & Impulse Recording Equipment Co., Westboro, Mass. This system can use telephone lines or radio.

### Operations Increasing

Concurrently with AT&T, Western Union has been increasing transmission facilities and facsimile operations. One of its newest installations is the 30,000-mile private wire-facsimile-data-voice exchange network, put into use in 1963 for NASA. Lines link the Marshall Space Flight Center at Huntsville, Alabama, with 66 stations in nine states and Washington, D. C. Facilities provide dial-selected, automatic connections among all points, for voice-coordinated facsimile transmission of documents, drawings, and administrative information.

For the General Services Administration, WU is building an Advanced Record System for use sometime in 1965. It is designed to handle facsimile, telegraph and high-speed data communications linking federal civilian agencies. This system, with 1,600 outstations coast-to-coast, will use computers to route communications automatically.

WU's broadband switching equipment also provides a new switched-type direct customer-to-customer service to transmit record communications (including facsimile and data) with voice coordination. Fast transmission and delivery of exact copies of

## FACSIMILE (Concluded)

messages, drawings and other graphic material also is available to the public in New York, Washington, Chicago, Los Angeles and San Francisco.

Though business is looking-up for manufacturers of electronic facsimile equipment, some premature pioneers have fallen by the wayside, been merged or reorganized. These include: Air Associates, which made the Electronic Messenger; RCA, which broadly popularized its Ultrafax, apparently has not profited from it; Hogan Laboratories, Inc., has become a TELautograph subsidiary; Times Facsimile Corp., a wholly-owned subsidiary of The New York Times, was sold to Litton Industries; Fairchild Camera and Instrument Corp. bought the assets of Acme Telectronix Division of Newspaper Enterprise Association (NEA) Service, Inc., and Finch Telecommunications, one of facsimile's biggest drumbeaters, finally flopped; there are many others not mentioned here.

This time, the perennially optimistic equipment makers feel that electronic facsimile equipment will thrive in industrial and commercial markets. Marketing men also cast a happy eye upon the profitable repeat sales of countless rolls of facsimile recording paper (though virtually all of the paper manufacturing is sub-contracted out.)

The biggest and most profit-making user of electronic facsimile is Western Union Telegraph Co. Broadband switching equipment provides direct customer-to-customer service to transmit exact copies of messages, drawings and other graphic material rapidly.



## Markets Foreseen

Present and future growth markets for electronic facsimile equipment are foreseen by John Hogan, Jr., whose father, the late John V. L. Hogan, was a laboratory assistant to Dr. Lee DeForest, a founder and Fellow of the IRE, and inventor of his own facsimile system. Hogan, Jr., anticipates increasing markets serving high-speed digital data reduction, weather map transmission, press services, and inter-office uses.

Varied interests of members of EIA's Facsimile Section reflect the nature of facsimile operations. Section chairman is George M. Stamps, who was initiated into facsimile at Hogan Laboratories. He is now staff engineer and coordinator of business machines engineering and marketing of Magnavox Research Laboratories, Torrance, Calif. His firm freshly announced its newest product: Magnafax, which sends "quick, clear copies of pictures and information over long-distance telephone lines."

Other interested facsimile equipment makers and/or users include: Alden, Muirhead Instruments, General Telephone & Electronics, Philco, Charles Bruning Corp., Xerox, Western Union, Bell Telephone Laboratories. Other users include U. S. Army Electronics Research and Development Laboratories, Boeing, and Douglas Aircraft.

A special situation concerns Stewart Warner which is licensed to make Datafax equipment under Hogan patents. This equipment is distributed and serviced by the Dictaphone Corporation, which also sells and services its own business dictation machines.

Another EIA Facsimile Section member is the A. B. Dick Co. whose "Videograph" process seriously complements yet competes with electronic facsimile equipment. It has adapted the video principles to scan, then transmit intelligence in the form of video signals. These are viewed or photographed from a cathode ray tube, or the same signals may be electrostatically printed. There are several other electronic facsimile manufacturers who are neither noted here, nor are they members of the EIA groups.

In future, electronic facsimile systems may well find a brighter future with proper marketing, plus newer means of communications facilities now at their disposal. Lasers already have been noted here, earlier. And, in the long run, a satellite communications system also sounds promising. But most likely the most promising call to wake up the sleeping facsimile giant will come by telephone and telegraph lines.

● A REPRINT of this article is available from ELECTRONIC INDUSTRIES Reader Service Department

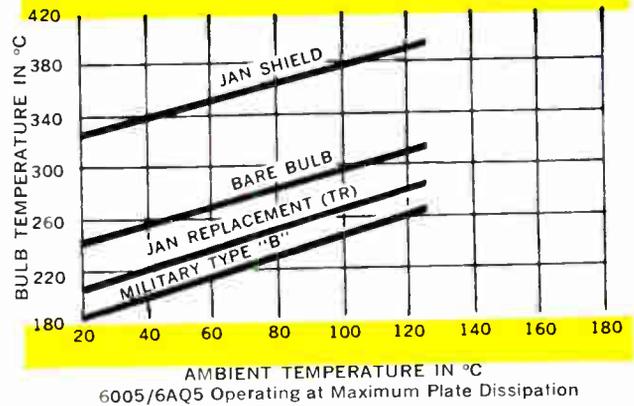


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\* Mean Time Between Failures is a result of many factors, but tube failure due primarily to high bulb temperature is generally acknowledged to be responsible for at least 70% of equipment breakdown. These Cinch tube shields are designed to provide a substantially cooler tube operating environment, reducing tube temperatures more than 50°C below bare bulb temperatures.



\*Tube life increases up to 1200% have been recorded in equipment using these tube shields, under actual operating conditions. This will naturally vary with tube type and operating temperature, ambient temperature, air circulation, etc.



**MILITARY TYPE "B"**—Cinch T5 and T6 Series are designed for new equipment applications. Each shield locks into a flanged base that mounts to the chassis through the tube socket mounting holes. Cinch T5 and T6 Series meet or exceed all physical and environmental specifications of MIL-S-9372C and SCL-6307.2, including for vibration (15 g, 10-2000 cps), heat resistance (200°C), heat dissipation (required 20°C actual 50°C at sea level and 50,000 ft.) and salt spray (50 hour).

**JAN-TYPE REPLACEMENTS**—Cinch TR Series are designed as direct replacements for obsolete JAN shields (now specifically prohibited by all military services). Actual heat dissipation under MIL-S-9372C is 40°C. They meet all physical and environmental requirements of MIL-S-9372C, MIL-S-19786, SCL-6307/2 and FAA-R-777.

**FAST DELIVERY**—Shields for all standard 7 and 9 pin miniature tubes are carried in stock. Most orders can be shipped immediately. Contact your Cinch representative or write us directly for detailed information.

Manufactured under license agreement with International Electronic Research Corporation.

**CINCH MANUFACTURING COMPANY**

1026 South Homan Avenue, Chicago 24, Illinois  
Plants located in Chicago, Illinois; Shelbyville, Indiana;  
City of Industry, California; and St. Louis, Missouri.

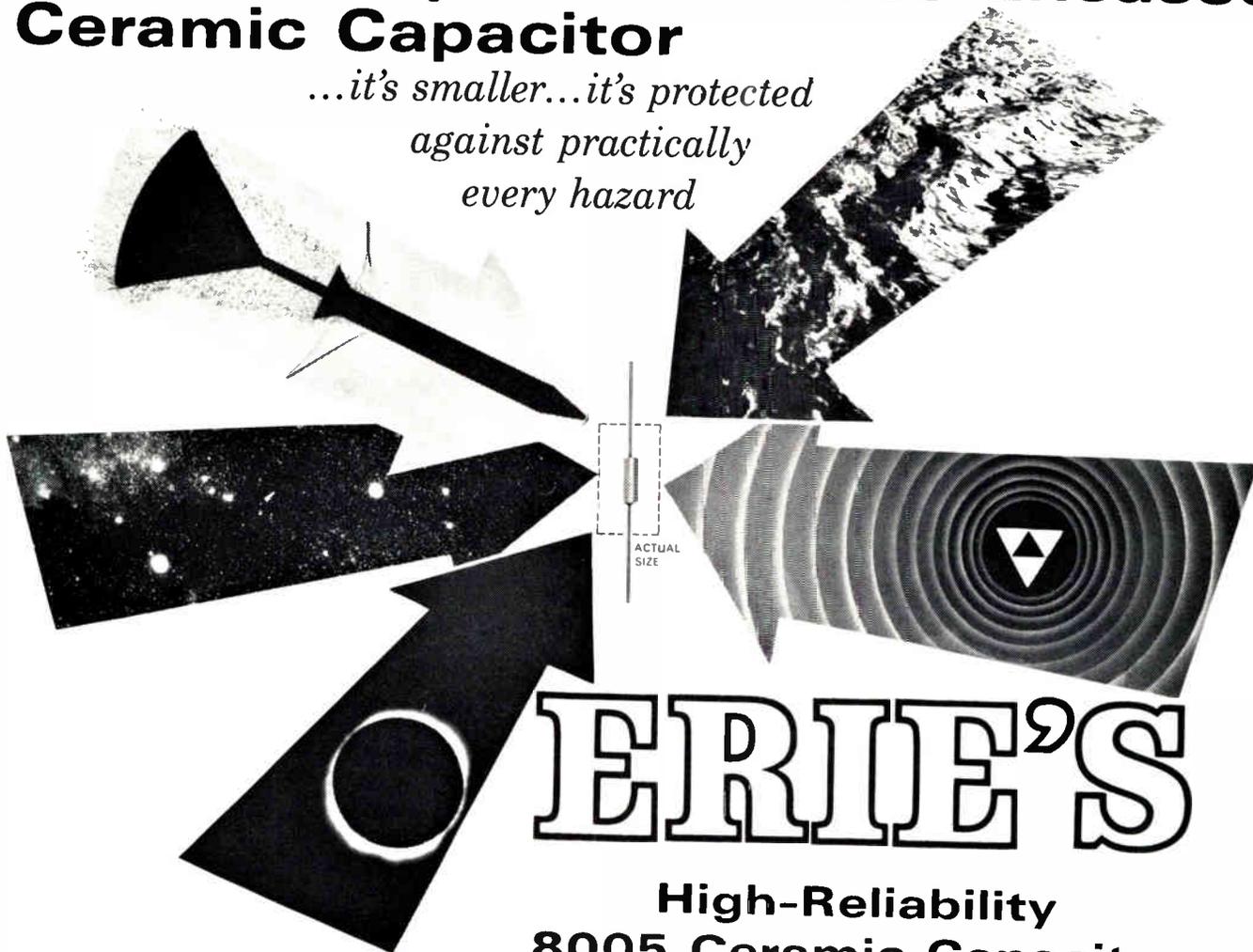


A DIVISION OF UNITED-CARR FASTENER CORPORATION, BOSTON, MASSACHUSETTS

# THE FIRST

## Hermetically Sealed Glass-Encased Ceramic Capacitor

*...it's smaller...it's protected  
against practically  
every hazard*



# ERIE'S

## High-Reliability 8005 Ceramic Capacitor *with a true hermetic seal*

Volumetric efficiency of Erie's 8005 capacitor is 10 to 100 times as great as that of conventional capacitors. This is achieved with Erie's exclusive *Monobloc Process*\* for producing thin ceramic films to give electronic components maximum capacitance/volume ratios with repeatability.

Erie 8005 capacitors are designed for the ultimate in aerospace and military environments . . . protected against vibration, moisture, vacuum, radiation and temperature. Production quantities available in six weeks from receipt of order. Evaluation quantities available off-the-shelf.

### Specifications:

Size: 0.290" max. by 0.100"  $\pm$  0.005" dia.

Values and T.C.: 10 thru 100 pf. with T.C. of zero  $\pm$  30 ppm;

150 thru 2200 pf. with max. capacitance change of  $\pm$  15%, -55° C to 125° C (W5R) at  $\pm$  10% or  $\pm$  20% tolerance.

Voltage: 100 VDC working

Typical IR:  $1 \times 10^{12}$  ohms

HERMETIC GLASS SEAL  
TYPICAL IR OF  $10^{12}$  OHMS  
HIGH VOLUMETRIC EFFICIENCY  
RADIATION RESISTANT DESIGN  
MICROMINIATURE PACKAGING  
BUILT BY ERIE'S EXCLUSIVE  
MONOBLOC PROCESS\*

DESIGNED TO MEET REQUIREMENTS  
OF THE NEWLY ESTABLISHED  
RELIABILITY SPECIFICATION  
MIL-C-38102/12 and MIL-C-39014

Ask us about our other Monobloc Process\* capacitors in CK06 (Style 6002) and CK12 (Style 6003) sizes.

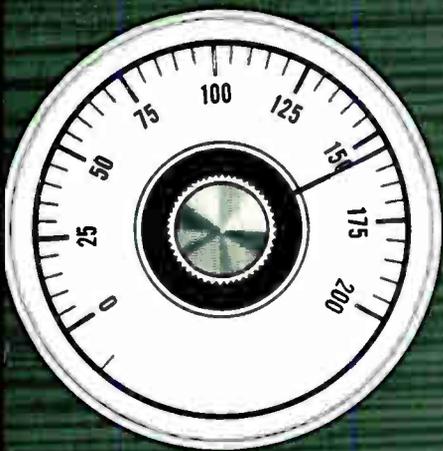
\*Monobloc Process is a trademark of Erie Technological Products, Inc.

Formerly Erie Resistor Corporation



644 West 12th Street  
Erie, Pennsylvania

WHERE IMAGINATION CREATES VALUE IN ELECTRONICS



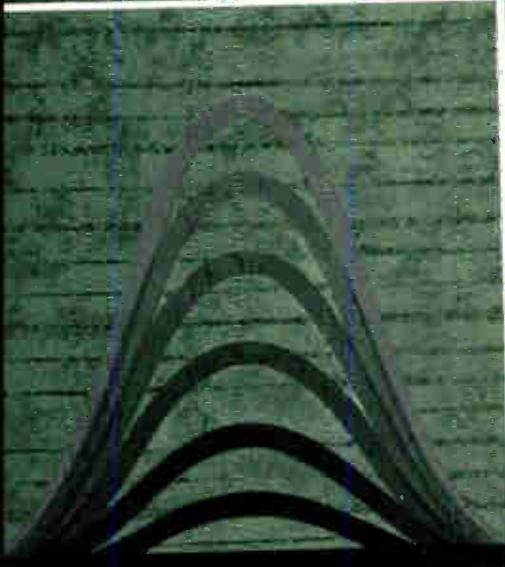
THERMAL STABILITY



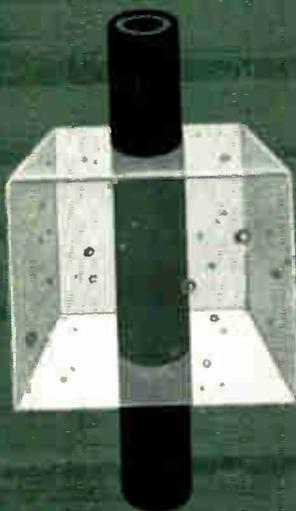
MOISTURE RESISTANCE



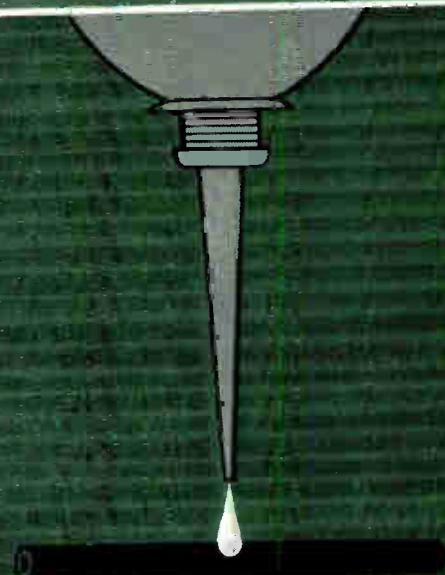
LOW TEMPERATURE FLEXIBILITY



OUTSTANDING DURABILITY



INSULATION COMPATIBILITY



CHEMICAL RESISTANCE

## New "Irvington" Brand Class F Tubing assures reliability under all conditions

Now, a 5000 volt tubing that maintains 5000 volts throughout its operational life! New "Irvington" Brand Epoxy Coated Glass Tubing No. 450 is a 5000 volt tubing at room temperature . . . remains at the 5000 volt level at 155°C. It even performs at higher temperatures for short periods (1000 hours at 180°C. for example). How about moisture? No problem. New No. 450 retains 5000 volts at 96% RH. Cold? Stays flexible at -60°C. And there's more good news. No. 450 is remarkably resistant to abrasion and solvents. Provides perfect compatibility with epoxy resins, varnishes and magnet wire enamels to assure void-free seals.

What does it all mean? Now you no longer have to put up with materials that are rated in a given tempera-

ture range but lose 50-75% of their dielectric strength when the temperature rises. You no longer have to over-compensate by jumping to expensive Class H materials to get Class F performance.

Get all the facts on how "Irvington" Tubing No. 450 can add new reliability to your Class F motors, transformers, epoxy encapsulated units or aerospace equipment. See your 3M "IQ" Man or write: 3M Co., Irvington/Mico Division, St. Paul 19, Minn., Dept. ECO-54.

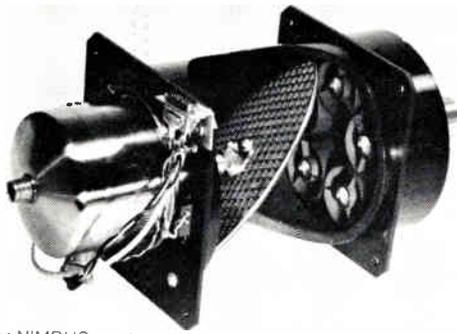
**INSULATIONS? SEE YOUR 3M IQ MAN\***

\*"IQ" means Insulation Qualified. Your 3M Man is trained and qualified to advise and assist with electrical insulation problems.

**3M** Irvington/Mico Division  
**MINNESOTA MINING & MANUFACTURING CO.**

"IRVINGTON" IS A REGISTERED TRADEMARK OF 3M CO., ST. PAUL 19, MINN.

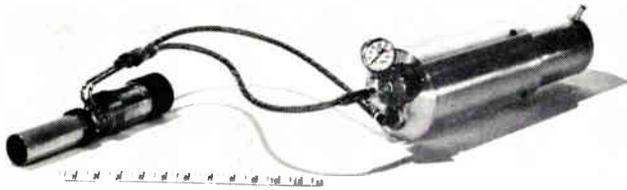
TAPES • RESINS • TUBING • VARNISHES • COATED FABRICS • LAMINATES • MICA PRODUCTS



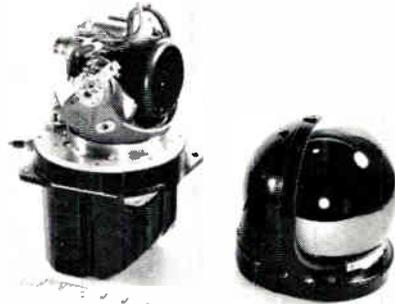
Radiometer for NIMBUS weather satellite



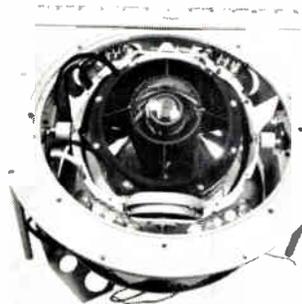
Interceptor IR installation



12°K closed-cycle cryostat



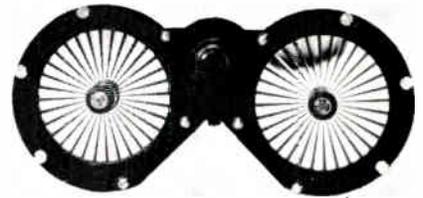
90C IR search/track set



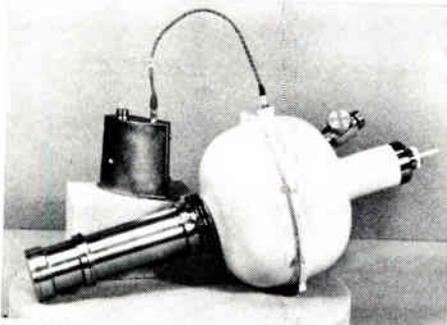
IR multi-channel tracking radiometer



Star tracker for SURVEYOR spacecraft



Modulated IR source



Liquid-helium-cooled IR detector



IR anti-tank missile controller

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ELECTRONIC INDUSTRIES • May 1964

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more  
precisely...  
this new  
one-piece  
**MOLDED  
SWITCH**



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Guardian's new *molded* switch *stays put*—cutting your assembly costs *way down!* Instead of 16 stacked and screwed parts, Guardian designs it down to just 6 parts—molded into one rock-fast unit. Solid! Precision alignment and adjustment are locked in.

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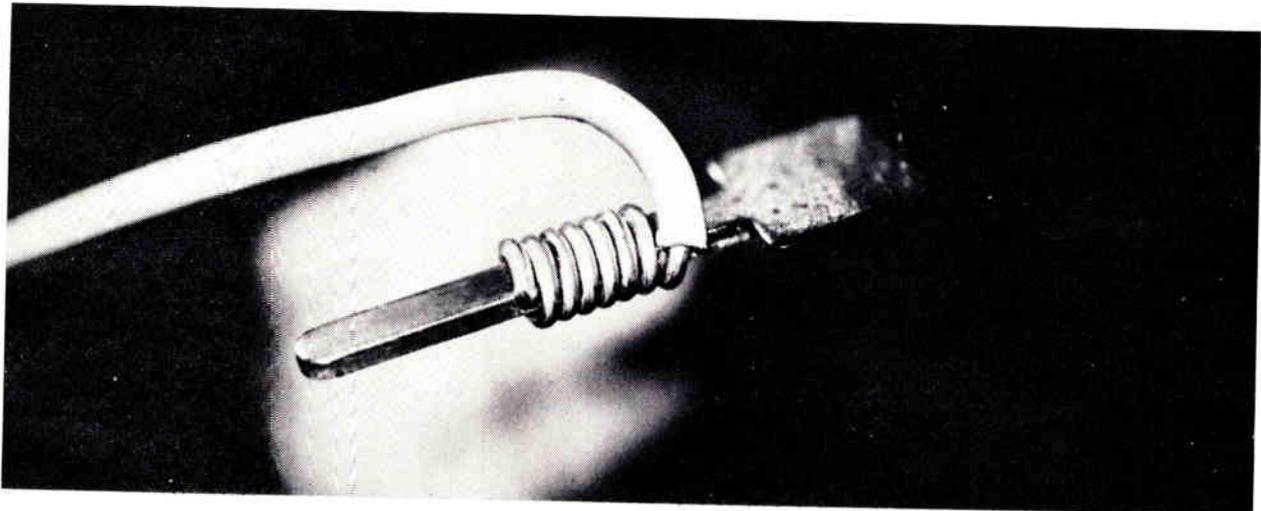
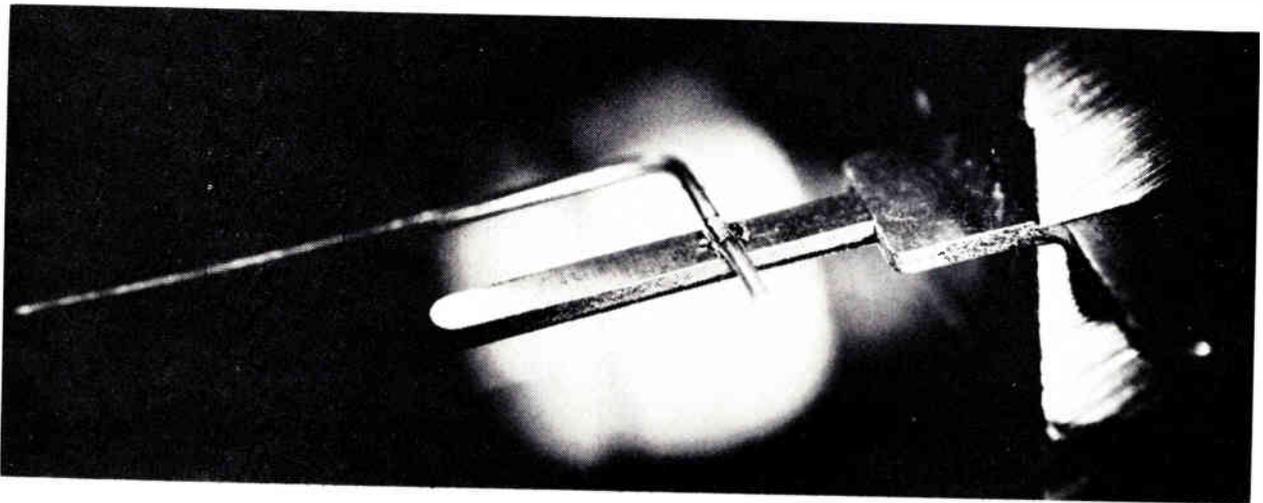
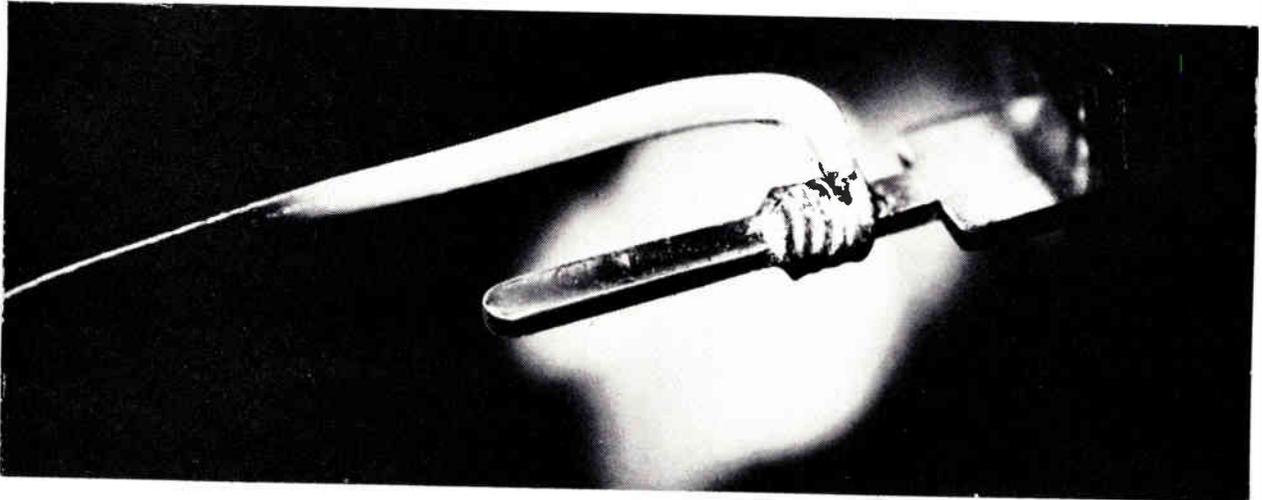
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- Low cold flow prevents shrinkage.
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- Lower cost in quantities.
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# GUIDE TO TODAY'S CIRCUIT INTERCONNECTIONS

The major types of interconnections are: crimping, wire-wrap, soldering, and welding. Each has certain advantages, as well as problems. This article describes both, and includes information on where to purchase the devices and machines.



THIS SPECIAL ARTICLE IS AN INDUSTRY-WIDE, state-of-the-art report on the newest methods and machinery for making permanent interconnections in electronic circuit packaging. Information presented here is based on data we received from 75 companies in response to our questionnaire. In summary, here is what they say:

### Comparing Interconnection Methods

It's a simple fact that the reliability of the interconnection is as important as the reliability of the component to proper functioning of the assembly, and interconnections usually outnumber components. The life of a connection is limited by either electrical or mechanical failure. Electrical failure generally appears if the connections were made improperly, whereas mechanical failures are due to excessive forces or fatigue of the junction.

There was a time when the superiority of one type of interconnection over another was determined by their life under identical environmental conditions. Today, especially in data processing and communications, where the need and desire exists for more automated methods of wiring, requirements are more specific, for example:

1. Ability of the method to use various kinds of wire—other than solid, stranded, etc.
2. Ability of a connection to be serviced in the field.
3. Reliability of the connection—independent of operator skill—under extremely adverse conditions.
4. Ability of the method to work with high density panel wiring systems with grid spacing as close as or closer than a 0.100 in. square.

Permanent electrical connections are being made by four principal methods. These include crimping, solderless wrap (or wire wrap), soldering and welding. All are used extensively.

The Bell System, one of the nation's largest users of interconnections, recently made tests on the four types they use most often, namely, solderless wrap, soldered, percussive welded and resistance welded. Measured were the number of hours the connections survived under various imposed environmental conditions such as vibration, shock, temperature extremes, corrosion, humidity and bending. The overall "order of merit" for the connections, based on fatigue life, placed the percussive weld first, although it must be pointed out that the quality of this particular weld in this case exceeded that of the others

because of special control measures. Next in order were soldered, solderless wrap and resistance welded connections.

But, the results of any such tests are not necessarily conclusive for all applications and materials. Certain of the interconnection applications may dictate use of specific interconnection methods as may be seen by a comparison of the capabilities of each.

**ELECTRONIC INDUSTRIES**  
**STATE-OF-THE-ART FEATURE**  
**STAFF REPORT**

ORDERS OF MERIT					
ENVIRONMENTAL CONDITIONS	CONNECTIONS TESTED	ORDER OF MERIT			
		BEST	SECOND	THIRD	POOREST
VIBRATION (90° bend)	320	P	S	SW	R
VIBRATION (Omitting 90° bend)	160	SW	P	S	R
<b>LABORATORY SHOCK</b> Using the standard vibration configuration, the fatigue life of the connections was compared after being subjected to 90 half sine wave shocks (30 in each of three mutually perpendicular directions) of 500 to 600 g's amplitude and 2 to 3 milliseconds duration.	160	S	SW	P	R
<b>RAILROAD SHOCK</b> Using the standard vibration configuration, the fatigue life of the connections was compared after being subjected to 10 round trips between Columbus, Ohio and New York City via railway express.	160	S	P	SW	R
<b>TEMPERATURE</b> Using the standard vibration configuration, the fatigue life of the connections was compared after being subjected to a temperature of 105° C for 154 days with mechanical disturbance every two weeks.	320	S	P	SW	R
<b>CORROSION</b> Using the standard vibration configuration, the fatigue life of the connections was compared after being subjected to the corrosive atmosphere of New York City (BTL at West St.) for 3 & 6 months (2 exposure groups).	160	P	S	SW	R
<b>HUMIDITY</b> Using the standard vibration configuration, the fatigue life of the connections was compared after being subjected to 90% relative humidity and 85° F dry bulb temperature for a total of 64 days.	160	P	S	SW	R
<b>LIGHTLY LOADED BENDING</b> Using the lightly loaded bending configuration, the fatigue life of the connections was compared. This bending fatigue method moved the wire 30° in each direction from its equilibrium position with a load that varied from zero to 4 grams.	160	P	SW	S	R
<b>HEAVILY LOADED BENDING</b> Using the heavily loaded bending configuration, the fatigue life of the connections was compared. This bending fatigue method moved the wire through an angle of 45° with a constant load of 300 grams applied.	160	SW	P	S	R

**NOTE:** S—Soldered, P—Percussive weld, SW—Solderless Wrap, R—Resistance weld.  
 —from Bell Laboratories Record

# INTERCONNECTION TOOLS & EQUIPMENT

COMPANY NAME AND ADDRESS

COMPANY NAME AND ADDRESS	HAND TOOLS	CRIMP				WRAP				SOLDER				WELD													
		POWER TOOLS & MACHINES	AUTOMATIC CONTACT FEED	WIRE STRIPPERS (MECH)	WIRE STRIPPERS (THERMAL)	TENSILE STRENGTH TESTERS	HAND TOOLS	POWER TOOLS & EQUIPMENT	PANEL WRAPPING MACHINES	WIRE UNWRAPPING TOOLS	HEAT CONDUCTION EQUIPMENT	RESISTANCE SOLDER EQUIPMENT	ULTRASONIC SOLDER EQUIPMENT	FLOW SOLDERING SYSTEMS	INDUCTION DE-SOLDERING TOOLS	HEATERS, MELTING POTS, OVENS	HEAT CONTROLS	SOLDER	FLUX & CLEANERS	GAS WELDING SYSTEMS	ARC WELDERS	RESISTANCE WELDERS	ELECTRON BEAM WELDERS	LASER BEAM WELDERS	ULTRASONIC WELDING EQUIPT.	WELD TESTERS & MONITORS	
Aeromet-General Corp., 1100 W. Foothill Blvd., Azusa, Calif. ....																											
Alloys Unlimited, 21-01 - 43rd Ave., Long Island 1, N.Y. ....																											
Alpha Metals Inc., 56 Water St., Jersey City, N.J. ....																											
American Electrical Heater Co., Detroit, Mich. ....																											
American Missile Prods., 15233 Grevillea Ave., Lawndale, Calif. ....																											
AMP, Inc., Harrisburg, Pa. ....																											
Anchor Alloys, Inc., 968 Meeker Ave., Brooklyn, N.Y. ....	X	X	X	X																							
Artos Engineering Co., 2753 S. 28th St., Milwaukee 46, Wis. ....		X	X	X																							
BTU Engineering Corp., 179 Bear Hill Rd., Waltham 54, Mass. ....																											
Buchonon Electrical Prods. Corp., Hillside, N.J. ....	X	X	X																								
Cannon Electric Co., 3208 Humboldt, Los Angeles 31, Calif. ....																											
Connecticut Valley Chemicals, Inc., 178 Prince St., New York, N.Y. ....																											
Contact, Inc., Hudson, N.H. ....																											
Diamond Tool & Horseshoe Co., Duluth, Minn. ....																											
Edsyn, Box 868, Arleta, Calif. ....																											
Eisler Engineering Co., Inc., 770 S. 13th St., Newark 3, N.J. ....																											
Elco Corp., Willow Grove, Pa. ....	X	X																									
Electro-Minature Corp., 600 Huyler Ave., S. Hackensack, N.J. ....																											
Electronics, Inc., Willow Grove, Pa. ....																											
Engineering & Electron Devices, Inc., 1024 N. McCadden Pl., L.A., Calif. ....																											
Eubanks Engineering Co., P.O. Box 563, Monrovia, Calif. ....																											
Ewald Instruments, Route 7E, Kent, Conn. ....																											
Fairmount Chemical Co., Inc., 136 Liberty St., New York, N.Y. ....																											
Farelloy Co., 1243-45 N. 26th St., Phila. 21, Pa. ....																											
Fostoria Corp., 1200 N. Main St., Fostoria, Ohio ....																											
Gardner-Denver, Quincy, Ill. ....																											
General Electric Co., Industrial Heating Dept., Shelbyville, Ind. ....																											
Hamilton Standard Div., United Aircraft Corp., Windsor Locks, Conn. ....																											
Henes Mfg. Co., 4301 Madison St., Phoenix 34, Ariz. ....																											
Hobart Bros., Hobart Square, Troy, N.Y. ....																											
Hughes, Vacuum Tube Prods., 2020 Short St., Oceanside, Calif. ....																											
Hunter Spring, Hotfield, Pa. ....																											
Ideal Industries, Inc., 5127 Park Ave., Sycamore, Ill. ....	X																										
Kohle Engineering Co., 3317 Hudson Ave., Union City, N.J. ....																											
Kelsey-Hoyes Co., Orangeburg, S.C. ....																											
Kent Mfg. Corp., 206 Center, Princeton, N.J. ....	X	X	X																								
Kester Solder Co., 4201 Wrightwood Ave., Chicago 39, Ill. ....																											
Kressilk Prods., Inc., 73 Murroy St., New York 7, N.Y. ....																											
Kulicke & Soffa, 135 Commerce Dr., Ft. Washington, Pa. ....																											
Lancashire Dynamo Electronic Prods. Ltd., Rugeley, Staffordshire, Eng. ....																											
London Chemical Co., Inc., 1533 N. 31st Ave., Melrose Park, Ill. ....																											
Mathias Klein & Sons, 7200 McCormick Rd., Chicago 45, Ill. ....																											
National Lead Co., 111 Broadway, New York 6, N.Y. ....																											
Nyborg Engineering Co., 533 Dawson Dr., Camarilla, Calif. ....																											
Omark Industries Inc., 9701 S.E. McLoughlin Blvd., Portland 22, Ore. ....																											
Oryx Co., 13804 Ventura Blvd., Sherman Oaks, Calif. ....																											
Precision Arc Techniques, 785 Woodend Rd., Stratford, Conn. ....																											
Prosser Industries Inc., 900 E. Ball Rd., Anaheim, Calif. ....																											
Sciaky Bros., Inc., 4915 W. 67th St., Chicago 38, Ill. ....	X																										
Sippican Corp., Barnabas Rd., Morion, Mass. ....																											
Sonobond Corp., West Chester, Pa. ....																											
Tescom Corp., 27th Ave., & 4th St., Minneapolis 14, Minn. ....																											
Texas Instruments Incorporated, P.O. Box 66027, Houston, Texas ....																											
Thomas & Betts, Inc., Elizabeth 1, N.J. ....	X																										
TRG, Inc., 400 Border St., East Boston 28, Mass. ....																											
Unitek, Weldmatic Div., 950 Royal Oaks Dr., Monrovia, Calif. ....																											
Weller Electric Corp., P.O. Box 345, Easton, Pa. ....																											
Weltek Div., Wells Electronics, Inc., 1701 S. Main St., South Bend, Ind. ....																											
Weltronic Co., 19500 W. Eight Mile Rd., Southfield, Mich. ....																											

# INTERCONNECTION SERVICES

## COMPANY NAME AND ADDRESS

COMPANY NAME AND ADDRESS	CRIMPING & WR. WRP.		SOLDERING						WELDING				ASSEMBLY									
	CUSTOM CRIMPING	CUSTOM WIRE WRAPPING	WIRE UNWRAPPING	WIRE STRIPPING (MECH)	HEAT CONDUCTION SOLDERING	RESISTANCE SOLDERING	ULTRASONIC SOLDERING	FLOW SOLDERING	INDUCTION DE-SOLDERING	WIRE STRIPPING (THERMAL)	GAS WELDING	ARC WELDING	RESISTANCE WELDING	ELECTRON BEAM WELDING	LASER BEAM WELDING	ULTRASONIC WELDING	WELD PULL TESTING	WELD ANALYZING TEST	MULTICONDUCTOR CABLES	CONNECTORS	TERMINAL STRIPS	PIGTAILS
AMP, Inc., Harrisburg, Pa. ....	X			X														X	X	X	X	X
Atlantic Instruments & Electronics, Inc., 103 N. Beacon St., Boston, Mass. ....	X	X			X					X	X	X	X					X	X	X	X	X
Cadre Industries Corp., Endicott, N.Y. ....	X	X			X						X	X	X					X	X	X	X	X
Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif. ....	X	X				X					X	X	X					X	X	X	X	X
Control Logic, Inc., Natick, Mass. ....																						
Data Science Corp., 3687 Voltaire St., San Diego, Calif. ....	X	X			X	X					X	X	X			X	X					
Dynalectron Corp., 440 Hester St., San Leandro, Calif. ....	X	X			X	X			X									X	X	X	X	X
Elco Corp., Willow Grove, Pa. ....	X	X			X	X					X	X						X	X	X	X	X
Electronics, Inc., Willow Grove, Pa. ....					X	X					X							X	X	X	X	X
Elektron Standard, Inc., South Windsor, Conn. ....											X		X					X	X	X	X	X
Elpac Engineering & Mfg. Co., 800 E. Main St., Norristown, Pa. ....					X						X			X				X	X	X	X	X
Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif. ....												X						X	X	X	X	X
Hughes, Vacuum Tube Prods. Div., 2020 Short St., Oceanside, Calif. ....												X						X	X	X	X	X
Mutron Corp., 125 Perkins Ave., Brockton, Mass. ....	X	X			X	X					X							X	X	X	X	X
Paraplegics Mfg. Co., Inc., 304 N. York Rd., Bensenville, Ill. ....					X	X			X		X							X	X	X	X	X
Pastoriza Electronics, Inc., 285 Columbus Ave., Boston, Mass. ....						X																
Sylvania, Parts Div., 1000 Huyler St., Teterboro, N.J. ....											X	X						X	X	X	X	X
Unitek, Weldmatic Div., 950 Royal Oaks Dr., Monrovia, Calif. ....											X	X						X	X	X	X	X
Walkirt Co., 10321 La Cienega Blvd., Los Angeles 45, Calif. ....					X						X											

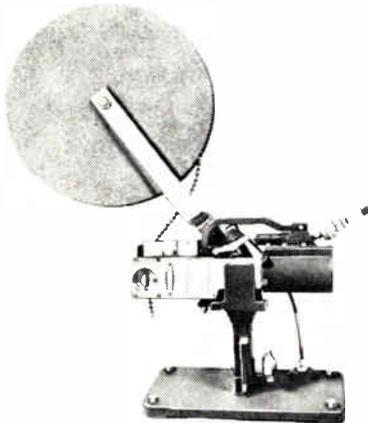
## COMPARISON OF INTERCONNECTION METHODS

METHOD	PRINCIPAL ADVANTAGE	FEATURES OF CONNECTION	SKILL LEVEL	REQUIREMENTS
Resistance Soldering	Even heating of joint; low heat radiation; power source can also be used for stripping	Large contact area	High	Conductors must be cleaned and fluxed; equip. moderately sophisticated
Heat Conduction Soldering	Simplicity of equip.; applicable to most interconnections	Large contact area	High	Conductors must be cleaned and fluxed
Resistance Welding	Low heat radiation; speed in making connections	Small size; high tensile strength	High	Sophisticated equip.
Wire Wrapping	No flux or cleaning required; connections readily unwrapped	Large contact area	Minimum	Tool space needed around connection
Crimping	No heat or flux; no subsequent cleaning of connection	High mechanical strength	Minimum	Tool space needed around connection
Electron Beam Welding	Negligible heat radiation; micro-miniature applications	Small size; high tensile strength; high density connections/unit area	Very high	Complex equip.; vacuum or gas atmosphere
Flow Soldering	Simultaneous connection of many joints	Large contact area	High	Critical heat control
Percussive Arc Welding	Joining of very thin materials; little thermal distortion	Very high tensile strength	Very high	Sophisticated equip.

### CRIMP JUNCTION

A Crimp Junction, formed by compressing a barrel or strip shaped contact around a conductor has the advantage that it can be made at any point in the production cycle. Crimping can be done by automatic machinery or by relatively inexperienced

personnel using simple hand tools. Of course, there is no fear of causing heat damage to components. Virtually any size solid or stranded wire can be used. Air and electrically powered machines with automatic feed have increased the speed of crimping operations to a few hundred connections per minute and with grid densities to 0.075 in. square. Equipment is available that strips the wire simultaneously with programmed application of clips and terminals.



Bench-mounted, air-powered crimping tool by Buchanan has large capacity reel.

AMP's automatic machine connects wires to panel terminals by clips for production.

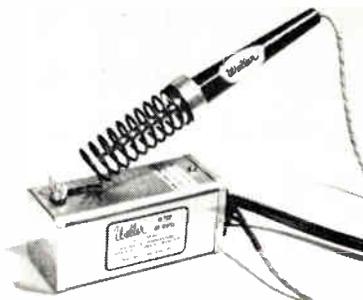


### SOLDERED JUNCTION



Single console has wire stripping, resistance soldering and conduction soldering in one unit with infinite heat control from American Heater Co.

Small sized temperature control permits accurate tip heat for precision soldering. is made by Weller.



Soldered Junctions, consisting of stranded or solid wires joined by soft metal, are achieved with minimum equipment and provide connections that are good mechanically and electrically.

Heat to melt the solder over the junction may be supplied by a hot iron (conduction soldering), or generated by a small electrical current flowing through the connection (resistance soldering) or conveyed to the joint by portable heaters, jets, or automatic ovens (induction soldering). Assemblies are also transported to heated tanks containing molten solder where the connections are either immersed in the solder or the solder is forced over the connections (flow soldering).

Resistance soldering provides uniform connections with minimum danger of transferring heat or splashing solder on nearby components. Contacts are heated quickly and evenly across the joint. A resistance soldering heat control mechanism is available that automatically controls the amplitude and time cycling of the electrical pulses that pass between the electrodes. Thus, inexperienced personnel may operate the soldering equipment successfully once the control is programmed.

Induction soldering is designed to localize solder in the joint area and minimize heat around sensitive components on the opposite side. Equipment is available that positions solder preforms at junctions and then places the circuit board under a hot air blast which melts the solder preforms.

Flow soldering techniques, while providing simultaneous soldering of several connections at moderately high rates of speed often need some hand touch-up soldering. Of course the assemblies must be designed with the connections brought out to an area of the assembly which can be immersed in the solder without damage to the components. In wave soldering, the molten solder is pumped to the surface under pressure to form a bulge or wave. The wave contacts the connections on the bottom of the moving assemblies. Wave and fountain soldering systems are designed to control immersion depths to within 1/32 inch.

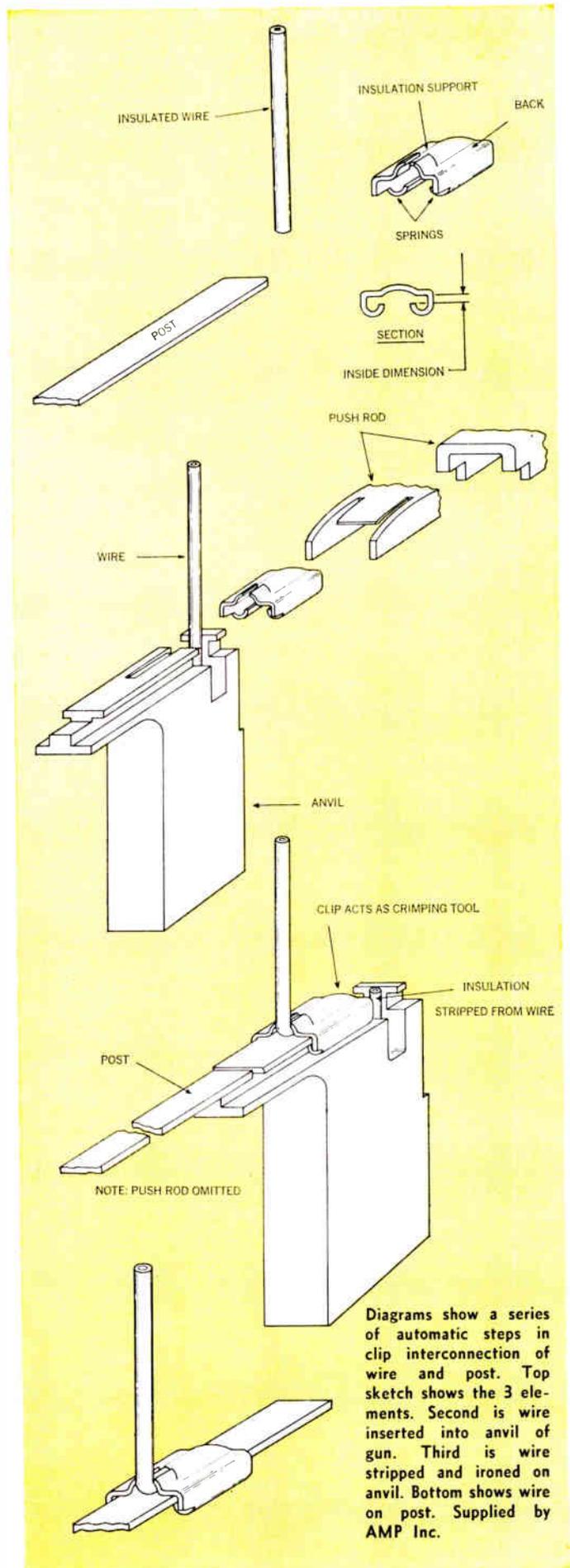
In ultrasonic soldering, parts to be soldered are heated to a temperature slightly above the melting point of the solder. Then, as the solder is applied to this heated surface, an ultrasonic vibrator creates an intense vibratory action within the solder. This removes metal oxide films and other contamination to permit the solder to alloy with the base metal. Other methods are being developed for melting the solder, including use of high intensity light beams produced by lasers and arcs, and by direction of high temperature air streams at connections fitted with solder preforms.

### Strength of Soldered Junctions

The strength of soldered junctions is greatly influenced by the base metal and its preparation. It has been common practice, especially in dip and flow soldering, to pre-plate the copper conductors of printed circuit boards with gold or nickel. This provides a protective coating for the copper during storage, as well as an aid to wetting of the solder when the boards are finally placed in production. Pull tests for tensile strength measurements were conducted by the Army Ballistic Missile Agency at Huntsville, Alabama. Tests proved that solder joints formed on a copper surface were stronger than those on gold-plated surfaces. Greater strengths were realized when the copper surface was nickel-plated, but the solder wetting was about half that of a properly prepared copper surface.

In other tests by Bell Labs., failures occurred when heavy gold plating had been used prior to soldering. When the proportion of gold in the lead or lead-tin reached 75%, a brittle alloy formed. Stronger joints were obtained with just a flash coating of gold.

*Continued on page 57*



# Any one of these tools will crimp most contact types

Crimps most contact types—MS or proprietary for electrical or electronic applications. No operator adjustments. For any production volume—low, medium or high. And tools that meet the performance requirements of MIL-T-22520. All these features are yours with these Buchanan cycle-controlled crimping tools ... field-tested and recommended by most Connector Manufacturers.

## NEW! MINIATURE HAND TOOL

This brand new miniature tool is just 6¾" long and weighs only 10 ounces! Open handle span is 4". Designed for crimping miniature removable pin and socket contacts #20 and smaller in a multitude of sizes and designs, it permits crimping in confined areas with minimum operator fatigue, making it ideal for female operators. Although it is approximately one-half the size of the standard MS-3191 crimping tool, the Buchanan miniature model retains virtually all of its vital features. No operator adjustments. Positioners program tool to provide crimp depth, crimp location and point of ratchet release.



## MIL STANDARD HAND TOOL

Meets all  
requirements of  
MIL-T-22520  
Class I.

Designed for low volume production and maintenance, this one tool and inexpensive positioners can crimp almost any proprietary or Mil-Spec contact #12 through #20 — for wire sizes #12 through #30. By selecting the positioner, you program the tool to provide crimp depth, crimp location and point of ratchet release. There are no operator adjustments.



## AUTOMATIC FEED TOOL portable or bench mounted

For high volume production, this tool automatically feeds contacts from disposable carriers which can be provided for almost any pin and socket contact #12 through #20 (also protects contacts from mechanical damage). Speed limited only by operator's ability to insert wires. Meets performance requirements of MIL-T-22520. No operator adjustments. Crimp depth automatically controlled by interchangeable snap-in blocks; accommodates foot valve control. In bench mounted unit carrier reel holds 2,000 or more contacts. For portable application, carriers in self-positioning "see-thru" magazines hold up to 102 contacts; magazine automatically selects proper crimp depth.

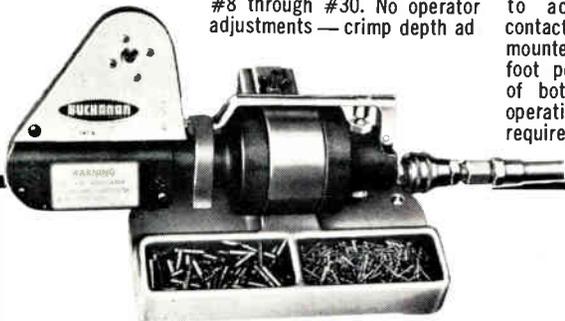


For complete information and engineering assistance of your particular crimping application; or for your free copy of the new manual "Crimping Pin and Socket Connectors", write today!

## MANUAL FEED TOOL portable or bench mounted

Pneumatic tool designed for moderate volume production can be used as portable tool or bench mounted. Crimps almost any proprietary or Mil-Spec contact for wire sizes #8 through #30. No operator adjustments — crimp depth ad-

justed by qualified personnel for specific job. Weighs less than 5 pounds. Replaceable, inexpensive contact locator properly positions contacts for crimping and can be provided to accommodate specific contact sizes and types. Bench mounted tool, available with foot pedal, permits free use of both hands for crimping operation. Meets performance requirements of MIL-T-22520.



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ELECTRICAL PRODUCTS CORPORATION

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## INTERCONNECTIONS (Continued)

### Solder Joint Quality

Quality of soldered joints can be judged accurately by visual inspection of spread, grain size and brightness. The experienced inspector knows that solder should spread across the base metal rather than ball up on it; balling up of solder normally indicates that the base metal is incompatible with the solder. Bright joints result when solder solidifies properly and is free of trapped gases. Joints should be formed and cooled rapidly because solder becomes grained during solidification. Fine grains and bright finish are typical of a quickly chilled joint, whereas columnar grains are apparent in a normal chill, and large grains form around the center of a slowly cooled joint causing a weak junction. The term "cold joint" usually refers to a gray crystalline formation. Studies prove this is the result of prolonged heating rather than lack of heat. In dip and flow soldering,

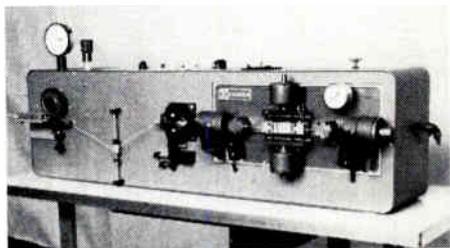
solder absorbs oxygen and tends to form large grains. To retain fine solder grains, strict thermodynamic controls are needed.

### SOLDERLESS WRAP

Solderless Wrapped Junctions made by wrapping solid conductors tightly around terminals provide gas-tight connections with large contact areas. Solderless wrapping, like crimping, requires only simple hand tools and little operator skill. Multiple conductor connections are easily accommodated, and terminals may be "unwrapped" and re-wrapped to meet changes in circuit design. Machines are available for wrapping conductors with very fine wire (#32), and with terminal hole diameters down to 0.075 in.

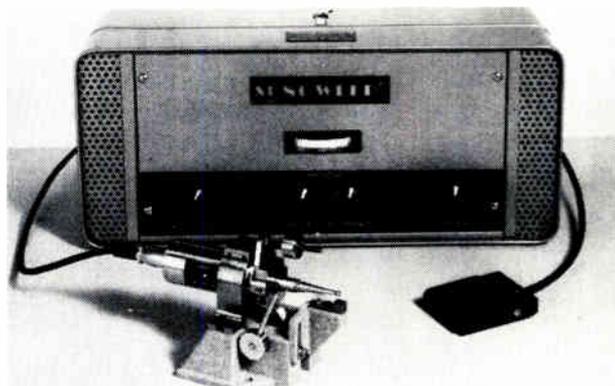
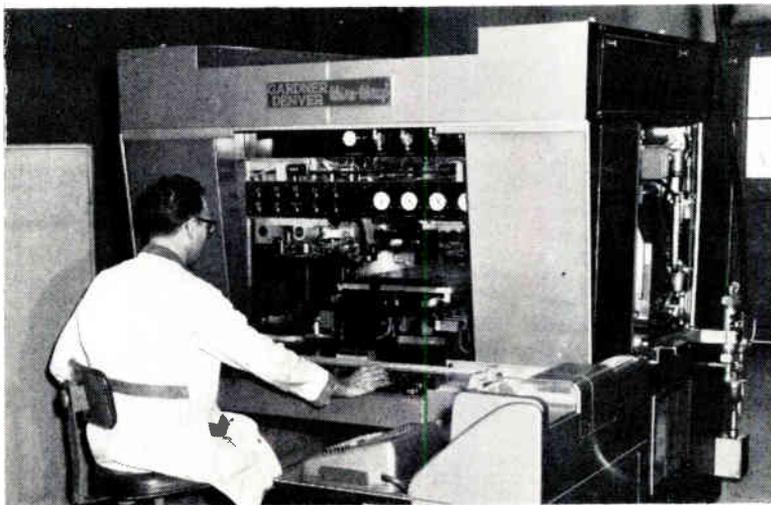
Wrap machines are well adapted to automated production, and much equipment is presently being used for high speed, programmed panel wiring. Machines accept insulated wire and automatically perform the stripping prior to wire wrapping.

*(Continued on page 59)*

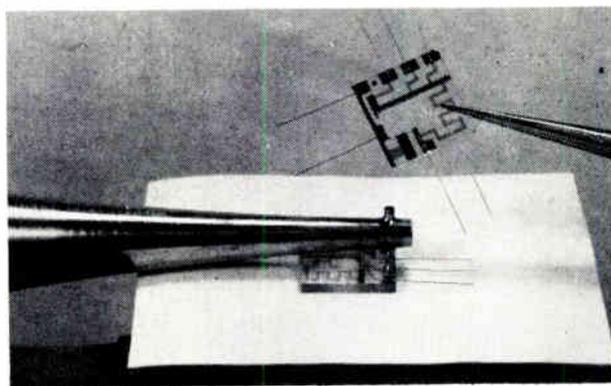


This solderless-wrap wire stripping machine by Eubanks Engineering can produce up to 4,000 pieces per hour.

Insulated solid-conductor wire is fed into this wire-wrap machine which automatically strips the wire and makes interconnections as programmed. Gardner-Denver Co. makes the machine.



This ultrasonic generator can easily weld dissimilar metals. The Sonobond Corporation manufactured this 20-watt unit.



Ultrasonic welding of aluminum connectors to a thin film circuit deposited on a glass substrate is possible.



## A NEW PLUS FACTOR IN RELAYS

PHILLIPS-ADVANCE = Phillips Control Company + Elgin Advance (two names long synonymous with the highest standards of relay reliability). The recent consolidation of PHILLIPS and ADVANCE adds up to numerous plus-factors of real importance to all relay users—broader range of relay types and sizes + expanded research and development + increased plant facilities + new production economies + greater number of skilled personnel + faster service thru broader distribution. For prompt attention to every relay requirement, contact the PHILLIPS-ADVANCE representative in your area.



## INTERCONNECTIONS (Concluded)

### WELD JUNCTION

A weld junction, formed by heat or metallurgical fusion of conductors, provides a strong electrical connection with good conductivity. Welding is widely used in micro-electronic packaging because of the minute (sometimes negligible) enlargement of the joint. Wires, ribbons, or films, as small as 0.0005 in. thick can be joined by resistance and electron beam welding methods. Heating is confined to a very small area, lessening the possibility of damage to neighboring components and circuits.

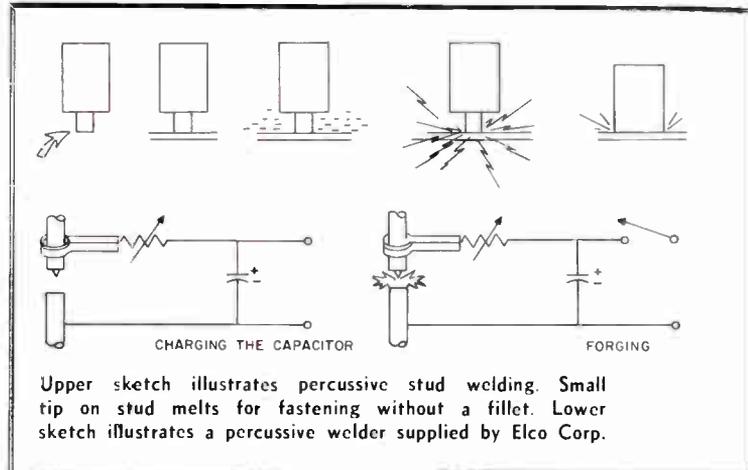
Percussive welding is an electrical arc method of welding studs and cable ends to plates and terminals. The weld is accomplished by storing electrical energy in capacitors, then releasing it to produce a high current density at the stud or cable tip. This ionizes an area which in turn produces an arc that melts the tip and allows the stud to be pressed against the plate for a welded union. The method is adaptable to a wide range of applications because any low-carbon ferrous (and many non-ferrous) metals can be welded, including: steel to steel, steel to lead-free brass, steel to stainless or plated steel, steel to copper, aluminum to aluminum, and aluminum to die-cast zinc.

Electron beam welding is capable of high volume miniature connections with negligible heat distortion to surrounding material. It is capable of producing thousands of welds in a single square inch of space. Power needs are high and electron scatter is a problem when work is outside an artificial environment.

In ultrasonic welding processes, the welder converts electrical energy to high frequency mechanical vibrations. These ultrasonic vibrations are delivered to the parts being welded so that dynamic stresses of high intensity are induced on the workpieces, causing local plastic deformation of the interfaces. A metallurgical bond is formed in the solid state with no melting of the materials being joined. Advantages include lack of thermal degradation or distortion of materials, and the ability to join dissimilar materials.

Laser welders are under development which are expected to produce high intensity welds in brief time periods, and with the added advantage of working in normal atmospheres. A present limitation is the inability of these systems to remove heat from the laser rod, requiring operation at low power and low pulse repetition rates.

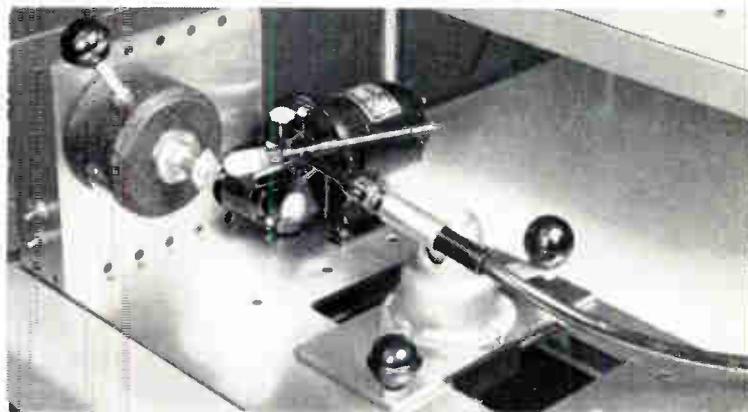
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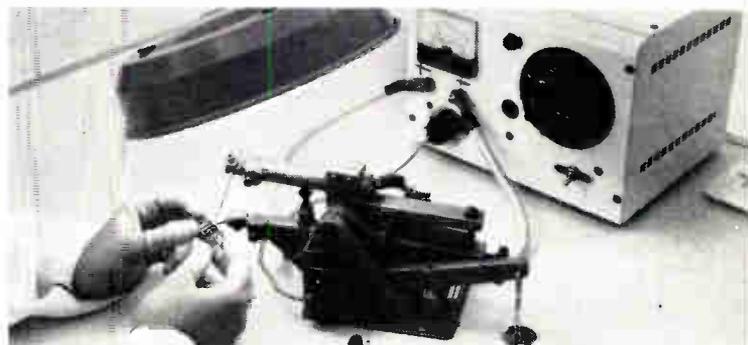
Upper sketch illustrates percussive stud welding. Small tip on stud melts for fastening without a fillet. Lower sketch illustrates a percussive welder supplied by Elco Corp.



Weld Energy Computer is used as a production monitor to indicate a GO, NO-GO condition in the fabrication of Welded Electronic Modules. Units are built by Weldmatic Div./Unitek.



Close-up view of an arc welding station by Precision Arc Techniques that permits welds on parts as thin as 0.0002 in.



Resistance welding of module is performed in a white room to avoid contamination on a welder by El-Pac Engineering & Mfg.



### Assembly

(less than 30 seconds)



### Performance

(up to 10Gc.)



### Cost

(save up to \$1.20)

These are FXR's revolutionary new Amphenol/IPC "quick-crimp" BNC coaxial connectors.

**Assembly:** Simplicity itself. No hypercritical tolerances, no tiny washers or inserts. Just three pieces that even a butterfingers can assemble in 15 to 30 seconds. And of course no braid comb-out or anything like that.

**Cost:** Less, much less. (\$0.60 each in quantities of 250.) That's 60 cents to \$1.20 less than other crimp-type connectors. And it's seven cents less than its UG 260 B/U counterpart. Plus the much-reduced assembly labor costs of quick-crimps over UGs.

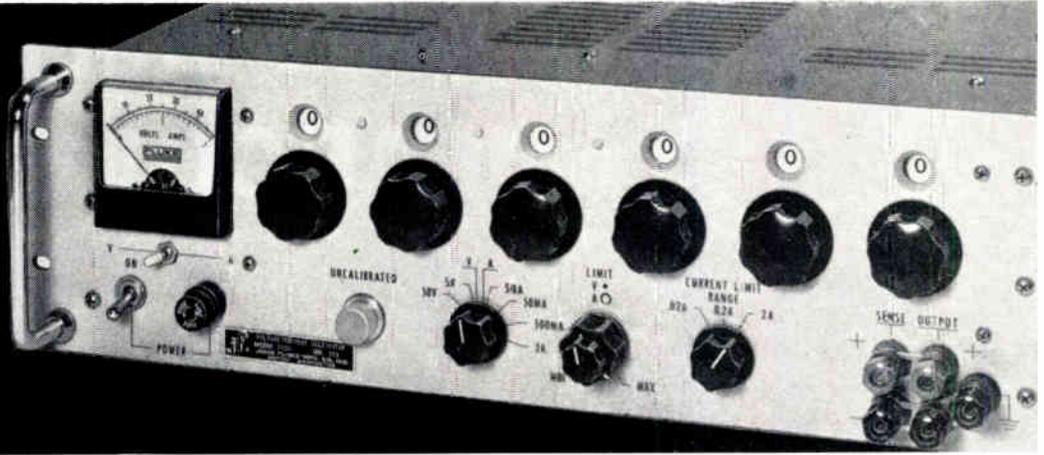
**Performance:** Positive electrical and mechanical uniformity. Increased cable retention. 500 volts rating. VSWR is uniformly excellent to 10 Gc. Connectors are impedance matched to all 50 ohm RG cables normally associated with the BNC Series, but may also be used with 75 and 95 ohm RG cables when VSWR is not critical.

Test them yourself. Order a few (or a lot—we're in mass-production now) from FXR or your local Amphenol-Borg distributor. FXR, 33 East Franklin St., Danbury, Conn.

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OF AMPHENOL-BORG ELECTRONICS CORPORATION



**±0.01%**  
VOLTAGE  
calibration  
accuracy



## ONE INSTRUMENT 382A OFFERS DUAL MODES



**±0.02%**  
CURRENT  
calibration  
accuracy



## NEW FLUKE VOLTAGE/CURRENT CALIBRATOR

New solid state Fluke Model 382A is a combination ±0.01% voltage calibrator with 0-50V capability in two ranges, and ±0.02% current calibrator with 0-2 ampere capability in four ranges.

Line or load regulation is 5 ppm. Main feedback loop amplifier is chopper-stabilized. Fluke-manufactured, precision wirewound resistors in the sample string are matched for accuracy and temperature coefficient. Reference zener diode and current regulating components are isolated in temperature-controlled oven.

Current and current/voltage limiting provide precise and continuously variable control of output. Continuous short-circuit is harmless to the instrument. Removal of overload restores normal operation. Current or voltage limiting is indicated by front panel lamp.

Output is controlled via six in-line front panel decade switches. Terminals are provided both front and rear for remote sensing of output voltage. Mechanical construction utilizes plug-in flow-soldered glass-epoxy printed circuit boards.

Model 382A requires only 5¼" of rack space. Price is \$1,595. The Model 383B, a digitally programmed version of the Model 382A, is available for systems applications. Be among the first to get the full story!

Send for full specification data on the Model 382A, plus new 64A Catalog Digest describing 40 models of Fluke differential voltmeters, power supplies and other precision instruments. Address JOHN FLUKE MFG. CO., INC., Box 7428, Seattle, Wash. 98133.

Precise performance in the  
**VOLTAGE MODE**  
for calibration of voltmeters and  
instrumentation systems

OUTPUT VOLTAGE: 0 to 50 VDC;  
0 to 5 VDC  
OUTPUT CURRENT: 0-2 amperes, limited  
to any preset value from 2 ma to 2 am  
in three ranges  
CALIBRATION ACCURACY: ±0.01%  
STABILITY: Per hour, 0.002%; per day,  
0.0025%; per month, 0.005%  
RIPPLE: Less than 50 uv RMS  
RESOLUTION: 100 uv (50V range); 10 uv  
(5V range)

Precise performance in the  
**CURRENT MODE**  
for calibration of ammeters, current  
shunts, resistors; gyro torquing and  
solenoid excitation

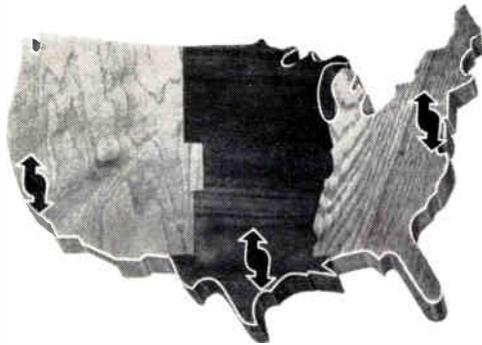
OUTPUT CURRENT: 0-2 amps in four rgs.:  
0-5 ma, 0-50 ma, 0-500 ma, 0-2 amps  
OUTPUT VOLTAGE: Limited to any preset  
value from 5 to 55 volts in one continu-  
ously variable range  
CALIBRATION ACCURACY: ±0.02%  
STABILITY: Per hour, 0.0025%; per month,  
0.005%  
RIPPLE: ±0.002% of range RMS  
RESOLUTION: 0.01 ua maximum



# For a good start... call ARCO!

Thinking of a new product line? Here's a good way to begin: Have a factory-trained Arco Sales Engineer stop in to discuss your parts list, present and future requirements. Need MIL-approved parts? Arco has them wherever specifications are applicable. Need a few pieces for breadboarding? Arco's Sales Engineer will take your prototype order. Maybe even give you samples. He can even help you

determine the specifications you need. And whatever you order from Arco, you're assured of delivery in production quantities, within 24 hours. Arco's regional headquarters are stocked in depth and are located to serve key industrial areas from coast to coast. You'll never lose production time if you phone, wire or TWX Arco to maintain production inventories. You'll always get top quality...for instance...



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TO SERVE YOU BETTER!**



## For best terminations... say DEUTSCH

No matter how good the equipment, it can't operate without perfect electrical contacts. That's why Deutsch Connector makes reliability a reality in plugs, receptacles and rack-and-panel terminations. All Deutsch contacts are precision machined of tough copper alloys. They are designed to eliminate bending or scratching of pins during mating or test probing, and are guaranteed for precise pin diameter and contact separation force. Deutsch designs, develops and produces a full line of multi-

contact electrical connectors, including: miniature, subminiature, coaxial, hermetic, rack/panel and umbilical types. All will meet or exceed MIL specifications wherever applicable, and are manufactured under the strictest quality controls. At Arco, the Deutsch Division is a self-contained unit for assembly of connectors, providing virtually any assortment on 24 hour notice. For complete specifications of Deutsch terminating devices, write or phone Arco Electronics for Bulletin DCC.

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# 48 HOUR DELIVERY ON THESE MIL SPEC RESISTORS

Daven Type	MIL-R 93C	MIL-R 9444	Dia. (Inch.)	Lgth. (Inch.)	MIL Watts	MIL Max. Volts	Lead AWG
1195	RB54	AFRT11	1/4	3/4	.25	300	#20
1250	RB55	AFRT10	1/4	1/2	.15	—	#20
1252	RB52	AFRT13	3/8	1	.5	600	#20
1283	RB56	—	1/4	11/32	.125	—	#20

If your application calls for one of the four precision wire wound resistors described above, you can get it in 48 hours from Daven! All are available in standard decade values. Tolerances of 1% to .01%. For complete information, write or call today.

## CHARACTERISTICS OF ALL DAVEN RESISTORS

**Non-magnetic, radiation-resistant, tolerances:  $\pm 0.005\%$  to  $\pm 1.0\%$ .**

**LEAD TYPES:** Axial wire, radial wire, printed circuit wire, radial lug, printed circuit lug, plus many wire lead materials and platings.

**385 STYLES:** Epoxy, varnish or silicone coated, metal encased, solder sealed.

**SIZES:** From .1" dia. x .235" long to 7/8" dia. x 2 1/8" long.

**OHMIC RANGE:** 1 milliohm to 25 megohms.

**TOLERANCE (production basis):**

Absolute — down to & including  $\pm 0.005\%$ .  
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**TEMP. COEF.:**  $\pm 1$  PPM/ $^{\circ}$ C to +6000 PPM/ $^{\circ}$ C.

**STABILITY:** Down to  $0 \pm 20$  PPM for 3 yrs.

**RISE TIME:** Down to .05  $\mu$ sec. **POWER:** .03 watts to 10 watts. **VOLTAGE:** 1000v to 2000v.

**THERMAL EMF:** Down to 2.5  $\mu$ v/ $^{\circ}$ C.

**NOISE:** Down to thermal noise level.

**MIL SPECS:** Meet or exceed MIL-R-93 & MIL-R-9444.

### HIGHEST RELIABILITY

with over 10 million test hours calculated failure rate of 0.02%/1000 hrs, based on full power @ 125 $^{\circ}$ C.

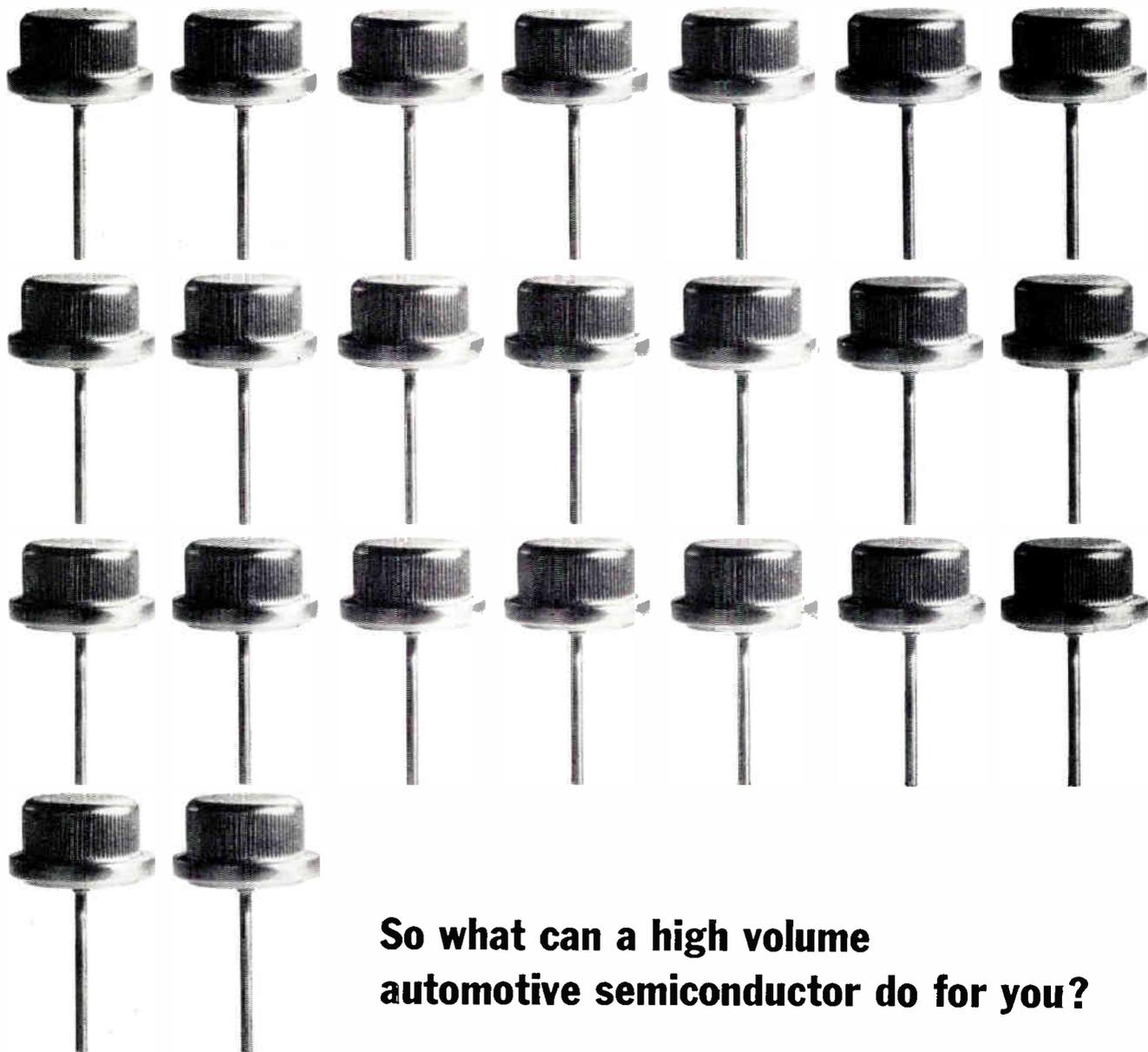
**PARTICIPATION IN ALMOST EVERY MAJOR MISSILE HI-RELIABILITY PROGRAM**

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The 18-ampere 1N3491-93 press fit series in 50, 100 and 200 P.R.V. ratings will withstand current surges to 300 amperes. Hermetic sealing and extensive thermal cycling assure stability of operation from  $-65^{\circ}\text{C}$  to  $+175^{\circ}\text{C}$ —for as low as two cents an amp.

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Or maybe you'd be interested in other rectifiers being readied for high volume applications such as: the new 750 ma, 50- or 100-volt silicon encapsulated DRS 100 series, the DRS 150 series of 1.5 ampere "top hats," or the heavy-duty 800 to 1200-volt, 250-ampere DRS-250 series.

For the full story on delivery, price and reliability advantages these high volume devices can offer you, contact any Delco Radio sales office. They'll supply you with data, prices and applications assistance.

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### 15 METALLIZABLE CERAMICS

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2 Beryllias 5 Aluminas

### 4 METALLIZING PROCESSES

Refractory Metal Powder Silver  
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Since all ceramics and metallizing processes are not interchangeable, our engineers will suggest combinations likely to meet your requirements.

### PLUS PLATING, including:

Copper, tin, silver, nickel,  
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### SOLDERS AND BRAZES, including:

60% tin-40% lead; 95% lead-5% silver;  
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97 1/2% lead-2 1/2% silver;  
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### METALS FOR ATTACHMENT, including:

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If you need facts about metallized ceramics, we suggest that you request

## ALSIMAG<sup>®</sup> BULLETIN No. 632

It has 20 pages on high and low temperature metallizing, high and low temperature hermetic seals, ceramics and metals commonly used in metal-ceramic assemblies, property charts, graphs comparing thermal expansions of these ceramics and metals, suggestions on patterns, and on design and installation.

If you will submit your problem in detail, our engineering staff will help you find the best combinations for your requirements. Prototypes can be supplied at reasonable cost.

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63rd  
YEAR  
OF  
CERAMIC  
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# HERE ARE THE WINNERS IN OUR MOST USEFUL ARTICLE IN 1963 CONTEST

**1<sup>st</sup> Prize Winner**

**JAMES FISK, E. E.**

Raytheon Missile/Space Div.  
Box 902, Hartwell Rd.  
Bedford, Mass.

## **"New Developments in Antennas"**

The most useful article in 1963 in ELECTRONIC INDUSTRIES was "New Developments in Antennas," (June, 1963) because it was very timely and informative and proved to have important practical application to my work. Shortly after reading the article our department was given an assignment which included some rather unusual antenna requirements. Since this work is somewhat out of our field, I was given the task of acting as liaison to the antenna group with whom I was to survey the latest developments and submit a report making recommendations on suitable antennas. Since I had only recently been informed of the State-of-the-art by this article, I had a better basis from which to start an investigation. This enabled me to ask more penetrating questions and to complete the task with a smaller expenditure of time and energy.

James Fisk

**2<sup>nd</sup> Prize Winner**

**HENRY M. ALKEN, Sr. Engr.**

Varian Associates  
1500 Kings Highway  
Cherry Hill, N. J.

## **"Disarmament: What Would it Mean to the Electronics Industry"**

The most useful article in 1963 in ELECTRONIC INDUSTRIES was "Disarmament: What would it Mean to the Electronics Industry," because this piercing, analytic article has caused me to take a long, considered look at the complete posture of my company's defense engineering program. The unusual depth and succinct presentation of the essential facts and the problems which will be encountered should disarmament be vigorously pursued have permitted my staff to re-direct their thinking toward the complete, total, big picture. I can confidently say the article has saved us incalculable time and money. Articles of this quality are all too rare.

Henry M. Alken

### 3rd Prize Winner

**F. J. D'AVOLA, JR.,**  
Comp. Engr.

GPL Div., General Precision  
Aerospace Group  
63 Bedford Rd.  
Pleasantville, N. Y.

#### **"Designer's Guide to: Lamp Selection: Indicator Lights and Illuminated Switches"**

The most useful article in 1963 in ELECTRONIC INDUSTRIES was "Designer's Guide to: Lamp Selection: Indicator Lights and Illuminated Switches," because up until the appearance of subject article, we maintained the use of many devices to obtain various individual indicating functions. Due to the information obtained from subject article, we were able to combine the functions of switching and indication within one component rather than the use of two components. We, therefore, obtained a cost saving, stocking problem and panel simplicity (human factors) of design. At one time we were improperly utilizing various neon lamps for circuit design which caused failures in the field. We have since been informed properly as to selection of lamps to obtain a higher reliability and service life.

F. J. D'Avola, Jr.

### 4th Prize Winner

**GEORGE A. WHITTEN,**  
Res. Sp.

Lockheed Missiles & Space Co.  
Dept. 91-35  
P. O. Box 504  
Sunnyvale, Calif. 94088

#### **"Who is the Unemployable Engineer"**

The most useful article in 1963 in ELECTRONIC INDUSTRIES was "Who is the Unemployable Engineer," because it incited me to a self evaluation as I read it. I decided that I was too specialized and I undertook some studies to broaden my technical perspective. Little did I realize that a few months later I was to find myself within the ranks of the surplus. It would be trite to say the article saved my job, but my new perspective enabled me to find—quite quickly—a new position within the company.

George A. Whitten

### 5th Prize Winner

**J. S. ROGACZEWSKI,**  
Engr.

Burroughs Corporation  
6071 Second Ave.  
Detroit 32, Mich.

#### **"A Look at Coded Disks and Encoders"**

The most useful article in 1963 in ELECTRONIC INDUSTRIES was "A Look at Coded Disks and Encoders," because the article revealed a possible solution to a serious instrumentation problem. Prior to reading the article, it seemed impossible to obtain a 10 bit encoder with a moment of inertia less than 15 gram cm<sup>2</sup> as a standard product. By contacting the author, it was discovered that such an encoder does exist and at a reasonable cost. As a result, two encoders were purchased and are going to be used in a piece of special purpose test equipment.

Jerome S. Rogaczewski

In the February 1964 issue we asked you to tell us which article that we published in 1963 was the most useful to you and why. The response was gratifying. From the many returns our editors selected these winners. Our congratulations to them and our thanks to all who participated. The most popular article was "Mathematical Models For Engineers." A reprint of this article is being sent to all participants.

The Editors, ELECTRONIC INDUSTRIES



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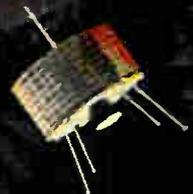
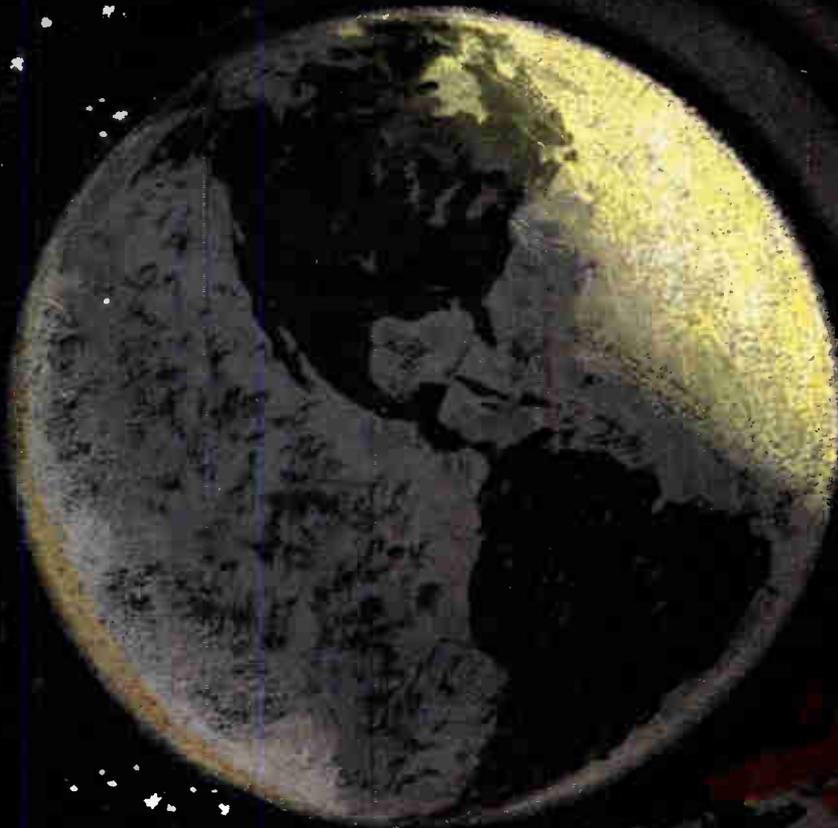
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**Syncom Satellite**—the first synchronous communications satellite built by Hughes Aircraft Company for the National Aeronautics and Space Administration. With an orbital speed matching the earth's rate of rotation, a synchronous communications satellite appears to hang motionless overhead; and at its height of 22,300 miles, more than a third of the earth can be seen. Thus, it is possible for three such satellites to form a vast television and telephone network which would circle the globe and provide uninterrupted service.



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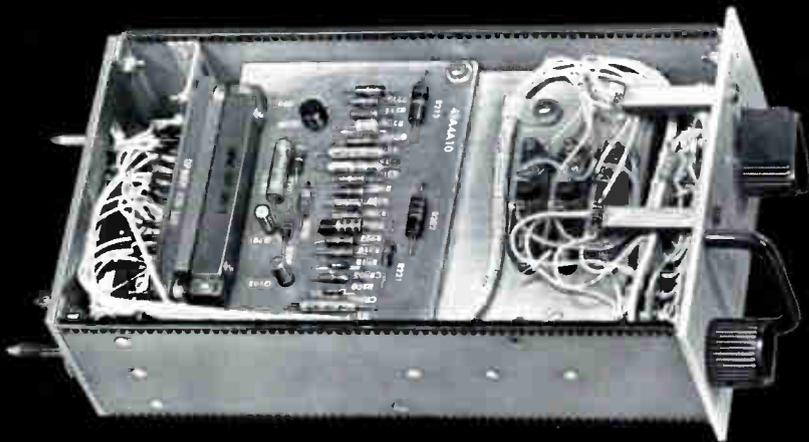
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Brush Instruments' Recorder and internal view of channel amplitude control showing use of A-B hot molded resistors.



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# THE HERMETICALLY SEALED CONNECTOR AND ITS CAPABILITIES

**ELECTRONIC  
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**STATE-OF-THE-ART**

**FEATURE**

What will hermetically sealed connectors do or not do?  
What can be expected of them  
as opposed to other connectors?  
How are they affected by temperature,  
humidity, pressures, thermal and physical shock etc.  
These and other pertinent questions are answered here.

This printed circuit card connector is made with hermetic seals. The pencil points out one of 50 glass seals used in the connector.



**By ARTHUR STASCH**  
Industrial Engineering Mgr.  
Amphenol Connector Div.  
Amphenol-Borg Electronics Corp.  
1830 S. 54th Ave.  
Chicago 50, Ill.



HERMETICALLY SEALED CONNECTORS offer a gas- or air-tight interconnecting junction that can help environmental problems. They can be used to bring electric circuits through walls and bulkheads in rocket engines, missiles, submarines, spacecraft and computers.

But hermetic sealing has limitations as well as advantages. An understanding of these benefits and limitations is essential for design engineers.

\* \* \*

Let's start with this definition: A hermetic seal must be gas-tight and be able to conduct a current into the sealed container with minimum disturbance to the circuit. This performance must be maintained for extremes of temperature, humidity, pressure, thermal and physical shock, vibration and corrosive atmospheres.

Under all these conditions, the connectors must withstand rated current and voltage, and maintain a high insulation resistance. They should produce no corona, nor have excessive shunt capacitance or dielectric losses.

### **Tolerances Harder to Obtain**

In spite of this, many designers treat a hermetically sealed connector like any other connector. Since a hermetically sealed type is subjected to heat to obtain the hermetic seal, tolerances are harder to obtain and hold than with a normal connector.

This problem is made even more acute by circuit designers who attempt to design their own connectors or who wait too long in laying out their circuits before considering what a sealed type can and cannot do.

What will they do—or not do?

Let's check temperature range first. A routine requirement is from  $-65^{\circ}$  to  $+400^{\circ}\text{F}$ . But, it is possible to produce hermetically sealed types that will operate from  $-200^{\circ}\text{F}$  to  $+600^{\circ}\text{F}$ . And, we're convinced this is not the final limit. Work is being done to extend this range.

When a designer wants a connector that will operate beyond the normal temperature ranges, he must realize that he is asking for a special product that will require design and development time of its own. He should factor this time into his scheduling.

The high temperature problem is quite complex. It creates related problems. Structural stability is critical because the atomic structure of most alloys becomes quite mobile at high temperatures. Few alloys are stable for long periods of time at high temperatures.

Age-hardened materials may overage, work-hardened materials may anneal and alloys contain-

ing many different elements may form new phases, lose strength and become brittle in certain temperature ranges.

What about mechanical loads and stresses? Various mechanical loads are imposed on today's airframes, rockets, missiles and power plant components.

But, these problems have been solved with the use of Austenitic stainless steels Types 310S, 316L, 321 and 347 in hermetically sealed connectors. They have good strength, good fabrication characteristics and good corrosion resistance where the needs are not too rigid. They are used where the temperatures range from  $-200^{\circ}$  to  $+600^{\circ}\text{F}$ .

Also, development work is now being carried out with aluminum for hermetically sealed connectors. This would help solve the weight problem for such uses as missiles and airframes.

To select the proper material for severe conditions of shock and vibration, the designer again must allow time for connector design and material development. These uses require working with such variables as tensile, yield, impact, fatigue, shear and bearing strengths; elongation, ductility and modulus of elasticity. Thermal failures might result from sudden intermittent or widely fluctuating temperatures. Physical properties, such as the coefficient of expansion and thermal conductivity, must also be evaluated.

Construction sometimes limits what a sealed connector will do. The seal, for example, is only as strong as its weakest link. An O-ring seal has a maximum temperature range of  $-65^{\circ}$  to  $+400^{\circ}\text{F}$ , while connectors without O-rings can have a much broader range.

### **First Consideration**

Good adherence between glass and metal is needed for an effective seal. Any glass will "wet" and adhere to a clean, gas-free metal if the metal surface is covered with an adherent oxide layer, and if the temperature is raised to where the oxide dissolves in the glass. Contrary to popular belief, a rough surface is not desirable. Glass never becomes fluid enough to fill tiny crevices.

Because thermal expansion curves do not coincide exactly as temperature rises to the annealing point of glass, stresses occur that must be considered. The seal can be made relatively free of stress if the shell material expansion curve shows that the glass is held in a constant state of compression, up to glass transformation temperature.

For instance, when iron-nickel alloy contacts—such as Driver Harris No. 52—are sealed to Corning 9010 glass, this stress-free condition is possible if

## SEALED CONNECTORS (Continued)

the Curie temperature of the metal, the glass transformation temperature and expansion coefficients are related to insure low stress at any temperature.

Briefly, an iron-nickel alloy contact should:

1. Have an expansion coefficient that closely matches the glass over the entire assembly temperature range.
2. Melt at a higher temperature than the glass.
3. Be stable at all temperatures below the sealing temperature (show no chemical transformations or accompanying expansion changes).
4. Adhere well to glass (for oxide seals, good adherence is needed between oxide and metal, and between oxide and glass).
5. Have good electrical and thermal conductivity if heavy currents are to be carried.

### Glass Must be Fluid

A temperature high enough for the glass to be fluid is needed when the glass and metal are brought into close contact for sealing. Sealing temperature of the metal generally equals or exceeds that of the glass.

De-gassed metal with surfaces free from contamination or defects is subjected to pre-oxidation prior to firing. This step is essential, depending upon material used. After sealing, if the proper oxide color appears, it is satisfactory. A bright, clean metal surface means poor oxidation prior to glass flowing on the metal; the seal may be vacuum-tight but lack mechanical strength. A black seal denotes over-

oxidation; the seal will be strong but inclined to porosity.

Seals made correctly are very tough and will bear large thermal shocks without harm.

Electrical properties of glass are important, since hermetic seals may fail by electrical leakage over the glass surface, or by electrolysis in the glass. Circuit characteristics, especially in the ultra-high frequencies, often depend on the power factor and the dielectric constant of the glass used. End use of a glass-metal seal is an important factor in the choice of materials. Properties for some glasses used for sealing are given in Table<sup>1</sup>.

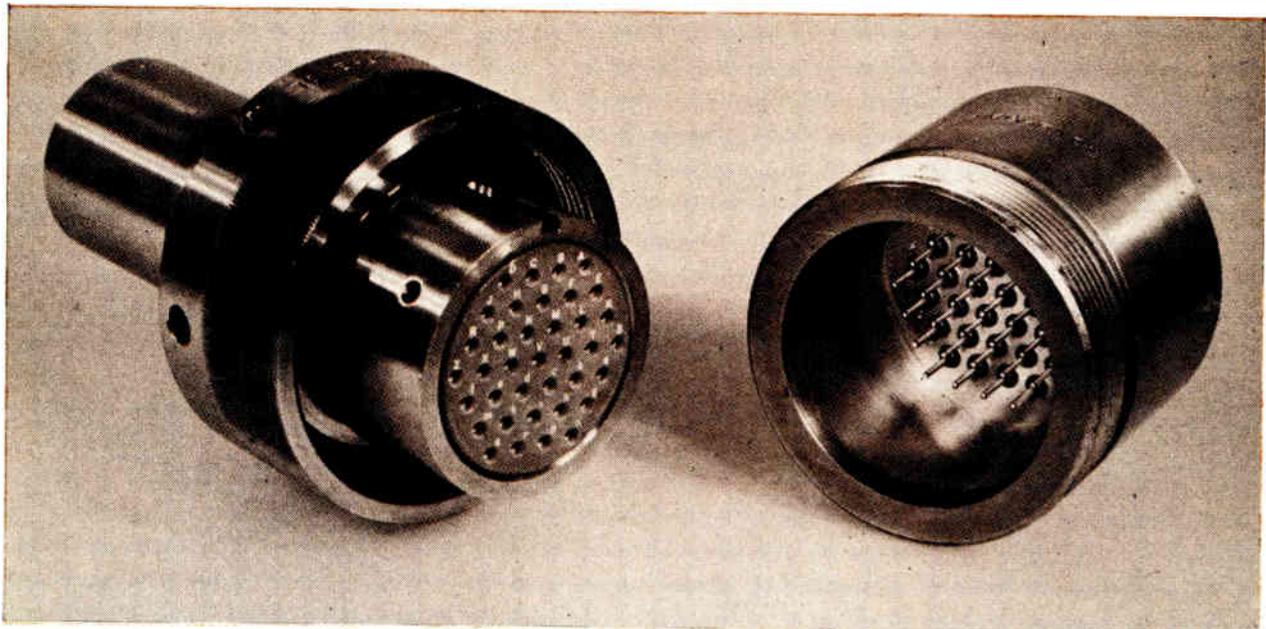
It should be recognized that thermal expansion is the rate a material increases its *volume* when heated. Linear coefficient of thermal expansion is the rate a material *elongates* when heated.

Several needs limit the choice of metals that can be joined to glass:

1. Thermal expansion must be uniform over temperatures ranging from below room temperature to above the annealing point of the glass.
2. Be stable during sealing (it must not soften or burn at sealing temperatures).
3. Adhesion between the metal and its oxide must be good.
4. Amounts of gas given off by the metal at sealing temperatures must be very low.

The mechanism of glass-metal seals is not completely understood. It depends, to a degree, on the oxide film that forms on metals when they are heated. The film should be relatively thin to eliminate danger of flaking from the metal surface. And,

Hermetic seals may be seen around contact pins in the plug section of this 37 pin connector.



it must be non-porous if a hermetic seal is desired. When glass and metal surfaces are heated, temperatures must be high enough so the glass becomes molten and makes close contact with the metal oxide film. The oxide is diffused or dissolved to some degree in the glass.

### Three Basic Seals Available

The glass-to-metal seals are produced in three main categories—soft-glass-frit, matched-glass, and compression-glass types. Each type depends for a seal upon a bond between a metal and a glass member. The method of obtaining the bond differs.

The soft-glass type uses an enamel-type glass bonded to mild steel. This glass is similar in some respects to the frit used on porcelainized steel. The combination makes an economical seal useful over a limited temperature range.

The matched-glass type uses low expansion alloys such as Kovar and glasses with matched expansion coefficients. This type is useful for withstanding thermal shock and wide temperature ranges.

The compression-glass seal is a fairly new development, aimed at increasing the physical strength of the glass-to-metal seal. It has a steel outer shell shrunk into the glass insulator so that the glass is under compressive forces at the needed operating temperatures. Unlike the other seals, the thermal expansion coefficients of the glass and metal are deliberately mismatched. This aids in maintaining a seal over a wide temperature range. One feature of compression seals is that miniaturized and multiple contact connectors and headers may be produced.

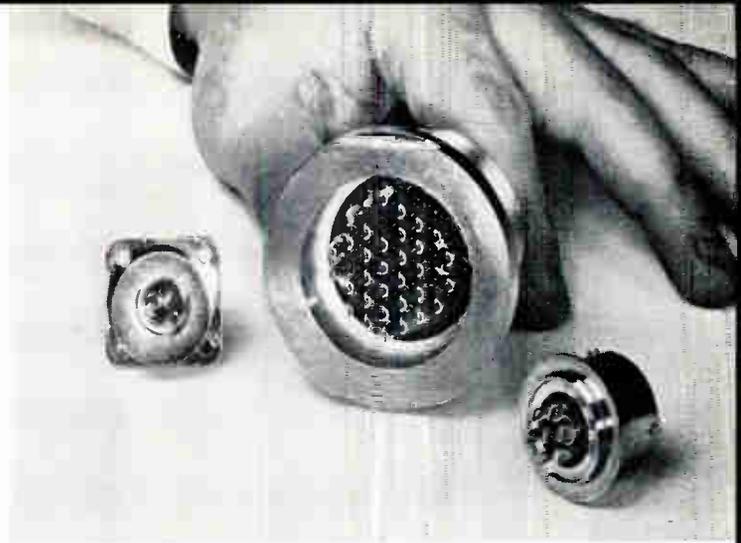
The matched-seal requires equal coefficients of expansion of the glass and metal, plus an oxide bond to form the seal. Metals used in such seals must be special alloys—such as Kovar, Rodar or Therlo. Because restraint or compression is not essential in a matched seal, the glass area can vary in shape from circular to elongated oval. These designs have less resistance to shock, both physical and thermal.

Glass thickness should not be less than 0.050 in. due to the inherent physical weakness of a matched seal and the high cost of manufacturer. Conversely, glass beads have been made as thick as 0.250 in.

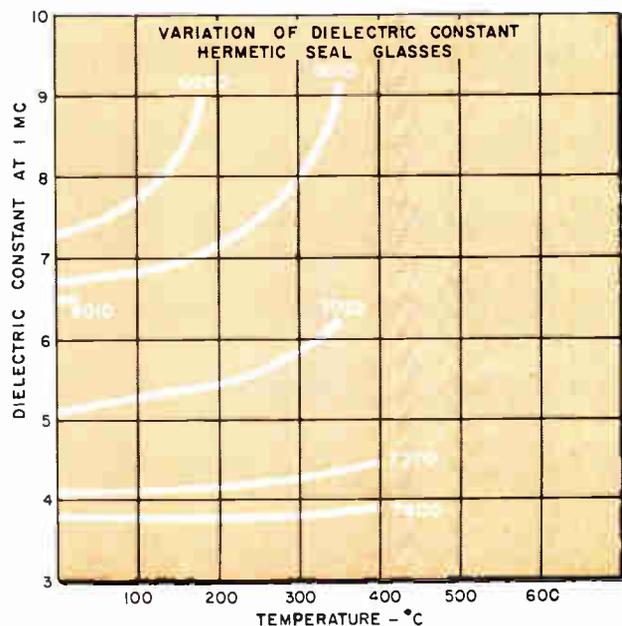
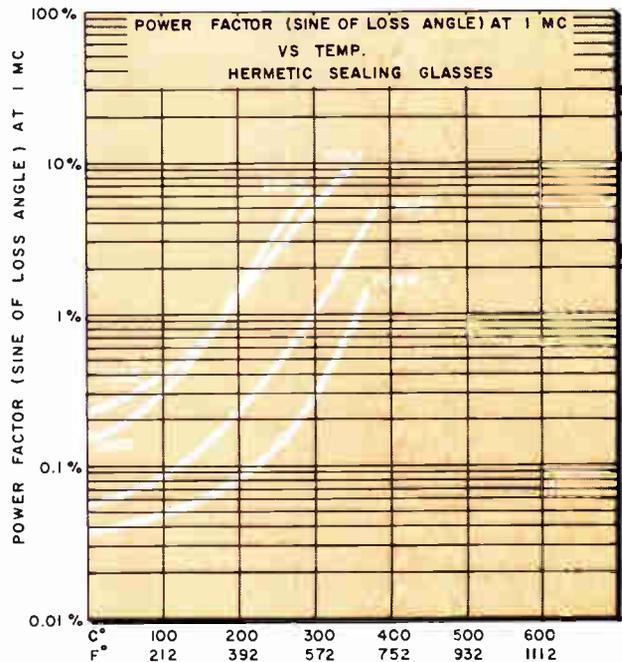
Contacts or terminals should be round in cross section where they pass through the glass; their shape at the point of electrical connection will depend upon usage. In a Kovar or matched seal, both eyelet and pin material must be of Kovar.

### Principle is More Physical

The underlying principle of the compression (or mismatched) seal is more physical than chemical.



These hermetically sealed connectors all have glass seal inserts. Shown, left to right, are a special unit in a Type 310 Stainless Steel shell, an AN type with a cadmium steel shell and a MIL-C-26500 connector with a Type 347 Stainless Steel shell.



## SEALED CONNECTORS (Concluded)

While matched seals depend upon formation of an oxide bond and the closely matched coefficients of expansion of the glass and metal, the mismatched seal depends to a great extent on the elasticity of glass and purposely mismatched coefficients of expansion.

But, more than a physical bond is present in a good compression seal. The great physical strength of the seal results from the glass being stronger in compression than in tension. In a compression seal, a substantial thickness of metal eyelet is needed to maintain compression. Basic material for such eyelets is low-carbon steel. This is fairly easy to machine, stamp or coin.

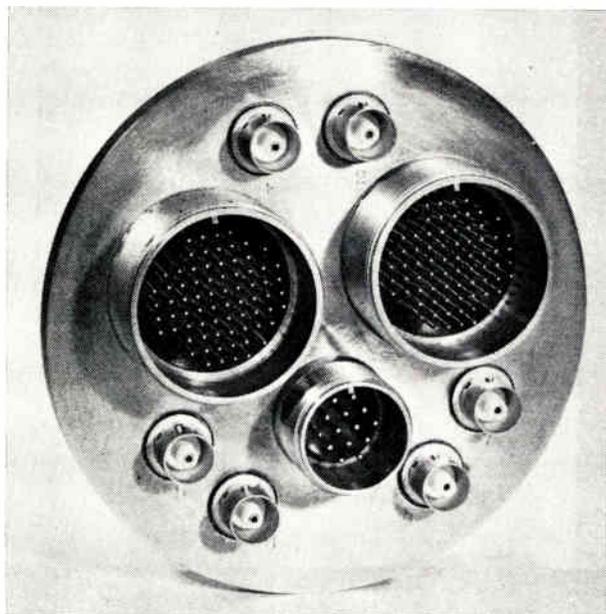
To maintain the balance of forces needed to keep the glass in compression, have at least 0.040 in. minimum web thickness. Thickness of the seals has been standardized at 0.093, 0.125, 0.156, 0.218 and 0.281 in. In certain cases, the glass might be as thin as 0.050 in. Conversely, glass seals have been made as thick as 0.750 in. Glass shape should be round, to keep equal distribution of forces. Pin or terminal cross section should also be round.

### Should Not Leak

A hermetic seal should not leak. A good seal is accepted on the basis of finding little or no leakage.

The allowable leakage rate is based on several factors—including sealed container volume, number

Space simulation chamber penetration plate has all hermetically sealed connectors. Three large ones show glass seals in a standard MS pin setup. Six smaller connectors are r-f units.



of terminals, desired component life, average pressure differential across the seal, and susceptibility of the component to contamination. The most severe condition is vacuum within the container. But, an inert gas is usually sealed within the container at an absolute pressure slightly more than one atmosphere. Then, any leakage will be outward until the pressure differential disappears.

Methods and equipment for detecting leaks of 10 to 12 cc of air/sec. are costly, difficult and time-consuming; they are best suited to the lab.

The most sensitive method that can be used with reasonable economy is the helium mass spectrometer detector.

### Cracks Can be Controlled

Cracks are controlled by a 10-15 power binocular microscope for visual inspection and by the Statiflux\* process. Mass spectrometer testing is not a sure method for detecting cracks. Statiflux locates cracks through pores or surface scratches in non-conductive, non-porous materials. Electrostatically charged particles build up clearly visible indications marking every defect on the surface.

There is a relationship between glass diameter and a tendency to crack. When the glass diameter exceeds its thickness by a five factor, trouble may be expected.

Physical properties of glasses are quite different from metals. Shear strength, for example, means much when associated with metals, but has little significance in glasses. Similarly, hardness must be measured in terms that rarely apply to ductile materials.

Glass is brittle. It does not plastically deform, before failure and it fractures only from tensile stresses, never from shear or compression. Stress curve for glass is a straight line up to the breaking point.

### Tensile is Limited

Intrinsic strength of all glasses is very high, possibly as much as 3,000,000 psi. Glass fibers have supported tensiles of more than 1,000,000 psi. But, the useful or every day strength is only a small fraction of these figures because of stress concentrations due to surface imperfections.

### Elastic to Breaking Point

For most purposes, glass is perfectly elastic up to the breaking point. Modulus of elasticity varies from 6,000,000 to 13,000,000 psi.

Glasses are harder than mica steel, mild steel, copper, aluminum and marble.

\*Statiflux is a trademark of Magnaflux Corp.

Table 1

## SEALING GLASSES &amp; THEIR ELECTRICAL PROPERTIES

To Seal To This Metal	Glass	Resistivity Log R (ohm-cm)		P.F.	Dielectric Prop. 1 mc @ 20°C Dielectric Const.	L.F.	Temperature °C	
		250°C	350°C				Working	Annealing Point
Aluminum	7570	10.6/8.7		0.22	15.0	3.3	555	365
Copper	0120	10.1/8.0		0.16	6.6	1.1	975	433
Dumet	0120	10.1/8.0		0.16	6.6	1.1	975	433
Fernico	7052	9.2/7.4		0.26	5.1	1.3	1115	475
Kovar	7052	9.2/7.4		0.26	5.1	1.3	1115	475
Mica	7570	10.6/8.7		0.22	15.0	3.3	555	365
Molybdenum	7052	9.2/7.4		0.26	5.1	1.3	1115	475
Platinum	0120	10.1/8.0		0.16	6.6	1.1	975	433
Rodar	7052	9.2/7.4		0.26	5.1	1.3	1115	475
SAE 1113	9010	8.9/7.0		0.22	6.5	1.4	1020	442
Sealmet #28	0120	10.1/8.0		0.16	6.6	1.1	975	433
Sylvania #4	0120	10.1/8.0		0.16	6.6	1.1	975	433

Impact abrasion resistance is evaluated by measuring resistance to sandblasting. Values recorded are relative compared to soda lime plate glass, which arbitrarily is given a value of 1.

Since glass fails only in tension, usually at the surface, the temporary stresses from sudden cooling are much more damaging than those resulting from sudden heating. This assumes that all surfaces are heated or cooled at the same time.

Transient thermal stresses increase directly with glass thickness and expansion coefficient. They also depend upon connector shape and method of chilling or heating. Thus, a complicated connector shape would be more severely stressed than a simple single-pin r-f type seal. Sudden chilling by immersion in cold water is more rigorous than blowing with cold air.

### Strain Disappears

When glass is subjected to stresses for short periods, the strain disappears when the stress is removed. Also, glass may be broken in many ways—by twisting, tension or impact. But, there is no connection between the numerical values of the breaking strengths as found by these methods. A failure in uniform compression is highly improbable. Fracture results from tensile stresses developed by the manner of applying the load.

An extensive study, made on the effects of moisture, showed glass to be 20% stronger when dry than wet, and 2½ times as strong when baked in vacuum than when wet. It also disclosed that glass fatigue disappears when tested in a vacuum.

Little is known about the effect of temperature on glass strength. At ordinary temperatures, Hook's law

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appears to hold for glass up to fracture. There is no evidence that with increased temperature a region of plasticity develops. As temperature increases, the viscosity diminution makes strength vaporize for loads that decrease with increasing temperature.

Electrical conductivity of glass depends on composition, temperature and to some extent on atmospheric conditions. At low temperatures, poly-component glasses are insulators, and some are among the best insulating substances. At all temperatures, glasses are electrolytic conductors, and from 25 to 1200°C its resistivity may range from  $10^{19}$  to 1 ohm.

Volume conductivity measurement at low temperatures is complicated by surface conductivity, probably caused by a layer of absorbed moisture. Surface conductivity is troublesome at high humidity and with glasses are electrolytic conductors, and from 25 to the volume conductivity.

Volume resistivity is defined as the longitudinal resistance in ohms/unit of length of a uniform bar of unit sectional area. Volume conductivity is the reciprocal of the resistivity.

Surface resistivity is the resistance in ohms of a strip of the surface of unit length and width.

### Better Glasses

Surface conductivity in some glasses may greatly exceed the volume conductivity. But, in better-grade glasses that are properly handled, surface conductivity is negligible. Proper handling includes absolute cleanliness and maintenance of a humidity well below saturation (even better, below 50%).

Many factors have to be considered when deciding how and where to use hermetically sealed connectors. In many cases, special designs have to be developed if the circuit is to operate properly. Obviously, the sooner this is known, the better.

# STATE-OF-THE-ART OF DYNAMIC PLOTTING PROJECTION DISPLAYS

NEW AND EXOTIC DISPLAYS (film transfer projection methods, light valve displays, EL panels, etc.) are, for practical large-area display use, a few years away. Or, their present cost, both initial and logistic, is often prohibitive.

Thus, the uninitiated is left with the impression that a void exists in the practical use of large-area displays. This is far from true. There are many large-area dynamic displays now in operation. These are Plotting Projection Displays, which are practical and working, and also economical.

**ELECTRONIC  
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**STATE-OF-THE-ART  
FEATURE**

Purpose of this article is to give a picture of the current state-of-the-art of these displays. It is specifically appropriate to discuss them now since recent technological advances have resulted in greatly improved performance of

the Plotting Projectors that are the heart of these displays. \* \* \*

Let us describe the basic operation of a typical Plotting Projection Display, Fig. 2.

A slide is automatically moved from the slide magazine into the projection position. The slide is made of glass and coated with an opaque material. Parallel with the slide is a glass plate with a stylus mounted in its center. This stylus plate can be tipped forward against the slide, causing the stylus to contact the opaque material. The plate is also movable in X and Y directions through servo mechanisms. When external servo

Electro-mechanical Plotting Projection Displays have proven economical for most large-area, dynamic display applications. This article gives a picture of the current state-of-the-art of these displays. Recent technological advances have resulted in greatly improved performances.

voltages are applied to the servo amplifiers driving the servo motors, the plate will move accordingly; and, the stylus will scribe a trace in the opaque material of the slide. The light from the illuminator will pass through the scribed trace. And, since the glass slide is focused on a projection screen, the trace will appear on the screen. Width of the trace on the 1-in.<sup>2</sup> slide is 0.001 in. The resulting trace on the display will be 0.1% of the screen size. By inserting a color filter in the light path, traces will be color coded.

Many plotting projectors may be placed side by side or in tiers. By translating their objective lens assemblies, their images can be caused to superimpose on the same projection screen. As a result, composite, multiple input displays can be generated.

Standard reference materials such as maps, grids, etc., can be superimposed on the dynamic information by Reference Projectors. These are identical to the Plotting Projectors except that the X-Y plotting mechanism is eliminated.

Fig. 3 shows a typical composite display generated by Plotting Projectors. In addition to multi-color traces, symbology is also displayed. It should be noted that a displayed symbol becomes permanently stored on the glass slide. Thus, no external memory is needed for symbol regeneration.

## History

Plotting Projection Displays are not old, having been in use for less than a decade. The principle behind them is electro-mechanic-optical as

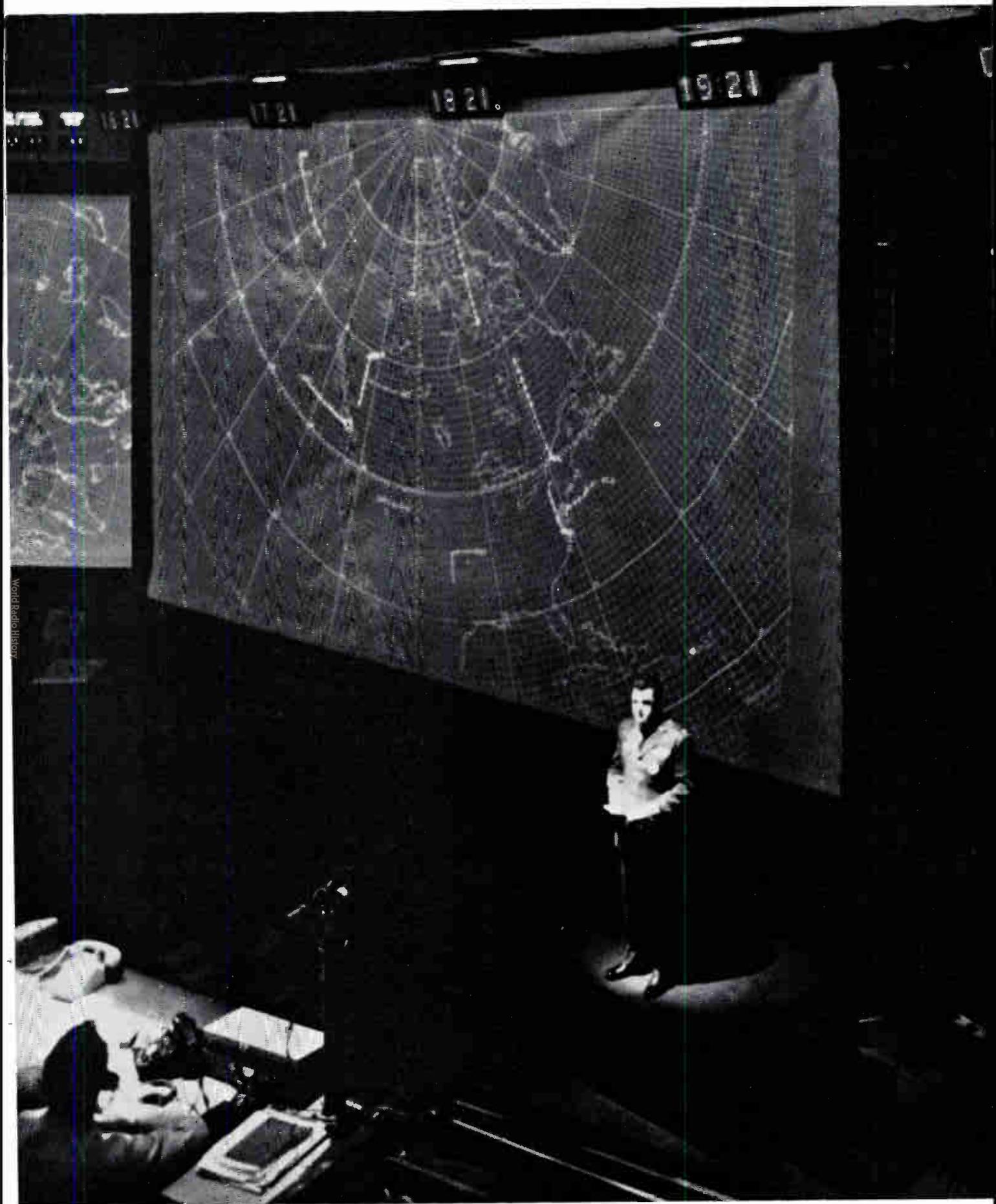


### By ROLF ANDRESSON

Chief Systems Engineer,  
Display System Plant,  
Ling-Temco-Vought, Inc.,  
Military Electronics Div.,  
Dallas, Texas

Fig. 1: This Plotting Projection Display at the North American Air Defense Command Center in Colorado Springs, Colorado is probably the largest dynamic display in the world. As can be seen on the display, each track has a tail of only its immediate past history. Thus, with this design, the display screen is not cluttered with data.





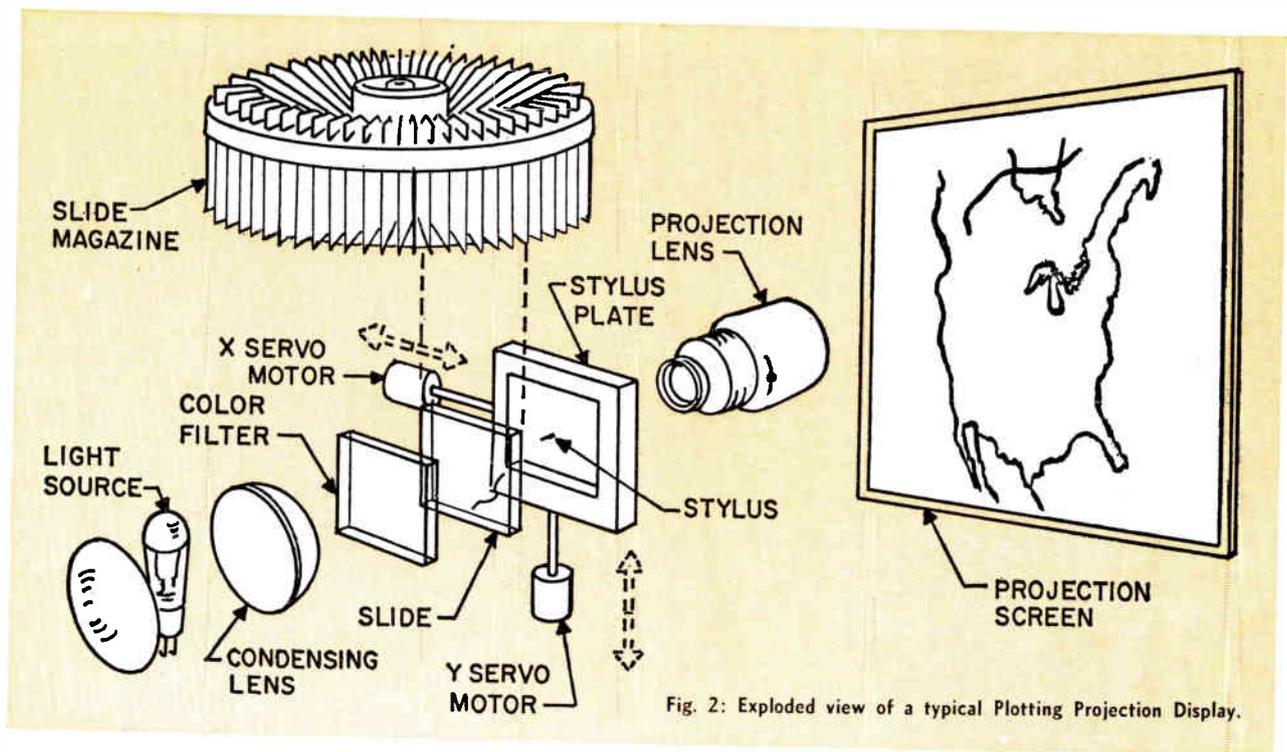


Fig. 2: Exploded view of a typical Plotting Projection Display.

## PROJECTION DISPLAYS (Continued)

we have already seen. Thus, there have been prejudices against them because of their low-data input rates compared with pure electronic displays.

Also, the original displays suffered from some mechanical unreliability. But, for the displays now in use, such problems have been eliminated and reliable operation has been achieved.

### High-Speed Projectors

Past limitations in the use of plotting projectors, due to low-data input rates, will in many uses be eliminated by high-speed plotting projectors now being introduced. These projectors represent the latest in the state-of-the-art of plotting projection displays. The fastest of these have a full scale slew time of about 50 msec. This is a factor of 20 to 30 times better than the previous generation of plotting projectors. This opens up new possibilities in large-area displays. Advantages of new concepts can now be taken to greatly simplify, reduce size, or otherwise improve the display. The rapid response of the high-speed projector permits an increase in track handling capacity. Thus, time-sharing of one projector between many inputs will suffice in many uses. In addition to the reduction of the number of projectors, savings can also be made in the amount of supporting electronics.

High-speed plotters also permit greatly increased rates of alpha-numeric character display. Twenty characters/sec. are feasible. This is close to the speed

with which the average observer can read and still comprehend.

What are the methods used that have allowed this drastic improvement of response? Dc torque motors have replaced ac motors for the servo drive. These will develop much more torque than corresponding size ac servo motors. Load inertia presented to the servo motors has been greatly reduced since the stylus assembly no longer carries one of the servo drive motors. Instead, clever mechanisms have been designed to transmit the X and Y servo motions from the stationary mounted servo motors to the stylus assembly. To further decrease the load inertia, the tachometers have been eliminated, and velocity compensation is done through passive networks in the servo amplifiers.

Servo performance has been improved since there are no gear trains in the servo system, and thus, no backlash. The torque motors drive their load directly without an intermediate gearing, and the feedback pots are ganged directly to the torque motors.

Another feature of High-Speed Projectors is that the number of moving parts and wearing surfaces have been greatly reduced. This is the case with the slide select and slide change mechanisms.

Inputs to the servo amplifiers are analog voltages. The High-Speed Plotter Display can, however, get its input from computers through buffers and Digital-Analog converters.

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## Systems Application

In uses where color coding of tracks is not needed, one high-speed projector can be used for time-sharing many inputs. If, as an example, 1-sec. update time of individual data points on a track is needed, one projector with combined slew and symbol plotting time of 100 msec. is capable of time-sharing 10 different input channels. Symbology is, in this case, used to distinguish the 10 tracks.

In case the 10 inputs are related, they can also be displayed in a specific color. If another set of inputs in turn are related, they must then be time-shared by another projector that displays in a different color. An example of this use is an air-surveillance display where all the different friendly tracks are time-shared by one color-coded projector and must be distinguished from all enemy tracks shown by another projector in another color.

Although we now have the high-speed projectors, the normal projectors with full-scale slew time of about 1 sec. are not outdated. As a matter of fact, for a great many uses, their speed is still enough.

This is specifically true when only a few inputs are displayed and when individual color coding of these inputs prevents the use of time-sharing. Plotting is done in real time and there is no undesirable time lag for all practical display scales. Time-sharing is still feasible with these projectors if the sampling interval is larger than a few seconds. This is the case in normal naval surveillance and navigation display uses. Fig. 4 shows a Navy CIC Plotting Projection Display.

Inputs to this display are automatically originated in radar repeaters during the normal tracking of targets by the operators. In this use projector response is not critical. This is because the sampling interval between successive target acquisitions, performed by the radar repeater operator, is longer than projector response time.

Another consideration in system design is the desirability of preventing the display screen from being cluttered with data. Plotting projectors provide a stable, permanent record on a glass slide. This feature, desirable in itself, sometimes leads to the belief that to prevent display clutter, the slide must be changed, resulting in loss of all past data. But, the method used to solve this problem is indicative of the versatile methods available for the system engineer with this type of equipment. In this case (Fig. 5) two projectors are assigned to the same target. First one projector is plotting; the second projector is then caused to plot, but with its illuminator turned off. After a period of time, this projector is turned on displaying the latest portion of the track. The first one is turned off, and its slide changed. The process



Fig. 3: Typical composite display generated by Plotting Projectors. Symbology and multi-color traces are both displayed.



Fig. 4: Four of these Navy CIC Plotting Projection Displays are presently installed in the CIC rooms of ASW Carriers.

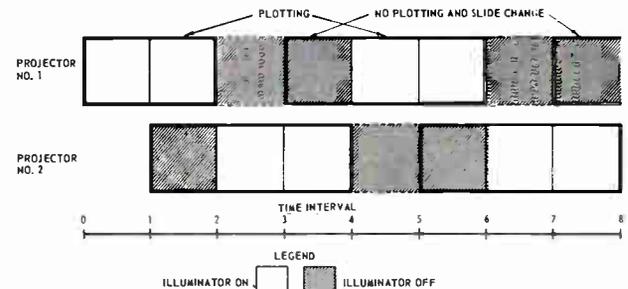


Fig. 5: Plotting Projection, Trace Erase Diagram. In this case two projectors are assigned to the same target. Result is a track that shows the latest portion of its past history.

Fig. 6: Three - Dimensional Ground Approach Control Display.



## PROJECTION DISPLAYS (Continued)

is then repeated with the first projector plotting with its illuminator dark. Result is that a track will always show the latest portion of its past history.

This method is used at the North American Air Defense Command Center in Colorado Springs, Colo., Fig. 1. This is probably the largest dynamic display in the world. As can be seen on the display, each track has a tail of only its immediate past history.

### Adaptations of Plotting Projectors

The basic Plotting Projector lends itself to a variety of uses. For instance, the slide mechanism can be removed, and the stylus plate can be replaced by an opaque plate with a translucent symbol in a desired setup. This "Spotting Projector" provides a dynamic non-permanent display. A Spotting Projector is, therefore, used when there is no need for any past history of a data input. A common usage of a Spotting Projector is as an operator-controlled cursor to show a selected position on display. Coordinates of this position are then available from pickoffs on the operator control.

Another projector setup is achieved if an additional servo drive is added to the projector. This servo rotates the symbol plate. In this manner we can display a non-permanent vector that can be positioned anywhere on the screen and rotated through 360°.

A further adaptation can be made by mounting a servo-driven iris on the rotating symbol plate. Rotating vector length can now be varied. An application of this type of projector is for naval weapon, fire control display. Here range and bearing from own ship to a target can be obtained. This can be done by

Dimensions (including electronics)		15 in. L x 7 in. W x 14 in. H
Weight (Approx.)	(Approx.)	15 lbs.
Plotting area (slide)		1 in. by 1 in.
Stew time—full range		60 msec.
Adjacent symbols—per sec.		20
Random Symbols—per sec.		10
Trace width		0.1%
Positioning accuracy		±0.1%
Positioning resolution		Essentially infinite
Positioning repeatability		±0.03%
Slide storage		40 slides
Slide access time, max.		1.2 sec.
Slide repositioning accuracy		0.02%
Color filter access time, max.		1 sec.
Spare lamp change time		0.5 sec.

placing the end of the vector on the own ship and rotating and changing the length of the vector until it reaches the target. Range and bearing can now be read out from pickoffs slaved to the range and bearing controls.

Three-dimensional plotting is achieved by the generation of two separate plots. These plots are projected through separately polarized filters for depth perception. As such, the composite plot appears to be suspended in space and in precisely the correct orientation. There are two ways to generate this 3-D plot. One method is to use two separate projectors and have the X coordinate presented to each projector modified as a function of the elevation (Z) input. For the other method a special double projector is used with the distance between the two stylus plates controlled by the elevation input through a separate servo drive. When two separate projectors are used, external analog summing or digital computing methods must be used to modify the X coordinates of the respective projectors.

## TEMPERATURE SENSING BRIDGE

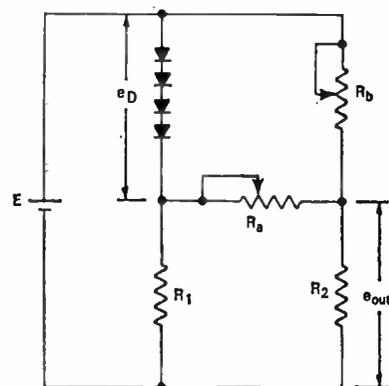
THIS SIMPLE CIRCUIT was designed to give an adjustable output voltage that varies linearly with temperature. The bridge is formed with temperature compensating diodes in one leg. The voltage drop,  $e_D$ , across the diodes decreases linearly with temperature over a limited range. Resistor  $R_b$  is adjusted for bridge balance at room temperature (25°C).

Under balance conditions  $R_a$  has no effect on output voltage. At all other temperatures within a prescribed range the bridge will be unbalanced because  $e_D$  decreases linearly as the temperature increases, or conversely as temperature decreases.

The voltage output will then be a linear function of temperature, provided  $R_b$  and  $R_2$  are large enough to cause negligible current change in the diodes over the operating temperature range. Under these condi-

tions,  $R_a$  serves as a voltage divider between  $R_b$  and  $R_2$ . If the value of  $R_a$  is changed from its initial setting, the output voltage will change correspondingly. This voltage can be varied from zero up to the full voltage drop across the diodes by adjusting  $R_a$ .

This circuit operated well over the range -20°C to +80°C.



From *NASA Tech Brief* 63-10537.

Circuit-package designers are faced with the problems of designing boards that are functional and economically feasible. Here are some tips that will cut costs both in designing and manufacturing

# DESIGNING PRACTICAL CIRCUIT BOARDS

IN MICROMINIATURIZATION, the etched-circuit board is an integral part of the package design. It provides an interconnection system and a base for mounting integrated circuits and similar devices. To justify miniaturization, designs are calling for smaller holes, terminal areas, and conductors; the entire board is smaller. Since the new boards will place greater demands on the production facility or manufacturer, producibility must be given more consideration when the board is being designed. This responsibility falls on the packaging engineer.

## Conductor Width

Conductor width is determined by the desired current-carrying capacity of the line, the expected service temperature rise, and the foil thickness. It may also be determined by the minimum width specified by a design standard or by local circuit restrictions, and the need to maintain insulation spacing between adjacent conductors. For military products, conductor width is determined from design curves in Mil-STD-275. Derating factors are included in these curves to compensate for raw material tolerances and variations due to processing.

But what effect do process variations have on these safety factors and also on current-carrying capacity? Current-carrying capacity, defined on the artwork by a selected conductor width, is altered by the manufacturing process in two ways. First, on boards with plated through-holes, additional copper is plated on the conductor, effectively increasing its cross-sectional

area. On boards without plated through-holes, there is no additional plating. Second, when the conductor pattern is formed by etching away unwanted copper, its width is less than shown on the artwork (i.e., undercutting), effectively reducing the cross-sectional area. This is true whether or not plated through-holes are used. The conductor width is reduced a fixed amount by etching, thus changing the width of a narrow line by a larger percentage than a wider line. In the design of miniaturized single or multi-layer circuit boards with predominantly narrow conductors, an artwork line width of 0.015-0.020 in. could be halved by normal processing.

The effects of plating and etching are shown graphically in Figs. 1 and 2, which are based on Mil-STD-275 and a typical manufacturing process. Fig. 1 shows the percent change in current-carrying capacity (cross-sectional area) of the etched conductor on a finished double-sided board with plated holes. The excess capacity attributable to the process is indicated by all values greater than zero. The zero ordinate represents the point of optimum design where process variations would not alter the desired current capacity of any selected line width. These curves also indicate the predominant influence of the additional copper plating after the metal removed by etching is taken into account. Contrast this with similar data in Fig. 2, where etching is the only factor affecting single-sided boards. Since the Mil-STD design curves include a 10% derating factor for 1 and 2 oz./sq. ft. foil cladding and 15% for 3 oz./sq. ft., fixed derating values are unrealistic as a measure of process variations and are too low when applied to the design of single-sided boards.

Figs. 1 and 2 are characteristic of one process for manufacturing gold-plated boards. The thickness of deposited copper was 1.4 mils, and conductor width reduction followed the empirical equation  $2T + 0.5$  (where T is the total thickness of copper to be etched, expressed in mils). That these curves characterize

Table One: Percent Increase of Insulation Spacing on Etched Board

Foil Wt. (Oz/Ft <sup>2</sup> )	Single Sided			Double-Sided		
	Artwork Spacing (Mils)					
	30	70	125	30	70	125
1	11.0%	4.7%	2.6%	20.3%	8.7%	4.9%
2	20.3%	8.7%	4.9%	29.7%	12.7%	7.1%
3	29.7%	12.7%	7.1%	38.0%	16.8%	9.4%

By R. A. NAGY

Senior Research Engineer  
Autonetics, A Div. of North American  
Aviation, Inc.  
Anaheim, Calif.

## CIRCUIT BOARDS (Continued)

one process is not important. What is important is the wide variation between the designed and actual current capacity likely to be obtained from any process. This suggests several ways in which the engineer can optimize his design and facilitate its producibility. First, by knowing the conductor width reduction produced by etching he can compensate by laying out wider lines on his artwork. If this allowance is included as a derating factor in design curves, it will not cause either excessive or negative safety factors.

Second, the engineer can lay out his artwork with the widest conductors possible. Design curves are used to obtain the minimum conductor widths, but the physical board size and conductor spacing should determine the maximum widths. Conductor defects such as nicks, pits, pinholes, scratches, etc., occur to some extent in most processes. The allowable maximum limits range from 20% (military) to 35% (commercial) of the etched line width. Therefore, using a wider conductor permits, within the same tolerance limits, an increase in the actual size of the imperfections.

### Conductor Spacing

Minimum spacing must be determined to preclude voltage breakdown, or flashover, between adjacent conductors. This spacing is variable and depends on the operating potential difference between adjacent conductors, the maximum service altitude, and whether or not conformal coatings are used. There is, however, a safety factor built into an etched circuit-board process that works in designer's favor. As the conductor pattern is formed by etching, there is a reduction in artwork line width and a corresponding increase in conductor spacing. The size of this increase for the process previously described is shown in Table 1. Here the largest safety factors are obtained at the narrow spacings ordinarily used in low-voltage circuits. From similar data determined for any process, spacing design curves with more realistic safety factors can be developed.

Maintaining minimum conductor spacing works to a disadvantage in production when the circuit configuration requires a conductor be run between two closely-spaced terminal areas and minimum spacing is maintained by removing a portion of each pad. Such a condition may consume all possible manufacturing tolerances, subjecting the board to a high-scrap rate. This cannot be compensated for by repositioning the hole in the smaller pad because the component lead spacing is fixed. Also, a minimum annular ring of conductor must be maintained around

the hole. On the other hand, it may be possible to design a circuit configuration without removing a portion of the pads; but whenever possible circuits should be re-routed.

### Minimum Hole Size

Process limitations found in the operating characteristics of the copper plating bath also control the minimum producible size of a plated through-hole. Generally, as the composition and operating limits of plating baths change or as the hole dimensions change, the ability to plate a given hole with a uniform thick-

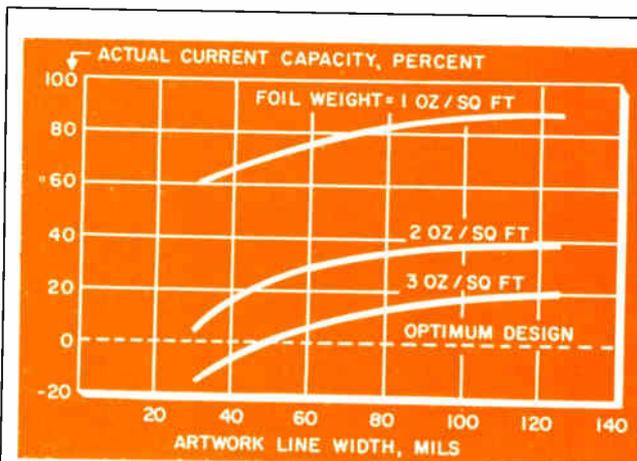


Fig. 1. Change of Designed Current Capacity of Etched Conductors on Double-Sided Boards.

ness also changes—less copper is deposited in a hole of smaller diameter or of greater length. To build the required thickness, a longer plating time is necessary. However, while this is occurring the surfaces from which conductors will be formed are also being built up. Hence, when the circuit board is etched, the etching time is increased and the final conductor width will be less than desired due to excessive undercutting. But where process operating limits have already been fixed to minimize undercut and obtain a desired minimum hole-plating thickness, the smallest desirable hole diameter/length (D/L) ratio has likewise been fixed. No difficulty is experienced in processing circuit boards for which D/L is greater than this minimum. But obtaining enough plating in the hole would be impossible where D/L is less.

The designer will select producible hole sizes if he knows the minimum D/L determined by the manufacturing process. Such data can be obtained by measuring samples plated in the process. Since the selected board thickness established the hole length, the minimum hole diameter (D) can be determined.

### Hole-Pad Diameter Ratio

In high-production, the accurate registration of the hole and surrounding terminal area is difficult. This

is due to the number of accumulated tolerances. Those affecting hole location are associated with drilling operations and exist in making a glass-circuit master for drill-jig preparation, actual drilling of the jig, and drilling of the circuit board. Also included are inaccuracies due to drill-bit and drill-jig wear, and drill wander (in stack drilling). Tolerances associated with locating the terminals-area pattern around the hole are related to screen stenciling. They exist in preparing and mounting the gelatin stencil image, and in aligning the drilled circuit board to the stencil pattern.

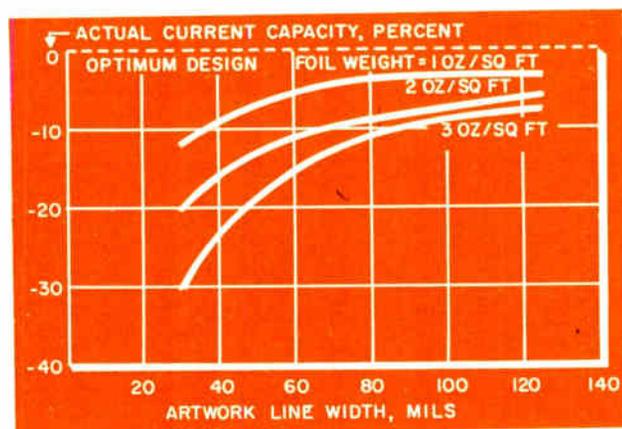


Fig. 2. Change of Designed Current Capacity of Etched Conductors on Single-Sided Boards.

Since these tolerances affect hole location within the terminal area and tend to become limiting factors for miniaturized circuits, producibility should dictate the design standard minimum for hole-pad diameter ratios. The pad-diameter reduction, due to etching, must also be considered. The designer helps production by not using smaller pads or designating larger hole sizes than are dictated by the standard minimum ratio. For small production quantities, the registration problem may often be eliminated by combining photo-resist printing with "eyeballed" drilling.

### Mounting Holes and Hardware

Properly designating circuit-board or component hardware mounting holes on the drawing and artwork materially eases product producibility. Often pads around mounting holes are not needed; but at times they are necessary to provide physical support for swaged hardware or bolted fasteners. Be careful to consider whether or not a hole should be plated. A hole without pads is usually plated if drilled before processing. Since this cylinder of plating is not firmly anchored, it could cause system failure by falling out under vibration or impact. The designer should, therefore, specify no plating on the drawing for holes

without pads. As a rule, these holes will be drilled after the board is etched.

Another source of difficulty is specifying the mounting-hole size. When used with mechanical fasteners, the hole size is sometimes specified as Drill No. (size), and pads are indicated on the artwork at the hole location. Since there is no qualifying note, the hole gets plated through and a drawing standard tolerance of  $+0.002, -0.001$  in. is assumed. This tolerance on a plated through-hole cannot meet and should be corrected by adding a "no plating" note.

When component clips or similar hardware are to be fastened with a swaged eyelet, it may be necessary to specify the side of the board on which swaging will be done. But wherever possible it should be left optional so that manufacturing can economically plan the tooling and swaging operation. Be careful to avoid specifying an eyelet with a head smaller than the mounting hole in the hardware.

### Warp and Twist

Although warp and twist in an etched board can be attributed to fabrication process or conductor pattern configuration, it is more frequently induced during manufacture of the copper-clad laminate. Most laminators have difficulty achieving both a homogeneous dispersion of the resin system components and a complete curing reaction between hardener and resin. In this condition, the laminate stock has internal residual stresses and is subject to further chemical reaction. Shearing the laminate sheet into circuit-board blanks and thermal effects during processing produce excessive warp, twist, or a combination of both.

The packaging engineer minimizes these effects in two ways. First, the direction of conductors is chosen so that bending stresses released in the etched copper foil on one side of the board is opposed by a similar stress pattern on the other side. This implies that a balance between large copper areas on both sides is beneficial. Second, large copper areas used as shields, grounds, etc., should be broken up by etched slots. A good figure for the maximum width of copper portions between slots is  $\frac{3}{8}$  in.

In a high-production operation, routing is the accepted practice to trim the board to its final size. Several boards are stacked and machined at one time, using a routing template as a guide. The radius of an outside corner is determined by template radius, but the radius of an inside corner is the same as the routing tool. Where inside radii differ from one design to the next, additional setup cost is incurred. The designer can alleviate this by specifying a single standard radius for all designs. The selection should be coordinated with the shop to assure optimum producibility.

The automatic data exchange system described here is a broadly applicable real-time message switching and information processing system. It can operate in the store and forward mode and/or it may be integrated with circuit switching equipment. The system represents a step forward in the application of computer methods to communications.

# DESIGN FOR A DATA EXCHANGE SYSTEM

THERE IS AN INCREASING DEMAND for fully automatic message/data switching centers. This demand comes as a result of the growth of the normal non-automatic centers to a size which impedes their efficiency. The ITT 7300 ADX Automatic Data Exchange System (Fig. 1) described here presents a solution to this problem. Designed for modern communication needs, it represents a mating of communication and computer methods. It is a fully-automatic, real-time message-switching and information processing system.

\* \* \*

The ADX system uses a "Multisequence Subsystem" to provide real-time input/output (I/O) control of external devices on a pre-fixed priority basis. The multisequencing method allows the ex-

ternal devices to request processor attention whenever they need service. Thus, the system achieves a high through-put rate for it is not necessary to use processor time to frequently scan all the I/O devices to learn if service is needed.

An automatic program interrupt is started when such a device needs attention. Servicing of this device is automatically started. Also, the hardware automatically saves all pertinent computer registers to enable return to the exact state of the machine prior to interruption.

This real-time I/O feature, coupled with the flexibility of the stored program method and the equipment reliability and modularity inherent in the ADX design make possible use of an automatic digital message switching system. This system will receive,

Fig. 1: The ADX system (at right) is a high-speed, fully-automatic real-time, message-switching and information processing system.

Fig. 2: This system installation at Eastern Air Lines (below) is used to switch more than 40,000 messages per day. It ties together more than 200 teleprinter stations in the United States, Canada and Mexico.

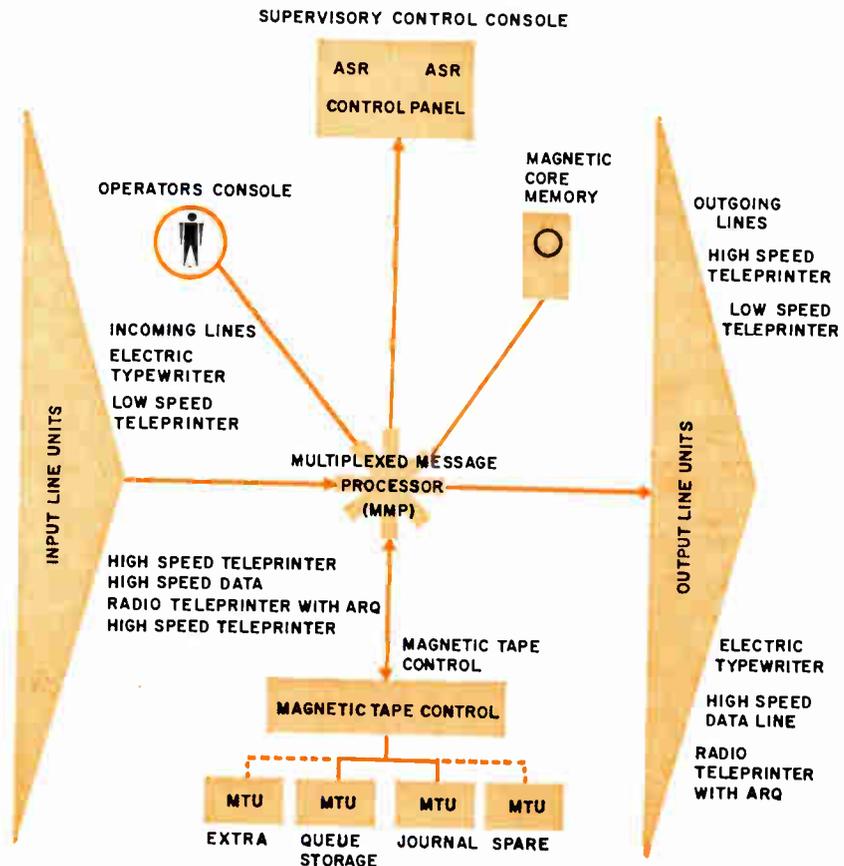




Fig. 3: The ADX system represents a mating of communication and computer methods.

process and distribute a variety of digital data and narrative communications traffic.

#### Line Termination Units

The System's I/O Line Units provide the interface between the external communication lines (a variety of line may be handled ranging in modulation rate from 45 to 2400 Bauds) and the ADX System. The Input Line Units receive data serially from a transmission demodulator and accumulate a character at a time. For synchronous high-speed line units, each incoming bit will be accompanied by a sampling pulse from the demodulator. For asynchronous low speed line units, each incoming bit will be sampled by the line unit by timing derived from the start-stop transition.

Incoming characters are converted to parallel form and transferred in real-time to the Multiplexed Message Processor under control of the Multisequence Subsystem. Mechanics for outputting information are essentially the reverse of those used for the inputting process. Each high-speed data line is terminated in an individual line unit. Low-speed teletype lines of the same speed are terminated in groups of eight.

By **ROBERT A. LEONARD**

ITT Data and Information Systems Div.  
P. O. Box 285  
Paramus, N. J.



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#### Multiplexed Message Processor

The central controlling and processing element of the ADX System is the Multiplexed Message Processor (MMP), Fig. 4. The MMP is a stored program, single address, fixed word length, multi-sequential computer. The basic processor has 4096 words of magnetic core storage, expandable in modules of 4096 words to a maximum of 65,536 words. Each MMP word consists of 18 binary bits which may be retrieved in 6  $\mu$ sec. There are 32 basic machine instructions (designed to speed real-time processing) with 146 available operations as variations.

The element which permits the MMP to be time-shared on an "on demand" basis over a large number of devices and communications facilities is the Multisequence Subsystem. This is a priority-interrupt system. It permits a service request from a higher priority device to interrupt the program servicing a lower priority device.

The basic multisequence subsystem contains 16 primary priority levels, there being 16 secondary priority levels associated with each primary level. This permits the ADX System to handle up to 256 separate I/O channels. These channels are assigned to communication lines and/or peripheral equipment.

A single MMP can service many lines. The MMP can provide concurrent operation of all I/O devices and their associated programs, along with the main operational program. Primary and secondary levels of the multisequence system can be visualized as forming a matrix. Each matrix element is repre-

## ADX SYSTEM (Continued)

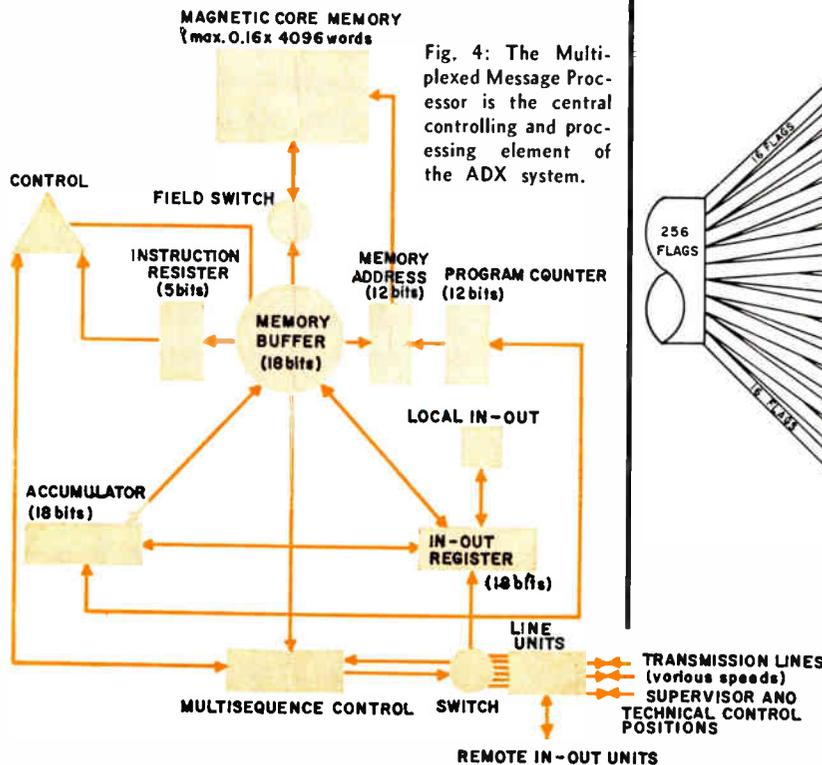


Fig. 4: The Multiplexed Message Processor is the central controlling and processing element of the ADX system.

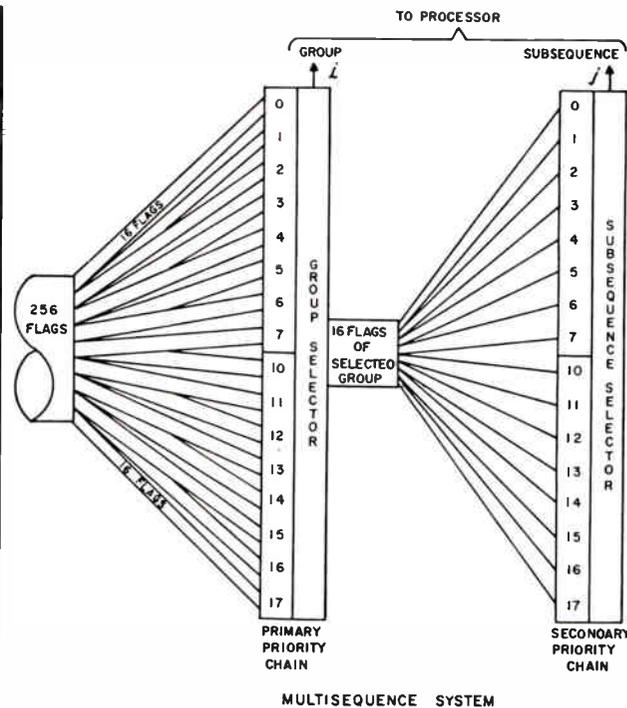


Fig. 5 (above): The Multisequence System permits a service request from a higher priority device to interrupt the program servicing a lower priority device.

sented by a combination of one primary and one secondary level. Further, each element represents a connection to an input or output line unit (or line unit group). Associated with each element of the matrix is a Service Request Flag (SRF), an indicator that the associated unit needs service.

Each primary priority level has a Priority Level Indicator (PLI). These are connected in a chain with an ordered relation, i.e.,  $PLI_0 > PLI_1 > \dots > PLI_{15}$ . When an input line unit is filled with a character of information, its associated SRF is automatically set. If another SRF for the same primary priority level had not been previously set, the PLI associated with this SRF is turned on.

If this new PLI is higher in value than the one being serviced, the system automatically interrupts the functions being performed. It saves the contents of the pertinent registers in the MMP. It then transfers control to a new sequence of instruction to start processing the character which just entered the system. This complete sequence break process from the turning on of the new PLI through the transfer of control is done in 20  $\mu$ sec.

For outputting, the SRF is set when the associated output line unit (or line unit group) has completed transmission. The interruption procedure is the same as above. When processing of an input or output character is completed, a set of instructions is ex-

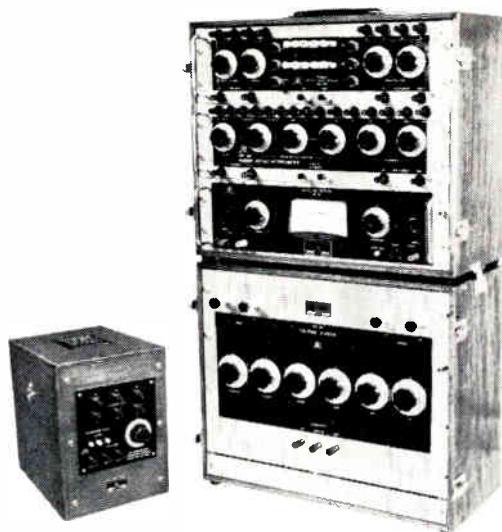
ecuted which returns the saved working MMP registers to their pre-interrupted state. They also turn off the PLI, reset the SRF, and allow the interrupted program to continue from the point of interruption.

If the PLI of a lower primary priority level is active at the time of return, an interrupt will occur in the same manner as discussed above for as many PLI's as are awaiting service.\* There may be several levels of interrupts between the time when a program is first interrupted and when control is finally returned to it. But, since the hardware automatically serves the pertinent registers, it is always possible to restore the interrupted program to the exact condition present when the first interrupt occurred.

Certain peripheral devices, e.g., magnetic tape units, magnetic drum, magnetic disks, need high transfer rates (about 1 million bits/sec.) These transfers are handled in the MMP by a high speed channel and an external control device associated with the peripheral equipment. The high speed channels provide a means of break-in transfer concurrent with (and independently of) computer program and

*(Continued on page 90)*

\*The flags are separated into 16 priority groups of 16 each. Members of a priority group may not interrupt other members of the same group. Members belonging to groups of higher priority will interrupt any number of lower priority groups. This operation is implemented by combining the 16 flags of the priority in an OR Gate, Fig. 5. Output of the OR Gate is true when one or more flags of the group is true (requesting service). This group request, along with all other group requests is entered into a logic chain which selects the highest priority group request.



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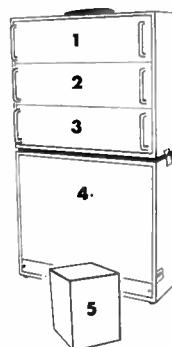


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- 4. Voltage Divider** — Accuracy: To 0.00001% of full scale.
- 5. Standard Cell Voltage Reference** — Accuracy: 0.0001%, certifiable by NBS.



"Notes On The Julie Ratimetric Method Of Measurement" is a 36-page technical booklet on an entirely new approach to dc measurements. Write to us (Att: L. M. McCulley) on your company letterhead for a free copy.

Circle number 80 for visit with an engineering sales representative, complete details and prices

# MATCHED MOTOR-GEARHEADS SERVO, STEPPER, MOTOR-TACHS

Choose from 10<sup>6</sup> Combinations



BOWMAR MOTOR-GEARHEAD

TYPICAL AMONG 106 STO. MOTOR TYPES:

SIZE	RATED VOLTS 400 cps Freq. Cont.	STALL CURRENT Max. Ma.	STALL POWER Max. Watts	STALL TORQUE Min. Oz.-in.	NO LOAD SPEED Min. RPM
8	26-36 ct	166-118	3.1-3.1	.35	6,500
8	115-36 ct	63-157	3.2-5.3	.28	5,800
10	26-26 ct	166-166	2.6-2.6	.3	6,500
10	115-36 sp	63-157	3.07-2.53	.28	5,800
11	115-115 sp	53-53	3.5-3.5	.63	6,200
8*	26-33 ct	225/154	3.1-2.7	.3	5,500
11*	115-115 sp	53/53	3.5-3.5	.6	6,200

\*INERTIALLY DAMPED



BOWMAR STEPPER MOTOR-GEARHEAD

TYPICAL AMONG 15 STO. MOTOR TYPES:

SIZE	RATED DC VOLTS	RESISTANCE DC	DEG./STEP	COUNTING RANGE Steps/Sec.	FRICTION TORQUE Oz.-in.	HOLD TORQUE Oz.-in.
8	28	900	45°	0-250	.10	.55
10	28	450	30°	0-420	.10	.30
10	28	900	45°	0-250	.10	.55
11	28	300	90°	0-125	.15	1.0
11	28	120	45°	0-250	.33	1.0



BOWMAR MOTOR-TACH-GEARHEAD

TYPICAL AMONG 44 STO. MOTOR-TACH TYPES:

SIZE	RATED VOLTS DC 400 cps	NULL VOLTAGE	TACH OUTPUT VOLTS	STALL TORQUE Oz.-in. Min.	NO-LOAD SPEED Min. RPM
8	26-26 Tach. Imp.:26	.010	275 min./ 1,000 rpm	.13	6,200
10	26-52 Tach. Imp.:26	.013	46/ 1,000 rpm	.28	10,000

TEMPERATURE COMPENSATED TYPES AVAILABLE

- Motors and gearheads MATCHED and PRECHECKED before delivery
- Many units available OFF-THE-SHELF
- Unique slotted motor shafts provide for checking lost motion AFTER installation
- Wide range of gearhead ratios immediately available
- Shock resistant glass molded motor terminals or wire leads

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SEND FOR SIX PAGE TECHNICAL BROCHURE

**BOWMAR**

INSTRUMENT CORPORATION

8000 Bluffton Road • Fort Wayne, Indiana

MECHANICAL COMPONENTS

COUNTERS INDICATORS

TIMING AND PROGRAMMING DEVICES

ALL TYPES OF SERVO PACKAGES



## ADX SYSTEM (Concluded)

the Multisequence System operation. These channels transfer information between the MMP's magnetic core memory and external peripheral device at the rate of 6  $\mu$ sec/18 bit word.

The external control devices use an interrupt channel in addition to the high speed channel to permit efficient use of the peripheral devices.

### Communications Control Console

The Communications Control Console (ccc) provides the operator with a centralized facility to monitor system operation and control key functions. One or more ASR teletypewriter units are located next to the ccc to allow communication between the system supervisor and the operating ADX System.

Features provided by the ccc include status indicators for each line reflecting an alarm or transmission condition (transmitting or receiving). Each line has inhibit switches to enable the operator to prevent reception or transmission of information over that line or group of lines. Other displays present real-time information about the status of: major equipment subsystems, current traffic load, etc.

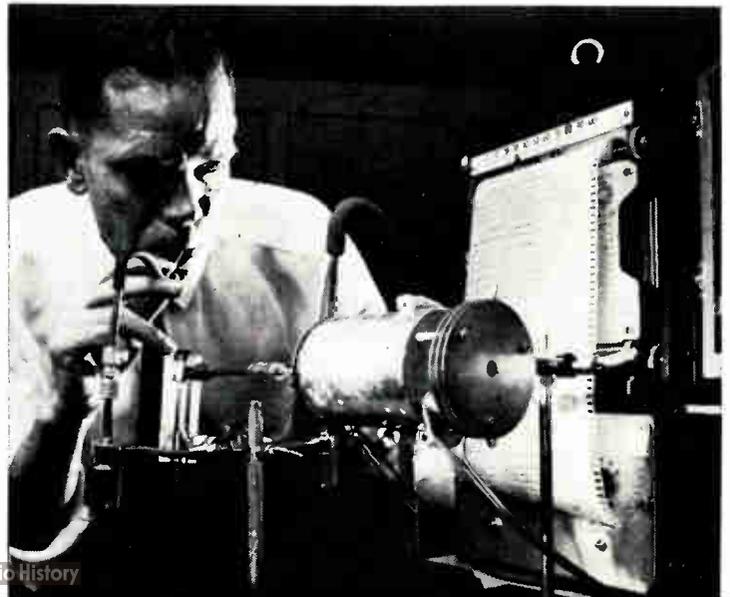
### Applications

Five ADX Systems have been delivered and are fully operational. Others are due for delivery this year.

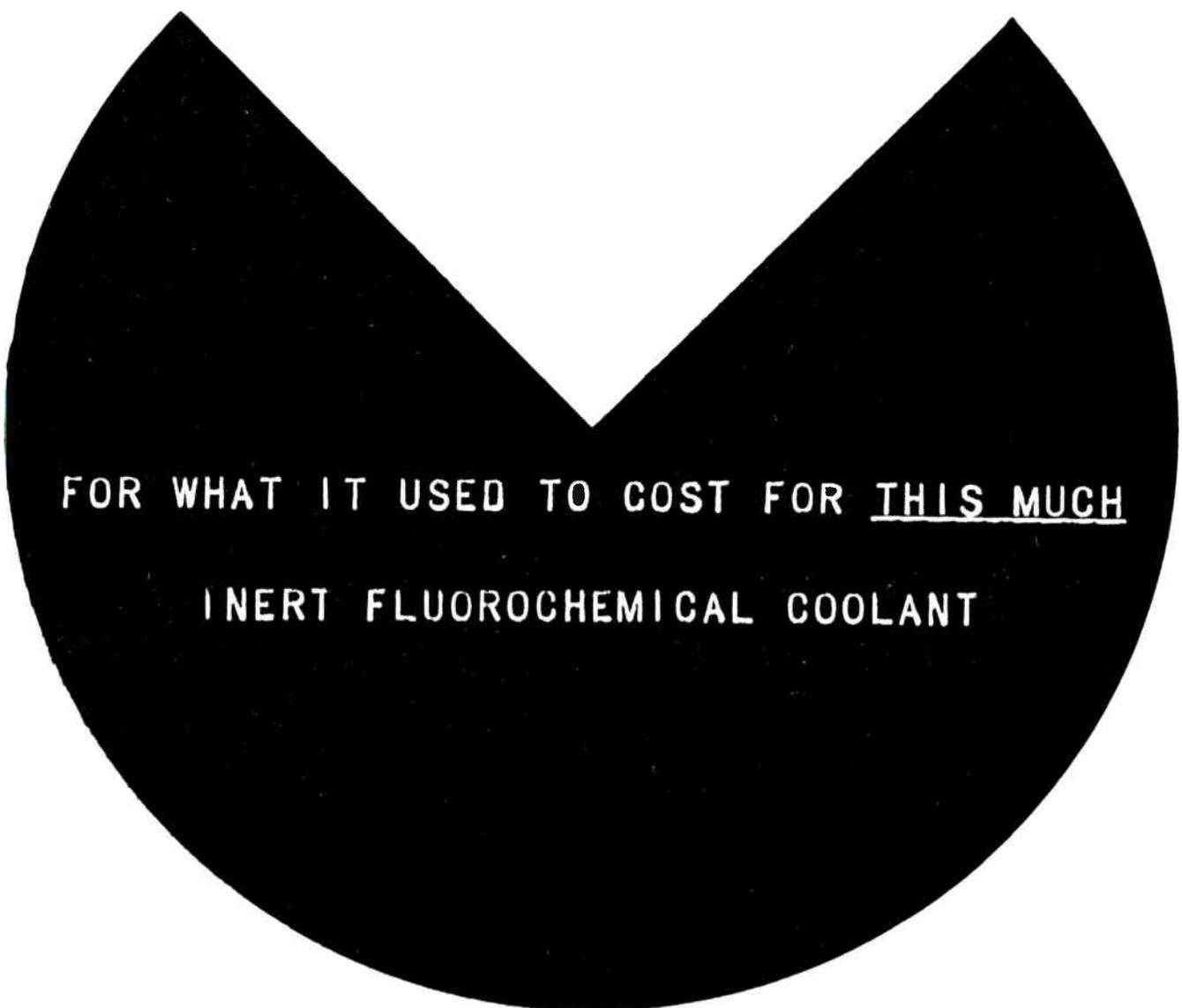
Current installations are: U. S. Dept. of State, American Embassy, Paris, France; USAF, Air Weather Service; Aluminum Co. of Canada; NASA's Space Flight Center in Huntsville, Ala.; and most recently a dual System for Eastern Air Lines. All these systems provide real-time information processing, each being tailored to its specific use.

### IT MEASURES THE OXYGEN YOU BREATHE

Using a unique "fuel cell" oxygen detector, W. M. Hickam, Westinghouse Research Laboratories, monitors oxygen removed by lungs. The detector, in metal container (foreground) uses the oxygen to generate a voltage which registers on moving paper. Detector is sensitive enough to trace oxygen content in each breathing cycle.







FOR WHAT IT USED TO COST FOR THIS MUCH

INERT FLUOROCHEMICAL COOLANT

## NEW FC-77 CUTS COST OF

This newest entrant to 3M's fluorochemical coolant family, 3M Brand Inert Liquid FC-77, solves a big inert cooling problem—cost! Because FC-77 can be produced more economically it makes possible savings of 25% (and more) to users and “should be” users. These new prices make FC-77 practical for many new electronic and aerospace designs.

FC-77, like the other family members, FC-75 and FC-43, takes the heat away faster than non-volatile organic liquid coolants. In fact, per gram of coolant

30 to 40 times faster. The secret? These liquids boil at about 100° C. Thus they vaporize and carry off heat at a higher rate than can other conventional convective coolants. FC-77 easily handles high heat fluxes with minimal changes in temperature of component. Bulk and weight are saved—unit size can be miniaturized as much as 4 to 1, weight by 2 to 1.

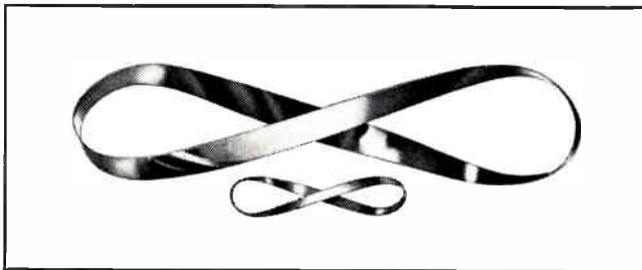
FC-77 coolant is truly compatible, too! It is neither affected by, nor does it affect, metals, plastics, elastomers—chemically or electrically! This





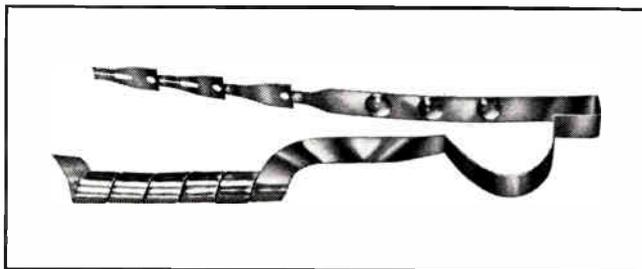
## REFRACTORY METALS APPLICATION NOTES

# There's no end to G-E molybdenum ribbon and its uses.



General Electric flattened wire molybdenum ribbon is available in continuous lengths in an almost infinite combination of thicknesses and widths, bare or nickel clad, gold or silver plated. Temper can be varied from as-rolled to dead soft.

Bend it, twist it, die form it, punch it, pull or coil it. It can be formed by almost any mechanical operation.



G-E moly ribbon's strength, moderate weight and ability to remain electrically conductive and provide a high modulus of elasticity even at high temperatures makes it ideal for many applications.

Its uses include high temperature contact springs, furnace windings, helices for traveling wave tubes and cross-straps for frame grid electronic tubes. Where can you use it?

Get wrapped up in G-E molybdenum ribbon. Write today for complete data. General Electric Co., Lamp Metals & Components Dept., 21800 Tungsten Road, Cleveland, Ohio 44117. Or call (216) 266-2970.

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

Circle 47 on Inquiry Card

## LETTERS

to the Editor

### Technical Semantics

*Editor, ELECTRONIC INDUSTRIES:*

I am deeply concerned about the trend that advertisements in technical and engineering journals has been taking. As an example, please refer to the ad on page 96 of the November 1963 issue. Is "4 full watts" different from any other kind of watts, or from just plain 4 watts? The instant I saw this, I was reminded of the "full half quart" statement currently being used by a soft drink manufacturer and it was impossible for me not to degrade the entire advertisement, thus making it useless as far as I was concerned.

. . . Perhaps I am over-critical but it is difficult to attempt technical exactness in one's work and then not expect the same in advertising and reporting in technical journals.

Frank E. Killian

Electro-Magnetics  
3463 Citrus Street  
Lemon Grove, California

*Stephen E. McCallum, Press Relations, G.E., Owensboro, Ky., answers:*  
Dear Mr. Killian:

Your letter to *Electronic Industries* has been forwarded to me. I am both elated and dismayed at the same time: elated to hear someone espouse a cause which I favor; dismayed because I am the culprit.

I can give you an explanation, but not an excuse, for the "four full watts." I am basically technically-minded, but I work in advertising and publicity. As you can imagine, this creates a psychological conflict of which the point-in-case constitutes an excellent example.

The test records on the tubes in question showed that all tubes delivered no less than four watts at all times. Some delivered more continuously. However, not enough of them delivered more than four watts all the time to justify saying "four and a half watts" or even "four and a quarter watts." How, then, could I connote this briefly and succinctly, as one must in advertisements? At the last minute I inserted the word "full" in my original copy.

(Continued on page 96)

# LOT CONTROL ASSURES

## ...series 88 resistor quality



LOOK FOR THE LOT CONTROL NUMBER ON EVERY SERIES 88 RESISTOR

**AXIAL LEAD WELD TEST LOG** SERIES 88 - LOT CONTROL DATA

SUB LOT NO.	DATE	OPER.	N.S.O.	LIAD DATA	DATE	CAP DATA	REMARKS	MACHINE NO.
1484	3/2	V.L.	1254-1		3/2	3/2		382

**CAP LEAD AND CORE ASSEMBLY TEST LOG** SERIES 88 - LOT CONTROL DATA

SUB LOT NO.	DATE	OPER.	CORE P.O.	DATE	LEAD DATA	USED FOR	REMARKS	MACHINE NO.
2491	3/16/63		B-3764	3/16	1.0.8			4100

**WINDING SUB LOG** SERIES 88 - LOT CONTROL DATA

SUB LOT NO.	DATE	CUSTOMER NAME	CUSTOMER ORDER NO.	SHIP ORDER NO.	SPIC. NO.	REVISION	WIND CODE	ASSEMBLY NO.	NO. WINDING	WIND. H.	SET-UP APPROVED BY
6203	10/16/63	H.P.		3747	49372		223	2491	40	PU	J.C.

**AGING SUB LOT LOG** SERIES 88 - LOT CONTROL DATA

SUB LOT NO.	DATE	EQUIP. NO.	TIME IN	TIME OUT	SET. OPERATOR	REMARKS
1359	10-11-63	115-71	2:15	4:15		

**MOLDED RESISTORS - MOLDING LOG** SERIES 88 - LOT CONTROL DATA

SUB LOT NUMBER	MOLDING DATE	NATURAL NUMBER	EXTENSION	CYCLE TIME & OVEN	DIF	RESULTS OF MOLDING	OPERATOR'S SIGNATURE & REMARKS
1235	10/11/63	100	NO	0	65	3	
1236	10/11/63	100	NO	0	65	3	

**CURING LOG MOLDED RESISTORS** SERIES 88 - LOT CONTROL DATA

CURING SUB LOT NO.	CURING DATE	CURING OVEN NO.	CURING CAN NO.	START OF CYCLE TIME	BY	REMOVED FROM OVEN BY	REMARKS
400	10-11-63	148131	3	0400	AUTO	J.W.	
401	10-11-63	148131	3				

**SILICONE CERAMIC, BATCH MFG. RECORD** SERIES 88 - LOT CONTROL DATA

BATCH NO.	DATE MADE	PENETRATION TEST	RESIN LOT NO.	SIGNATURE	REMARKS
702L	9/2/63	138	170	C.C.	
703L	9/2/63	137			

**SERIAL LOT NUMBER LOG** SERIES 88 - LOT CONTROL DATA

LOT NO.	WINDING	AGING	MOLDING	CURING	TEST V. OPERATOR	RESISTANCE	WATT SIZE	NO. NO. FAIL	NO. NO. FAIL	DATE STAMP	OPERATOR	CUSTOMER NAME
D-300	6303	1955	1236	Vol		0	40	40	40	10/11/63	J.W.	G.E.P.

Lot control provides a permanent record of all the materials, manufacturing procedures, and testing that go into each Series 88 resistor. These records can be analyzed for any resistor, by means of the lot number marked on each unit, permitting a continuous program of reliability improvement.

**LOAD LIFE TESTING**—Production is constantly sampled, and units are put on load life tests for 10,000 hours.

**LOW TEMPERATURE COEFFICIENT**—Standard T.C. is only  $\pm 20$  ppm/°C. Still lower T.C.'s are readily available.

**CONSTRUCTION**—Single layer winding of resistance alloy wire on a ceramic core with metal end caps and axial leads. All internal connections are welded. The silicone-ceramic coating is molded on (not dipped). This gives a hard, dense jacket, uniform in size and shape, which permits 100% safe, snug fits in clips, and qualifies resistors as insulated units (1000 VAC

V-block test). Standard leads are solderable. Weldable leads are also supplied.

**THREE CATEGORIES FOR DIFFERENT APPLICATIONS**

**MIL-R-26C (Series 881)**—Fast delivery off-the-shelf in 107 MIL values from 0.1 to 8200 ohms; G and V characteristics from 2.5 to 11 watts.

**COMMERCIAL POWER (Series 882)**—1.25, 3.75, 6.5, 8, and 11-watt sizes with 3% tolerance for one ohm and higher values. Units derate to zero watts at 350°C ambient. Made to order in values from 0.1 to 200,000 ohms.

**HIGH STABILITY, PRECISION POWER (Series 884)**—Tolerances down to 0.05. Derate to zero watts at 275°C ambient. Supplied off-the-shelf in 1, 3, 5, 7, 10-watt sizes, and all 1% standard values of MIL-Bell System up to 200,000 ohms.

Be Sure You Have the Latest Data. Write for Bulletin 101.



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MANUFACTURING COMPANY  
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Phone: (312) ORchard 5-2600

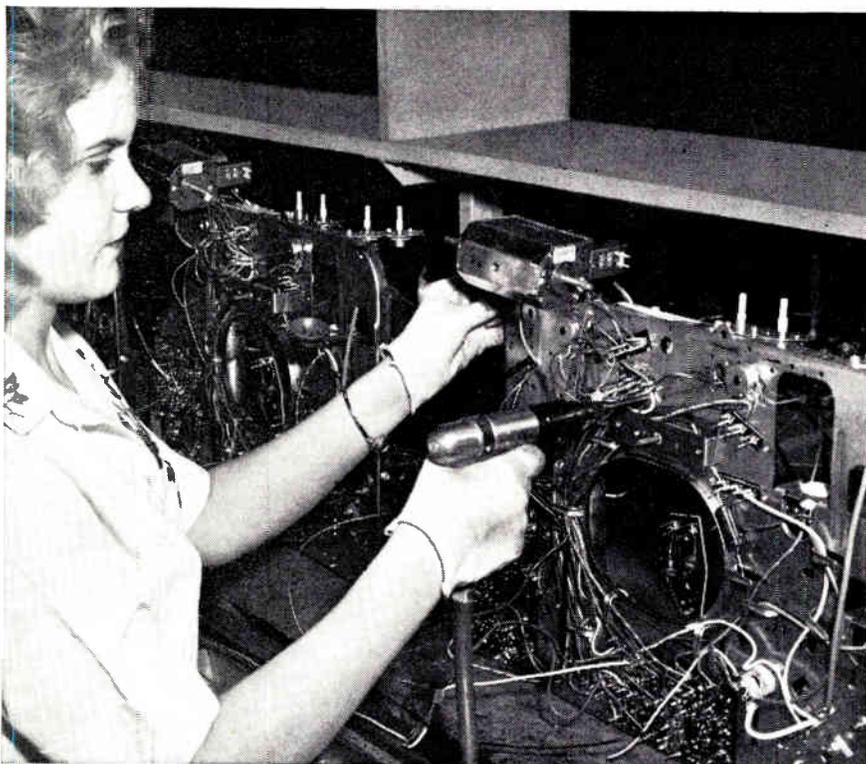


■ RHEOSTATS • POWER RESISTORS • PRECISION RESISTORS • VARIABLE TRANSFORMERS  
TANTALUM CAPACITORS • TAP SWITCHES • RELAYS • R.F. CHOKES • SEMICONDUCTOR DIODES

TO SEE WHAT AIR CAN DO SEE GARDNER-DENVER

In the sixties alone we have added hundreds of new and improved products to our lines of compressors, rock drills, air tools, drilling rigs. So before you invest in new air equipment, find out—from Gardner-Denver—how air can serve you better.

## "WIRE-WRAP" TOOLS CONNECT TERMINALS FOR KEEPS



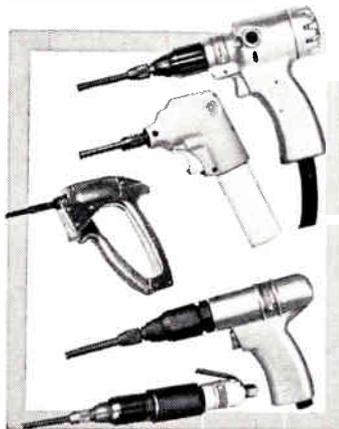
Make permanent, solderless connections that remain gas tight under severe corrosion and vibration conditions. More than 15 billion connections have been made this way—without a reported electrical failure.

Less than three seconds are required per connection.

For miniaturized components use "Wire-Wrap" tools with wire as fine as 30- or 32-gauge.

Take your choice of Gardner-Denver "Wire-Wrap" tools—air, electric or battery powered, or hand-operated models.

For complete information on "Wire-Wrap" tools—and automatic "Wire-Wrap" machines for modular panels—write for Bulletins 14-1 and 14-121.



KEEP UP-TO-DATE WITH  
**GARDNER-DENVER**

Gardner-Denver Company, Quincy, Illinois

## LETTERS

to the Editor

(Continued from page 94)

And so, there is a shade of difference between "four watts" and "four full watts." It is intended to convey to the reader that there is no question about all the tubes having delivered four watts at all times during the test in question. I am sure you, like myself, have often questioned ratings of certain equipments and components because we suspect they are marginal or averages, or both. The phrase as I used it was intended to preclude such eye-brow raising.

S. E. McCallum  
Press Relations

General Electric Co.  
Owensboro, Ky.

### "Mathematical Models For Engineers"

Editor, ELECTRONIC INDUSTRIES:

In response to your offer made in the January issue of your magazine, I would appreciate very much a reprint of the article "Practical Applications of Mathematical Tools" by Dr. Raymond S. Berkowitz. I am engaged in furthering the educational activities of a large segment of the FAA electronic engineers and technicians and I feel that this article may be of considerable value.

J. P. Monkres,  
Electronic Engr, Instructor  
ANF Branch, PT-975.3  
FAA Academy  
Oklahoma City, Oklahoma

### "Calculating System Linearity"

Editor, ELECTRONIC INDUSTRIES:

I have found an error in my original manuscript "Calculating System Linearity."

The summation under Case I shows that

$$\sum_{k=1}^5 \Delta k^2 = E(m, b) = 54.64 - 109.6m$$

+ 55m<sup>2</sup> + 30mb - 30m + 5b<sup>2</sup>  
the term -30m should read -30B.

Harold Y. Wong  
1787 Mallard Way,  
Sunnyvale, Calif.

(Continued on page 100)

# *automatic RFI analysis saves up to 70% of user time*

Stoddart's versatile and compact NM-62A saves up to 70 percent of the time and cost of conventional RFI measurements through automatic

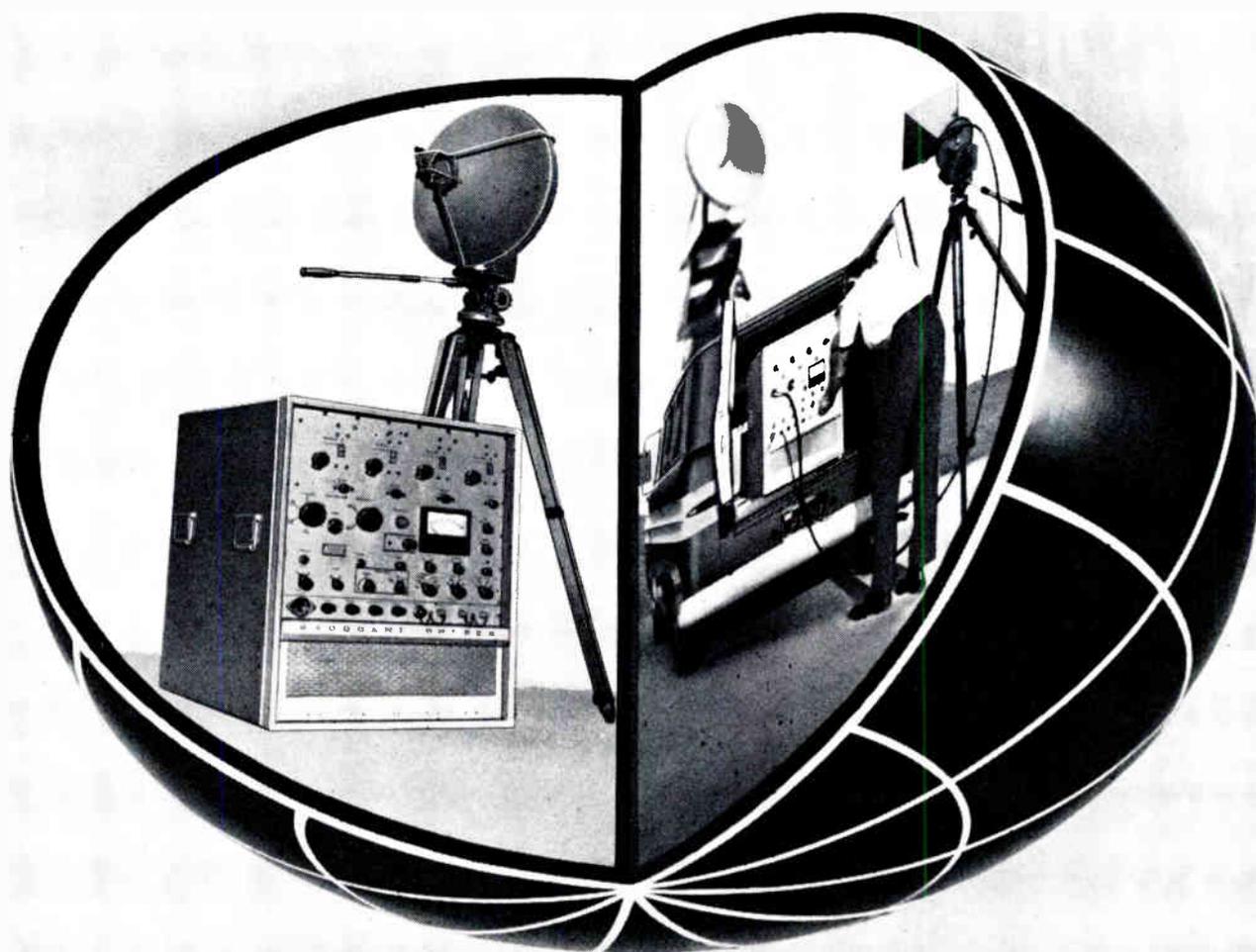
data collection and automatic spectrum signature recording over four bands: 1.0-2.3, 2.3-4.4, 4.4-7.3, and 7.3-10 gc. Typical of operator conveniences is one-knob instant band-switching to change output, input and voltage connections simultaneously.

These outstanding features make the NM-62A ideal for interference measurements to determine RI-FI compatibility of equipment producing electromagnetic fields; for radar field strength measurements and microwave antenna studies; and for general use in the field and laboratory as an electromagnetic detection instrument.

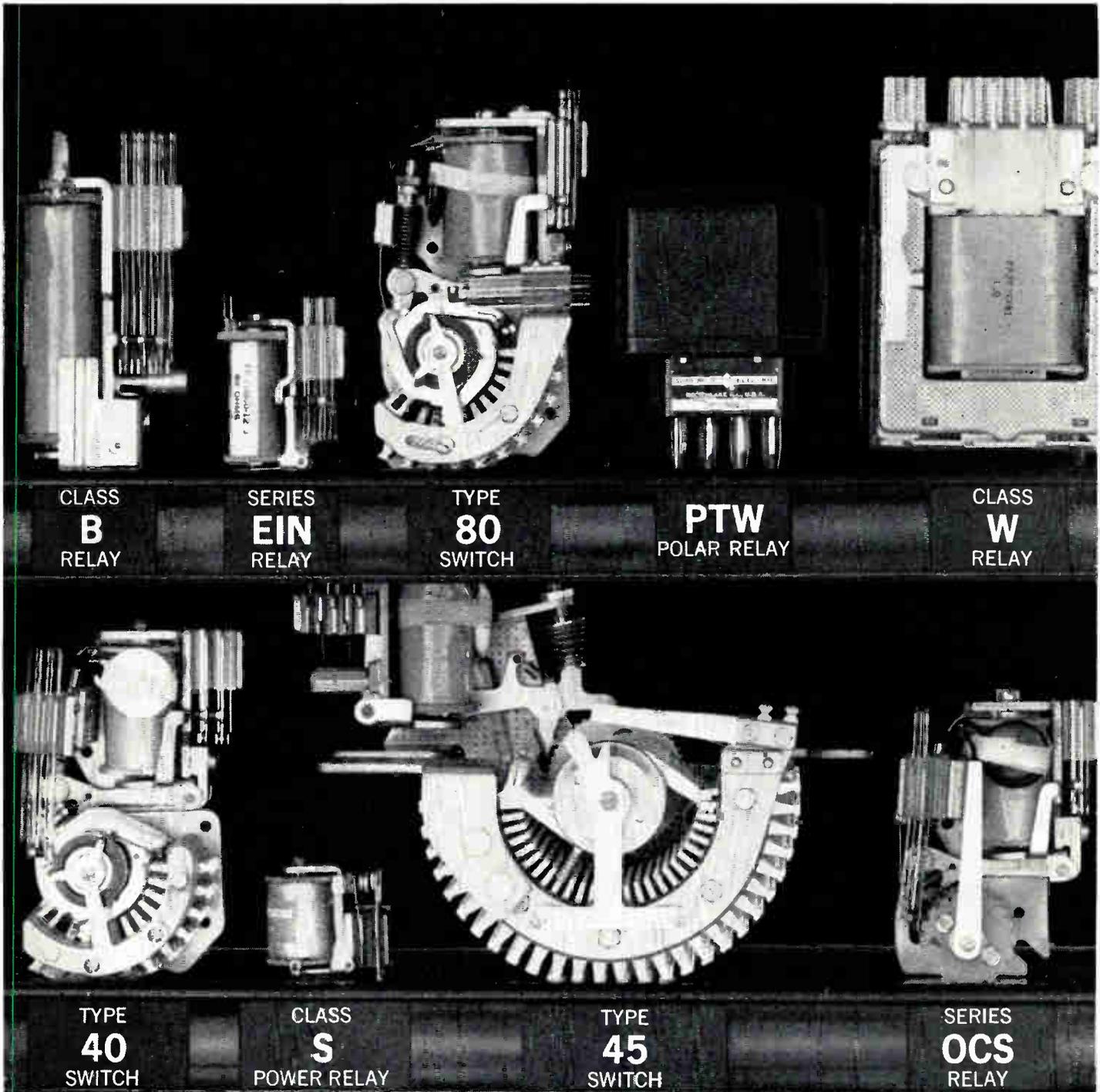
In addition to varied commercial applications, the NM-62A meets or exceeds all applicable military specifications, and is currently in use with all the services. The instrument is qualified per MIL-I-11748B (Sig. C.), MIL-I-26600, MIL-I-6181D(USAF) and MIL-I-16910(Ships). Federal Stock Number is FSN 6625-977-2820.

For complete details on the NM-62A and other advanced RI-FI measuring equipment, write or call Stoddart Aircraft Radio Co., 6644 Santa Monica Boulevard, Hollywood 38, California. Phone: (213) HOLLYWOOD 4-9292. A subsidiary of Tamar Electronics, Inc.

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## 14 in-stock answers to your relay needs.

Fast delivery of relays and stepping switches direct from the manufacturer—yours at no extra charge, thanks to the AE Stock Program.

Under this growing program we keep more than 200 kinds of relays, switches and accessories on hand at all times, in sufficient quantities to fill your ordinary requirements within 7 days. These include many of the hottest types from AE's broad line: EIN (integral socket) relays with power

contacts; rotary stepping switches with Gold Levels for low-level circuits; ERM (magnetic latching) relays; Class E relays equipped with Taper Tab Terminals for easy adaptation to EIN; and many more.

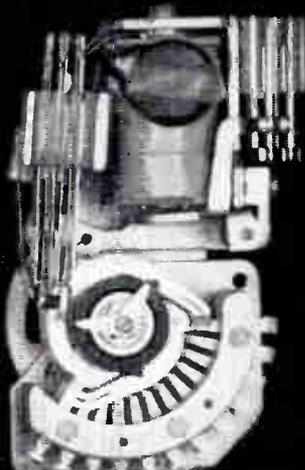
Send for your free copy of AE's "Stock Letter," which is the latest complete listing of AE relays and switches in stock for quick delivery. Write to the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois 60164.



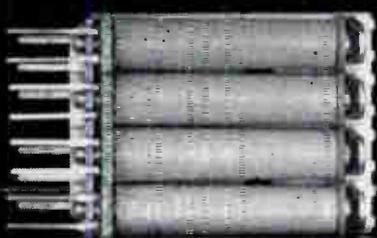
MERCURY WETTED-CONTACT RELAY



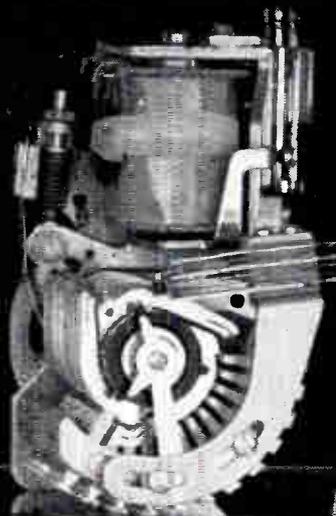
CLASS E RELAY



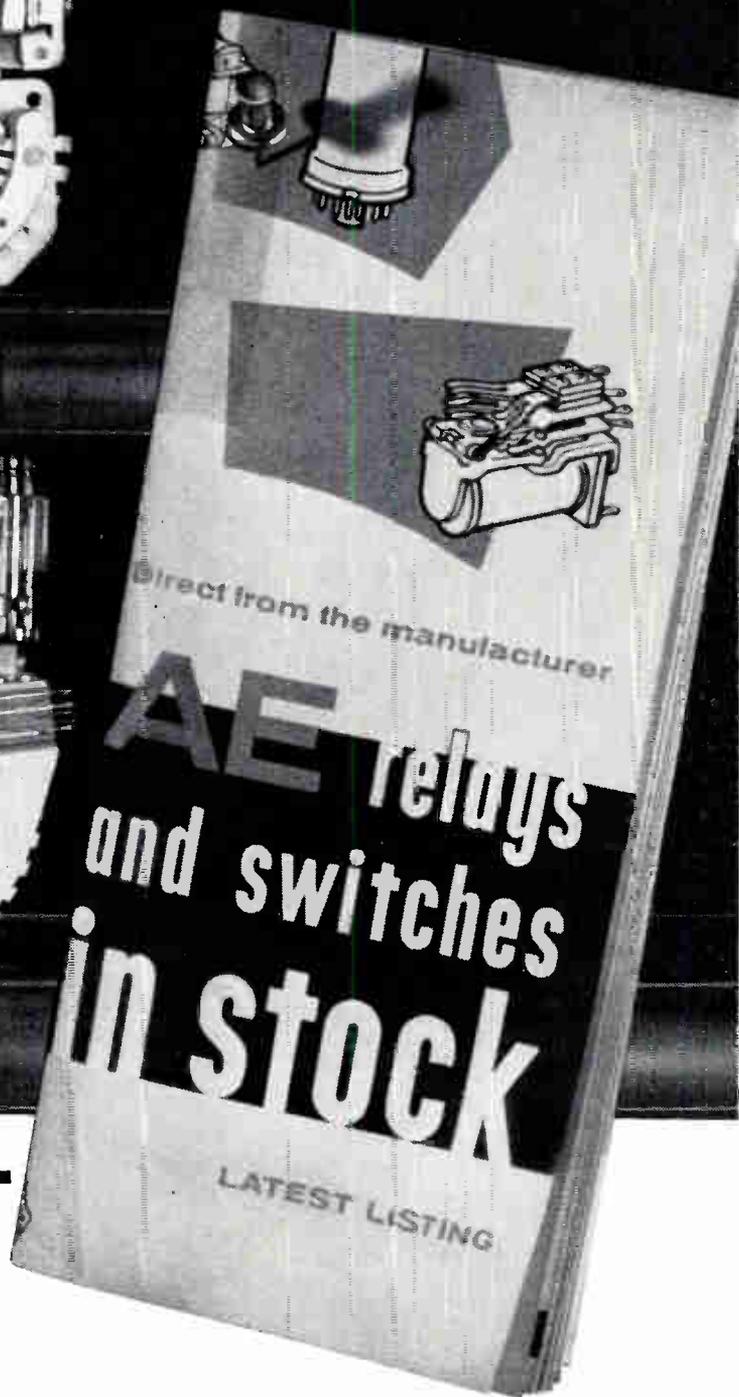
TYPE 44 SWITCH



4 DIGIT CODEL RELAY

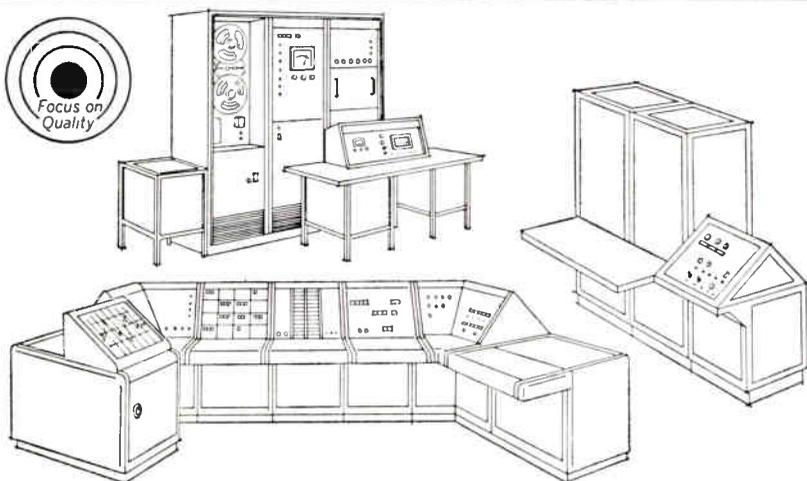


TYPE 88 SWITCH



Get 191 more here.

**AUTOMATIC ELECTRIC**  
SUBSIDIARY OF  
GENERAL TELEPHONE & ELECTRONICS **GTE**



## Here's How EMCOR® Enclosures Can Save You BIG MONEY Over Custom-Type Designs

### YOUR COSTLY DESIGN TIME

Enclosure design and specifying time is reduced from hours to minutes with easy to use, complete EMCOR Modular Enclosure Systems full line catalog.

### YOUR TOOLING AND PRODUCTION

This manufacturing phase often prices your product out of the market. Enclosure engineering, tooling, and production are our specialty . . . and you pay EMCOR mass production prices.

### YOUR INTERMITTENT PLANT OPERATIONS

Catalog-ordered EMCOR Modular Enclosures eliminate your intermittent plant operations. Your key people and machines are free for profitable production.

### YOUR COMPLETE SATISFACTION

You never settle for anything less than complete satisfaction. There are EMCOR Modular Enclosures to meet your every need.

### EMCOR DEPTH OF LINE

Choose from four EMCOR Lines—EMCOR I Standard Enclosures . . . EMCOR II—“individualized custom look” Enclosures . . . EMCOR III and Special Series RFI Shielded Enclosures . . . EMCOR Heavy Duty rugged application Enclosures. Available in a variety of configurations with thousands of component parts. EMCOR Solid Bearing and Ball Bearing Chassis Slides engineered for all frames without costly handmade adaptors.

### EMCOR CONTINUING RESEARCH

Ingersoll Products EMCOR Engineers and Roy C. Ingersoll Research Center Scientists are continuing to perfect “better products through creative research and engineering.” Write or call for full details today—no obligation.

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Most Ingersoll Products Sales Engineers also represent McLean Blowers for enclosures

Circle 53 an Inquiry Card

## LETTERS

to the Editor

(Continued from page 96)

### “Why Not Quote Prices?”

Editor, ELECTRONIC INDUSTRIES:

We are in sympathy with the views expressed by Richard Jenkins of Holt Instrument Laboratories in his letter to you titled, “Why Not Quote Prices?” Since we deal mostly with power system components and equipments, which as catalog items are pretty much technically alike, we are mostly interested in their prices.

Mr. Jenkins may be pleased to know that it is our practice to file catalogs which do not list prices in the “circular file.”

R. F. Holler, Engineer

R. G. Pierlott, Engineer

Philco Corporation  
C & E Computer Division  
3900 Welsh Road,  
Willow Grove, Pa.

### “Color Our Faces—Red!”

Editor, ELECTRONIC INDUSTRIES:

I've been guffawing—and Ted Maiman can't decide yet whether he should guffaw, too, or squirm—over a sort-of typographical error in your . . . presentation of Dr. Maiman's article on the state-of-the-art in LASERS. (Feb. 1964, p. 68)

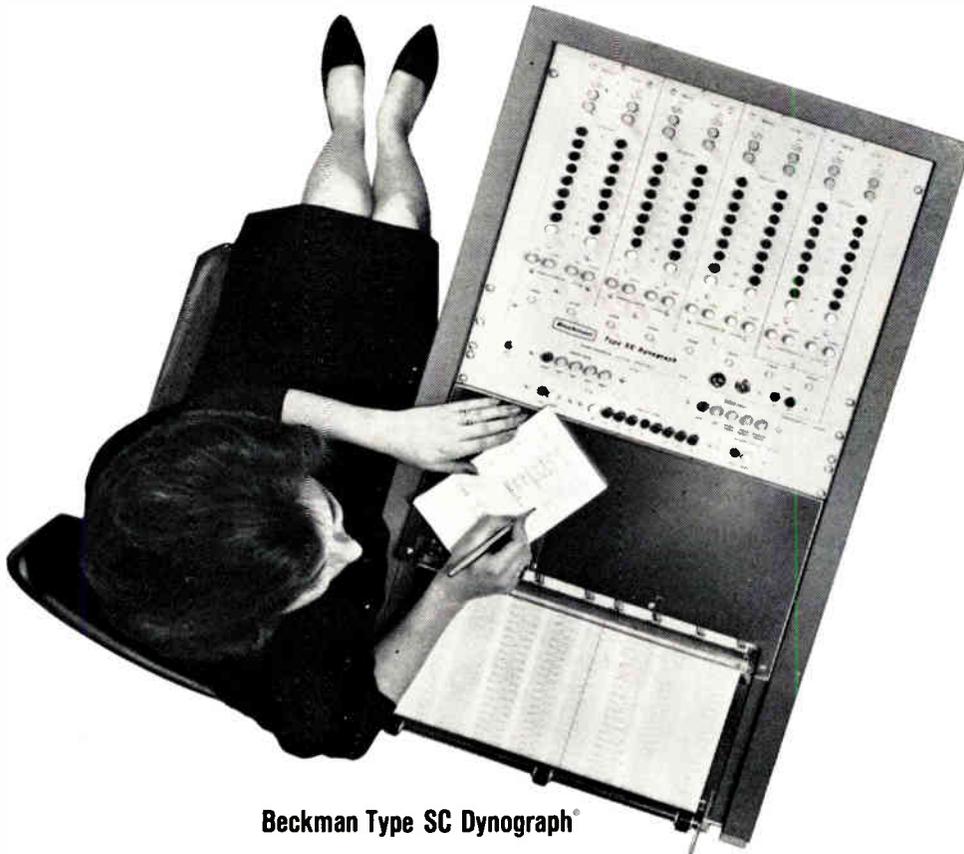
I'm referring, of course, to that last line in the second paragraph, concerning this “must” article . . . and, though I've explained this to Dr. Maiman's satisfaction, some of his fellow scientists have been having considerable fun with him, complimenting him on his “admirable sense of modesty,” etc.

James B. Marine,  
General Manager

Korad Corp.,  
Santa Monica, Calif.

Ed: One of the liberties that ELECTRONIC INDUSTRIES takes with a feature article is to add a few paragraphs at the beginning to explain its significance to the state-of-the-art. Asterisks are usually used to separate these comments from the author's text. In this instance, they were unfortunately dropped from the article. This made it appear that Dr. Maiman was praising his own work. This was certainly not the case and we offer our apologies to Dr. Maiman for making it appear to be. Incidentally, we (the editorial staff at EI) still feel that it is a “must” article.

# New Ink Rectilinear Recorder for analog computer or telemetry write-out



Beckman Type SC Dynograph®

## All the desirability of the Dynograph ink-rectilinear recorder, in a design for complete compatibility with analog computers

*Famous Locked-In Accuracy* at the tracing! Servo system constantly compares pen tip and input signal for maximum accuracy and linearity.

*Reliable Solid-State Circuitry* eliminates drift, component aging. No warm-up time; low total power consumption (230 w. max., for 8 channels).

- Channels: 8 analog plus event marker (standard)
- Width: 40 mm (50 divisions)/channel
- Sensitivity Range: 2.5–250 volts full scale
- Input Impedance: 1 megohm, single-ended or differential
- Linearity:  $\pm 0.25\%$
- Frequency Response: DC-150 cps
- Zero Suppression: 3 times full scale
- Computer Controls: "Operate," "Hold," "Reset"
- Polarity Reversal: for each channel
- Local-remote Controls: "Chart Speed," "Event Marker"
- Centralized Push Button Controls: "Sensitivity," "Paper Speed," "Calibrate," "Polarity," "Local-Remote"
- Pressurized inking system
- Paper Capacity: 1,000 ft. high gloss maximum contrast
- Paper Take-up: Reel standard, optional take-up assembly available
- Paper Drive: Zero weave, 8 or 16 speeds
- Calibration: Operate, zero, calibrate, attenuator
- Overload Indicator: each channel
- Timing Marker: one/sec or remote; second marker optional

Write, or see your local Offner Representative,  
for Bulletin O64-1039 on the Type SC Dynograph®

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OFFNER DIVISION

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**BELL  
LABORATORIES**

## **MICROWAVE RADIO SYSTEM USES NEW FREQUENCY DIVERSITY ARRANGEMENT**

*Microwave stations, like the one shown here, must often be located at remote sites. Therefore, the new system was designed with equipment packages for easy installation at such sites, with simple battery operation, and with an automatic alarm system that provides quick trouble location. Each radio channel is capable of carrying 600 telephone conversations.*

Microwave radio systems carry much of the telephone, network television, and data traffic of the Bell System. First introduced in 1948, microwave radio is used both for coast-to-coast backbone routes and for shorter routes carrying smaller amounts of traffic. Because of the extensive growth in the use of microwave systems and the likelihood that this growth will continue, available bands of frequencies must be used efficiently—otherwise congestion could result in the future.

The Federal Communications Commission has assigned three broad bands of frequencies for use by the common carriers, centered on 4000, 6000, and 11,000 megacycles. Because of atmospheric effects, transmission is more reliable in the lower two bands; thus the backbone long-haul routes of the Bell System operate in these bands. However, the 11,000 megacycle band is satisfactory most of the time, with transmission impairment occurring only during heavy rainstorms.

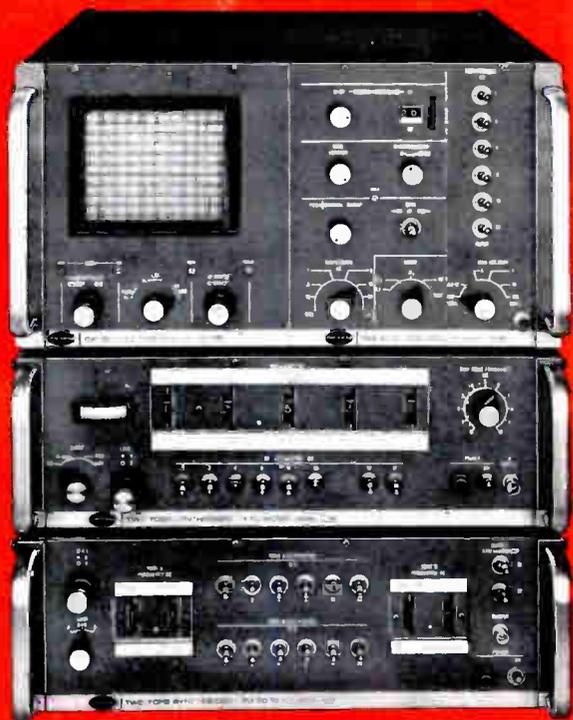
Engineers at our Merrimack Valley Laboratory (North Andover, Massachusetts) have developed a new microwave system which can operate alternatively in the 6000 and 11,000 megacycle bands. Should fading or equipment troubles occur while operating in one band, the system automatically switches to the other band—so rapidly that a television viewer, for example, cannot see or hear any difference. Thus reliable transmission is assured and available microwave bands are used efficiently.

The new system is designed to be economical for short-haul service—i.e., for routes up to 250 miles in length. It handles broadcast TV, educational TV, telephone or data with complete flexibility. Bell Laboratories engineers have worked closely with Western Electric Company manufacturing people to ensure maximum performance, reliability, and economy. **BELL TELEPHONE**



**LABORATORIES** . . . World Center of Communications Research and Development





**Model 2936**  
Universal Single Sideband Test Complex

Polarad Engineering has scored again. Here, in one compact, economical package, is **every facility** you will ever need for SSB system analysis, anywhere in the 1-40 MC (80 MC optional) band. From the transmitter exciter to the output of the receiver, you can turn any SSB system **inside out**, without a single accessory instrument.

Comprehensive test capability is only one of many outstanding instrumentation developments embodied in the Model 2936. Consider, for example, the exclusive new 2-tone frequency synthesizer module, which combines the inherently low distortion pure-RF technique with the "crystal-stability" and precise resettability of a digital frequency synthesizer . . . continuously variable over the entire band from 1-40 MC!

Consider the calibrated power-output capability from 0 to -127 dbm . . . the more than 60 db dynamic range of the spectrum display circuitry . . . the automatic sweep mode, the continuously-optimized resolution . . . the absolute log, linear, and power calibration — direct calibration — of the display . . . feature after feature after feature. This is the **most** SSB instrumentation ever offered in a single instrument!

This limitless versatility is provided, furthermore, in a modularized design — permitting independent use of the individual modules, both alone and in other test configurations. (Matter of fact, we have several new configurations "in the oven" at this moment.)

**Is all this too good to be true?**  
**Turn the page, and see for yourself!**

# here's everything you'll ever need for single- sideband analysis...

in the new

**POLARAD**

## universal modular ssb test system

— featuring the exclusive new continuous  
2-tone pure-RF signal synthesizer!

**UNLIMITED TEST VERSATILITY . . .**  
**TURN THE PAGE FOR PROOF!**

Postage  
will be paid  
by  
addressee

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Postage Stamp  
Necessary  
If Mailed in the  
United States

**BUSINESS REPLY MAIL**

First Class Permit No. 18, Long Island City 1, N. Y.

**POLARAD ELECTRONIC INSTRUMENTS**  
A Division of Polarad Electronics Corporation

34-02 Queens Blvd.  
Long Island City, N. Y. 11101

Better than 10 cps resolution at 3 db points, with 60 cps sidebands down 65 db.

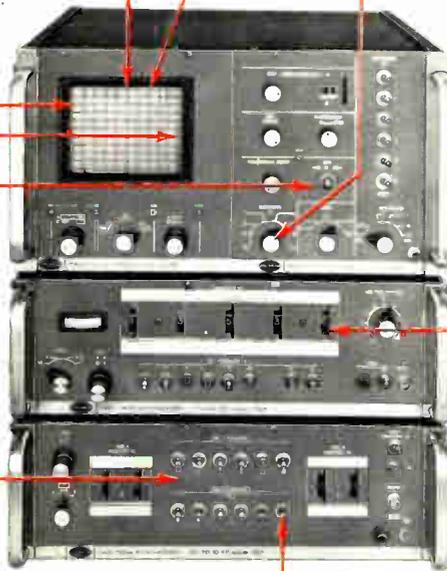
Foolproof illuminated graticule calibrations read directly in the units displayed — log, linear, or power db, automatically selected by mode control. Calibration is both absolute and direct-reading.

4" x 5" rectangular display provides 50% more usable calibrated area, for higher resolution and accuracy.

Calibrated sweep — automatically provides optimum resolution (manual sweep also provided for detailed analysis of display). Dispersion range, 150 cps - 30 KC.

Rate multiplier — for rapid signal location.

Digitally-tuned two-tone audio, 100 cps - 10 KC.

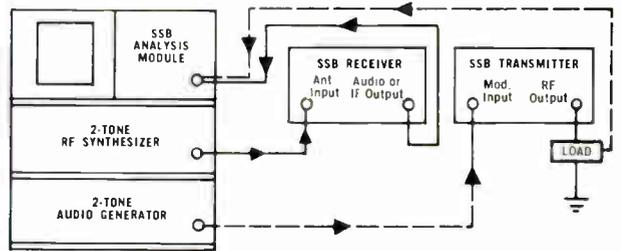


Precision input attenuator, 0-63 db.

Digital two-tone RF synthesizer tuning.

Each audio tone independently adjustable over 63 db range.

## unlimited versatility



Test every stage of both SSB transmitters and SSB receivers, at any frequency, any separation, throughout the entire 1-40 MC range.

## unlimited versatility

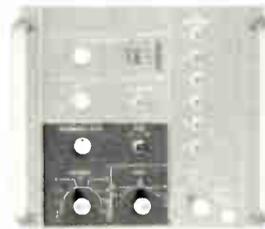


**FORGET "SPOT" FREQUENCIES** — generate two absolutely pure RF tones, continuously adjustable from 1-40 MC, with .01% repeatability, and any desired separation from 0 to  $\pm 10$  KC, with crystal stability.

## SPECIFICATIONS

Frequency Range (Audio two-tone section):	100 cps to 10 KC
Frequency Range (RF section):	
LF	10 cps to 30 KC
IF1	500 KC / custom frequency available
IF2	1750 KC / custom frequency available
Two-Tone RF Output	1 to 40 MC, $\pm 10$ KC differential
RF Generator Output Attenuation	Digital, 0 to $-127$ db, 1 db steps
Input Levels	AUDIO, 0.1 to 100 volts f.s. IF and RF, 1 millivolt f.s.
Attenuators:	
Precision Input	0 to 63 db, 1 db steps, acc'y .05 db/db
IF Step	20 db
Vertical Display:	
Linear	20 db
Log	40 db $\pm$ 20 db calibrated step
Power	10 db
Dispersion	Six fixed, calibrated ranges with automatic optimum resolution from 150 cps to 30 KC
Manual Sweep	Over full range of dispersion in excess of 60 db for all intermodulation products

## unlimited versatility



Automatically provides optimum resolution, yet permits manual sweep control, and provides sweep multiplier for rapid search.

## unlimited versatility



Precision attenuators on both output and input permit an unmatched excitation/response range of over 250 db!

Polarad Electronic Instruments • Division of Polarad Electronics Corporation  
34-02 Queens Blvd. • Long Island City, New York 11101

### Gentlemen:

- I want to see it! Have my local Polarad Field Engineer call me at once to arrange for a demonstration.
- I have no immediate requirement, but I would like full technical data for my files.
- I may have a requirement soon. Rush me the full technical data, and have my local Polarad Field Engineer get in touch with me shortly thereafter, to discuss my requirements.
- Send me the complete Polarad Spectrum Analysis Catalog.
- Send me the complete Polarad Signal Generator Catalog.

My application is \_\_\_\_\_

My frequency range of interest is \_\_\_\_\_

NAME \_\_\_\_\_ TITLE \_\_\_\_\_

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

TELEPHONE \_\_\_\_\_ EXT. \_\_\_\_\_ C 123456789

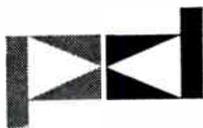
Printed in U.S.A.

World Radio History

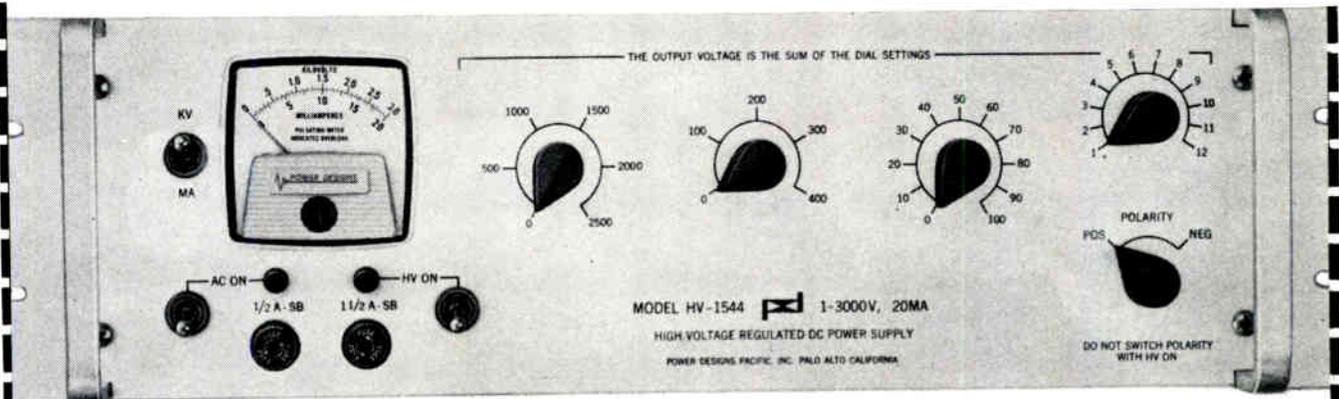
- ... LIKE TO TRY ONE?
- ... NEED APPLICATION ASSISTANCE?
- ... PREFER TO CHECK COMPLETE SPECIFICATIONS FIRST?
- ... USE THIS POSTAGE FREE CARD FOR PROMPT ACTION



# NOW A STANDARD IN A.E.C. AND OTHER LABORATORIES THROUGHOUT THE WORLD



**MODEL 1544**  
**0-3KV · 0-20MA**



PRICE \$543 F.O.B. WESTBURY, L. I., N.Y.

Providing an order of magnitude improvement in performance over previous precision DC high voltage sources . . .

Offering exceptional stability, unusually low noise level, self-indicating overload and short circuit protection.

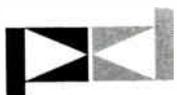
Other models available • Write for complete specifications.

MODEL	VOLTAGE	CURRENT MA	REGULATION LINE OR LOAD	RIPPLE PK TO PK MV	PANEL HT	PRICE FOB FACTORY
1565	1-2000	0-15	.001%	1.0	3½	\$415
1544	1-3000	0-20	.001%	1.0	5¼	\$543
1547	1-3000	0-40	.001%	1.0	5¼	\$595
1545	10-5000	0-20	.001%	1.0	8¾	\$635
1556	10-6000	0-20	.001%	1.0	8¾	\$685
1543	10-10000	0-10	.005%	5.0	12¾	\$995

Prices subject to change without notice.

## FEATURES

- .001% Regulation
- .001 Volt Peak to Peak Ripple
- 0.25% Calibration Accuracy
- .02 Volt Resolution
- .005% per hr/ .02% per day Stability
- 50 $\mu$ s Response Time
- 19" Rack Panel Mounting



**POWER DESIGNS INC.**  
1700 SHAMES DRIVE • WESTBURY, N. Y.

**POWER DESIGNS PACIFIC, INC.**  
3381 JUNIPERO SERRA • PALO ALTO, CALIFORNIA

# bulletin

**MAGNETICS inc.**

## How Cold Water Solves a Hot Core Problem

**Problem:** Cores of high powered pulse transformers, such as those used in radar equipment, generate a tremendous amount of heat. High operating frequencies cause high core loss since the heat cannot be transferred through the windings without damaging both windings and core. This restricts the use of high permeability materials using standard constructions.

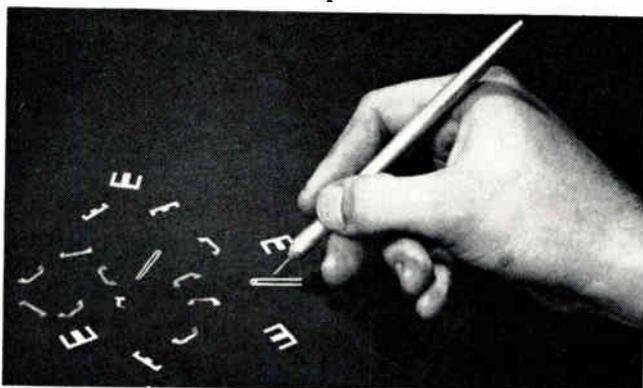
**Solution:** Magnetics developed a unique encased core within a case that allows water to circulate around—but not through a core of  $\frac{1}{2}$  mil material. Constant core temperature is maintained with very little shift in the core's magnetic properties. Do you have similar problems of overheating cores? We would like to help.



Core assembly with water cooling jacket.

## Photoetching of Intricate Parts Reduces Prototype Costs

Quite often we photoetch small shapes in prototype quantities, then tool for punching when they reach the production stage. Saves not only money but valuable time. Magnetics Inc. can photoetch precision flat components from almost any magnetic or specialty alloy used in the electronics industry. This process is especially effective when difficult configurations are needed in thicknesses less than .001". Materials ranging from .020" to .00025" can be processed and tolerances held from .005" to .0005". Should you require precision flat components, Magnetics can help.



A variety of precision flat components photoetched from strip less than .001" thick. Tolerances can be held to .0005".

## New Two-Material Cores Extended Linear Operating Range of Transformers

How do you extend the linear operating range of a transformer—especially a current transformer—and still hold down its cost and size?

By making cores from combinations of materials—such as Permalloy 80 and Alloy 48, or Permalloy 80 and Magnesil—Magnetics Inc. extended the linear operating range. Fig. A shows this type construction. By using different constructions, unique characteristics can be developed due to the multiple saturation points in a single core. Fig. B shows a core which would saturate at different input levels giving unique output characteristics. If you need a combination core, Magnetics can help.



Fig. A



Fig. B

## "Race Track" Core Becomes a Winner

A manufacturer of transformers needed cores with exceptionally precise high voltage windings. Conventional windings on toroidal cores would not withstand the high voltages without breakdown between turns. Standard laminations would not provide high permeability, low core loss at high frequencies, or low leakage flux which could be obtained from a toroidal structure. Magnetics Inc. solved this problem by designing a rectangular "race track" core. This special shape provided a uniform flat surface area on which high voltage windings could be applied, provided high permeability at high frequencies with low core loss, and prevented leakage flux. If you have a similar problem, Magnetics can help.



Rectangular core provided flat surface area needed for high voltage transformer coil.

## Need More Versatile Magnetic Components?

When your products won't operate with standard magnetic components, you need the help of a specialist. Magnetics Inc. will manufacture unusual components by strip winding, photoetching, punching, and hydrostatic pressing of intricate shapes . . . and we make our own materials which are quality checked at every stage.

You specify the size, shape, temperature values, cases, materials, windings and other characteristics . . . we'll do the rest and give you the part you need to put your product on the market.

Tell us what you require by writing Dept. EI-4, Magnetics Inc., Butler, Pennsylvania.

# This Is Not the First 1<sup>13</sup>/<sub>16</sub>" 10-Turn Precision Potentiometer. Just the Best.

Under punishing side-by-side environmental tests, the new BOURNS® Model 3400 performed dependably long after competitive units had sagged, sogged or snapped under the strain. In rotation-life tests it displayed far greater mechanical strength than any other unit. In vibration and shock tests, it kept operating after broken pigtailed and terminations had put competitive units out of commission.

This new kind of industrial reliability stems from Bourns' many years of experience in developing potentiometers for military and aerospace use. Model 3400 has a molded, all-plastic case for superior humidity performance... sliding contacts to eliminate fragile pigtailed... an extra-large slider block for high stability. And it has the exclusive, virtually indestructible SILVERWELD® termination that replaces vulnerable single-wire terminations to overcome the chief cause of potentiometer failure.

Model 3400 undergoes 100% in-process and final inspections, and is subjected to the famous Bourns Reliability Assurance Program. In reliability and in performance, it is a premium potentiometer. One of its best features is that there is no premium in price.

Write today for free technical data.

Model 3400, 1<sup>13</sup>/<sub>16</sub>" Diameter, Bushing Mount

LINEARITY:	±0.15%, STANDARD
Resistances:	100Ω to 500K, standard
Power rating:	5.0W at 40°C
Humidity:	Steady state
Operating temp. range:	-65 to +105°C
Resolution:	0.005 to 0.045%
Length (body):	1.75"



ONE-HALF ACTUAL SIZE



**BOURNS**

BOURNS, INC., TRIMPOT DIVISION  
1200 COLUMBIA AVE., RIVERSIDE, CALIF.  
PHONE 684-1700 · TWX: 714-682 9582  
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MANUFACTURER: TRIMPOT® & PRECISION POTENTIOMETERS, RELAYS; TRANSDUCERS FOR PRESSURE, POSITION, ACCELERATION. PLANTS: RIVERSIDE, CALIFORNIA; AMES, IOWA; TORONTO, CANADA

Circle 10 on Inquiry Card

## New! BUSS SPACE SAVER PANEL MOUNTED FUSEHOLDER



**Actual Size**  
Only 1 7/8 inches long . . .  
Extends just 29/32 inch  
behind front of panel

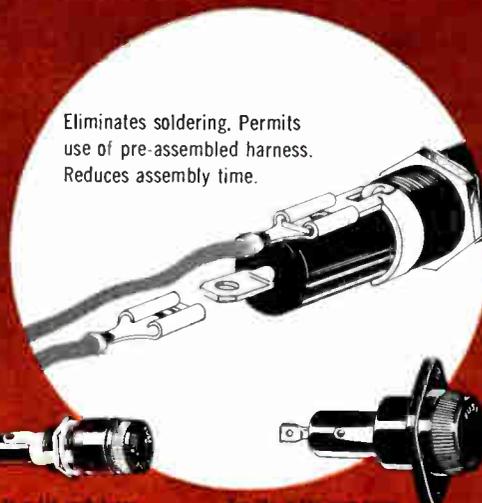
- Fuseholder takes 1/4 x 1 1/4 inch fuses. Converts to 9/32 x 1 1/4 inch fuses simply by changing screw type knob. Holder is rated at 30 ampere for any voltage up to 250.
- Also available in military type which meets all requirements of MIL-F-19207A.

**BUSS** Write for BUSS  
Bulletin SFH-10

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

Circle 57 on Inquiry Card

## Save Assembly Time with Quick-Connect Terminals on BUSS Fuseholders



Eliminates soldering. Permits  
use of pre-assembled harness.  
Reduces assembly time.

For 1/4 x 1 1/4 inch fuses,  
Series 92, 94, and 95

For 9/32 x 1 1/4 inch fuses,  
Series 97C

**BUSS** Write for BUSS  
Bulletin SFH

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

Circle 57 on Inquiry Card

# BUSS: 1914-1964, Fifty years of Pioneering....

### Connectors Catalog

This 48-page catalog describes a line of AMP-Incert® Series M crimp, snap-in type pin and socket connectors. It contains up-to-date data on 10 different configurations ranging from a 14-position connector to two versions of a 104-position connector, all available with suitable hardware and a complete array of accessories. The catalog contains a section on the AMP mated contact-tool controlled-crimping technique; another on plating as a critical factor for satisfactory performance; and still another on types of tooling. Design and performance characteristics are given for 3 types of contacts and block materials. Complete specs. for contacts, blocks, and hardware are also included. AMP Inc., Harrisburg, Pa.

Circle 125 on Inquiry Card

### Transistor Logic

Transistor-resistor logic (TRL) circuitry are widely used for the simplicity, low cost, and high reliability that result from its economy of components. The disadvantage of TRL for moderately high-speed switching is the stringent requirements it places on the transistors. Because of the heavy losses in resistor inputs, fan-in and fan-out are restricted unless high-gain, high-voltage transistors are used. Application note 38017 shows how operation at high voltage improves fan-in fan-out. Sprague Electric Co., Marshall St., North Adams, Mass.

Circle 126 on Inquiry Card

### Motors Nomograph

This nomograph (Vol. 44, No. 2) is concerned with factors of torque, speed, freq., hp and stator poles of electric motors. It provides an easy, fast way to visually determine unknown values of related factors, when compared to know, measured on designed values of factors which are related formula-wise. Bodine Electric Co., 2500 W. Bradley Place, Chicago, Ill.

Circle 127 on Inquiry Card

### Materials Catalog

This 28-page instructive catalog, "High-Temperature Materials," incorporates technical data on commercial refractory materials as well as a number of newer refractory hard metals. Data on granular and powdered materials for use with oxyacetylene or plasma spray equipment has been added. Norton Co., Refractories Div., 1 New Bond St., Worcester, Mass.

Circle 128 on Inquiry Card

### Transformer

Data sheet CV-175 describes a new multiple-output constant-voltage transformer. The Multi-Tap CV provides line regulation of  $\pm 1\%$  or less, as well as current limiting and isolation from primary voltage. Four ratings are available: 150, 225, 300, and 450va. The transformer can be used as a power source for ac or dc outputs or a combination of both. Sola, Div. of Basic Products Corp., 1717 Busse Rd., Elk Grove Village, Ill.

Circle 129 on Inquiry Card

### Disconnect Devices Wall Chart

This wall chart is a quick-selection guide to the proper mate for disconnect tab receptacle already part of a switch, potentiometer, barrier block or other component wired in the circuit. It may also be used when selecting quick-disconnect devices for new circuits being designed. For ease of reference, the disconnect devices are listed on the chart in various categories, including snap plugs, push-on type terminals, adapters, insulated snap plug and tab receptacles, etc. The chart has 14 samples mounted on it. Waldom Electronics, Inc., 4625 W. 53rd St., Chicago 32, Ill.

Circle 130 on Inquiry Card

### Relay Catalog

Catalog MR-3 outlines a complete selection of basic reed relays and coils for reeds, including all electrical and physical specs. and prices. Also included is a general informative summary covering coil requirements and design recommendations. Coto-Coil Co., Inc., 65 Pavilion Ave., Providence, R. I.

Circle 131 on Inquiry Card

### Flutter Causes

The cause and measurement of flutter in wideband recording systems is discussed in Volume 2, No. 2. The data outlines the causes of flutter, and gives a measuring technique that aids in defining flutter from noise. Mincom Div., 3M, 2049 S. Barrington Ave., Los Angeles, Calif.

Circle 132 on Inquiry Card

"... STATE-OF-THE-ART information on Components and Equipment."

## Coax Cables Catalog

This 16-page catalog describes the construction and characteristics of 58 widely used coaxial cables made with polyethylene and Teflon® insulation. The cables meet applicable military specs. It is available from Alpha Wire Corp., a sub. of Loral Electrics Corp., 180 Varick St., New York, N. Y.

Circle 133 on Inquiry Card

## Integral Circuit Uses

This bulletin describes the Techno-Pak concept, which was developed to accommodate the designer who desires to independently control the performance and economy of the circuit he uses. The illustrated bulletin contains data on units for digital functions, communication networks, amplifiers, and power supplies and controls. The concept provides custom integral circuits at standard circuit prices. Molecto Corp., 2950 San Ysidro Way, Santa Clara, Calif.

Circle 134 on Inquiry Card

## Inertial Guidance Brochure

Recent advances missile and space-vehicle inertial-guidance systems including those developed for the Polaris missile are described and pictured in Brochure No. 4940. General Electric Ordnance Dept., 100 Plastics Ave., Pittsfield, Mass.

Circle 135 on Inquiry Card

## Testing Guide

This 66-page booklet, "Testing & Evaluation of Servomechanisms" is for engineers engaged in servo testing. It is divided into 8 sections. Some of the topics covered include Principles and Characteristics of Servomechanisms; Test Objectives; Test Methods; Common Difficulties and Precautions; Test Planning; and Data Interpretation & Manipulation. The booklet contains block diagrams, equations, curves, and tables. It will be a real aid to test engineers and design specialists. Military Electronics Div., of Ling-Temco-Vought, Inc., P. O. Box 6118, Dallas, Tex.

Circle 136 on Inquiry Card

## Industrial Resins Bulletin

Bulletin D-102A, 16 pages, describes properties and applications of industrial resins. The illustrated booklet covers uses of these resins in the manufacture of a wide range of products. Durez Plastics Div., Hooker Chemical Corp., N. Tonawanda, N. Y.

Circle 137 on Inquiry Card

## Magnetic Bulletin

Bulletin 21, 12 pages, describes a line of permanent magnets. Details include size, shapes, physical dimensions, weights, magnetic characteristics, and holding-force in lbs. The bulletin shows a wide range of magnet configurations including bars, multiple bars, rods, U-shapes, cylinders, arched and channel horseshoes and rings. With the data contained in this bulletin, an engineer can make accurate preliminary calculations as to the correct magnet for his particular requirements. Indiana General Corp., Magnet Div., Valparaiso, Ind.

Circle 138 on Inquiry Card

# ....New Developments in Electrical Protection

**LOCKS**  
for  
**BUSS FUSES**

**SCREW TERMINALS**      **SOLDERED TERMINALS**

Standard type — 1 to 12 pole.

**BUSS**      Write for BUSS Bulletin SFB.

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

Circle 57 on Inquiry Card

**BUSS Sub-Miniature PIGTAIL TRON FUSES**

Body Size Only  
.145 x .300  
Inches

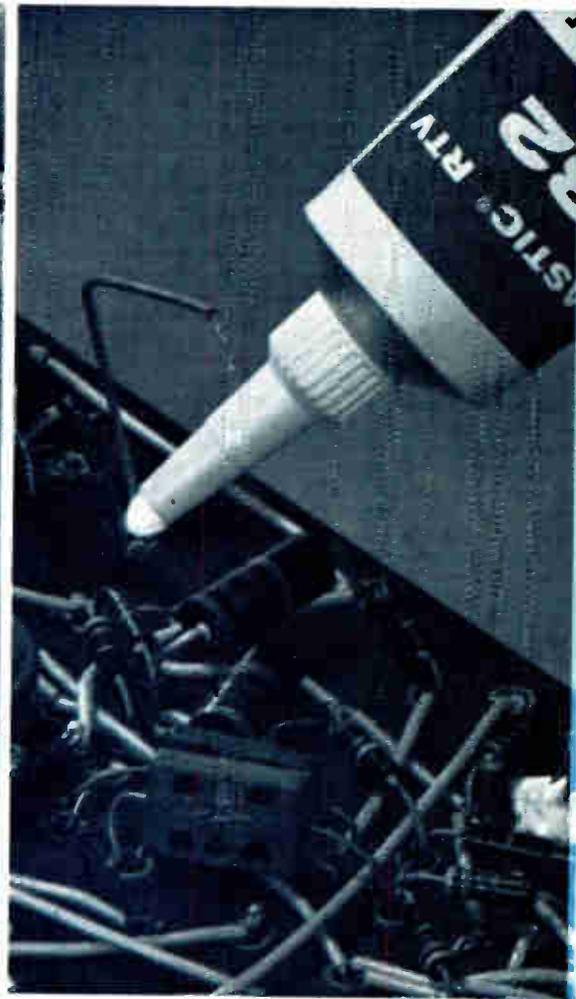
Tron fuses are so small they can be used as an integral part of circuit — to protect miniaturized devices — or gigantic multi-circuit electronic devices, without sacrifice of space.

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 SFB.

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

Circle 57 on Inquiry Card



## News Briefs



**To package and protect** heat-sensitive components, specify Sylgard® 184 resin, a colorless, solventless silicone. Designed for potting, filling, embedding and encapsulating electronic circuits, it is applied as a low viscosity fluid . . . cures at room temperature without exotherm . . . forms a transparent, resilient embedment that permits visual inspection of components and circuits. When necessary to repair or replace defective components, Sylgard 184 resin can be cut away, then replaced with new material. Tensile strength from 800 to 1000 psi and long service life at operating temperatures of -65 to 200 C assure circuit integrity.

CIRCLE 22 ON READER-SERVICE CARD



**Designed specifically** to meet the requirements of MIL-1-8660A, Dow Corning® 4 compound retains its grease-like consistency and electrical properties over the broad temperature range of -60 to 205 C (-70 to 400 F) . . . won't dry out or harden. Used as a moisture-proof dielectric seal for connectors, terminations, toroids, many other components. Dow Corning 4 compound features low loss factor; seals out corrosion and corona, increases surface resistivity of plastic parts. Can be applied to dry metals, ceramics, rubber, other insulating materials.

CIRCLE 23 ON READER-SERVICE CARD

# Ready-to-use silicone rubber encapsulates, seals, bonds . . .

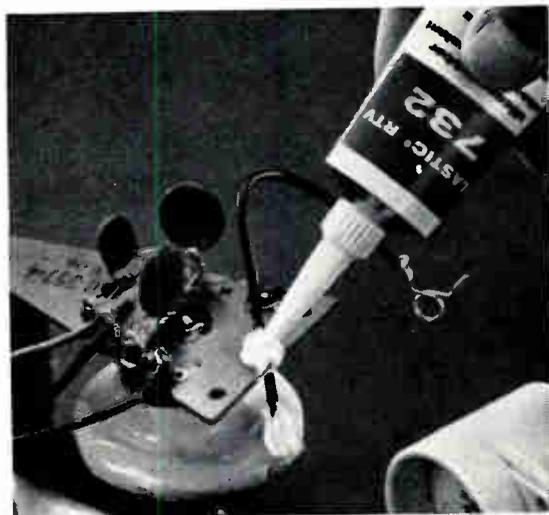
Silastic® 732 RTV silicone rubber is a tough, squeeze-on adhesive/sealant that stays where you put it — on metal, glass, plastics, rubber and many other materials. It bonds, waterproofs and insulates . . . cures at room temperature in 24 hours to a solid rubber.

Silastic 732 RTV rubber stays flexible at temperatures from  $-60$  to  $260$  C ( $-85$  to  $500$  F), has excellent electrical insulating properties and resists weathering, moisture, corona.

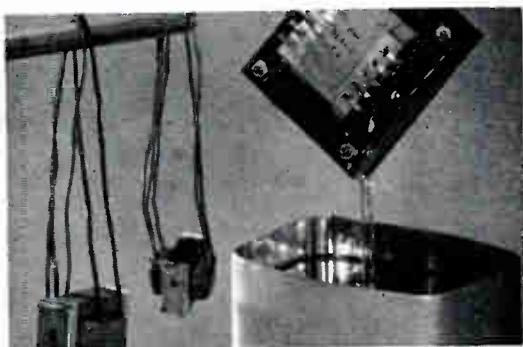
Use this easy-to-apply non-shrink adhesive/sealant to bond wires, seal connectors, splice and repair cable and lead wires, to seal radome and antenna enclosures, to dust-proof cabinets and housings. Where vibration, flexing or differential expansion between parts is breaking bonds or opening seals, specify Silastic 732 RTV silicone rubber. If color coding is a consider-

ation, Silastic RTV 732 rubber is available as a translucent material as well as in black or white.

For a free sample of this material write on your letterhead indicating intended use.



CIRCLE 21 ON READER-SERVICE CARD



Sylgard® 1377 varnish is an easy-to-process thermally stable impregnant designed specifically for electronic applications. Applied by dipping, flooding or vacuum impregnation, it assures added reliability for devices such as transformers and reactors, control actuators, servo mechanisms, gyro motors. When specified for equipment designed to operate at temperatures to  $200$  C, it assures high bond strength, resistance to chemicals and repellency to moisture. Sylgard 1377 varnish offers the optimum balance of properties, simplified processing and flexible cure schedules.

We'll be pleased to forward full information on these and other materials that aid reliability and performance. Just write Dept. F305, Electronic Products Division, Dow Corning, Midland, Michigan.

## Dow Corning

CIRCLE 24 ON READER-SERVICE CARD

## Low Cost / High Quality Ratio



Model TR040M

New ERA highly regulated DC power source provides continuously variable output, 0-40 VDC @ 0-500 ma for only **\$99**

Compare the *price* of the new ERA all-solid state Model TR040 with other make power supplies providing the *features* and *specs* shown below. You'll agree that here is a truly unique power supply whose cost/quality ratio makes it ideal for the broadest possible range of applications, from laboratory to equipment-component use.

### FEATURES

- Compact, Lightweight
- Highly Stable
- Tight Regulation
- Low Ripple Content
- Constant Current Operation
- Short Circuit Proof—Automatic Recovery
- Automatic Current Limiting
- Vernier Control for Fine Adjustment
- Remote Programming Provision
- Remote Sensing Provision
- Isolated Outputs
- Front Panel Metering (Optional)
- Fully Repairable
- Relay Rack or Bench Mounting
- For Laboratory or System Use

### SPECIFICATIONS

Input: 105-125 VAC, 50-1000 cps  
 Output: 0-40 VDC at 0-500 ma  
 Line Regulation: Within  $\pm 0.015\%$  or 5 mv, whichever is greater  
 Load Regulation: Within 0.03% or 5 mv, whichever is greater for 0-100% load change  
 Ripple: Less than 800  $\mu$ V RMS  
 Operating Temp. Range:  $-20^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$  free air, full rating  
 Constant Current Operation: 0-500 ma  
 Remote Programming Constant: 500 ohms per volt  
 Remote Sensing: Connections provided  
 Short Circuit Protection: Automatic current limiting  
 Thermal Protection: Automatic thermostat operation  
 Series or Parallel Operation: Connections provided  
 Output Terminals: Ungrounded, either positive or negative terminals may be grounded  
 Cooling: Internal convection-cooled  
 Panel Size:  $3\frac{1}{2}'' \times 7\frac{1}{2}''$  (designed for bench or half relay rack mounting. Two units may be mounted side-by-side in a 19" standard rack dimension for dual outputs.)  
 Price: \$99.00 (for current/voltage metering, add \$15.00 and suffix M. Relay Rack Mounting Kit—single or dual mounting, add \$5.00.)

Write for ERA's new complete catalog #131 today!



**ELECTRONIC RESEARCH ASSOCIATES, INC.**

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SUBSIDIARIES: ERA Electric Co. • Advanced Acoustics Co. • ERA Dynamics Corp. • ERA Pacific, Inc.

## NEW TECH DATA

### Scope Accessory Booklet

This illustrated 36-page booklet covers a family of accessories for oscilloscopes. Described are trace-recording cameras, light filters, graticules, polarized viewers and viewing hoods; also carts and mounting accessories, including cradle mounts and frames. A variety of sampling scope accessories are also shown. Logarithmic amplifier adapters, UHF and BNC-type connectors, crystal ovens and input time constant standardizers are also described. A highlight of the booklet is a section on probes, which includes a probe-instrument compatibility chart. Address requests on business letterheads to Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

### Modular Probe Systems

Brochure 308, in color, describes a building-block approach to the problem of multiple-point probing within micro-in. areas. A complete assortment of pneumatically-moved probe heads, modular controls, high-accuracy work positioners, etc., are listed. Kulicke and Soffa Mfg. Co., Inc., 135 Commerce Dr., Industrial Park, Ft. Washington, Pa

Circle 139 on Inquiry Card

### Terminal Block Covers

Bulletin 230G describes a complete line of standard, self-gripping, neoprene and silicone terminal block covers. The TA line offers block covers for MS25123 blocks, commercial blocks, and individual single terminal studs. Sizes are available for any standard length block, and stud sizes from 5-40 to  $\frac{1}{4}$ -20 threads. An easy-to-read chart crossreferences the standard part number to the proper terminal block it is designed to fit. Samples may be obtained by requesting on company letterhead. TA Mfg. Corp., 4607 Alger St., Los Angeles 39, Calif.

Circle 140 on Inquiry Card

### Molded Products

This catalog contains data sheets describing a line of miniature standoff terminals, barrier strips and terminal boards, feed-through terminals, high-temp., coil forms, connectors, and headers for hermetic sealing. Garde Mfg. Co., 53 John St., Cumberland, R. I.

Circle 141 on Inquiry Card

### Electrolytic Capacitor

Data is available on a vertically mounted, aluminum electrolytic capacitor that may be snapped easily into place on PC boards or to conventional metal chassis. Type CVM is designed for transistorized circuits. Rated operating temp. range is  $-20^{\circ}$  to  $+65^{\circ}\text{C}$ . Voltage range is 3 to 150vdc; capacity is 5 to 5000 $\mu$ fd. Single, dual and triple capacitance and voltage ratings are available. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind.

Circle 142 on Inquiry Card

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**the most  
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TECHNICAL  
DATA on**

**Microwave  
Energy  
Sources**



Whatever your problems in microwave energy generation the solutions can most likely be found in the new Trak Technical Manual and Catalog (64-A). It lists more than 100 stock oscillators, harmonic generators, amplifiers and special products at frequencies from 400 Mc. to 11 Gc. All can be modified to other frequencies or special requirements. In many cases, Trak devices permit development of previously impossible projects because of their small size and advanced capabilities.

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**TRAK MICROWAVE  
CORPORATION**

5006 N. Coallidge Avenue Tampa, Florida  
Phone: 877-6735

Circle 93 on Inquiry Card

## NEW TECH DATA

### Switch Module

The Krytron-Pac is a cold-cathode switch tube. It combines a miniature trigger transformer in an epoxy package. The switch module measures  $\frac{3}{4}$  in. in dia. by  $1\frac{1}{2}$  in. in length. It may be used in pulse-forming and package energy. Data and specs are available from Edgerton, Germeshausen & Grier, Inc., 170 Brookline Ave., Boston, Mass.

Circle 143 on Inquiry Card

### Resistance Boxes

Catalog sheet 203 describes the K-114 and 115 decade resistance boxes. The resistors are adjusted on dc and give the following tolerances: Tens and above,  $\pm 0.005\%$ ; units,  $\pm 0.1\%$ ; tenths,  $\pm 0.05\%$ . Four and 5 dial boxes are available. Max. resistance is 111,110 $\Omega$ . Muirhead Instruments Inc., 1101 Bristol Rd., Mountain-side, N. J.

Circle 144 on Inquiry Card

### Traveling-Wave Tube

The L-3898 is an extremely linear gain traveling-wave tube which serves as an intermediate pulsed amplifier. It is designed for narrow pulse operation, primarily in side-looking radar. It is rated at 6.0w. peak min. power output over the freq. range 8500-9600mc. Min. small-signal gain is 22db. The TWT operates with a 1.5w linear power output. Noise figure is 30db max. Additional data is available from Litton Industries, Electron Tube Div., San Carlos, Calif.

Circle 145 on Inquiry Card

### Read/Write Amplifier

Product data sheet No. 1-402 describes the MA315 read/write amplifier. In conjunction with a tape handler, it records digital data on magnetic tape. It reproduces data on command. Two models are offered to cover the range of IBM-compatible tape formats: the MA315 uncompensated for 200 lpi operation, and the MA315 compensated for 200/556/800 lpi. Dual tape speed operation is available for speeds between 1 and 150 ips, with information transfer rates up to 120,000 characters/sec. Potter Instrument Co., Inc., 151 Sunnyside Blvd., Plainview, L. I., N. Y.

Circle 146 on Inquiry Card

### Amplifier

This technical bulletin describes the Model DCA-10 direct-coupled amplifier which delivers 10w. from dc to 1mc with extremely low distortion. Freq. response is  $\pm 1$ db, with distortion of 0.1% and dynamic range of 80db. With a suitable oscillator, it provides power at very-low distortion over an extremely wide freq. range, essential in applications such as precision wide-band meter calibration. The bulletin is fully illustrated and contains curves, waveforms, and specs. Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge, Mass.

Circle 147 on Inquiry Card



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4379 30th Street

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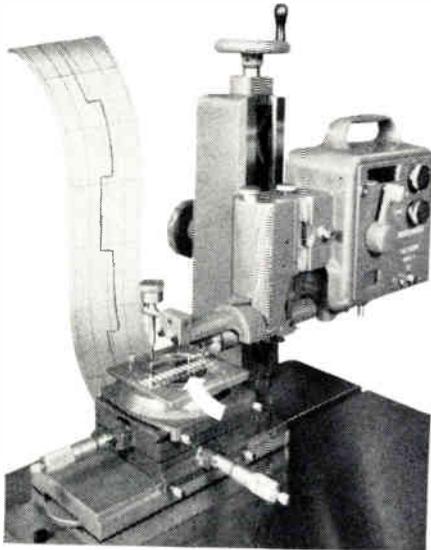
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### evaluates Thin Films and Substrates to 50 Angstroms

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For thin film or any parts requiring unquestioned accuracy—whether of hard or soft material, flat or curved shape—the Talysurf is your guarantee of reject-free production, whatever the surface finish specification.

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Circle 59 on Inquiry Card

## NEW TECH DATA

### Thin-Film Service

A wide variety of low- and medium-power digital and analog microcircuits can be delivered with short lead time and low initial tooling cost by using the custom hybrid thin-film fabrication process available from Philco Corp., Lansdale, Pa. The tantalum-based system permits the fabrication of highly-reliable hybrid circuits in small, hermetically-sealed packages. Complete details are available.

Circle 148 on Inquiry Card

### Capacitors

The Series H metallized polycarbonate capacitors are available in wrap-and-fill, rectangular and round hermetically-sealed styles. They cover capacitance ranges of 0.001 to 10.0  $\mu\text{fd}$  in 200, 400 and 600vdc ratings; operating temp. of  $-55^\circ$  to  $125^\circ\text{C}$ . The units are self-healing. Additional data available from Electron Products, 1960 Walker Ave., Monrovia, Calif.

Circle 149 on Inquiry Card

### Plastic Tubing

Data is available on 2 new Flexite Shrinkdown tubings—type HT-105 and SD-105. Both types are heat-shrinkable at less than  $200^\circ\text{F}$ . The tubing adds special mechanical or electrical protection over terminals, connectors, cables, components, or assemblies of irregular shape. Samples are available from L. Frank Markel & Sons, Norristown, Pa.

Circle 150 on Inquiry Card

### Breadboard Circuits

Data is available on a new method of preparing prototype breadboard circuits for laboratory testing or for limited production circuitry. Called Proto Boards, the units are available in kit form. The boards eliminate hundreds of tiny hardware parts. Vicon Instrument Co., P.O. Box 2742, Colorado Springs, Colo.

Circle 151 on Inquiry Card

### Taut-Band Meters

Bulletin 38 describes taut-band panel meters which are offered with standard  $\pm 1\%$  tracking. It includes a discussion of why  $\pm 1\%$  tracking is important to meter users and carries brief definitions of tracking and absolute accuracy. Assembly Products, Inc., Chesterland, Ohio.

Circle 152 on Inquiry Card

### Resistor

The 3105M is said to be the smallest chassis-mount resistor available today. Mil performance requirements are fully met or exceeded. It is made to 1% or closer tolerance and T.C.  $\pm 20 \text{ ppm}/^\circ\text{C}$ . Standard resistance range is  $0.05\Omega$  to  $20\text{K}\Omega$ . The 8w. ratings is based on  $4 \times 4 \text{ in.}$  0.040 aluminum heat sink rating. Other sizes available in 14, 25 and 50w. ratings. Additional data available from Sage Electronics Corp., East Rochester, N. Y.

Circle 153 on Inquiry Card

a tool chest  
in your  
pocket

for electronic assembly  
and service work



Shockproof, UL, breakproof,  
plastic handles with clips

#### ROUND BLADE SCREWDRIVERS

$\frac{3}{16}$ " and  $\frac{1}{4}$ " x 2", 3", and  
4" blades

#### PHILLIPS SCREWDRIVER

Point size #0, 2" blade

#### BERYLLIUM-COPPER SCREWDRIVER

Non-magnetic, non-sparking  
 $\frac{1}{8}$ " x 2" blade

#### NUTDRIVERS

10 Hex sizes from  $\frac{3}{16}$ " to  $\frac{3}{8}$ "  
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Color coded handles

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Fit  $\frac{1}{4}$ " and  $\frac{3}{16}$ " O.D. spanner nuts  
on external antenna and phone  
jacks of transistor radios

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# XCELITE

## PROFESSIONAL POCKET TOOLS

XCELITE, INC., 28 Bank St., Orchard Park, N. Y.

Canada: Charles W. Pointon, Ltd., Toronto, Ont.

Circle 60 on Inquiry Card

ELECTRONIC INDUSTRIES • May 1964

# NEW TECH DATA

## How to Measure

This tech. bulletin covers the topic "Measuring Speed of Response of High Current Transistors." The bulletin concerns itself with turn-on and turn-off times in switching from cutoff to saturation and conversely. Included are tech. diagrams, pnp life tests, speed of response testing techniques, and a listing of new STC transistor types registered with the E.I.A. Silicon Transistor Corp., Carle Place, N. Y.

Circle 154 on Inquiry Card

## Coaxial Cable

A new 24-page bulletin, CF1, details engineering data, performance curves and electrical-mechanical characteristics of Corr-O-Foam semi-flexible, air-dielectric coaxial cable. Curves for cables in 4 dia. indicate attenuation and power ratings in KC and MC for impedances of 50 and 75Ω. Phelps Dodge Electronic Products Corp., 60 Dodge Ave., North Haven, Conn.

Circle 155 on Inquiry Card

## Plug-in Cards

Data is available on 37 multi-purpose digital plug-in card modules, which cover most subsystem circuit needs. All outputs are diode clamped so any module may be connected directly to any other module. Data and specs. available from Data Technology Corp., P. O. Box 10935, Palo Alto, Calif.

Circle 156 on Inquiry Card

## Infrared Accessories

Bulletin 7000-92 describes accessories for infrared spectrophotometers which permits investigation by both Variable Angle Reflection (VAR) and Attenuated Total Reflection (ATR). The VAR allows specular reflectance investigations to be carried out from virtually any given angle rather than only a single set angle. The ATR accessory uses collimated rather than convergent light. With collimated light more rays are available to produce the ATR effect. True band intensities are achieved with only one reflection. Scientific and Process Instruments Div., Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif.

Circle 157 on Inquiry Card

## Low-Loss Laminate

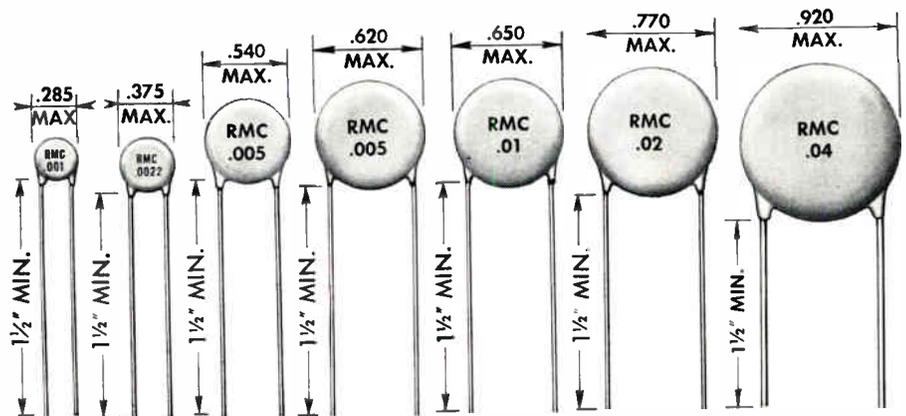
LL-161 has a temp. coefficient of capacitance which is a 300 to 500% improvement over the best low-drift phenolic laminates currently available. In addition, the lower initial dielectric constant minimizes capacitance effects. Insulation resistance after exposure to humidity ranges from 3 to 10 times higher than for phenolic or epoxy laminates. Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N. Y.

Circle 158 on Inquiry Card

Put the  Bee

on Filtering, Coupling  
or Bypass Applications

# RMC TYPE B DISCAPS



150	680	.0015	.0033	.0047	.0068	.01	.02*
220	750	.0018	.0039	.005	.0082	.02†	+80% -20%
330	800	.002	.0047*	.01*	.01*	+80% -20%	.04**
470	820	.0022	.005*	±20%	.02* †		+80% -20%
500	.001			.02* †			
560	.0012			+80% -20%			

\*Rated 500 V.D.C.W. Flash Test 1250 V.D.C.  
† Dual disc construction—Long leads only

Specifically designed for by-passing, coupling or filtering applications, Type B DISCAPS are available in production line quantities in capacitances between .00015 and .04 MFD. These DISCAPS offer a high value of capacitance per unit volume coupled with a reasonable temperature stability. They should be specified in applications such as audio coupling or bypass networks and where the reliability provided by their higher voltage rating is desired. The conservative design of Type B DISCAPS allows their use in areas where intermittent high voltage, transient pulses may occur.

Write on your letterhead for information on Type B and other quality DISCAPS.

## Specifications

Capacitance: Within tolerance @ 1KC and 25°C  
Capacitance Tolerances: 20%, +80 -20% or GMV  
Working Voltage: 1000 VDC  
Power Factor: 1.5% max. at 1KC  
Insulation Resistance: Greater than 7500 Megohms @ 500 VDC  
Temperature Coefficient: Z5U, Y5V, X5V  
Flash Test: 2000 VDC for 1 second  
Life Test: Per EIA RS-165-A Class II  
Power Factor after Humidity: 2.5% @ 1KC  
Insulation Resistance after Humidity: Greater than 1000 Megohms @ 500 VDC  
Body Insulation: Durez phenolic—vacuum wax impregnated  
Lead Styles Available: Long lead tinned copper and all types for printed wire circuits—#22 Awg.



DISCAP  
CERAMIC  
CAPACITORS

**RADIO MATERIALS COMPANY**

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FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

# NEW TECH DATA

## Copper Alloy

Data is available on a new copper-alloy conductor that has physical characteristics far superior to ordinary copper. Alloy 63 is basically a drawn copper alloy which is plated and redrawn, sometimes several times, to assure a superior surface. Tests disclosed that the alloy, which has 90% of the conductivity of copper, has almost twice the tensile and breaking strength and has the same elongation as copper. ITT Corp., 320 Park Ave., New York 22, N. Y.

Circle 159 on Inquiry Card

## Shaded-Pole Gearmotor

Data is available on a low-cost, low-torque shaded-pole gearmotor with all Delrin gearing. It is available in output speed ranges from 3 RPM to 260 RPM. The initial reduction gear is a Delrin helical, and all other gears are of Delrin except for the output reduction gear. Micro Gear Div., Howard Industries, Prophetstown, Ill.

Circle 160 on Inquiry Card

## Test Chambers

High control accuracy, bench-type temp. test chambers, interchangeable test trays and fixtures, and automatic cycle time controllers are described in this illustrated brochure. Complete specs. and easy-to-use selection tables are included. Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Circle 161 on Inquiry Card

## Digital Voltmeter

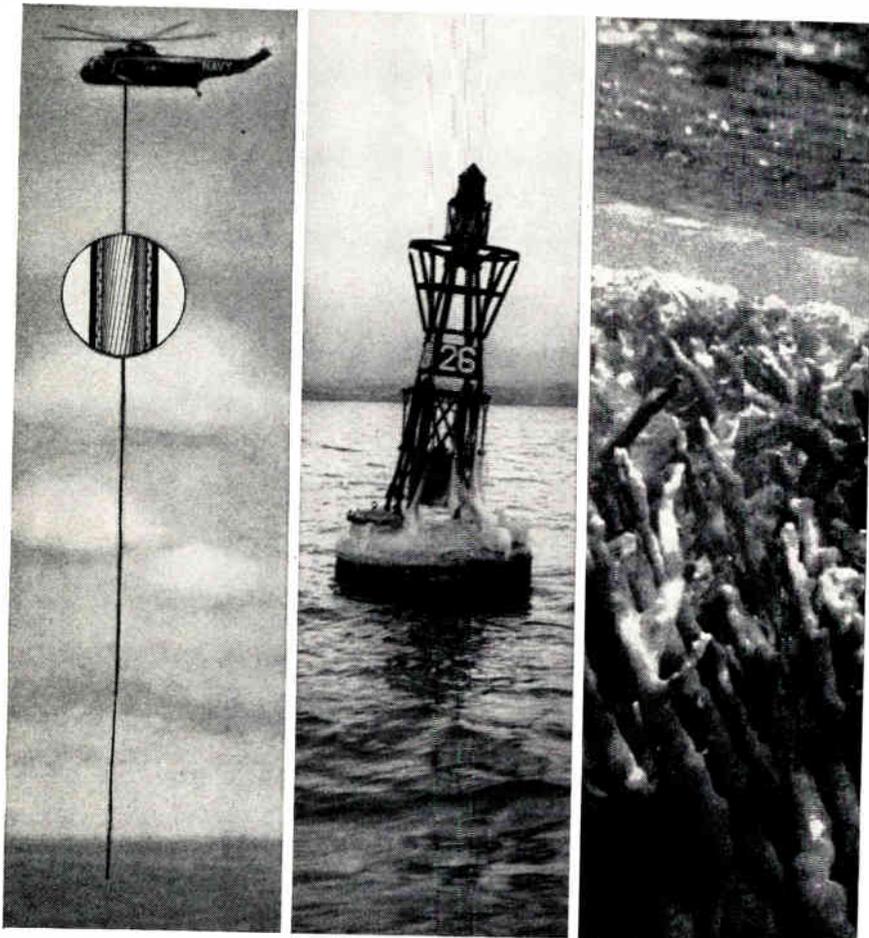
The 2350 series digital voltmeters provide in one 7 in. instrument dc ratio and ac measurements, 5-digit readout and a 6th monitoring analog meter signal. With a max. sensitivity of  $10\mu\text{v}$  and a new, unique bridge and zener combination technique, dc accuracies are 0.005% throughout a 40-100°F amb. temp. range. Ranging and polarity are automatic with 200msec. average balancing time. Common-mode rejection is 120db with full overload protection on all ranges. Additional data available from Houston Instrument Corp., 4950 Terminal Ave., Bellaire, Tex.

Circle 162 on Inquiry Card

## NAND Gates

The 2016 DG-1 NAND gate is capable of operating at speeds to 25mc. There are 2 independent 4-input NAND gates/card. The circuit consists of a 4-input diode gate followed by a transistor inverter. Input and output characteristics are -6v. to ground. Each output can be loaded with 5 unit loads. Output-pulse rise time with 5-unit loads and 50pf shunt capacitance is 10 nsec; the fall time is 10 nsec. Rese Engineering, Inc., A and Courtland Sts., Phila., Pa.

Circle 163 on Inquiry Card



**DROP IT      FLOAT IT      SINK IT**

# IMPOSSIBLE

(without TIMES cables and assemblies)

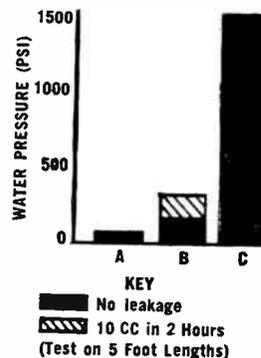
**DROP IT** into sea water from a hovering helicopter; connect a transducer to it — reel and dereel it at high speeds, that's what the Navy does with TIMES drop cable assembly, mechanical and electrical life line of the Bendix Pacific Sonar Detection systems in the Sikorsky SH 3A Sea King subhunter. It's rugged, flexible and designed for indefinite use in sea water. TIMES' new Polyurethane jacketing compound (Formulation C) makes it so, and provides the high reliability that's required.

**FLOAT IT** and control the exact degree of buoyancy on the surface or at specified underwater levels. TIMES has in use many buoyant insulated conductors and coaxial cables functioning on submarine and surface ships, seismic and ASW applications.

**SINK IT** with cable end pressures up to 1500 P.S.I. without having longitudinal leakage anywhere and less attenuation at all frequencies — proof again of TIMES' capability to manufacture non-hosing cable with superior electrical and mechanical characteristics.

TIMES' engineering and manufacturing staff specializes in solving cable and cable assembly problems in radiation, attenuation, VSWR, electrical length, stability, flexibility, abrasion and chemical resistance. For additional technical data and a reprint on "HOW TO DESIGN and SPECIFY CABLE ASSEMBLIES" wire, write or call TIMES' Sales Manager, Dept. EI-45.

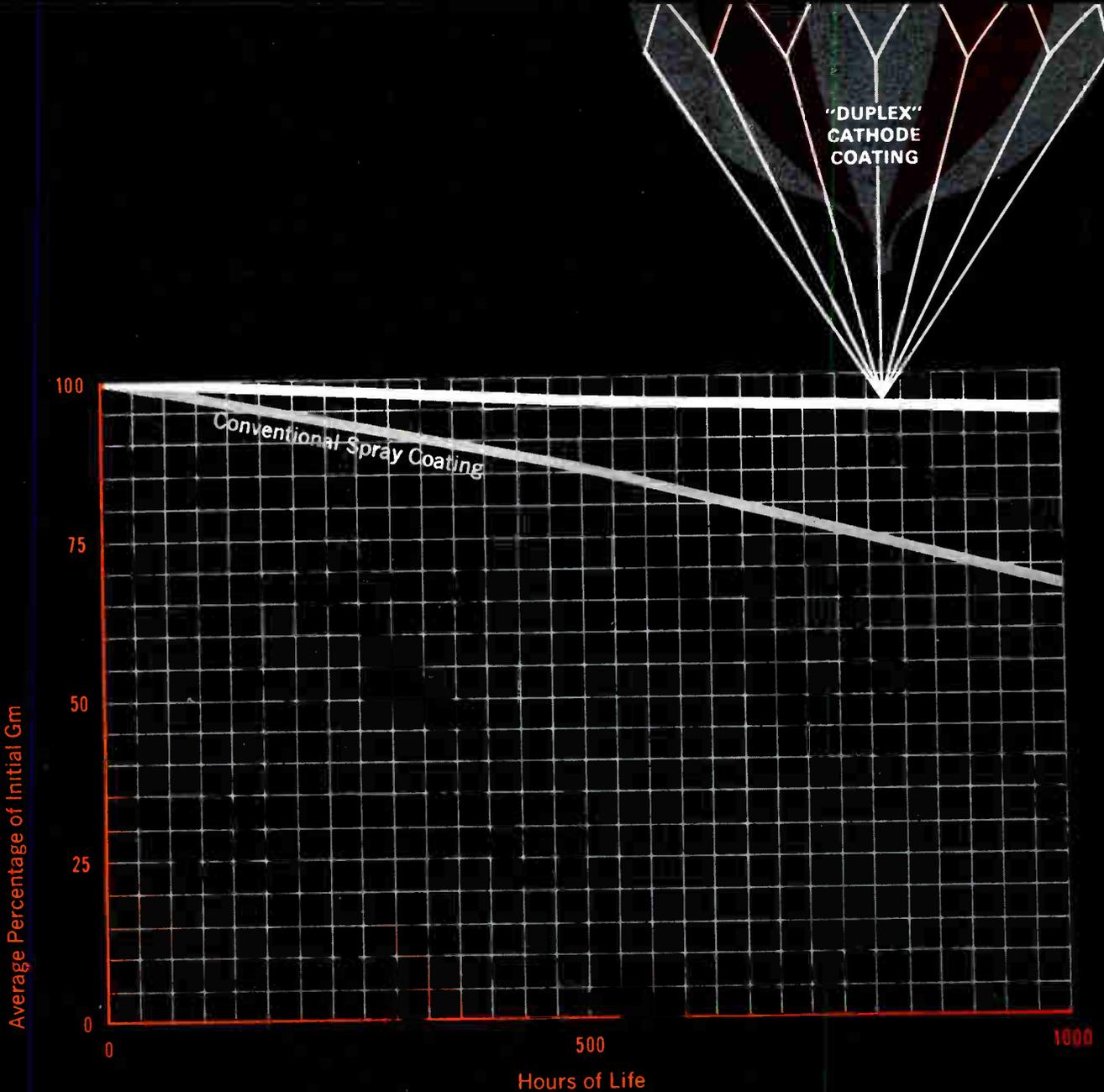
**PRODUCT A**  
(Regular MIL-C-17C, RG-217/u)  
**PRODUCT B**  
(Watertight versions of RG-217/u,  
before Times' latest development)  
**PRODUCT C**  
(Latest watertight version of  
RG-217/u-M1-1235)



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## New lift for Gm—new reason to specify GB Gold Brand

The nearly flat Gm line you see above is the result of a new and important advance in the tube art—from Sylvania.

The Duplex cathode includes two coatings, one which establishes good characteristics initially and through the early hours of life. Then—and this is the news—a second, later acting part takes effect to keep performance strong when other tubes start to deteriorate. Actual operating tests showed a 24% reduction of average Gm slump over 1000 hours of life!

Another Sylvania plus is the LIFE-BOOST\* Cathode. Its extreme purity (through powder metallurgy) contributes much to life, stability and uniformity.

There's more: heaters made of rhenium-tungsten have overcome the brittleness problem...dark heaters operate cooler, more efficiently, have extended life of the heater-cathode com-

\*Trademark



plex...new high-conductivity plate materials improve power and heat dissipation...and a special process for the gold-plated grids reduces the possibility of grid emission problems.

When equipment design calls for extreme reliability, GB Gold Brand Tubes by Sylvania are the logical answer. Making use of these important advances, and aided by on-the-spot application study, Sylvania engineers designed each tube to do a specific job better than any other tube can. Carefully controlled manufacture, stricter-than-normal testing and thorough evaluation by users further assure top performance and reliability.

For more information, contact your Sylvania sales engineer or write to ELECTRONIC COMPONENTS GROUP, Electronic Tube Division, Sylvania Electric Products Inc., Box 87, Buffalo, N. Y. 14209.

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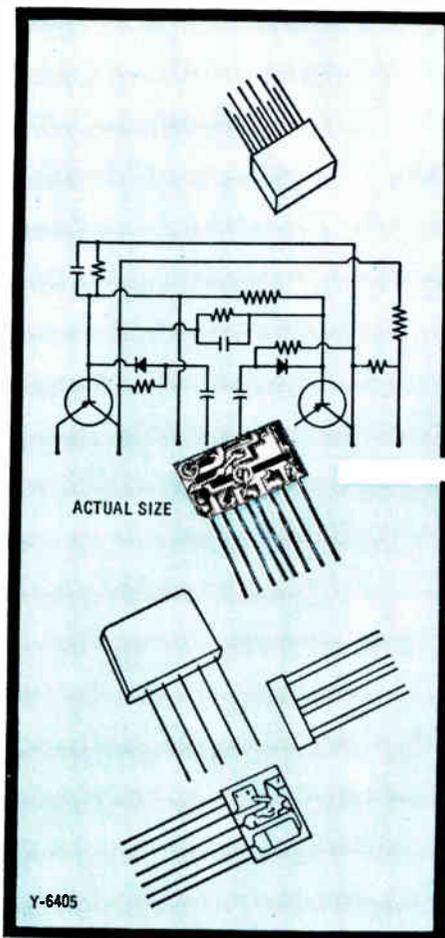
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World Radio History



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## AVAILABLE NOW FROM CENTRALAB

Proven and practical, here and now—Centralab PEC Integrated Circuits with active and passive components. More than a quarter of a billion have been used in two decades of military and commercial application.

PEC's offer you these advantages: Complete flexibility of form and circuit design, extremely high reliability, ability to include a wide variety of components and values, simple interconnections, costs comparable to and frequently lower than discrete components.

Centralab offers you these advantages: Complete engineering assistance, ability to supply integrated circuits in production quantities, realistic delivery schedules.

Write for Centralab's brochure, PEC Basic Data.



THE ELECTRONICS DIVISION OF GLOBE-UNION INC.  
P.O. Box 591, Dept. 38E • Milwaukee, Wisconsin 53201  
In Canada: Centralab Canada Ltd., P.O. Box 400, Ajax, Ont.  
Circle 64 on Inquiry Card

### Silicon Transistors

These ultra-high reliable power transistors, RCA Types 2N3263 thru 66, can switch 20a. in less than  $1\mu\text{sec}$ . Applications include switching control amplifiers, power gates, switching regulators, dc-dc converters, and dc-ac inverters, dc-to-r-f amplifiers and power oscillators. Data available from Commercial Engineering, RCA Electronic Components and Devices, Harrison, N. J.

Circle 164 on Inquiry Card

### Strain-Gage Literature

Bulletin 68-563 describes a highly isolated all-silicon Isoply series designed for use in strain-gage or transducer circuits. It offers 19 output options from 200ma @ 1v. to 40ma @ 50v. All voltages are adjustable at least  $\pm 6\%$ . Elcor, div. of Halliburton Co., 1225 W. Broad St., Arlington, Va.

Circle 165 on Inquiry Card

### Read/Write Unit

Data is available on a bi-directional asynchronous magnetic-tape device. The Digi-Store DS-2 is a single unit which operates in both read and write modes and can replace paper-tape punch and tape reader. Speeds up to 333-eight-bit parallel characters/sec. are obtainable, which make full use of a 3kc line. Parallel-to-serial conversion logic is also available. It stores 1000 characters/ft. Trak Electronics Co., Inc., 59 Danbury Rd., Wilton, Conn.

Circle 166 on Inquiry Card

### Voltage Standard

Calibrating production-line digital voltmeters by a dc voltage standard is the subject of bulletin 5-15. It includes photos and block diagram showing the use of the 303A dc voltage standard which measures from 0 to 1111.1110v. with greater than 0.01% accuracy. Cohu Electronics, Kin Tel Div., Box 623, San Diego 12, Calif.

Circle 167 on Inquiry Card

### Sample Magnetometer

Data is available on a Foner-type vibrating sample magnetometer. This precision instrument measures permanent or induced magnetic movements over an extended range of temp., field and crystallographic orientation. The unit can be used with any conventional laboratory electromagnet, or can be readily adapted to superconducting magnets. Princeton Applied Research Corp., Box 565, Princeton, N. J.

Circle 168 on Inquiry Card

### Antenna Positioner

Bulletin 8530 gives specs. on a new elevation over azimuth positioner for microwave antennas. Designed for a tactical communications system, the Type 30131 is lightweight and compact, yet suitable for heavy-duty fixed operation. It withstands 125 mph winds with a 6 ft. parabola in place and is operational with  $\pm 1^\circ$  accuracy in 30 mph winds. Andrew Corp., P.O. Box 807, Chicago, Ill.

Circle 169 on Inquiry Card

### Terminals

Glass-to-metal terminals in assemblies ranging from accelerometers to zener diodes are described in 15 data sheets. The data sheets cover items that are available off-the-shelf, and also emphasize the company's technical service for custom-made terminals. The Carborundum Co., Electronics Div., Latrobe, Pa.

Circle 170 on Inquiry Card

### X-Y Recorder

This illustrated brochure describes the F-80 X-Y Recorder. The unit features unique paper hold-down system, time base with adjustable margins, and a wide range of input impedance. Full mechanical and electrical specs. are given, along with a list of available accessories and instructions for custom installations. Varian Associates, 611 Hansen Way, Palo Alto, Calif.

Circle 171 on Inquiry Card

### Dummy Strain Gages

This weldable dummy strain saves time through convenience of installation. It is insensitive to strain, but reacts to temp. It can be mounted alongside an active gage on a strained structure to provide improved temp. compensation. The gage eliminates the problem of finding additional strain-free locations within test structures. Each gage is adjusted to match test-material characteristics. Specs. available from Microdot Inc., 220 Pasadena Ave., S. Pasadena, Calif.

Circle 172 on Inquiry Card

# NEW TECH DATA

## Temperature Sensor

Data is available on the Model 104AT which has an O.D. of 0.084 in. This sensor will repeat to  $\pm 0.05^\circ\text{C}$  at  $0^\circ\text{C}$  when used over its entire range of  $-260^\circ\text{C}$  to  $+250^\circ\text{C}$ . When used over a narrower range, the stability is better. It is available in 100 to  $2000\Omega$  resistances. Rosemount Engineering Co., 4900 W. 78th St., Minneapolis 24, Minn.

Circle 173 on Inquiry Card

## Retainers

This brochure contains data, photos, and drawings on a line of Top Hat® retainers for plug-in components. The units provide positive protection from severe shock and vibration. Useco Div. U. S. Engineering Co., 13536 Saticoy St., Van Nuys, Calif.

Circle 174 on Inquiry Card

## Band-Pass Network

Data is available on a constant delay band-pass network. Passband is 200-500 cps; stopband 0 to 120 cps; 900 to 10kc (80db). Delay: constant  $\pm 10\mu\text{sec}$ . from 230 to 500 cps. Burnell & Co., Inc., 19 Pelham Pkwy., Pelham, N. Y.

Circle 175 on Inquiry Card

## Synthesizer-Exciter

Model 263 can be used as the master oscillator in radio transmitters or receivers. The unit, operating on the triple-mix method, has a max. power output of 1w., and provides an output from 100kc to 300mc, adjustable by 5 decade switches in steps of 1mc, 100kc, 10kc, 1kc, and 100 cps. An interpolation oscillator with a 0 to 100 cps range supplies the intermediate freqs. so that the output is continuously adjustable over the total range. Rohde & Schwarz Sales Co., Inc., 111 Lexington Ave., Passaic, N. J.

Circle 176 on Inquiry Card

## Data Transmission

The Dial-o-verter D521 is a high-speed magnetic tape terminal. It transmits over voice-grade telephone lines, or over broadband communications facilities. A line utilization factor of 95% is achieved by overlapping transmission time with tape-reading and writing time. The terminal is completely self-contained, and does not require computer time for transmission. Complete details are available. Digitronics Corp., Albertson, N. Y.

Circle 177 on Inquiry Card

## Tantalum Capacitor

The TSO series of solid-tantalum capacitors are 0.12 in. long and have a diameter of 0.65 in. Leakage current of  $0.2\mu\text{a}$  at  $25^\circ\text{C}$  and  $2\mu\text{a}$  at  $85^\circ\text{C}$  is one-half the requirements of existing mil. specs. and industry standards. U.S. Semicon, 3540 W. Osborn Rd., Phoenix, Ariz.

Circle 178 on Inquiry Card

## Cycle Timer

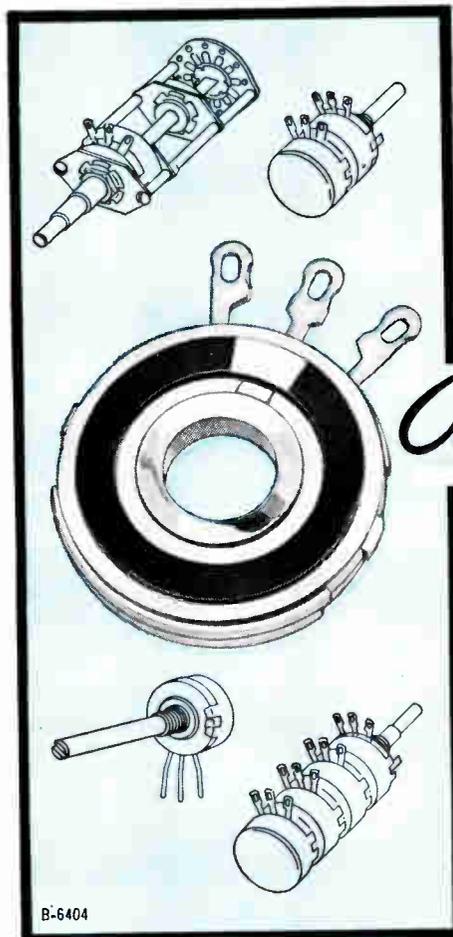
Bulletin B-20 describes a new replaceable switch cycle timer which can be adapted for numerous uses. The bulletin contains technical diagrams and includes data on operation, specs. and special features. Bristol Motors, Old Saybrook, Conn.

Circle 179 on Inquiry Card

## Indicator Light

The Series-O neon indicator light features 3 terminals, two of which are common to one side of the internal circuit. This provision is useful in multiple arrangements. The Series-O can be operated on 110-125v. Dialight Corp., 60 Stewart Ave., Brooklyn, N. Y.

Circle 180 on Inquiry Card



B-6404

## RV4 style Centralab potentiometers

### THE INDUSTRY'S BROADEST LINE

These low-noise, hot molded element, back-lash-free units are available as singles, twins, dual concentrics, triples, quads, attenuators, and singles with front or rear mounted rotary switches. Five shaft styles, three bushing types, with wire-wrap or standard terminals, as well as encapsulated units, are standard.

Rated at 2.25 W at  $70^\circ\text{C}$ , a complete range of resistances and tapers can be supplied. Write for detailed engineering data.

For Immediate Delivery—3 styles, 91 popular values are available from Centralab Industrial Distributors in quantity, at factory prices.

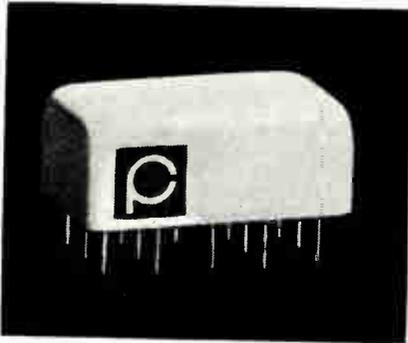
**Centralab**®

THE ELECTRONICS DIVISION OF GLOBE-UNION INC.  
P.O. Box 591, Dept. 38E • Milwaukee, Wisconsin 53201  
In Canada: Centralab Canada Ltd., P.O. Box 400, Ajax, Ont.

... advancing the STATE-OF-THE-ART in Components & Equipment.

## RELAY

Microminiature 4-pole unit has a min. life of 100K operations @ 2a.

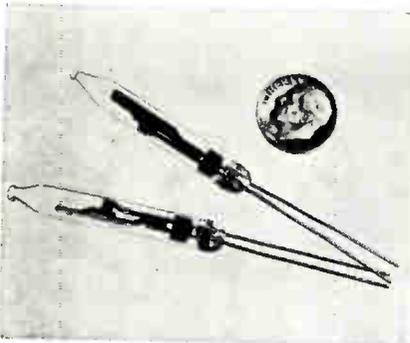


Type 64 relay has overall dimensions of 1 x 0.600 x 0.400 in. Additional specs. include: contact rating, low-level to 2a./26vdc; amb. temps., -100°C to +125°C; shock, 65G for 11ms; vibration, 30G thru 2Kc; max. operating time, 5ms; max. release time, 5ms; the dielectric strength is 1kc RMS terminal to case, 500v. RMS between contacts. Available with either plug-in or solder terminals. Phillips Control Co., 59 W. Washington, Joliet, Ill.

Circle 181 on Inquiry Card

## MAGNETIC SWITCH

Glass-enclosed switch handles 3a. at 125v. or 1.5a at 240v.

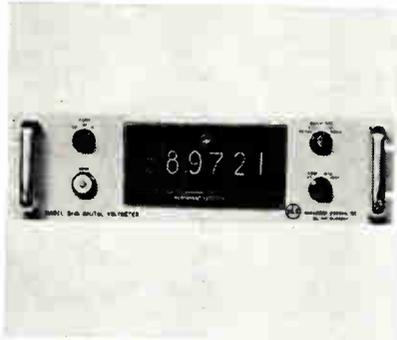


This glass-enclosed magnetic switch handles high power. Hermetically-sealed, the snap-action unit is activated by a small magnet. No mechanical connections are necessary. The glass jacket can be vacuum or inert gas filled, depending upon the application. Switching speed is 4msec. with an operating freq. to 20 cps and a temp. range of -54°C to +200°C. Life expectancy is from 100,000 to 1 million cycles, depending on the load. Sylvania Electric Products, Inc., 730 Third Ave., New York, N. Y.

Circle 182 on Inquiry Card

## DIGITAL VOLTMETER

Programmable unit has  $\pm 0.01\%$  accuracy. Features 100 $\mu$ v sensitivity.



Series 9100 is a 5-digit digital voltmeter. Range is  $\pm 9.9999/99.999/999.99$  vdc and  $\pm 99.999\%$  dc voltage ratio. By means of accessory converters, the instrument also measures ac voltage and ohms. Min. speed is 1 reading/sec. Logic eliminates all unnecessary range and polarity changes. Input resistance is 10 meg for volts and 1000 meg for voltage ratio. Non-Linear Systems, Inc., P. O. Box 728, Del Mar, Calif.

Circle 183 on Inquiry Card

## CALIBRATOR

Has 5ppm line and load. Voltage calibration, 0.01%; current, 0.02%.



Model 382A is a solid-state voltage/current calibrator. It uses current and current/voltage limiting for precise and continuously variable output control. Zener diodes in temp.-controlled enclosure, precision wire-wound resistors in decade sample strings, and flow-soldered glass-epoxy PCBs contribute to accuracy and stability. It has a 0-2a. capability in 4 ranges. John Fluke Mfg. Co., Inc., Box 7428, Seattle, Wash.

Circle 185 on Inquiry Card

## ELECTROLYTIC CAPACITORS

High-density packaging cuts capacitor size 2/3. Meets Mil-C-3965/4C.

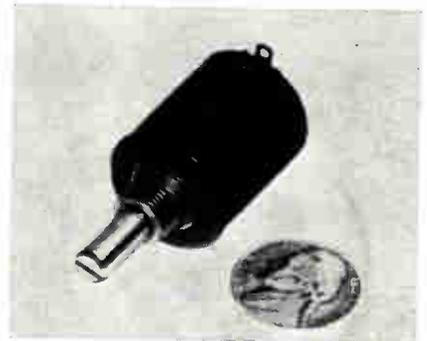


The tantalum Super-Pak electrolytic capacitors combine multiples of individual tantalum wet-slug capacitors in encapsulated modules. Weight and space are reduced by using tantalum powders compacted with improved sintering and pressing techniques, plus a unique method of internal wiring and packaging. They are available in values ranging from 160 $\mu$ f to 2640 $\mu$ f ( $\pm 20\%$ ) and in working voltages of 10, 15, 20, 25, 30, 50, 75 and 100v. International Electronic Industries of SPS, Box 9036, Nashville, Tenn.

Circle 184 on Inquiry Card

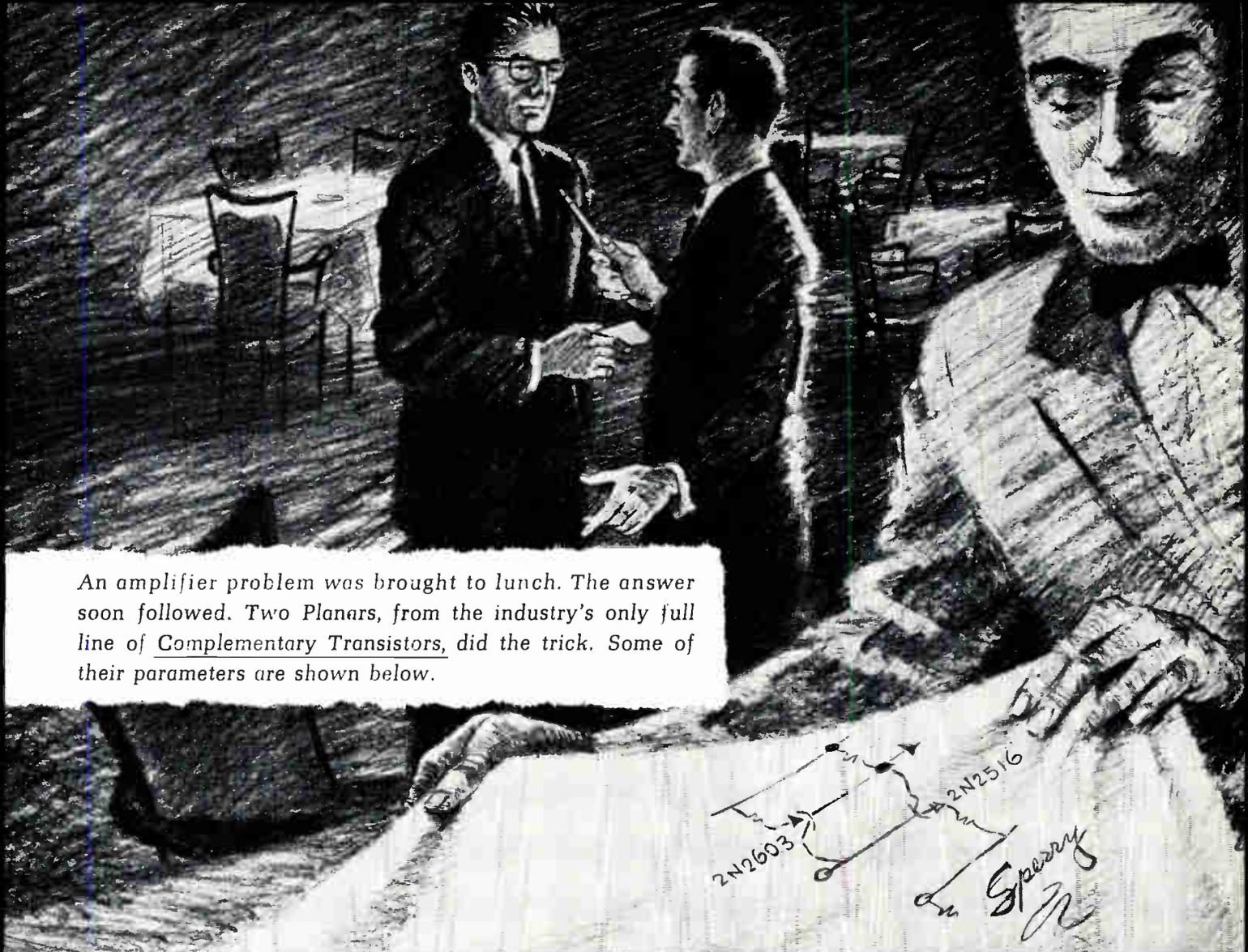
## POTENTIOMETER

Standard linearity of  $\pm 0.20\%$  in resistance values of 500 to 125K $\Omega$ .

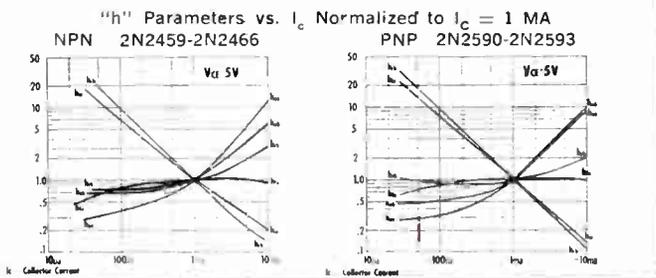


Type MF78 is a low-cost, 10-turn unit with a power dissipation of 2w. @ 40°C. It features all welded terminations, precious metal contacts and wiper plus many other features found only in costly Mil spec. potentiometers. Specs. include: electrical angle, 3600° nominal; mechanical angle, 3600° +10° -0°; torque, 0.6 oz./in.; backlash, 1° max. It withstands a shock of 50G for 11msec. Fairchild Controls, div. of Fairchild Camera and Instrument, 225 Park Ave., Hicksville, L. I., N. Y.

Circle 186 on Inquiry Card



An amplifier problem was brought to lunch. The answer soon followed. Two Planars, from the industry's only full line of Complementary Transistors, did the trick. Some of their parameters are shown below.



	TO-46 Case	MAXIMUM VOLTAGES			I <sub>C</sub> Max. @ 25°C (μA)	h <sub>ie</sub>		V <sub>CE(SAT)</sub> Max. (Volts)	f <sub>T</sub> Typ. (MC)	
		BV <sub>CEO</sub> (Volts)	BV <sub>CBO</sub> (Volts)	BV <sub>EBO</sub> (Volts)		Min.	Max. @ I <sub>C</sub> (mA)			
NPN	2N2460	100	60	8	.002	70	130	5	0.3	200
PNP	2N2591	-100	-60	-7	-.025	70	135	-5	-0.4	100
NPN	2N2461	100	60	8	.002	120	130	5	0.3	225
PNP	2N2592	-100	-60	-7	-.025	115	200	-5	-0.4	125
NPN	2N2462	100	60	8	.002	170	230	5	0.3	250
PNP	2N2593	-100	-60	-7	-.025	160	275	-5	-0.4	150

**Ideas happen anywhere.** When a good engineer sinks his teeth into a problem, he doesn't let go until he comes up with an answer.  Our complementary transistors have provided many answers to circuit problems – they help you increase performance with same power (or cut power requirements); reduce number of stages; improve high density packaging.  By manufacturing the industry's first full line of complementary transistors, (not just selecting a PNP that is close to an NPN), Sperry Semiconductor again demonstrates its leadership in PNP low-level silicon devices. Our record of reliability validates our credentials for the future. Question them, inspect them, use them – they can help on your military projects and in your industrial control work. Whether you need volume production or personal attention in custom engineering – contact us. It costs you no more to buy from the leader of PNP small signal silicon transistors.  Eastern Regional Office: 69 Hickory Drive, Waltham, Mass.; Midwest Regional Office: 3555 West Peterson Avenue, Chicago 45, Ill.; Western Regional Office: 1680 North Vine Street, Hollywood 28, Calif. Sales Representatives: Orbit Electronics, 250 Carroll Street, Fort Worth, Texas; Perrott Associates, Incorporated, 2321 East South Street, Orlando, Fla.  Keep in touch – with SPERRY SEMICONDUCTOR Norwalk, Connecticut.

# SPERRY

DIVISION OF  
SPERRY RAND  
CORPORATION

Circle 66 on Inquiry Card

# NEW PRODUCTS

## GLASS TRIMMER CAPACITOR

Length behind panel: 9/32 in.; capacitance range: 1.0 to 10.0pf.



The SG 11054 is a glass dielectric piston-trimmer capacitor. It is 1/4 in. in dia. It has a temp. coefficient of  $0 \pm 50$  PPM/°C; dielectric strength of 1 kvdc at 50% relative humidity and max. rated capacitance; working voltage is 500vdc. Approx. Q: 1000 @ 1mc; 500 @ 50mc; 400 @ 100mc; 350 @ 500mc; etc. Roanwell Corp., 180 Varick St., New York, N. Y.

Circle 187 on Inquiry Card

## VACUUM GAUGE

Monitors pressures from 50 Torr to 1 micron in a single range.



Model KTPG thermistor Pirani vacuum gauge uses all solid-state circuitry. Its fast response and extended range makes it ideal for commercial and laboratory use. Compact and lightweight, it uses a regulated power supply and a Wheatstone bridge. The thermistors used in the gauge tubes can be exposed to atmospheric pressure during operation without damage. A fast response to slight pressure changes makes it a fine vacuum-system, trouble-shooting tool when used in conjunction with a hydrogen-rich gas. Kinney Vacuum Div., The New York Air Brake Co., 3529 Washington St., Boston 30, Mass.

Circle 188 on Inquiry Card

## BRIDGE SUPPLY

For strain-gage power supply. Out variable from 5 to 24v.

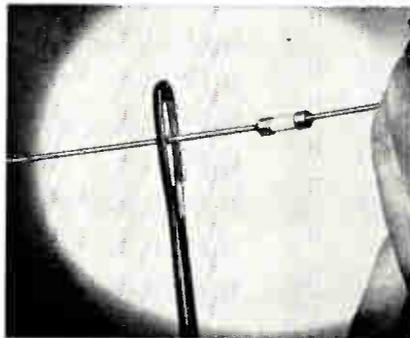


The solid-state Model 6179 bridge supply is a full-floating, triple-shielded, regulated power supply. It has a bridge-balance switch that permits monitoring by external bus of bridge voltage or bridge balance. The unit permits use of 3, 4, 6, or 7 wire connected systems. It supplies 0 to 200ma dc. Dynamics Instrumentation Co., 583 Monterey Pass Rd., Monterey Park, Calif.

Circle 189 on Inquiry Card

## CERAMIC FUSES

Available to 5a. with interrupting capacity of 300a. at 130vdc.



These PicoFuses are 0.078 in. in dia., 7/32 in. long. They are available with 2 styles of leads, axial and radial, or fit into diode-type mounting. Series 275 has 1-9/16 in. axial leads extending from each fuse end. Series 276 is made 1 1/2 in. radial leads at right angles to the ceramic body's end caps. Interrupting capacity to 300a. @ 130 vdc. Blowing characteristics, 100%, 4 hrs. min. and 200%, 5 sec. max. They can be soldered to within 1/4 in. of fuse end or snapped into a standard type mounting. The fuses can be used in encapsulated circuitry. Littlefuse, Inc., 800 E. Northwest Hwy., Des Plaines, Ill.

Circle 190 on Inquiry Card

## DC POWER SUPPLY

Continuously adjustable from 0 to 60vdc at 50a., max. ripple is 300mv.

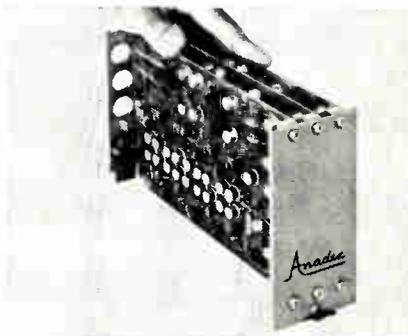


Model KN20 is designed for 208vac, 60 cycle, 3-phase input. The dc output is isolated from the ac line and ground. The unit features a solid-state phase-failure sensor which turns off the power supply if one or more of the 3 input phases opens. It also prevents the supply from starting if the ac source has an open phase. Opad Electric Co., 43 Walker St., New York 13, N. Y.

Circle 191 on Inquiry Card

## PULSE COUNTER

Operates from the output of flowmeters and tachometers.



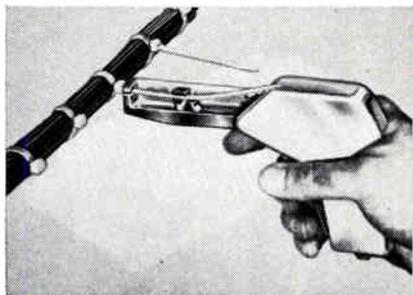
Model CD-43M plug-in pulse scaler has 3 separate pulse-counter channels. Since a flowmeter output is normally low-level and varies in amplitude with freq., it is difficult to read accurately on an oscillogram. This unit provides an output that is independent of input amplitude and gives a scaled output (every 10th pulse is larger than the unit pulses and every 100th pulse is larger than the 10th pulse). The oscillogram reader reads this scaled output, then counts the pulses by 100's, 10's, and units. This increases accuracy. Freq. range is 5 cps to 3200 cps. Anadex Instruments Inc., 7833 Haskell Ave., Van Nuys, Calif.

Circle 192 on Inquiry Card

## NEW PRODUCTS

### CABLING TOOL

Tension setting is easily calibrated for convenience and control.

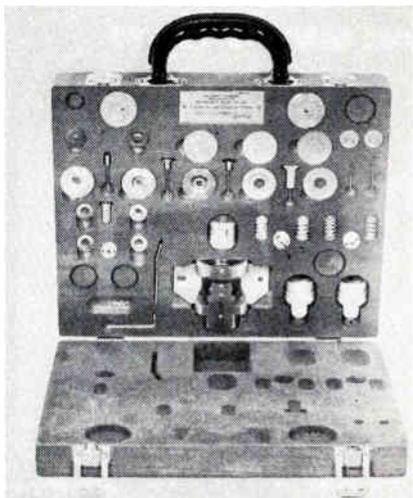


The GS-2B is of the direct in-line feed type with strap cutoff at a present and controlled strap tension. The tension level is readily controlled and adjusted without the need of separate and auxiliary tools. Same tool is used to install both standard and miniature cable ties, clamps and identification markers. Panduit Corp., 17301 Ridgeland Ave., Tinley Park, Ill.

Circle 193 on Inquiry Card

### SWITCH KIT

Allows building of pressure switches for prototype, and test use.



The Erect-to-Spec Kit contains standard modular do-it-yourself components for assembling pressure switches covering the 1 to 3000 psig range. It helps designers to complete functional prototype systems and to observe the effect of pressure changes and adjustments during the design process. The switches can be calibrated to duplicate actual field conditions. A 16-page illustrated handbook accompanies the kit giving full instructions for use and adjustment procedures for building 5 different pressure sensing systems. Haydon Switch & Instrument, Inc., 1500 Meriden Rd., Waterbury, Conn.

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## STOP HIDDEN PROFIT LEAKS!



with **STANCOR**  **VOLTAGE STABILIZERS**

COMPLETE RANGE . . . 15 to 3000 VA  
Immediate delivery from your Authorized  
STANCOR Industrial Distributor

Write: We'll send bulletin and name of distributor



**ELECTRONIC MARKETING DIVISION**  
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CORPORATION

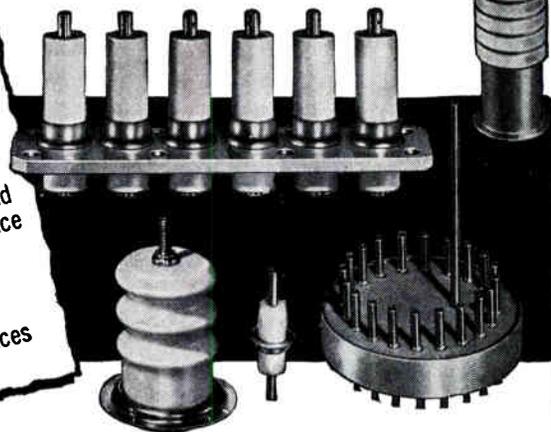
WAREHOUSES IN:  
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Circle 68 on Inquiry Card

## ALITE<sup>®</sup> HIGH ALUMINA Ceramic-to-Metal Seal Assemblies

Combine . . .

- Vacuum-Tightness
- Superior Mechanical Strength
- High Temperature and Heat-shock Resistance
- Reliable Electrical Characteristics
- Precision Tolerances



An Alite ceramic-to-metal seal may be just the answer to your problems of reliability and maintenance where service conditions are extremely severe or critical.

Every manufacturing step is handled within our own plant

Send today for free, helpful brochures.

and carefully supervised by our strict Quality Control methods to assure absolute adherence to specifications, utmost uniformity and reliability.

Write us about your requirements.

ALITE  
DIVISION

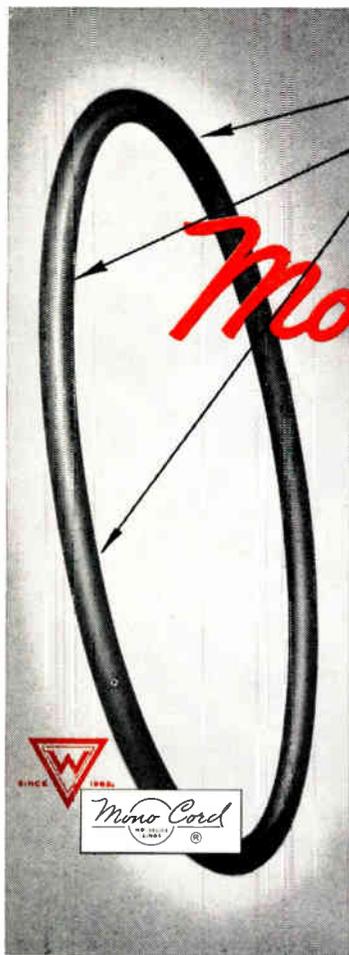
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ORRVILLE, OHIO



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- ONE PIECE — no splice
- UNIFORM — no splice humps
- ECONOMICAL — no splicing cost

# Mono Cord

**NO SPLICE RINGS**

Mono Cord one piece, no splice round section rings are used as reciprocating or static seals in pressurized systems by the automotive, plumbing and many other industries.

These seals, built to critical standards, must be leakproof against liquids or gases, unaffected by chemical or temperature changes and remain physically constant throughout use.

Mono Cord no splice rings are molded from natural and synthetic rubbers in a wide variety of sizes to fit your specifications. For precision rings at economy prices, specify Mono Cord rings by Western.

*Write or phone for information, literature or a visit by our sales engineer in your area*

**WESTERN RUBBER CO.**  
**GOSHEN 10, INDIANA**

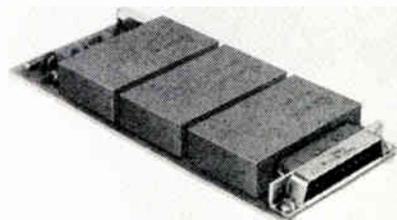
*Molded and Lathe-Cut Rubber Parts for All Industries*

Circle 70 on Inquiry Card

## NEW PRODUCTS

### OPERATIONAL AMPLIFIER

*Unity inverter stability is 10 $\mu$ v/day;  
unity integrator drift is 10 $\mu$ v/sec.*



The Model 142 is produced in 3 logical subsections, each of which is encapsulated within compression molded covers. Sections are then interconnected with a master etched circuit board. This packaging reduces down time to merely replacing the section affected. Full 100v., 20ma output is available from dc to 25kc with a max. slewing rate of 15v./ $\mu$ sec. Freq. response is 1mc and input impedance exceeds 1 megohm. Zeltex Inc., 2350 Willow Pass Rd., Concord, Calif.

Circle 195 on Inquiry Card

### WIDE-BAND WATTMETER

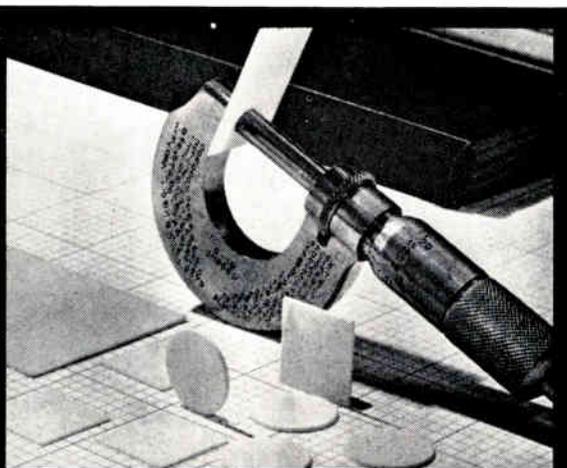
*Uses a Hall-effect wattmeter transducer. Freq. range, 40 cps to 50kc.*



The panel meter of this unit provides a direct measurement of real power in 4 ranges: 100 to 3kw, full scale. The influence on the measurement with a leading or lagging power factor of 1 to 0.1 is less than 1% full scale. The calibrated voltage at the output jacks has a dc component proportional to the real power and an ac component proportional to the v.-a. product. These voltages may be used to compute power factor and phase angle, and provide visual indication of power waveform when applied to an oscilloscope. Applied to an X-Y recorder, they provide the data for a power vs. freq. curve. F. W. Bell, Inc., 1356 Norton Ave., Columbus, Ohio.

Circle 196 on Inquiry Card

**NOW  
FROM  
SAXONBURG**



## ALUMINA CIRCUIT PLATES

Made from high-purity 96% alumina, these lightweight plates are used primarily as printed circuit bases for assembly into electronic components. The plates provide high physical strength and resistance to softening as well as good electrical properties.

**THICKNESSES:** Down to .008" with tolerances to  $\pm$  .0005"

**FLATNESS:** Polished or lapped faces made parallel within .0005"

*Write for additional information and samples.*

**Saxonburg**  
CERAMICS, INC.

8003rd Ave. • SAXONBURG, PA.  
*Quality Ceramics for Industry Since 1924*

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*Now! RCA brings Cermolox® Power to UHF-TV*  
**RCA-8501 DELIVERS 5.5 KW AT 890 MC**

New economy and convenience in broadcast power are now possible. RCA-devised techniques developed for military applications are being employed to advantage in the new RCA-8501—a Cermolox tube designed for use as an RF amplifier in the UHF-TV band. The tube delivers 5.5 kw at peak of sync at 890 Mc.

An all-ceramic-metal, forced-air-cooled tetrode, the RCA-8501 is made of space-age materials and takes advantage of RCA's exclusive grid-forming technique. Unmatched uniformity results.

Distinguished outwardly by a high-efficiency radiator of 163 individually-stamped

fins, this Beam Power Tube features a thoriated-tungsten mesh filament. You benefit from extended tube life and the lower replacement costs.

The 8501 is the latest development in a continuing program to optimize the usefulness of RCA Cermolox tubes for UHF. Your RCA Representative has complete details on the RCA-8501 and other RCA Cermolox tubes. Call him today.

For technical bulletins on the 8501 or any other specific types, write: Commercial Engineering, Section E-50-DE, RCA Electronic Components and Devices, Harrison, New Jersey.

---

**RCA-8501—Maximum Ratings  
in Class B Television Service**

---

DC Plate Voltage	7000 volts
DC Grid-2 Voltage	1500 volts
DC Plate Current	4 amps
DC Grid-2 Input	150 watts
Plate Dissipation	10 kw
Grid-1 Input	100 watts

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**ALSO AVAILABLE THROUGH YOUR AUTHORIZED  
RCA INDUSTRIAL TUBE DISTRIBUTOR**



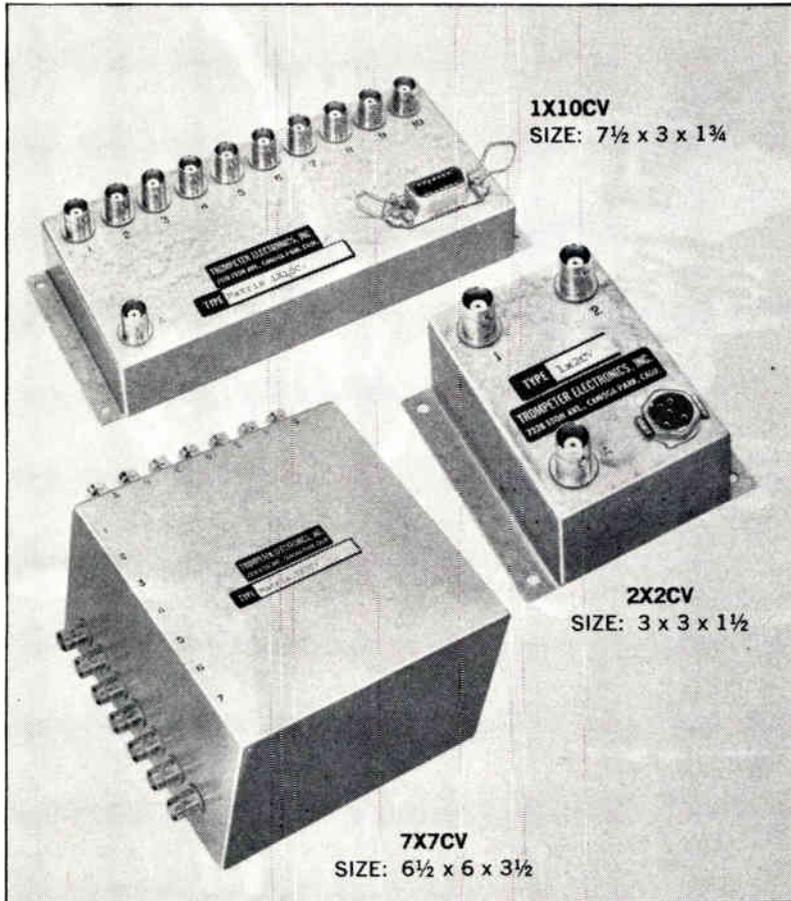
**The Most Trusted Name in Electronics**

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World Radio History

# COAXIAL SWITCHING MATRICES

REMOTE CONTROLLED  
PRE-PROGRAMMABLE VIDEO AND DATA SWITCHING



**NOW AVAILABLE!!** A complete series of switching matrices for analog or digital switching up to 5 mc., and coax or twinax video switching up to 60 mc. The matrices allow any input or series of inputs to be connected to any output or multiple of outputs. They are available in 1 by 2 up to 25 by 25 crosspoint versions. Also available are multiple pole (up to 25 points) single throw coaxial switches. Switching control can be accomplished by a remote control panel, pre-programmed punched card or tape, or computer control for automatic checkout applications.

#### SPECIFICATIONS

Crosstalk characteristics:	
Digital and analog to 5 mc.	— 60db minimum
Video to 20 mc.	— 80db minimum
Maximum insertion loss	0.2db at 60 mc.
Control voltage	12 to 48 volts dc.
Actuation time	1 millisecond

## TROMPETER ELECTRONICS

7238 Eton Avenue • Canoga Park • California • Telephone (213) 346-1550

## NEW PRODUCTS

### LASER WELDER

Beam energy is adjustable  
from 0.1 to 2.0 joules/pulse.

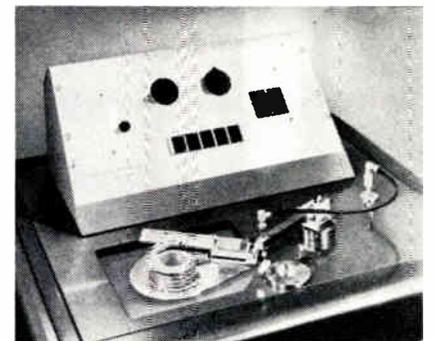


The Model 500 laser welder is for microwelding operations on an assembly line. It uses a pulsed ruby laser to achieve a powerful burst of highly-concentrated energy. Repetition rate is 12 pulses/min. @ 1 joule or 9 pulses/min. @ 2 joules; pulse duration is 0.5-1.5msec. Either manual or automatic firing control can be selected, and the weld spot size is adjustable from 0.005 to 0.020 in. A binocular microscope is used for viewing, and aiming is achieved by means of a cross-hair reticle. Hughes Electronic Products Div., 500 Superior Ave., Newport Beach, Calif.

Circle 197 on Inquiry Card

### SILICON DICE TESTER

Handles, tests and sorts dice 0.030  
in. round or sq. at the rate of 1/sec.



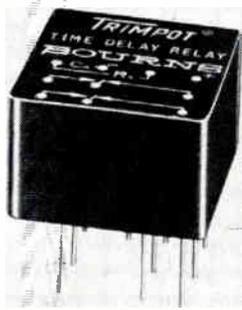
The DS-10 is a fully automatic high-speed dice tester. During the test part of the cycle, electrical contact is made to both sides of the die and a series of electrical tests are applied. After test, the die is deposited in 1 of 16 bins, a new die is picked up by the vacuum chuck, and moved into the test position. Actual transport time is 0.6 sec., leaving 0.4 sec. for test time. Most silicon or germanium diode dice and many transistor dice may be tested with minor modifications to the equipment. Transistor Automation Corp., 101 Erie St., Cambridge, Mass.

Circle 198 on Inquiry Card

## NEW PRODUCTS

### TIME-DELAY RELAY

*Time-delay range, 0.1 to 200 sec.;  
min. life, 100,000 switches.*

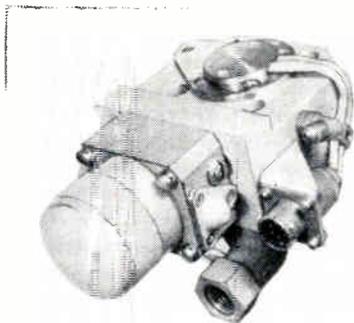


Model 3908 dpdt relay provides adjustable delays on operate from 0.1 to 15 sec. over a nominal voltage range of 20 to 30vdc with an external timing resistor. With the addition of an external capacitor, the total delay can be extended to 200 sec. Internal delay adjustment is provided by a potentiometer. It switches 1a. resistive at 26.5vdc. Supply voltage fluctuations of 20 to 30vdc will not affect its  $\pm 5\%$  repeatability. After actuation, it draws less than 0.05a. Bourns, Inc., Trimpot Div., 1200 Columbia Ave., Riverside, Calif.

Circle 199 on Inquiry Card

### MAGNETRON TUNING

*Actuator adjusts to wide range  
of frequencies and stroke.*

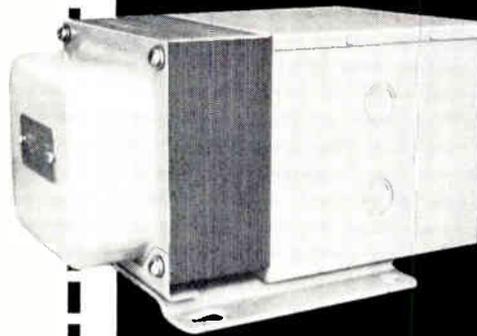


E/HA-106 is a hydraulic servo actuator designed for the magnetron-tube tuning. It holds any position within its stroke to close tolerances, or it can adjust the tuning over a wide range of cycling freqs. and stroke. Stroke ranges to 0.250 in. p-p; cycling rate is from 0 to 60cps. The unit is designed for 60 million cycles at max. stroke and freq. A specially developed seal assures negligible leakage during life of actuator; total leakage during service life is held to 3 cc max. Eastern Industries, div. of Laboratory for Electronics, Inc., 100 Skiff St., Hamden 14, Conn.

Circle 200 on Inquiry Card

**Acme**  **Electric**

**---KNOWS HOW TO**



**MAKE LINE VOLTAGE  
BEHAVE!**

With an Acme Electric Voltage Stabilizer connected to the supply circuit, output voltage becomes precisely constant regardless of line voltage fluctuation or changes in the load.

Voltage regulation is practically instantaneous with response to either undervoltage or overvoltage variation occurring in approximately 25 milliseconds. Stabilization is held within 1% over a range of 15% line voltage variation.

Improved circuitry provides a high degree of wave-form fidelity. Protected automatically against overload or short circuit by its current limiting design. Sturdily constructed, no moving parts, practically no maintenance.

**A STANDARD  
DESIGN FOR  
EVERY APPLICATION**



Dependable, approved designs are available in ratings from 15 VA to 5 KVA. Secondary voltage outputs of 6.3; 120; 240; 480 volts.

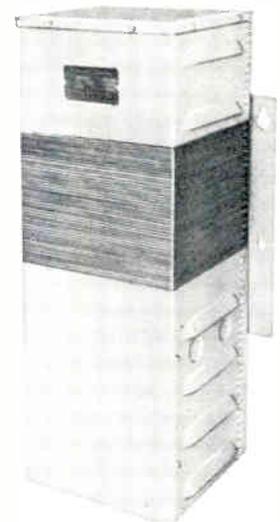
SAA-3740-3055

**Acme**  **Electric**

**Engineers and Builders of...**

895 WATER STREET, CUBA, NEW YORK

In Canada: Acme Electric Corp. Ltd.  
50 Northline Rd., Toronto, Ont.



REGULATED POWER SUPPLIES  
STATIC POWER RECTIFIERS  
VOLTAGE STABILIZERS  
VOLTAGE REGULATORS



## MEASURE A NANO VOLT!

The new Keithley 148 Nanovoltmeter provides the most dc voltage sensitivity, highest stability and lowest noise of any commercially available voltmeter. The 148 has 1% accuracy at the output terminals, input impedance of 1000 ohms on the  $10^{-4}$  volt range rising to 1 megohm on the  $10^{-3}$  volt range, front panel zero suppression and amplifier gains up to  $10^4$ .

Applications include measuring outputs of thermocouples; measuring super conductivity in the  $10^{-6}$  ohm range; conducting Hall Effect studies and use as a null detector.

- 10 nanovolts ( $10^{-8}$ v) full scale sensitivity
- 10 nanovolts per 24 hours stability
- 1 nanovolt noise, peak-to-peak
- 3000:1 line frequency rejection
- line or rechargeable batteries
- \$1275

Send for New 148 Engineering Note

### other microvoltmeters

- Model 149 0.1 $\mu$ v sensitivity \$895
- Model 150A 1 $\mu$ v sensitivity \$750
- Model 151 100 $\mu$ v sensitivity \$420



**KEITHLEY INSTRUMENTS**

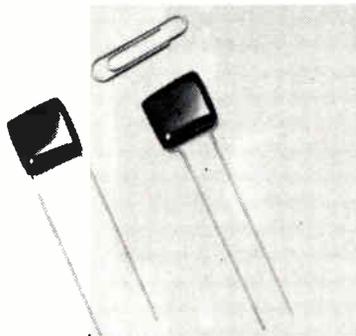
12415 Euclid Avenue • Cleveland 6, Ohio

Circle 75 on Inquiry Card

## NEW PRODUCTS

### CAPACITORS

Miniature units have a dielectric strength of 300vdc for 5 sec.

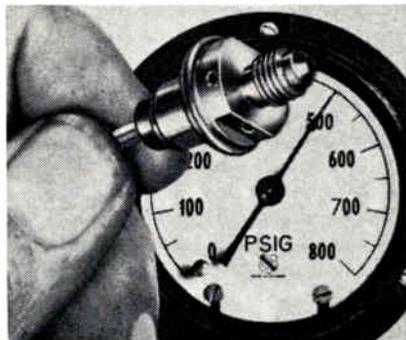


These encapsulated metallized Mylar capacitors are rated at 200wvdc. Designated type QCA, 12 sizes have been standardized ranging in capacities from 0.01  $\mu$ f to 1.00 $\mu$ f. The series is designed for use in miniaturized solid-state circuitry. Operating temp. is from  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . All sizes come with optional straight leads or formed leads. Dissipation factor is less than 1% at 1kc and  $+25^{\circ}\text{C}$ . Hopkins Engineering Co., P. O. Box 191, San Fernando, Calif.

Circle 201 on Inquiry Card

### PRESSURE SWITCH

Controls, limits, or indicates pressure from 40 to 500 psia.



The Klixon® 3PS features vibration resistance of 40 G, small size, 15-gram weight, and hermetic sealing. Max. leakage rate is  $1 \times 10^{-8}$  cc He/sec. Both the switching and sensing elements are snap-acting. The arrangement of the 2 snap-acting elements in series produces an abrupt make or break action. The unit is free from contact chatter, false indications or inadvertent actuations when used in high vibration uses. Premature contact erosion under inductive loads is avoided. Metals & Controls Inc., div. of Texas Instruments Incorporated, 34 Forest St., Attleboro, Mass.

Circle 202 on Inquiry Card

# STANDARD AND CUSTOM ELECTROMAGNETIC DELAY LINES

... for your every requirement

A full range of sizes and delay times allows you to select delay lines which satisfy your most exacting requirements. For more sophisticated applications, our engineers will custom-design delay lines to your specifications. Fixed or variable, standard or miniature, lumped constant or distributed constant — ESC, the world's largest producer of electromagnetic delay lines, has them all.

Send for your free SHORT FORM CATALOG today!

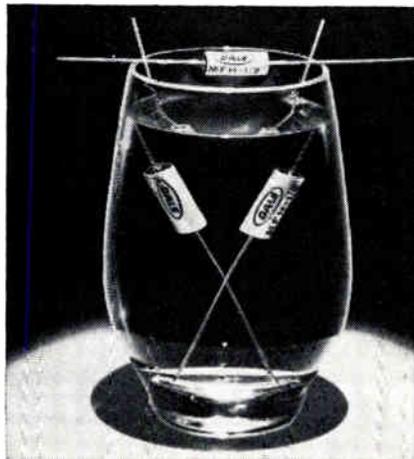


Circle 100 on Inquiry Card

## NEW PRODUCTS

### FILM RESISTOR

Available in 1/10, 1/8, 1/4, 1/2, 1 and 2w. ratings.

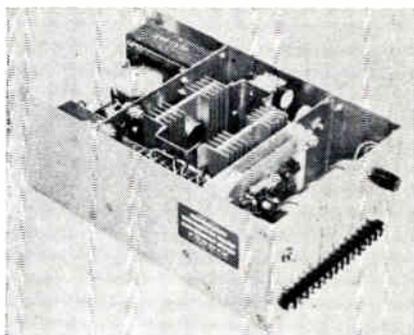


The MFH hermetically-sealed, precision metal-film resistors meet the requirements of Mil-R-10509E, characteristics, C, D, E and G. It offers both precision tolerances and close temp. coefficients. Resistance 49.9 ohms-15 meg. Tolerances available include: 0.1%, 0.25%, 0.5%, 1%, 5%, 10%. Four temp. coefficient codes are available. Dale Electronics Inc., Box 609, Columbus, Nebr.

Circle 203 on Inquiry Card

### MODULAR POWER SUPPLIES

Output voltage adjustment of 0.75v.,  $\pm 5\text{mv}$  line and  $\pm 5\text{mv}$  load regulation.

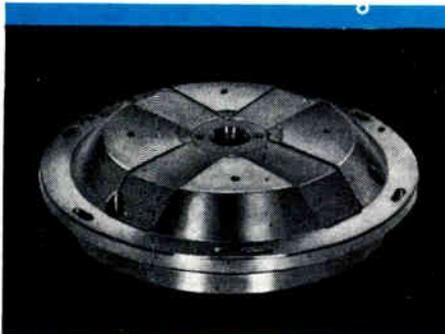


The CM series are of open-type construction with vertical mounted components. This allows for easier cooling in system and computer uses. They are available in power ratings of 15, 35, 75, 150, 275 and 500w. in almost any combination of voltage and current from 1.75 to 45v., 0.5 to 30a. They have 5mv p-p ripple, 50 $\mu$ sec. response time. The units feature no damaging turn-on/turn-off power failure transients; ac input of 05-125v., single phase, 47-420 cps. They have interchangeable control-circuit boards for ease of maintenance. Perkin Electronics, 345 Kansas St., El Segundo, Calif.

Circle 204 on Inquiry Card

## REEVES' PANCAKE RESOLVERS PUT YOU YEARS AHEAD IN VERSATILITY, PRECISION AND RELIABILITY

Our high-precision resolvers will meet a wide range of requirements for accuracy, compactness, ruggedness and application.



### 10-SECOND DUAL SPEED RESOLVERS

Both 1- and 16-speed outputs from one resolver. ■ Direct two-speed operation. Simplified circuitry. Superior reliability. ■ Readily adaptable to digital systems. ■ 10-second accuracy, consistent in production units. ■ Integral bearings... direct mounting. ■ Beryllium housings... thermal stability.



### 10-SECOND SINGLE SPEED RESOLVERS

10-second accuracy with 2-second repeatability. ■ For data transmission, stable platform applications. ■ Integral bearing... direct mounting to gimbal structures. ■ Stable operation under extreme temperature variation... Beryllium housings.



### MULTI-SPEED RESOLVERS

Available with speeds from 2<sup>n</sup> to 64-speed for ready digital conversion. ■ Other speeds, such as 15, 25 and 36, also available. ■ Permit design of compact, simplified systems of superior reliability. ■ Furnished either as synchros or resolvers. ■ Reeves' multi-speed resolvers are readily adaptable to digital output when used in conjunction with the new Reeves' RDC 4162-1000 analog-to-digital converters.



### TANDEM RESOLVERS

New mechanical design and configuration. ■ Stacking, up to 3 units in tandem on common shafts, provides multiple-output from a single mechanical input. ■ Each unit only 5/8" thick. ■ Available in transmitter and receiver models.

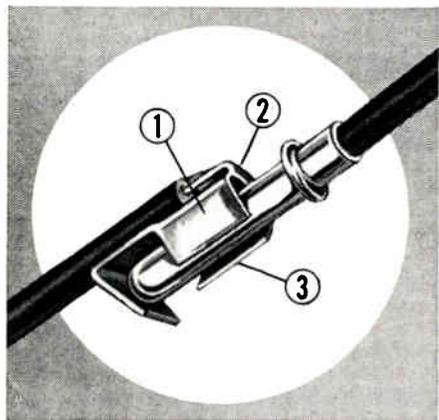
These are merely indicative of Reeves' unique and almost limitless capability in the field of resolvers, synchros, gyros and other components. If you have some "tough" problems, we may already have some answers.

Write for Data File 105 ... and use our advisory services without obligation.



**REEVES INSTRUMENT COMPANY**  
Roosevelt Field, Garden City, N.Y.  
Division of Dynamics Corporation of America

# IN CONNECTORS it's the CONTACT that counts!



**3** positive contact surfaces on each Alden top-connected contact give you:

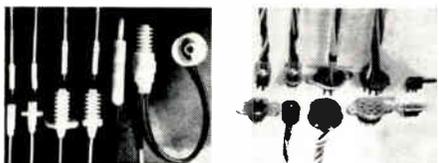
- More reliable electrical contact
- More secure mechanical grip
- Minimum electrical resistance

Each lead has individual strain relief because wire is doubled back through contact tab. Punch press contact design permits rapid heat transfer—eliminates unreliable cold solder joints as in screw machine contacts. Danger of insulation pull back is eliminated by bringing wire insulation right into molded clip pocket.

Unique Alden molding techniques in connector design drastically reduce the number of parts required and make possible multi-contact connectors of amazing basic simplicity and reliability.

Resilient Alden contacts can be included in any type of molded insulation for any combination of contacts. Hundreds of standard off-the-shelf designs are quickly available—with or without leads.

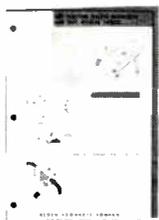
Our Customer Department will work closely with you on any connecting or cabling problems. A letter with description or sketch will enable us to provide recommendations or samples at once.



**Alden High Voltage Connectors** are simpler, more reliable, less expensive than conventional designs; will tame arc-over and corona problems up to 30KVDC. Send for free wall chart.

**Standard Assembled Connectors** in non-interchangeable layouts with from 2 to 11 contacts; miniature connectors, plain or shielded, for carrying power or signal; miniature plugs and sockets; signal connectors; and CRT connectors are all available for fast delivery.

A unique product from Alden's broad line of components for mounting, housing, fastening, connecting, and monitoring electronic/electrical circuitry.



SEND FOR  
CONNECTOR SECTION  
OF ALDEN HANDBOOK

# ALDEN

PRODUCTS COMPANY

5123 N. Main Street, Brockton, Massachusetts

Circle 77 on Inquiry Card

130

## NEW PRODUCTS

### SWITCH MODULES

*Breaks currents of 2a, at 28v. Contact life is 250,000 cycles min.*

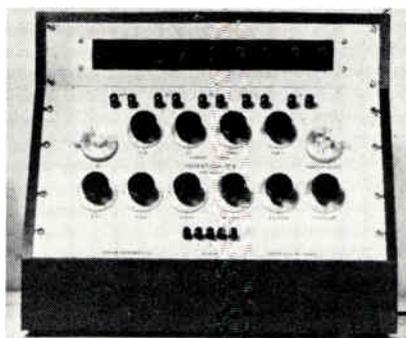


Series SM-412 thumbwheel modular switches use non-printed switch wafers. Three basic variations of switch modules are available: 2-pole, 12-positions; 3-pole, 10-positions, and 4-pole, 6-positions. Switch position is indicated by a numerical readout. Modules may be stacked side-by-side for any number of digits. They are O-ring sealed. BCD outputs of 1, 2, 4, 8 or 1, 2, 2, 4 are typical of coded outputs when the switches are used for conversion purposes. North Atlantic Industries, Inc., Plainview, N. Y.

Circle 205 on Inquiry Card

### SIX-FIGURE POTENTIOMETER

*Three ranges cover a value of 0-2M $\Omega$  with max. resolution of  $\pm 0.01\mu\Omega$ .*

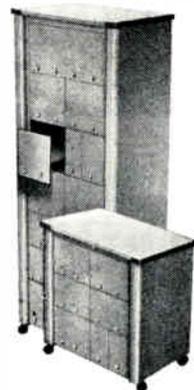


The Type 9160 precision dc potentiometer is designed for 19 in. rack-panel mounting. It has a remote illuminated 6-digit readout. Accuracy is  $\pm 20$  ppm of reading without the use of correction curves. The panel contains 5 press keys giving 4 sensitivity stages and a reversal of the galvanometer to eliminate the effect of thermal emf's. The potentiometer is self checking. The 6 measuring dials each have 10 steps, not 9. This enables a complete auto-calibration to be carried out. Singer Metrics Div., The Singer Co., 915 Pembroke St., Bridgeport, Conn.

Circle 206 on Inquiry Card

# SIMPLIFY

your enclosure problems with . . .

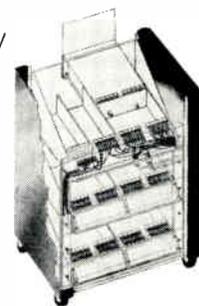


# ALDEN

## pre-engineered UNI-RACKS

Designed to provide optimum housing for a variety of electronic gear. When used with the basic ALDEN Unit Construction System, it cuts engineering, construction, and servicing time in half.

- Standardized packaging approach on modular Alden slide-in chassis assures good design to free top engineering talent from time-consuming mechanical routine.
- Simplified Interchassis Connecting System outmodes laced cables; minimizes production space, delays and expense.
- Standardized, modular elements utilizing efficient sub-assembly technique makes it practical to build one or a hundred units with minimum lead time, pre-figured costs.
- Circuit sub-division by function on slide-in chassis and simplified straight line point-of-check for all inputs/outputs/interconnections cuts downtime to a minimum, solves the high cost of servicing equipment in the field.
- Color coding for bold circuit identification.
- One basic uni-rack design, in two standard heights and depths, means immediate delivery, greater economy, simplified purchasing.



A unique product from Alden's broad line of components to mount, house, fasten, connect and monitor your electronic/electrical circuitry.



WRITE FOR 24-PAGE  
QUICK ORDER GUIDE

# ALDEN

PRODUCTS COMPANY

5123 N. Main Street, Brockton, Massachusetts

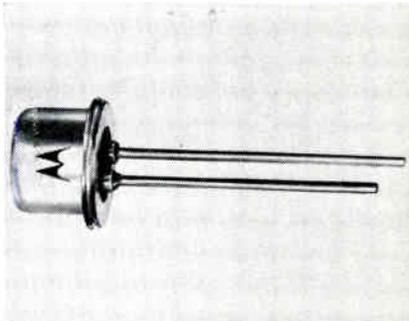
Circle 78 on Inquiry Card

ELECTRONIC INDUSTRIES • May 1964

# NEW PRODUCTS

## SMALL SCR

*For low-cost, 8a. applications.  
Available voltages from 25 to 400v.*



Types MCR1304-1-6 are ideal for power and motor-speed control. They are housed in a steel case 0.345 in. dia. and 0.278 in. high. Capable of switching up to 3.2kw, they control a full 8 amp. dc output and operate over a junction temp. range of -40 to +100°C. In addition, it exhibits extremely low power loss. Motorola Semiconductor Products Inc., Box 955, Phoenix, Ariz.

Circle 207 on Inquiry Card

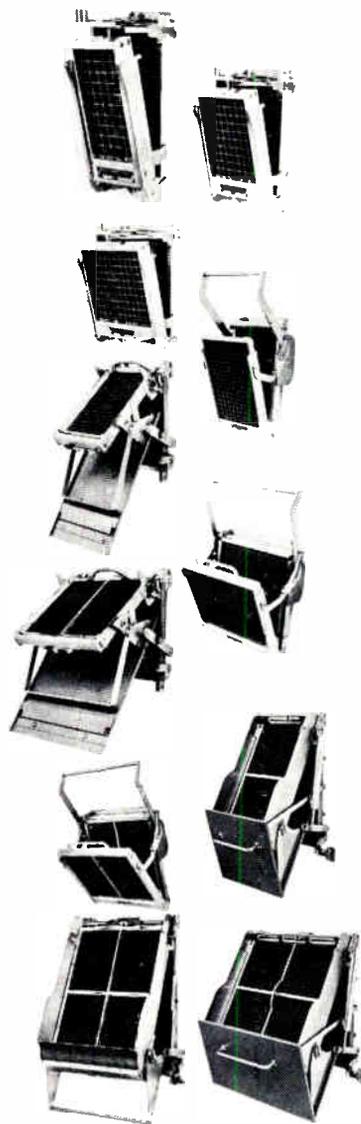
## STORAGE TUBE

*Storage time is variable from 1/30 sec.  
to 2 min. for histories of moving targets.*



The QV-286 is a miniaturized, dual-gun recording storage tube. It measures 12 in. long and less than 1 3/4 in. in dia. Tube was designed for scan-conversion uses in aircraft and space vehicles. It receives and writes a signal in one scanning mode, and simultaneously generates a separate signal. This output can be read in another scanning mode and/or time base. Resolution of radar data is 125 range rings/dia. at 50% amplitude modulation. Television resolution is 600 TV lines. The tube can be cleared of target information in less than 2 sec. Raytheon Co., Industrial Components Div., 55 Chapel St., Newton, Mass.

Circle 208 on Inquiry Card



## ENGINEERED TO MEET YOUR NEEDS

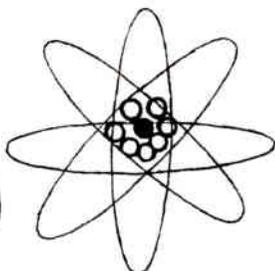
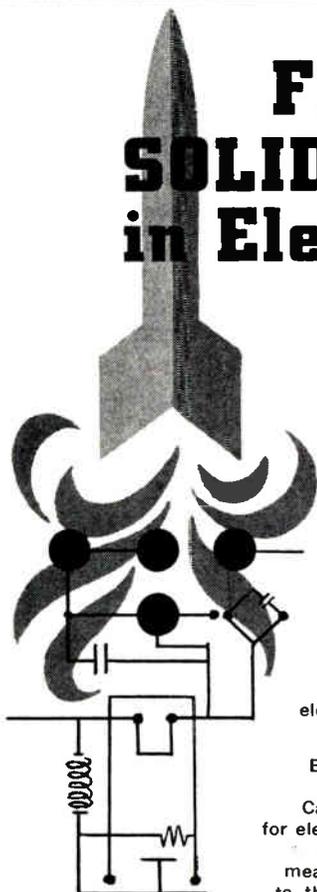
Eleven sizes of precision MAC Panel Plugboard Programming Systems plus a complete line of plugwires and hardware provide one source for reliable, flexible program control.

MAC Panel's Plugboard Programming Systems range in size from 200 to 5120 positions, and are designed and engineered to assure rugged construction, flush mounting capabilities and ease of plugboard insertion. Each system consists of a precision engineered receiver, lightweight molded phenolic or diallyl phthalate plugboard and a complete line of plugwires. Whether your requirements call for special design applications or for a system to fit standard racks, MAC Panel assures you of quality and guaranteed satisfaction. See your MAC Panel representative or write for specifications.

**MAC PANEL COMPANY**  
HIGH POINT, NORTH CAROLINA



# Florida... SOLID STATE in Electronics



Employment in Florida's electronic industry has multiplied 14 times in 9 years ... indicative of solid growth.

Florida's rapid growth has paralleled that of the pace-setting electronic industry, which has established plants in 81 key Florida cities.

Expansion into this "Space-Age Market," supported by the vast complex of Cape Kennedy... the increasing demand for electronic components... instrumentation... and general manufacturing can only mean growth for your business. In addition to the built-in market, the entire industrial explosion of the southeast will be at your doorstep.

Florida provides you with the ideal business climate in which your plant will grow best. Unlimited R & D creativity... ease of recruitment for engineers and technicians... lower... taxes, with no state, corporate or personal income taxes add up to an environment of solid growth for your business.

A Florida move means more than just a favorable climate... Florida means business.

Move where the electronic growth is... move down to Florida.

# Florida



### FLORIDA'S ASSURANCE POLICY

"You have my personal assurance of a sunny business climate here in Florida. You have positive assurance of every aid and assistance possible from our Florida Development Commission and from the overwhelming majority of our businessmen, industrialists, and financiers. We have everything to make your large or small enterprise healthy and successful. Write, wire or phone us TODAY. The only thing better than a FLORIDA vacation is having your plant here."

FARRIS BRYANT, Governor

Mr. Wendell Jarrard  
Chairman-Director  
**FLORIDA  
DEVELOPMENT  
COMMISSION**  
AN OFFICIAL AGENCY OF  
THE STATE OF FLORIDA  
Box 4335B  
Tallahassee, Fla. 32304

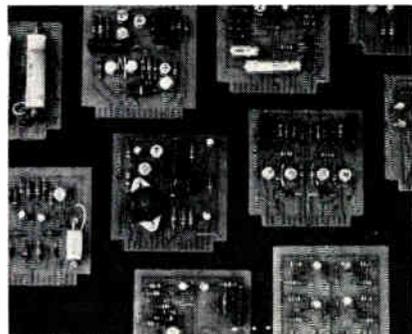
Please send me brochure, "Why Your New Plant Should Be Located in Florida," containing the facts about FLORIDA'S opportunities for New Industry, the 12 BILLION DOLLAR CONSUMER MARKET, Labor, Climate, Schools, Favorable Tax Structure, Natural Resources.

NAME \_\_\_\_\_  
FIRM NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_  
STATE \_\_\_\_\_ ZIP CODE \_\_\_\_\_

## NEW PRODUCTS

### TEST MODULES

*Silicon-circuit test modules for constructing test instruments.*

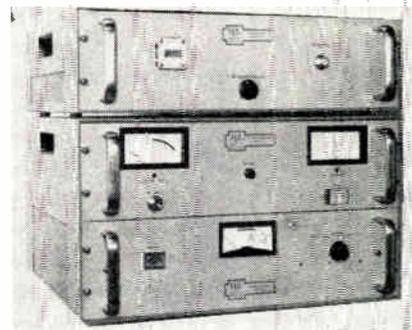


These modules can be obtained in a wide variety of configurations, including voltage regulators, pulse generators, followers, operational amplifiers, voltage comparators, programmable current drivers, one-shots and flip-flop board. The chief advantages of the modules are low cost, max. design flexibility, high reliability, and a lifetime guarantee. The Eagle-Picher Co., Instruments Branch, 1038 W. Evelyn, Sunnyvale, Calif.

Circle 209 on Inquiry Card

### STABLE OSCILLATOR

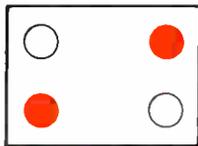
*Has crystal stability at klystron power level. Freq. range is 2.0 to 12.4gc.*



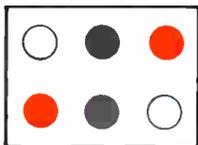
Operating at any fixed freq. within its range, these units exhibit a short-term stability of better than 1 part in 10<sup>6</sup> and a long term stability of 1 part in 10<sup>9</sup> under normal laboratory conditions. Power output is a function of the klystron used. This series has uses in Doppler tracking systems as the local oscillator or source of the transmitted signal; in narrow bandwidth communication systems to conserve the spectrum by precisely controlling the carrier and modulation signals; and as a laboratory source to aid in the development and calibration of microwave components and equipment. Frequency Engineering Laboratories, Farmingdale, N. J.

Circle 210 on Inquiry Card

## MOST 4-LAMP, 2-COLOR ILLUMINATED PUSH-BUTTON SWITCHES ARE THIS SIZE:

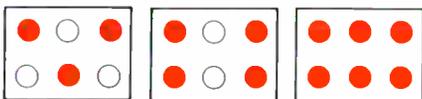


**NEW IEE LUMI-SWITCH<sup>®</sup> IS JUST AS SMALL:**

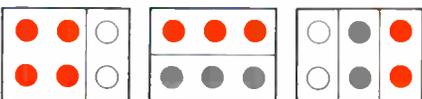


## BUT ONLY LUMI-SWITCH GIVES YOU 6 LAMPS, 3 COLORS!

Lumi-Switch gives you 3 colors with 2-lamp-per color reliability. Or, you can get these color/lamp combinations:

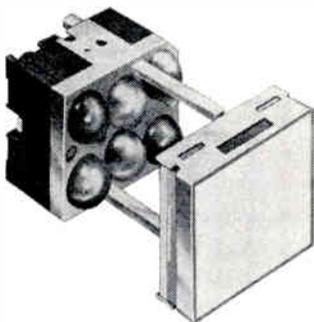


You also have horizontal and vertical split-face options like these:



The big advantage of Lumi-Switch's small size (besides saving space) is the fact that it fits existing panel cutouts made for 4-lamp push-button switches. Though Lumi-Switch is only 0.965" H x 1.205" W, it offers more display screen (0.75" H x 0.98" W) for your message than units of comparable size: up to 5 full lines with characters up to .12" high.

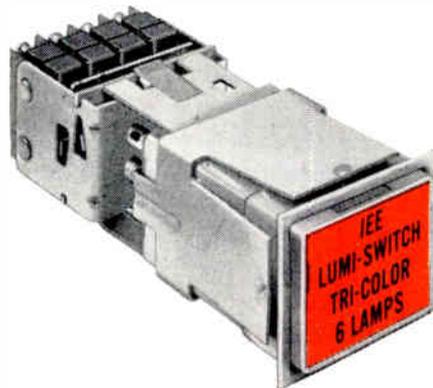
To pack 6 standard MS T-1 $\frac{3}{4}$  midget flange-base lamps into a space where only 4 lamps normally fit, we eliminated the center switch shaft found in conventional illuminated push-button switches.



This, in turn, permits proximity grouping of lamps for other advantages: bright, even light and color distribution, completely free of hot spots.

For easy replacement of lamps, the lamp/screen assembly (shown above) pulls

out from the front. No twist action or tools involved. A safety mechanism prevents switch from being activated accidentally during re-insertion of assembly. Another safety protects against pop-out up to 50 G's.



## EASY TO MOUNT; EASY TO WIRE

You insert the entire unit, including retainer frame, from the front through cutout in panel. Two integral screws inside the housing are tightened, also from the front, to draw mounting sleeve against back of panel. For easy wiring of lamp terminals, switch module snaps off; after wiring, module is locked in place by positive latch that prevents accidental disengagement.

## FOR DEDICATED BUTTON PUSHERS, A FEW MORE FEATURES:

- Lumi-Switch push button travels independently of lamp housing; lamps remain stationary for longer life.
- In 3 color applications, exceeds 100 foot lamberts in brightness. Even brighter in 2 colors (3 lamps per color).
- Accepts MS silicone rubber color boots. IEE "Hi-Temp" molded plastic color caps also available in matched sets.
- Legends may be engraved and filled or on film mounted behind screen.
- May be ordered with any switch module up to 4PDT, momentary contact, alternate action, and with holding coil.
- Optional features include positive drip-proofing, vertical and horizontal separator barriers, and a transparent face guard that prevents accidental switch actuation. An elliptical mask insert helps identify switch units when mounted with non-switch indicators in same panel.
- 6-lamp Lumi-Switch is priced at \$18.75, with decreasing scale for quantity. Price includes basic unit, color boots, standard 2PDT switch. An identical 4-lamp unit is available at \$14.35.

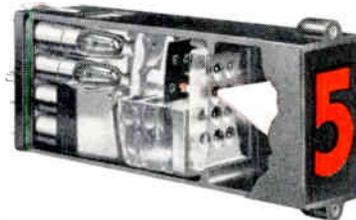
*We are anxious to send you all sorts of information about Lumi-Switch. We'll even include material on our readouts. All we need is your inquiry.*

**IEE INDUSTRIAL ELECTRONIC ENGINEERS, INC.**

5528 Vineland Avenue, North Hollywood, California  
Phone: (213) 877-1144 • TWX: (213) 769-1636  
Representatives in Principal Cities ©1964 IEE

## SOME COMMON SENSE OBSERVATIONS ON READABILITY OF READOUTS

As you may know, we build more rear-projection, single-plane readouts than anyone. Here's a cut-away of a typical IEE unit:



One of the main reasons our readouts are so much in demand (especially by end-users): "IEE readouts are the most readable readouts made."

Why they're so readable is no secret. Here's a comparison with another popular readout, the gas ionization tube:

- IEE characters are bigger, thicker, bolder.
- IEE makes the presentation in a single plane; only the message that's "on" is visible.

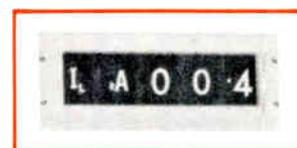


- IEE projects the message against a dark surrounding area. This makes for strong visual contrast, essential for good legibility.

- IEE readouts are bright (up to 90 foot lamberts). And, because they are rear projectors, they are free of glare. A lot more relaxing to the eye than the glare of a direct light source. There is such a thing as being too bright for comfort. Our readouts can also be dimmed for greater eye comfort when used in dark surroundings.

These are some of the reasons IEE readouts are the most readable. But that's only as it should be. After all, what's a readout for if not for optimum readability?

## DIGITAL TRANSISTOR/DIODE TESTER BY FAIRCHILD; VISUAL TRANSLATION BY IEE



For economical digitally-programmed volume inspection of solid state devices, it's the Fairchild Series 500... a real sophisticated sort of thing. And, right in the center of things, you can see an assembly of IEE Series 10 rear-



projection readouts. The operator can see them too. Sharp and clear, and from wide angles. Even in brightest light. IEE readouts make their presentation in a single plane, there's no visual hash. We're glad Fairchild uses IEE readouts. Bet the operator is glad too.



Symbol  
of  
Superiority

## IN PRECISION WIRE-WOUND RESISTORS

- CLOSER TOLERANCES
- BETTER STABILITIES
- LOWER TEMPERATURE COEFFICIENTS
- PROVEN RELIABILITIES



### SUB-MINIATURE RESISTORS

Series "EP" (Sub-Miniature) — Solves many space and weight problems. Typical size: .125" x .125" Diameters to .080" and lengths to .125" Available in axial or combination axial-radial leads.

### STANDARD RESISTORS

Series "EP" (Standard) — Choice of over 40 standard sizes — all reflecting the performance superiority of Kelvin precision wire-wounds. Resistance as low as .01 ohm. Resistance tolerances to .005%. Temperature coefficients to 1 PPM.



### PRINTED CIRCUIT RESISTORS

Series "PC" — For mass production assembly and optimum space utilization. Available in special "high density" (rectangular) packaging and standard round configurations.

### HIGH STABILITY RESISTORS

Series "O" — Used where resistance matching or accurate voltage division is required over long periods of time. Heavily utilized in A to D converters, analog computers, differential voltmeters and guidance computers for military applications. Long term resistance stability of .003% maximum per year and standard TC of 10 PPM. Available in all standard physical sizes down to .187" x .375".



### FAST RISE TIME RESISTORS



Series "RT" — Ideal in fast switching circuits. Exceptional high frequency performance with rise times in the range of 50 to 100 nanoseconds, depending on style and resistance value.

### RESISTOR NETWORKS

Custom resistor, diode and capacitor combination networks. Built to meet special requirements. Used as voltage dividers, summing and integrator networks, binary resistive networks and other network applications. Ratio tolerances to .0005%. TC tracking as close as 1 PPM to military requirements.

### OTHER FEATURES OF ALL KELVIN RESISTORS

- Standard leads are both weldable and solderable
- All welded internal construction
- Non-inductive windings
- Vacuum encapsulated with high temperature epoxide material
- Special winding technique for assured stability

Write for complete new catalog.



**KELVIN**

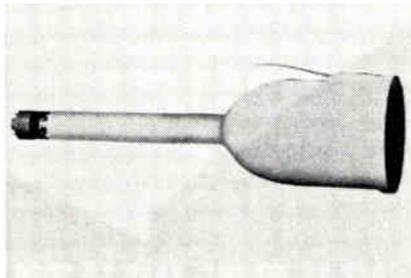
5919 Noble Avenue, Van Nuys, Calif.  
(213) 873-3430

Circle 83 on Inquiry Card

## NEW PRODUCTS

### CATHODE-RAY TUBE

For applications requiring extreme sweep linearity and high writing speed.

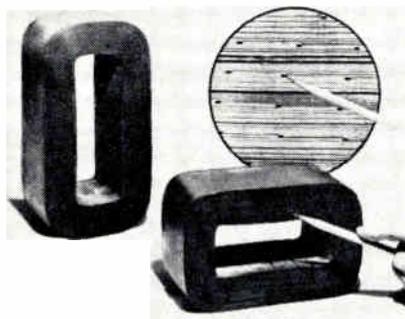


The L-4125 features a very uniform, fine-grain, low-noise phosphor screen on an optical quality face plate. Minimum useful screen dia. is 4 1/4 in. The relatively narrow 24° deflection angle for the screen width allows faster writing speeds, realization of greater sweep linearity, and less deflection defocusing for a given yoke and deflection amplifier. Focusing and deflection are accomplished electromagnetically. Heater potential is rated at 6.3v., and heater current is 0.6a. Litton Industries, Electron Tube Div., San Carlos, Calif.

Circle 211 on Inquiry Card

### TRANSFORMER CORES

Has 30% lower watt losses than C-core designs.

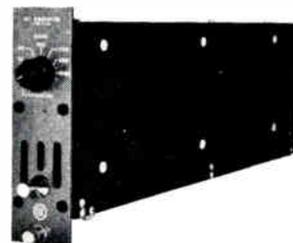


This series of Silectron cores are for use in power transformers, magnetic regulators, and reactors. Thirty-six core sizes of various strip widths, buildups, window widths and lengths are available. The rectangular-shaped single-phase core design eliminates gap effect, and reduces noise level in applications such as 60-cycle oil-filled and dry-type transformers. The strip material used in making up the series of tape-wound laminations is overlapped and produces a distributed-gap design. The Arnold Engineering Co., DGSC Dept., Marengo, Ill.

Circle 212 on Inquiry Card

CEC's Type 1-162A Galvanometer Driver Amplifier is a universal, flexible tool for use with any oscillograph recording system. At a cost less than any others, it offers unmatched reliability and performance. Ideal for both military and industrial use, the 1-162A features 1 to 7 channels per case, frequency response of 1% from d-c to 10 kc, and variable gain of .0 to 2.5. Ask for Bulletin 1162-X17.

## Best galvo driver made



## Wideband capability

CEC's Type 1-155 D-C Amplifier provides full bandwidth capability with long-term reliability for use in optimum data systems. Solid-state, precision-built, the 1-155 handles low-level data signals and provides output current compatible with any fluid-damped galvanometer. Features high line isolation, superior linearity, low noise and drift. For full facts, ask for Bulletin 1155-X12.

**CEC**

Data Recorders Division

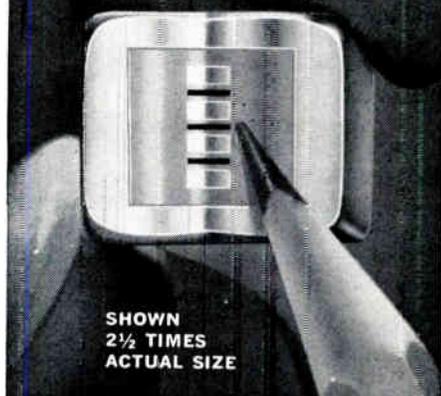
**CONSOLIDATED ELECTRODYNAMICS**

A SUBSIDIARY OF BELL & HOWELL/PASADENA, CALIF. 91109  
INTERNATIONAL SUBSIDIARIES: WOKING, SURREY, ENGLAND  
AND FRANKFURT/MAIN, GERMANY

Circle 84 on Inquiry Card

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!**

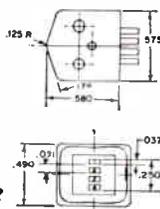
Multiple channels for less — with Nortronic's new, compact "BQQ" heads. Designed for digital, instrumentation, analog and audio recording or reproduction, "BQQ" heads are readily available in production quantities — will fit existing 4-track systems. Types include Record only and Record/Reproduce heads 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 Nortronics first! Industry's widest line of "standards" plus specialized "know-how".



**Nortronics**

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## NEW PRODUCTS

### REAR WINDOW CRT

Permits photographing of images without interfering with vision.

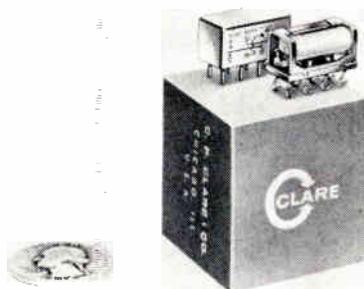


SC-3821 is suited for aerial reconnaissance and radar navigation. Using the optically designed rear window, still photos or movie films can be made. In addition to photographic recording, images or maps can be projected through the rear window to appear on the face tube screen. The data being received by the tube can then be assessed in a real-time relationship with the map. The tube is of the single-gun variety and uses a 7 in. round glass envelope with a slow decay phosphor screen. The optically-flat rear window is sealed to the tube funnel. Sylvania Electric Products Inc., 730 Third Ave., New York 17, N. Y.

Circle 213 on Inquiry Card

### CRYSTAL CAN RELAY

Min. contact load life is 100,000 miss-free operations at 2a., 28vdc.



The Type HF subminiature relay is desirable for low-level to 2a. switching needs. The contact arrangement is 2 form C (dpdt) with bifurcated contacts. Standard 26.5vdc coil is rated at 1250Ω. Max. coil dissipation is 0.8w. at 125°C and 1.0w. at 25°C. It is sensitive to 160mw with an operate time of 5msec. at 25°C. The relay operates from -65°C to 125°C and withstands vibration from 20g. There are 15 mounting styles available with plug-in, straight, or solder-hook terminals. C. P. Clare & Co., 3101 Pratt Blvd., Chicago, Ill.

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## AUGAT

COMPLETE LINE OF  
MINIATURE TEFLON\*  
SOCKETS FOR  
SEMI CONDUCTORS

A full line of sockets with securely anchored, closed-entry contacts of beryllium copper. Various terminal configurations are available.



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Insulation:  
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Available in 6, 8,  
10, 11 and 12 pin  
arrangements.

PRINTED CIRCUIT OR SOLDER  
POCKET TERMINALS

Write for Bulletin No. 263 which also includes information on heat dissipators for above case sizes.

We welcome your inquiries on special requirements.

**Please write us today.**

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**AUGAT INC.**

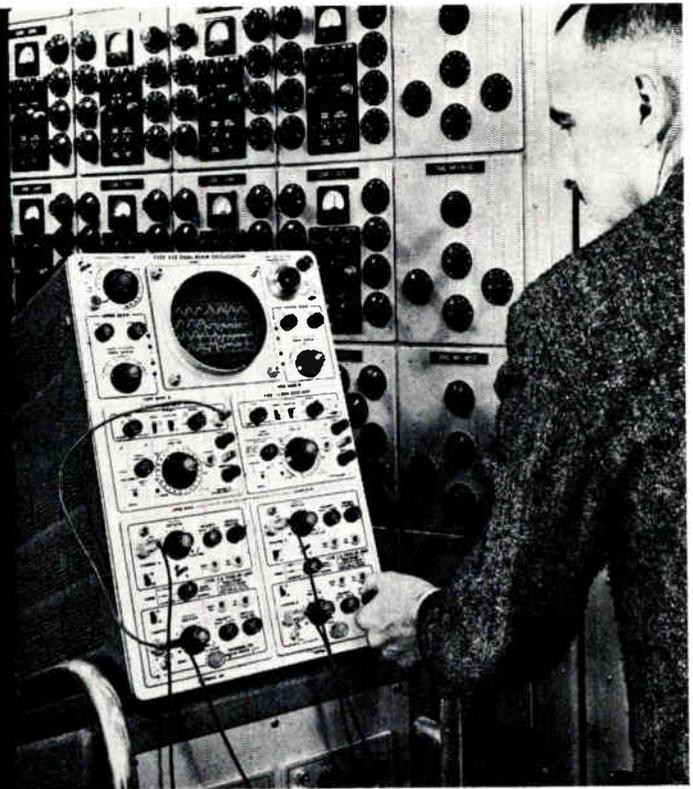
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ATTLEBORO, MASSACHUSETTS

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# WAVEFORM-COMPARISON ANALYSES

with a  Type 555  
**DUAL-BEAM  
 OSCILLOSCOPE**

*with Sweep Delay  
 Independent  
 X and Y Deflection  
 DC-to-30 MC,  
 12-nanosecond risetime  
 with fast-rise plug-in units*



Photographed at Bonneville Power Administration, Portland, Oregon.

## CHARACTERISTICS

*Adaptable Vertical System*—accepts interchangeable plug-in pre-amplifiers.

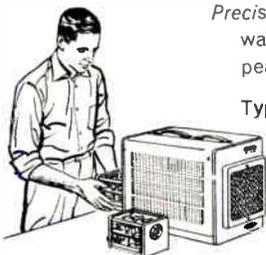
*Versatile Sweep Features*—wide range from 0.1  $\mu\text{sec/cm}$  to 5  $\text{sec/cm}$  in 24 calibrated main sweep rates, continuously variable uncalibrated to 12  $\text{sec/cm}$ . 5X magnifier increases calibrated sweep time to 20  $\text{nsec/cm}$ . Single sweep facilitates recording one-shot phenomena.

*Calibrated Sweep Delay*—two modes of jitter-free operation.

*Complete Triggering Facilities*—amplitude-level (manual) selection or fully automatic control.

*High Writing Rate*—10-KV accelerating potential provides bright traces at low repetition rates. 4 by 10 centimeter display for each beam, with 2 centimeter overlap.

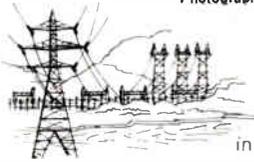
*Precise Amplitude Calibrator*—with 18 square-wave voltages (from 0.2 mv to 100 v peak-to-peak) available at the front panel.



Type 555 (without plug-in units) . . . \$2650  
 Includes Indicator Unit, Power Unit,  
 2 Time-Base Units, 4 Probes, Time-  
 Base Extension, other accessories.

Dual-Trace Plug-Ins illustrated:  
 Type CA Units each . . . . . \$260  
 U. S. Sales Prices f.o.b. Beaverton, Oregon

**CALL YOUR TEKTRONIX FIELD ENGINEER  
 FOR A DEMONSTRATION**



At Bonneville Power Administration—in one of many continuing studies with their transient analyzer—a System Engineer uses a Tektronix Type 555 Oscilloscope to display fast switching transients occurring in each phase of a transmission system. By observing the three switching-transient traces with a timing trace, he can quickly and easily compare magnitudes, phase relationships, transient times, and accurately determine overvoltage characteristics of the system.

Although invaluable in displaying up to four traces at once—with Tektronix dual-trace units in both channels—the Type 555 adapts easily to almost every oscilloscope application in the dc-to-30 mc range.

For example, you can control either or both beams with either time-base generator. You can operate one time-base unit as a delay generator—*hold off the start of any sweep generated by the other for a precise interval from one-half microsecond to 50 seconds*—and observe both the original display and the delayed display at the same time. *You can interchange any combination of 17 "letter-series" plug-in units for signal-handling ease and versatility in waveform-comparison analyses, such as dual-beam pulse-sampling, transistor-rise-time testing, semiconductor-diode-recovery-time studies, strain gage and other transducer measurements, differential-comparator applications, as well as multiple-trace work in general laboratory experiments.*

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# NEW Design Concept of Modular Packaging for BOTH Mercury-Wetted and Dry Reed Relays

Amazing Design Simplicity makes possible NEW LOW COSTS

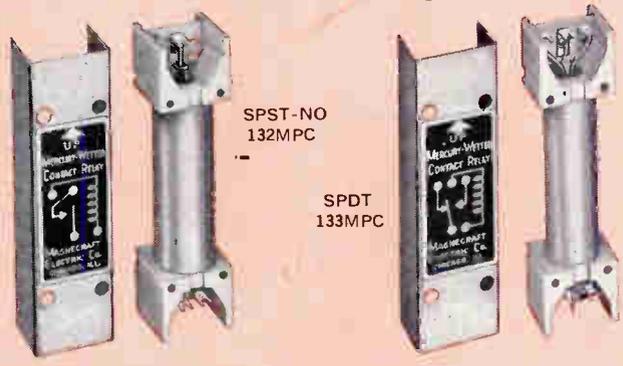
## Some of the Features.

- Rigid positioning and stress-free mounting with complete mechanical protection of glass switch capsule, coil and terminals
- Magnetic shielding; prevents interaction between relays.
- Compact, modular package for plug-in assembly to printed circuits and flexibility for other applications.
- Mercury-Wetted and Dry Reed types, are dimensionally interchangeable.

1. Steel, snap-on cover adds mechanical protection, provides magnetic shielding and prevents interaction between relays.
2. Nylon bobbin integrally molded with terminal board supports and mounting base.
3. Epoxy resin terminal board with tinned terminal supports and terminal pins riveted in position.
4. Rugged support terminals of the enclosed switch are soldered to terminal supports without bending; the terminal leads are not subjected to stresses that transmit to the reeds inside the capsule and disrupt adjustment stability.

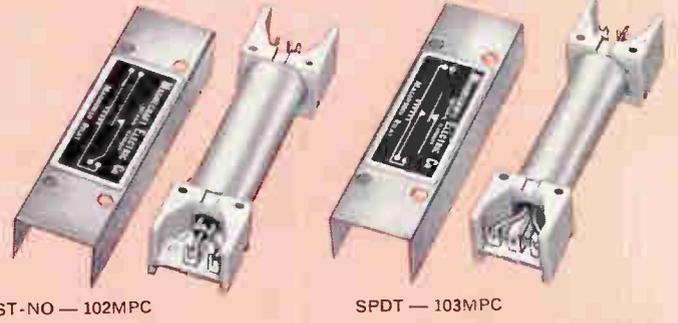


## MAGNECRAFT Mercury-Wetted

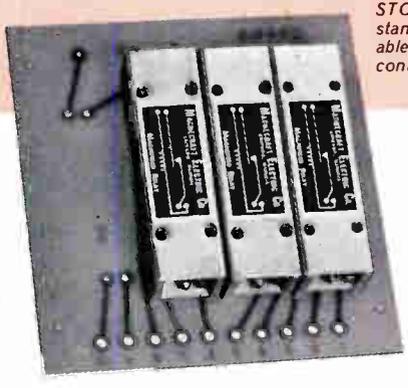


- Over a BILLION operations life expectancy.
- Constant contact renewal through entire service life with complete freedom from contact erosion, welding, bounce and chatter.
- High Reliability switching of loads from 50 VA down to extremely minute current and voltage.

## MAGNECRAFT Dry Reed Relays



- High speed switching combined with operating sensitivity: Fills the gap between relatively slow acting electro-mechanical relays and high speed, complex and costly solid state devices.
- Contact stability through long life.
- Contacts hermetically sealed against dust, contamination and physical injury.
- Exceptional mounting flexibility and economy.



Quick, plug-in assembly to printed circuit boards

STOCKED for immediate delivery in standard DC operating voltages. Available with Form D, make before break contacts on special order.

## SPECIAL RELAYS

MAGNECRAFT Reed Relays are available for Power and High Voltage Switching, also for applications requiring high insulation resistance.

Both Mercury-Wetted and Dry Reed Relays are available as magnetic latching relays; also in a wide variety of packaging; with different contacts and different contact arrangements. For prompt information send your requirement specifications.

STOCKED for immediate shipment in standard DC operating voltages.

NEW  
Engineering Bulletin No. 101-64 details latest developments in Mercury-Wetted and Dry Reed Relays.  
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5577 North Lynch Avenue, Chicago, Ill. 60630. Phone (312) AV 2-5500

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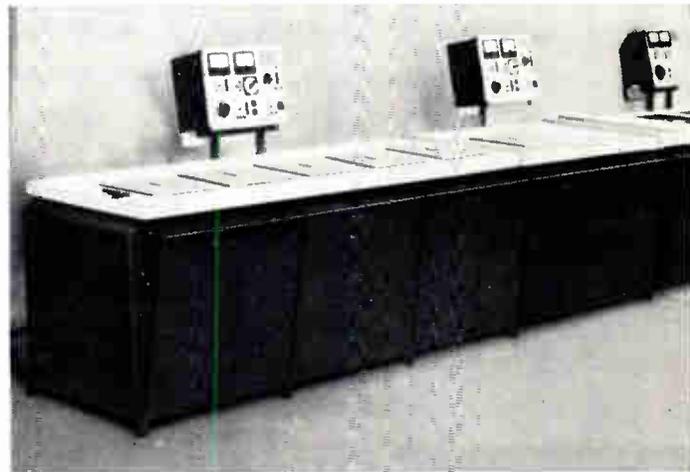
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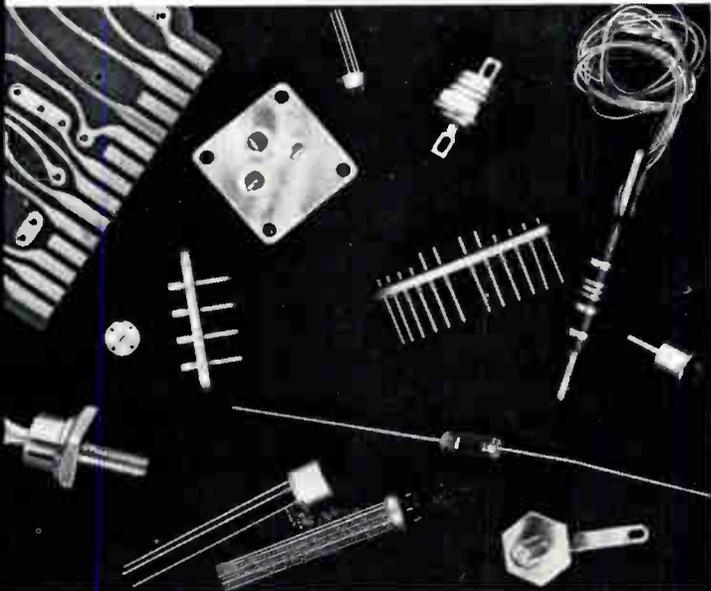
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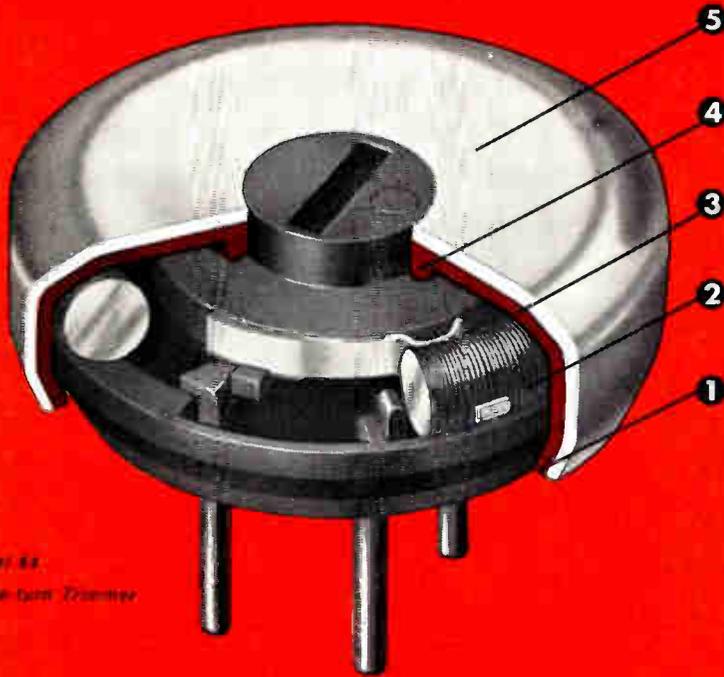
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Here's a switch—men are more accurate than instruments when it comes to measuring radio signals. Engineers at Martin, Orlando had a problem when measuring intelligibility in pulse modulation systems. Signal-to-noise measurement data and conventional systems didn't apply. Martin's approach called for establishing an intelligibility yardstick based on listener tests, using ASA phonetically balanced word lists. Tests showed that with a 13db signal-to-noise ratio, the intelligibility was 74.3%. This is better than the limit of an analog system.

An instrument that provides a stable reference for establishing an accurate vertical line-of-sight with various optical instruments has been developed by Digital Development Corp., La Jolla, Calif. The automatic device, Model 5010, compensates for slight inclinations of the instrument body by using glass and liquid optical wedges to maintain a collimated light beam aligned with the direction of gravity. Accuracy is 0.2 sec. of arc.

The Vibrometer is a vibration analysis device which detects wear in parts before they cause breakdown. Built by Televiso Electronics, the device gives displacement readings by indicating the amount of clearance between parts. It also gives acceleration and velocity readings by indicating the forces involved in the operation. It can be used to predict the rate of wear on parts.

The Westinghouse Scientific Equipment Dept. has developed a compact, ultrasensitive instrument which measures evaporated film as thin as  $10^{-6}$  gm/cm<sup>2</sup>. The model 701 quartz-crystal microbalance measures changes in mass deposited on a crystal surface by measuring the corresponding change in the crystal's resonant freq.

A portable radiation thermometer that measures temp. distributions over surfaces of targets which are unmeasurable by conventional methods has been developed by Barnes Engineering Co. If the target surface fills the field of view, then the readings are independent of the distance between the thermometer and the object under observation. The instrument, PRT-4, is applicable to measurements of extended targets such as water bodies, clouds, or backgrounds. Its 2° field of view provides high spatial resolution for mapping thermal gradients over such areas.

General Electric has devised a series of tests to prove the reliability of their TWTs. Typical test includes a 50G impact blow and rattling at 15G with 5 CPS to 3KC vibration. They are frozen at  $-65^{\circ}\text{C}$ , baked at  $100^{\circ}\text{C}$ , and tested for voltage breakdown at a simulated 100,000 ft. The tubes are also subjected to high noise and humidity.

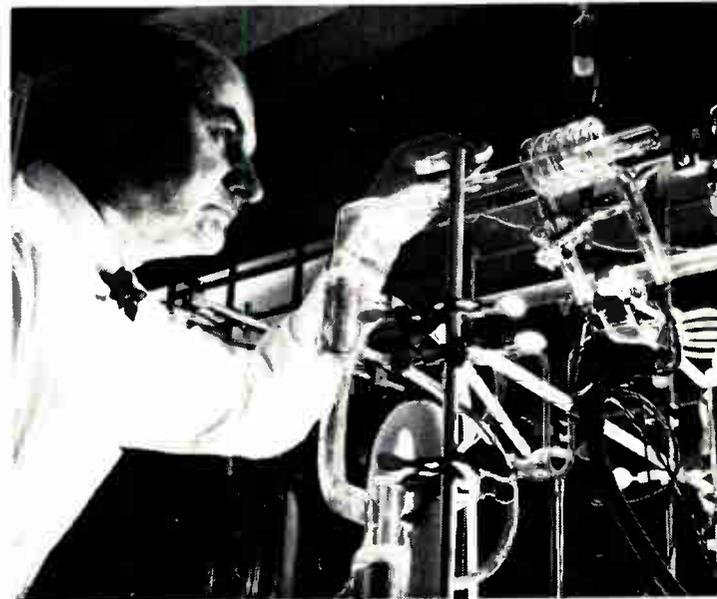
A printed-circuit surface area detector has been designed to reduce the costs of overplating. The instrument, built by Kahn & Co., provides an accurate measurement of the surface area in a matter of seconds. To operate the unit, a printed-circuit negative is placed in a sliding drawer in the instrument. A built-in electro-optical, converter-integration network senses the area to be plated and translates this data to a sq. in. measurement on a meter. Accuracy is 2% of scale.

A new sensor evaluation unit, developed by Circuits, Inc., Berlin, Conn., will aid in selecting sensing methods to be used in production. The unit, SC42001, replaces the trial-and-error method and decreases to 1/10th the time needed to evaluate different types of sensors.

An instrument which will permit precise detection of the effects drugs may have on heart action of unborn babies has been invented at NASA's Ames Research Center. A piezo-electric transducer monitors the heartbeat of a chicken embryo quickly, continuously, quantitatively and without egg damage.

## THIN-FILM ANALYSIS BY LAMP

A quick method for determining the gas and carbon content of thin films has been developed at Bell Telephone Labs. The method uses a xenon flash-discharge lamp to remove the thin metallic films quickly and easily from inorganic substrates. In making an analysis, the thin film is placed in a vacuum and flashed with the xenon lamp. The temperature rise in the film, due to heat ( $5000-8000^{\circ}\text{C}$ ) absorbed from the flash, is sufficient to vaporize the thin film completely from the substrate. The gases are collected and analyzed by a gas chromatograph.



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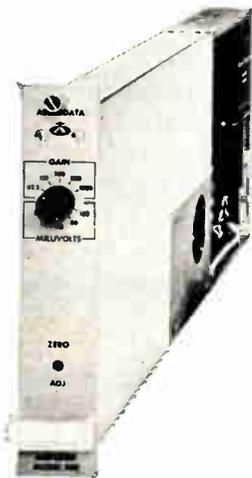
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BAND WIDTH: dc to 200kc  
GAIN: Greater than  $10^6$   
NOISE REFERRED TO INPUT: 2 mv rms  
INPUT RESISTANCE: 3 megohms at dc, 1 megohm above 5 cps



**Model 133B Dual-Channel Galvanometer-Driver Amplifier** provides 18 independent amplifier channels in 7 inches of panel space.

GAIN RANGE: Zero to 4, with ten-turn, continuously variable, locking control  
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**Model 880 Differential Amplifier** for low-level, low-frequency systems.

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LOW NOISE: less than  $1\mu\text{v}$  rms

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**Model 112 Chopper-Stabilized Operational Amplifier.** Versatile, modular for analog control systems.

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**Model 120 Nanovolt Amplifier** gives you high-gain/low-noise amplification for seismic transducer signals, cryogenic studies, thermocouple or strain gage signals.

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**Model 121 Nanovoltmeter** provides  $0.1\mu\text{v}$  full scale bridge balance detector or thermocouple indicator for standards and calibration work, in the field as well as in laboratories.

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# POWER-TIME VOLTAGE TESTING OF TRANSISTORS

In the semiconductor industry, the operation and results of this type of testing is difficult to understand. This article defines a new performance criteria to help eliminate much of the confusion, and provides a new rating procedure to predict the stability of a transistor. The test method will assure that good thermal contact is made between the active portion of the device and the header.

AN INVESTIGATION OF THE ERRATIC PERFORMANCE of silicon mesa transistors, when these transistors are tested for voltage breakdown, led to a new criteria of performance.

All transistors are tested for the collector-emitter voltage breakdown with various base-to-emitter conditions. In general, these tests are conducted at specified current levels with the criteria that the voltage at

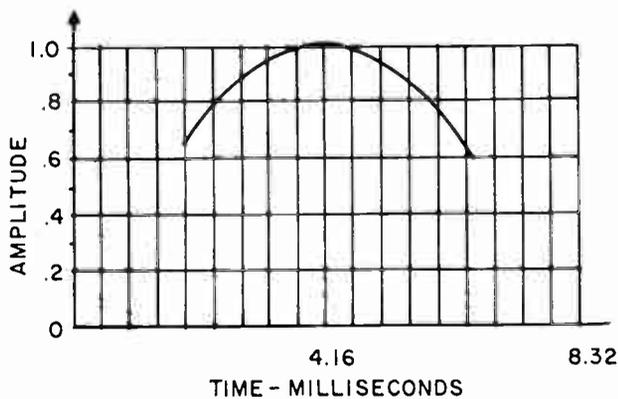
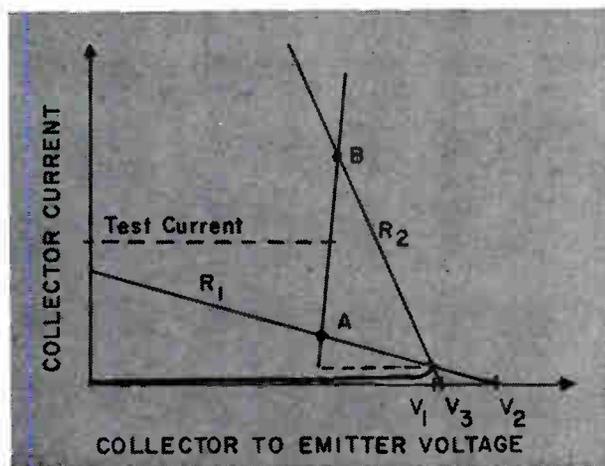


Fig. 1: Portion of a 60-cycle sine wave. Note the different time durations of voltages with 0.8 and 0.9 of peak values.

Fig. 2: Characteristic of a mesa transistor. With the loads, a higher and lower collector current than the test current results.



this current has to be above a specified value for a given transistor type.

At times, the transistor curve tracer is used, but this may not be a satisfactory test method, since the power-time relationship cannot be readily determined. When the curve trace is used, the junction temperature changes and the breakdown voltage fluctuates. In many cases the trace on the rising portion of the sine wave differs from the trace on the decreasing position of the waveform and it is difficult to accurately determine the breakdown voltage at the specified current.

\* \* \*

A look at the increasing portion of the 60 cycle sine wave shows that the voltage exceeds 0.9 of the peak value for about 1.2 msec. and 0.8 of the peak value for about 1.7 msec. If the decreasing part of the sine wave is taken into consideration, the 1.2 and 1.7 msec. time intervals would be doubled giving 2.4 and 3.4 msec., respectively. Fig. 1 is a partial plot of the 60 cps sine wave with a time axis added.

The time intervals, as determined by the device characteristics and the sine wave, can be used to find an effective pulse width, but this is an involved process since each device is different. An indication of the involvement is given below.

By JOHN G. NABOROWSKI

Sr. Proj. Engr.  
Missile Systems Div.  
Raytheon Co.  
Oxnard, Calif.



## POWER-TIME TESTING (Continued)

### Collector-Load Characteristics

When the curve tracer is used, the value of series resistor in the circuit can be changed by the external series resistor control. The value of this resistor can change the apparent voltage characteristic of the transistor being tested since this resistor may change the average and the peak power that is dissipated by the device. The change in average and peak power in turn may change the power-time relationship. This results in localized as well as overall device temperature changes.

Fig. 2 is a plot of the collector characteristic of a silicon mesa transistor with two different load lines (series resistors) added. The collector voltage must exceed  $V_1$ , to permit the transistor to enter the negative resistance region and allow test current to flow.

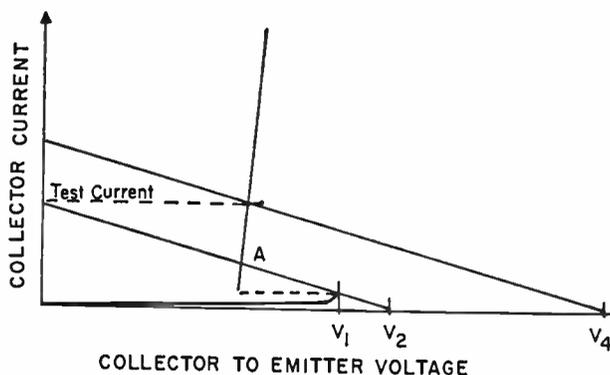
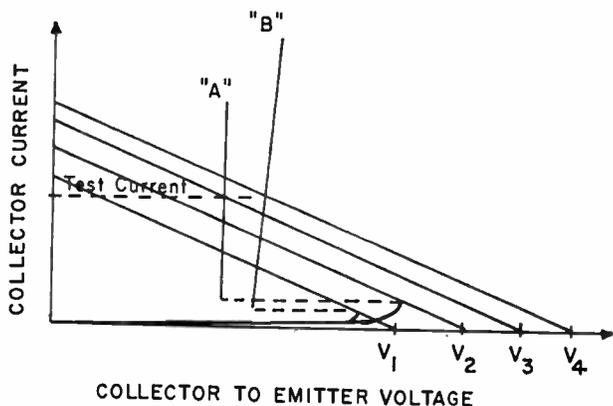


Fig. 3 (above): When the supply voltage for the load resistor  $R_1$  of Fig. 2 is raised to  $V_4$ , we get the specified test current.

Fig. 4 (below): Plots indicate that transistors differ, since A and B need different supply voltages for the same test current.



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Considering the resistor load line  $R_1$ , the supply voltage has to exceed the voltage  $V_2$  to bring the collector voltage to  $V_1$ . Immediately after the voltage  $V_2$  is exceeded, the negative resistance region is entered and the operating point will jump to point A, which is below the test current. The supply voltage will then have to be increased to  $V_4$  as shown in Fig. 3 to permit the test current to flow. If  $R_2$  in Fig. 2 is chosen as the load line, the operating point will jump to point B immediately after the voltage  $V_3$  is exceeded and the collector current will be too high.

If the load line is selected for each individual transistor, the test current can flow immediately after the negative resistance region is entered. But, transistors are peculiar devices and they will not all exhibit the same characteristic. Fig. 4 shows two transistors when they are tested with a fixed resistor in the collector lead. Consider transistor A, the supply voltage has to exceed  $V_2$  for the transistor to enter the negative resistance region, and then the voltage has to be increased to  $V_3$  to permit the test current to flow. For transistor B, the unit breaks over initially when the supply voltage exceeds  $V_1$ , which is lower than  $V_2$ , but the supply voltage has to be increased to  $V_4$ , which is higher than  $V_3$ , to permit the test current to flow. These two transistors show that selection of the load resistor is an almost impossible task.

Fig. 5 shows a plot of a transistor characteristic placed on a normalized voltage scale. With the load line  $R_a$  an idealized case has been chosen to show that before the  $45^\circ$  point on the rising portion of the sine wave is reached, very little current flows in the transistor and hence, the power dissipation is low.

### Power Dissipation

Fig. 5 shows that after the 0.707 v. value is passed, the operating point will jump very rapidly to point A on the load line. At point A, the current is below the test current and with the same load resistor  $R_a$ , the supply voltage has to be increased to 1.0 v. to pass the test current. The breakover point is reached at  $45^\circ$  and the transistor is dissipating appreciable power for  $\frac{1}{8}$  of a cycle on the rising edge of the sine wave. If the transistor characteristics were to remain identical on the decreasing portion of the sine wave (after the  $90^\circ$  point), the transistor would be dissipating power for a complete  $\frac{1}{4}$  of a cycle, corresponding to 4.17 msec.

If the collector resistor were chosen so that it would correspond to the load line  $R_b$  in Fig. 5, appreciable power would be dissipated for a very short period of time on the leading edge of the sine wave, but this would require a selection of the load resistor.

Fig. 6 is a plot of the same transistor shown in Fig. 5 with typical voltage and current values applied. Table 1 shows the average power over the entire interval and Table 2 shows the power dissipated at a particular portion of the cycle. From these tables we see that the average power over any interval shown in the table is greater than 4 w, even though the instantaneous power shown in Table 2 may be as low as 2 w for a portion of the cycle. Table 2 also shows that the instantaneous power is greater than 4 w for the portion of the time after the 64° point.

If a load line between  $R_a$  and  $R_b$  in Fig. 5 is chosen, the average power and the total time this power is dissipated will change. But, since the sine wave is flat near the peak as shown in Fig. 1, appreciable power will still be dissipated for a long period of time if the supply voltage has to be increased after the negative resistance region is entered at 0.87 of the peak voltage. From Fig. 1, we see that appreciable power will be dissipated for 1.39 msec. on the rising portion of the sine wave and for the same time on the decreasing portion, if the transistor characteristic doesn't change. This is effectively a very long pulse.

### A More Useful Test Criteria

Testing with the curve tracer has no uniform meaning for low power devices, or devices that cannot withstand the instantaneous or average power dissipation. A more meaningful criteria would involve a power times time relationship that cannot be found with a curve tracer with a 60 cycle voltage drive.

To more accurately determine the power-time relationship, a constant-current generator was modulated with a 300  $\mu$ sec. square pulse. This gave a square pulse of constant current. In this test, the current magnitude was changed since the equipment

TABLE 1

Angular Limits	Average Power Dissipated Watts
45° to 90°	4.0
50° to 90°	4.2
60° to 90°	4.55
70° to 90°	4.8
80° to 90°	4.96

TABLE 2

Angle	Instantaneous Power Dissipated at This Point of the Cycle (Watts)
45°	2.07
50°	2.66
60°	3.66
64°	4.0
70°	4.4
80°	4.85
90°	5.0

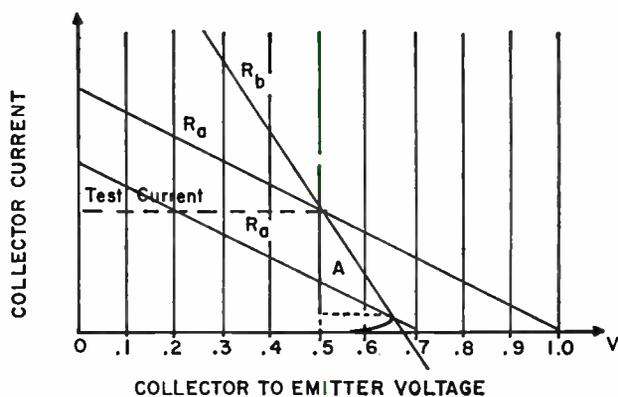
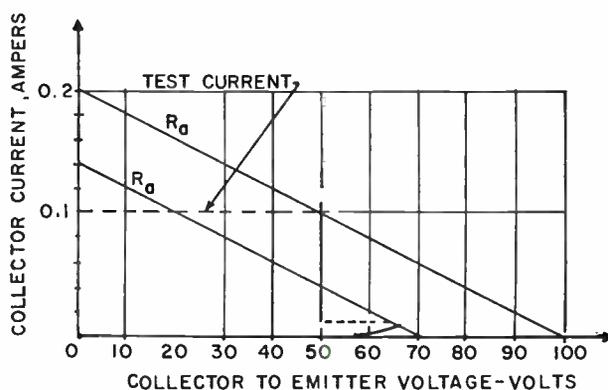


Fig. 5 (above): Breakover is near the same normalized voltage point, but the time of power dissipation with  $R_a$  is longer than with  $R_b$ .

Fig. 6 (below): The same transistor used for Fig. 5 has this characteristic for typical values of voltages and currents applied.



was not set up for a variable modulating pulse width. In a test to find the power-time relationship suggested by this article, a variable width, constant-current pulse should be used.

### Test Results

In this test, the collector-emitter voltage was monitored on one oscilloscope and the operating point excursion was monitored on a separate scope.

Some of the typical voltage characteristics that were observed with a fixed pulse width and constant current of 50 ma. are shown in Fig. 7. These curves are only a sample of many, because all of the results cannot be shown. These curves show the reduction in the voltages as the transistor temperature increases. The results of changing the current level on a given transistor are shown in Fig. 8. This is a plot of the voltage-current characteristic, and it shows that the current stays constant but the voltage decreases for the larger current values.

At 25 and 50 ma., the voltage remained constant for the complete 300 msec. pulse. At 75 ma., the voltage started to decrease, indicating a "hot spot," or the beginning of a breakdown. As the current in-

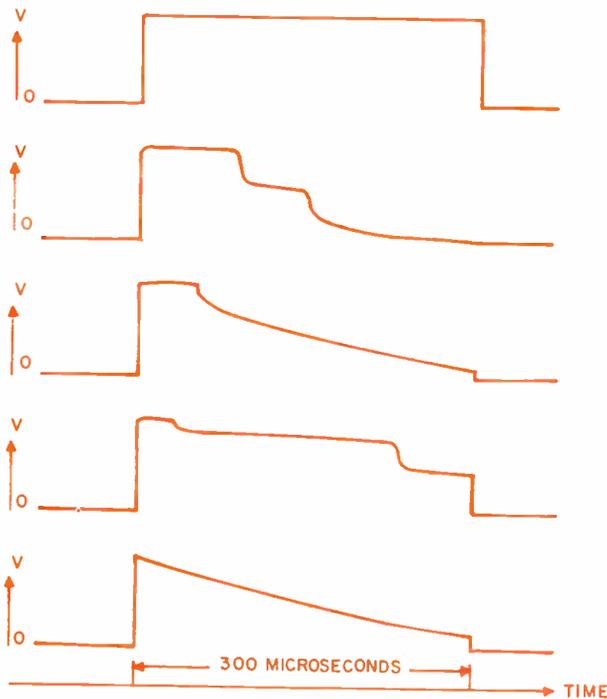


Fig. 7 (above): Typical voltage characteristic of various transistors. All have a fixed pulse width and constant current applied. The voltage decreases as the transistor temperature increases.

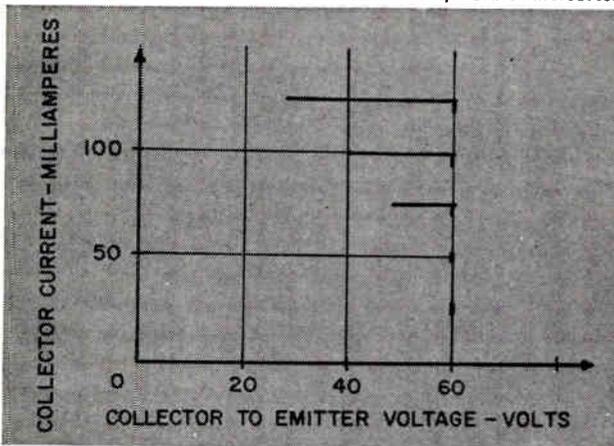
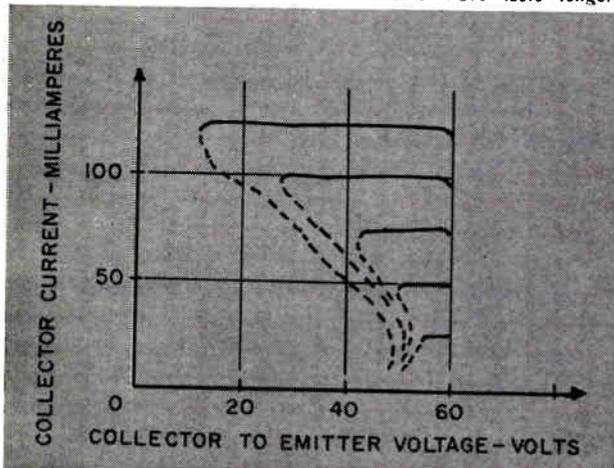


Fig. 8 (above): Results of changing the current level of a 300- $\mu$ sec. pulse to a transistor are shown. Voltage breakdown starts at 75 ma. Voltage decays for any larger currents which are held constant.

Fig. 9 (below): The transistor of Fig. 8 was tested on a 60-cycle curve tracer. The voltages drop to lower values for the same current levels, because the effective sine wave lasts longer.



## POWER-TIME TESTING (Concluded)

creases, the time before the "hot spot" developed decreases indicating a power-time product.

Fig. 9 shows the characteristic of the same transistor when the transistor is tested on a 60 cycle curve tracer. A comparison of Figs. 8 and 9 shows that the 60 cycle test causes the voltage to reduce to lower values for the same current level. Again indicating a power-time product since the sine wave is effectively a longer pulse. The scope trace on the decreasing portion of the sine wave will appear as a solid curve, but is shown dashed in Fig. 9 for convenience.

### Figure of Performance

The power-time product for "figure of performance" will have to be an additional test, since we still have to know the voltage rating of the device. This power-time product test can be conducted with a variable-pulse-width constant-current generator. Initially, the constant-current generator will be set for a short pulse width to find the voltage of the device. When the voltage is found, the operator will refer to a chart like that shown in Fig. 10 to determine the needed pulse width. The operator will then increase the pulse width to agree to the time shown on the chart. If the voltage does not change, with the required pulse width, the device meets the needs of the power-time product.

Fig. 10 is a graph showing constant-current curves plotted on a voltage-time axis. This plot is given for a device that would have a 1 and 5 watt-msec. figure of performance. But, for any other rating, the time axis may be multiplied by the factor needed.

As an example of the use of this figure of performance, assume a device to have a voltage rating of greater than 40 v. and a figure of performance of 1 watt-msec. The device is to be tested with a 100 ma. pulse. The pulse width would be set at 10  $\mu$ sec. to start and the first observation is used to determine the actual voltage of 60 v., the chart is then consulted and it is found that for 60 v. and 100 ma., for a 1 watt-msec. rating, the pulse should be applied for 166  $\mu$ sec. If the voltage of the transistor does not change when the pulse width is increased to 166  $\mu$ sec., the transistor can be considered to meet the needed specs. If the voltage drops, the device cannot be rated as a 1 watt-msec. device at this stage of testing.

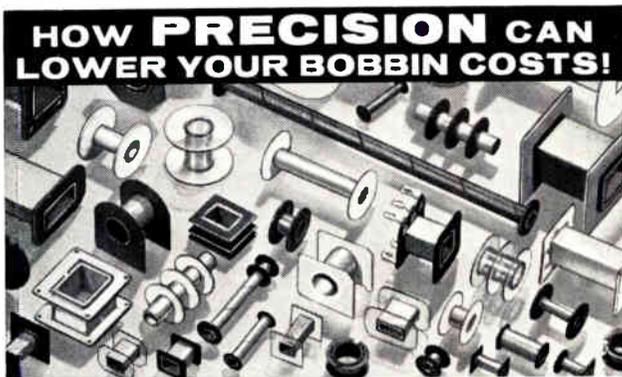
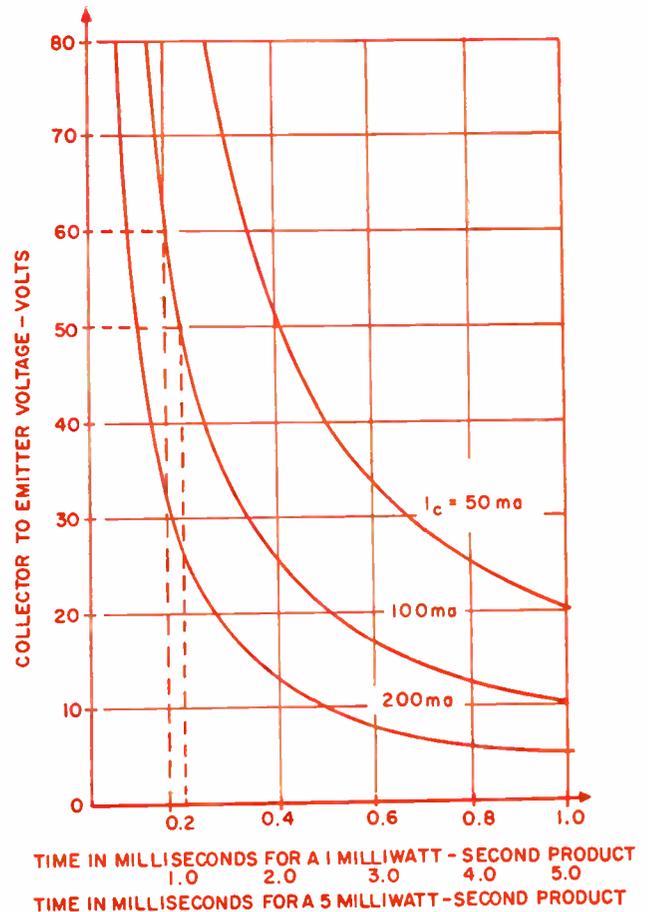
As in any situation, it may be found that after initial testing, the device voltage rating drops to 50 v. and the voltage may now stay constant at this value for the needed time of 0.2 sec. It will apparently meet the 1 watt-msec. need but, some change has occurred in the device and the entire test cycle should be re-

Fig. 10 (right): The voltage of a transistor is found with a variable-pulse-width generator. Then, the time-voltage relation on this chart is used to determine the pulse width to apply for testing.

peated because other parameter changes may have occurred, which would restrict the use of the device.

This figure of performance can help to eliminate many of the transistor failures that occur, contribute to the overall reliability and eliminate much of the confusion that occurs during device testing.

This figure of performance may also be used to learn the effective thermal resistance and thermal time constant of a device. It is obvious that these two thermal ratings are related in a test of this type. At the present time, the thermal resistance and the thermal time constant are specified for some devices. The power-time product includes both of these characteristics in a single characteristic. However, if the device is used for any type of constant power dissipation, such as would be found at the quiescent point of a class "A" amplifier, the thermal resistance will still have to be known. In some uses, the thermal time constant is important but, another form of a power time test could be applied to the active region of the device characteristics that would eliminate the need for the thermal time constant.



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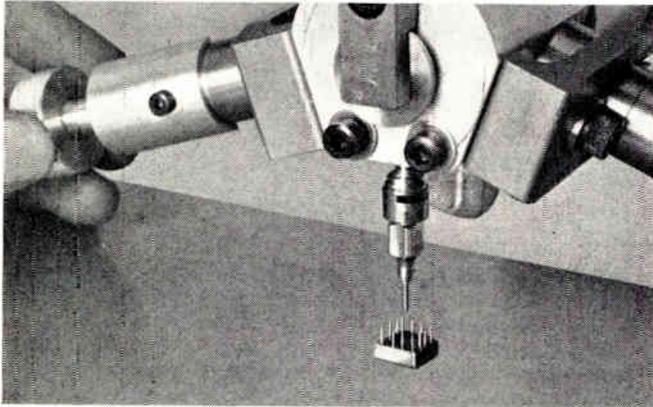


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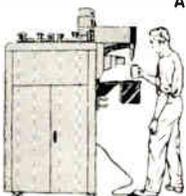
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## SYNCHRO-TEST NOTES

Where precision synchros and servos are being checked out for synchronism error with an ultra-precision Gertsch or Theta synchro-resolver bridge, a quick-check step-motor zero-set switch circuit to rapidly position synchros and servos into the 0-60-120-180-240-300° positions and compare them with a precision-servo synchro indicator, is a convenient time-saver. That is, the stepping-switch circuit uses the standard synchro zero-set circuit together with the suitable (R1-R2) and (S1-S2-S3) reversals, to get the required preliminary 60°-step-position checks. Also, a Ballantice ac VTVM type rack-mount #320 is useful here for checking synchro (S1-S3) Ov. -0° position and synchro C.T. (R1-R2) Ov. -0° output in rapid preliminary check-outs.

A rather convenient method of plotting synchro and servo position or synchronism bracket error, is to use standard polar plot paper such as K & E type #340-P, instead of the Cartesian type. This saves a lot of writing since one merely runs off the curve about one of the circular axis. Such a polar plot would also be useful for plotting gear, pulley and flywheel lateral and radial run-outs in servo, phono T.T., and tape-recorder drives. Nothing new, but handy.

Where a precision 0-360° instrument dial is not on hand in the lab, a temporary jury-rig dial can be quickly made up from a standard 3 to 5 in. plastic drafting 360° protractor dial, with the back side sprayed with white enamel, or rubber-cemented with white paper to bring out the graduations. This will do until a precision dial can be obtained.

Submitted by TED POWELL, 115 1st St., Bethpage, L. I., N. Y.

**INFRARED RADIATION** is being used to identify short-life or faulty parts, or predict reliability in circuits and assemblies at Rome Air Development Center, Griffiths Air Force Base. No special circuitry is needed other than normal power supply. The technique merely depends on an infrared camera to make thermographs that show temperature distribution over large areas. By using Polaroid Land photo film, a thermograph print is ready in 10 seconds. The image is made of horizontal lines in a raster. Cold targets appear as black areas and warm targets as varied grays and whites. Gray tone scale permits quantitative analysis. Hot spots or overstressed parts can be noted at a glance. For reliability prediction, failure rate curves in reliability handbooks must be re-plotted to show failure rate as a sole function of surface temperature.

# Watch For Your June 1964 State-of-the-Art

## Reference Issue

This issue will be sectionalized, by product, for the convenience of readers.

1. Resistors
2. Capacitors
3. Inductors, Coils, Transformers
4. Vacuum Tubes
5. Semiconductors
6. Wire and Cable
7. Electromechanical Components  
pots, relays, switches, etc.
8. Rotary Components  
motors, blowers, synchros, etc.
9. Circuit Interconnectors  
plugs, connectors, disconnects, etc.
10. Microwave Components  
tubes, isolators, waveguides, etc.
11. Electrical Devices  
fuses, lights, panel meters, etc.
12. Materials and Hardware  
fasteners, shielding, boards, etc.
13. Power Sources
14. Test and Measurement Equipment

**Each section will report up-to-the-moment capability.**

**DON'T MISS READING**

**ELECTRONIC  
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## EDITOR'S NOTEBOOK

**UNDERWATER RADIO SYSTEM** using only the human ear as receiver enables a diver to talk to all others within 100 yards. Voice is amplified through water and can be heard without receiving equipment. Walter P. Rhea, General Manager of Bendix Marine Department, producer of the system called "Watercom," said it includes a transmitter attached to a driver's air tank. The system also has a special mouth mask that allows the diver to move his lips freely, plus a throat microphone.

**INTERNATIONAL PEN PALS** will soon be writing to each other around the world on various science and engineering subjects, thanks to the Parker Pen Co. Called the "International Penfriend Program," project goal is to promote better understanding among peoples of the world. A million or more persons of all nations are expected to be matched by computer in the next two years. Parker will conduct the project at its pavilion at the New York World's Fair. When a visitor signs up for the program at the pavilion he will receive instantly from the computer the name and address of his matched overseas' Penfriend.

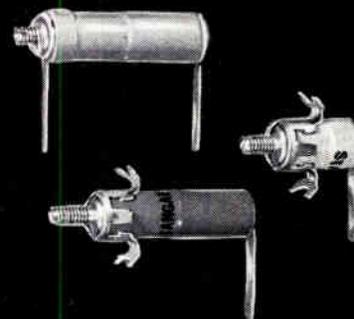
**ELECTRO-MYOGRAPHIC (EMG) POTENTIALS**, electricity of human muscles, is under study for use as control functions. Philco Corp. and New York University, working for Office of Naval Research, are looking for recognizable patterns of frequency modulation signals. Study will involve detecting and processing signals on a skin area. Signals, including EMG, noise, etc., would be routed to an amplifier-filter to separate the signals from noise and undesired factors. Computer programming would determine criteria for a perceptron to be used in adaptive sequences.

**ELECTRONIC NURSES** may monitor hospital patients "round-the-clock" in the not too distant future, predicts Dr. Ernest W. Reynolds, Jr., University of Michigan Medical Center. University doctors have run continuous electrocardiograms and heart beat recordings of about 30 in-patients for as long as a week. The heart beats are computed and recorded on paper. U-M researchers are working on a monitor and computer system that won't have to be placed at bedside, and can monitor 24 patients at once.

- Low cost results from solid electrode band technique and automated production
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Amplitude of the TWT can be continuously controlled over a 50 db range using an external 0 to 10 volt signal. Similar pulse modulation range is available.

Only the Alfred amplifiers provide a gain variation of less than 0.2 db for 105 to 125 volt line variation. Low peak-to-peak ripple provides excellent short term phase stability. Precise voltage regulation, including regulated dc heater supply, insures long term phase and gain stability.

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<b>Gain (at rated power)</b>	30 db (minimum)
<b>Gain Adjustments</b>	0 to 50 db minimum gain reduction
<b>Gain Variation with Line Voltage</b>	0.2 db or less at 1 watt output for 105 to 125 volt line voltage variation
<b>Modulation</b>	Modulation input is direct coupled to permit pulse modulation or continuous control. 10 volts required to cover full 50 db range.
<b>Rise Time</b>	Models 560 and 561, less than 4 $\mu$ sec. Models 562 and 563, less than 2 $\mu$ sec.
<b>Spurious Modulation</b>	At least 45 db below output signal level.
<b>Input Power</b>	115/230 volt, 50/60 cps
<b>Price</b>	Model 560, 1 to 2 Gc: \$2150. Model 561, 2 to 4 Gc: \$2150. Model 562, 4 to 8 Gc: \$2650. Model 563, 7 to 12.4 Gc: \$2650.

For complete information or a demonstration, call your Alfred engineering representative or write us at 3176 Porter Drive • Stanford Industrial Park • Palo Alto, Calif. Phone: (415) 326-6496.

**ALFRED ELECTRONICS**

Reporting late developments affecting the employment picture in the Electronic Industries

**ENGINEER ENROLLMENT HIGH IN EUROPE INSTITUTIONS**

European students in growing numbers are trying to enroll in European universities and technical schools that offer engineering programs, according to a Lafayette College professor who has completed a study of many of the programs.

"At a time when enrollment in the U. S. appears to be on the decline, it is significant that throughout Europe the demand for these courses is on the increase—and at a rapid rate," said Prof. Jacob A. Benner, of Lafayette's mathematics department.

There are currently 7000 engineering students enrolled at Delft, and 20,000 are expected by 1970, Prof. Benner said. He added that new technical colleges are being established to handle the overflow.

**FIRM FUNDS ITS OWN PH.D.'S, FORGIVES LOAN LATER ON**

HRB-Singer, Inc., has disclosed a Forgivable Pre-Doctoral Loan Program. Objective is to further technical and professional progress of its technical employees and to maintain the company's technical competence.

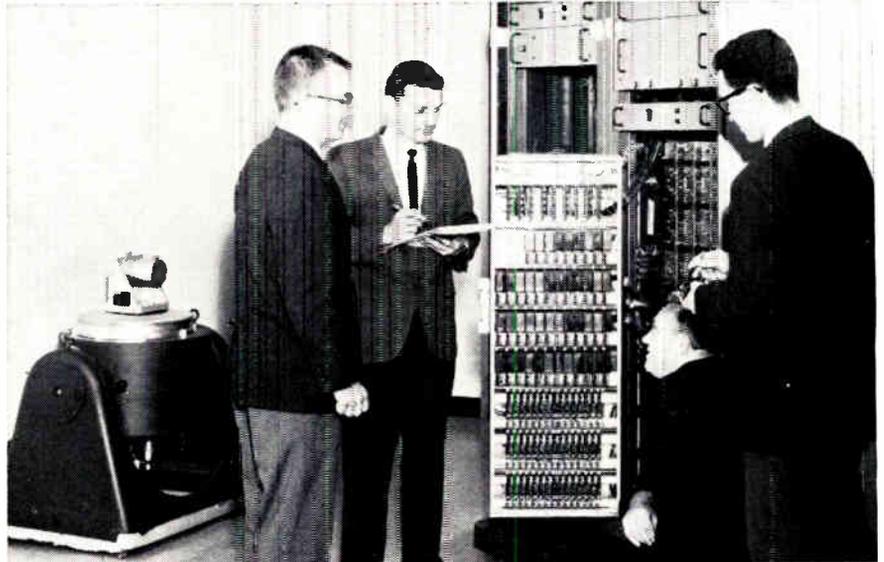
Under the program, qualified employees may apply for loans to pursue doctoral studies. Eighty per cent of the loan will be forgiven over a period of time after the candidate receives his doctorate. That is, assuming the award is made within three years after the loan.

**NSPE SAYS NON-TECH. LAWYER CAN'T ARGUE PATENT CASES**

Proposed legislation to allow any lawyer to handle patent cases "without technical background" is opposed by the National Society of Professional Engineers.

In testimony before the House Judiciary Committee, an NSPE spokesman said, in effect, that a lawyer without technical training is not able to argue a good case while having to cope with mathematical and scientific data that underlie patent application and prosecution.

**VIBRATION ENVIRONMENT TESTING COURSES OFFERED**



For electronics test laboratory engineers who want or need to know more about science of vibration environment testing, LTV Ling Electronics Division of Ling-Temco-Vought, Inc., is conducting two courses. One is seminar in "Study in Vibrations," the other is "Operations and Maintenance." In photo, students take notes on test lab equipment.

**COMPANIES WILL PAY MORE FOR 1964 ENGINEER GRADS**

Companies are more likely to find once again a seller's market on campus with the demand for engineering graduates increasing faster than supply. According to the official newsletter of the National Society of Professional Engineers, firms will have to pay more than they expect to meet hiring goals.

A recent survey by Northwestern University shows that 205 firms plan to hire 25% more engineers with bachelor's degrees this spring, and more than 40% more master's degree holders. Frank S. Endicott, Director of Placement at Northwestern, said that demand for non-engineering graduates will be up 8.1% at the bachelor's level and 26% for master's holders.

The same companies plan to start the bidding at \$610 per month for engineering bachelor graduates, up from

\$595 paid last year. Pre-season estimates are usually about 5% low. This year's substantial increase in demand may push actual starting rate averages up to \$620.

As in the past, the highest salaries are expected to go to electrical and aeronautical graduates.

Surveyed companies showed mixed feelings over the increasing number of graduates going on for advanced degrees. While demand for engineers with master's continues to rise, many firms feel salaries for this group are too high, that two years of experience would be more valuable, and that "master's holders are too hard to fit into their organizations."

Beside this, more than half of the surveyed companies said that the trend toward advanced degrees hurts the quality of first level degree holders.

"We must wait a year for the top graduates," was one typical comment, "and then many of them are out of our reach." Despite complaints, demand and salaries for master's degree holders continue to rise.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 158.

# TRAINING ENGINEERS IN COST-CUTTING TECHNIQUES



Incentive contracts are here—and so is the mandatory and growing need for engineering economics, once a wistful experiment. A contractor must keep down engineering design costs or he may be an “also ran” in contract negotiations. GE suggests training engineers in engineering economics as a likely answer.

ALMOST EXCLUSIVE USE OF FIXED-PRICE incentive contracts by the Department of Defense has underscored the latest economy drive; it is creating significant shifts in industry-wide, fiscal control practices.

Pressures from this type of contract are forcing defense industries to look for better ways of assuring that the job will be completed within cost and performance requirements, as well as on schedule. Technical ability alone is not sufficient.

The need today is for engineers and managers better trained in engineering performance as related to dollars and cents. Serious efforts are going on throughout the industry to foster an engineering climate in which the complicated inter-relationship of technology and economic factors and the trading off of these factors are understood.

At General Electric's Light Military Electronics Department, Utica, N. Y., we defined the problem as how to optimize engineering effort, decrease cost, and increase value by better use of the design process.

One method we found for solving this problem was to use our most important resource, the engineer, more effectively. To do this we had to foster a new awareness of the economics of engineering, the first and most important influence on the cost of electronic equipment.

## Broad Look at Realities

In essence, we looked for a method to give engineering design managers and project engineers a broad look at the realities of business life.

As Dr. John G. Hutton, LMED General Manager said, “It isn't enough for an engineer charged with the design of a new piece of electronic equipment to be aware of the design costs. He must also know what it will cost to manufacture the equipment as well as how much money is needed for the supporting efforts of the rest of the business. He

must know the total effect his design will have on the business.”

To develop this awareness we elected a training program in Economics of Engineering. This difficult task was implemented and directed by John F. Burlingame, Manager of Engineering.

Initially, much time and effort was spent researching the country's engineering schools to find a course or series of courses that would teach the economics of engineering design. We soon discovered that competing demands in engineering education have precluded very much concern for engineering economics as a separate discipline. Because no one engineering school course met all the requirements for our Program, we decided to create a program to suit our business needs.

From the beginning, we used the clinical approach and imported experts in economics, engineering science, and engineering design as lecturers. The course format was flexible to meet changing conditions.

Text book publishers and management consultation firms were also queried. We tried to find any material that might have lightened the task of creating such a course. For the most part these efforts were fruitless.

## One Name Was Prominent

Throughout our search, we heard one name mentioned repeatedly as the man with the background closest to our needs. He was Sakari T. Jutila,

By **LEE K. SINGER**

Engineering Personnel Development and Education,  
Program Developer and Administrator  
Light Military Electronics Department  
General Electric Company  
Utica, N. Y.



Ph.D.E.E., of Syracuse University Graduate School of Engineering. Dr. Jutila, besides his special interest in materials engineering and electronics, also holds a Ph.D. in economics. Dr. Jutila consented to be both a program lecturer and general Program Moderator.

The next step was to organize the Program outline. Areas to be covered had to be broad enough to acquaint the engineering manager with the whole business picture, enabling him to relate design engineering to the total business situation. Conferences were held with representatives from our GE Finance, Legal, Manufacturing, Marketing, and Engineering Departments. Each area was reviewed with respect to the material that could be contributed towards the accomplishment of the program's goals. Contributions were measured quantitatively and qualitatively in light of current business needs and the immediate pressures inherent in Defense contracting policies.

Once the format was established, we started a search for qualified experts to serve as guest lecturers in the various subject areas. We decided not to use in-house experts except in areas peculiar to our own business operations.

#### Sources for Lectures

We found that the various government agencies handling defense work were excellent sources for guest lecturers. These agencies were anxious and

willing to cooperate with private industry in exchanging information on the importance of economic relationships and constraints in engineering defense work.

Written matter covering philosophy, objectives, and description of the Program was sent to each expert contacted. If he agreed to participate as a lecturer, a set of suggested guidelines in his subject material was submitted for his approval.

We stated clearly that these guidelines were in no way meant to restrain the lecturer from presenting the material as he thought best. Each lecturer was invited to communicate as often as necessary with the Program Moderator, and the Program Administrator.

Presentations were set to be two to three hours in length with approximately one hour for class discussion. Although the original plan was followed by the guest lecturers, it was nearly impossible to limit class discussion, especially when the lecturer invited comment and/or questions at any time. The interchange of ideas, philosophies, and methods during these "two-way" discussions was a benefit to both the participants and the lecturer.

#### Each Session Taped

To facilitate development of a course text, each session was taped. In many instances the participants  
(Continued on page 159)



To develop economic awareness of effect of engineering design on business, a training program in Economics of Engineering was elected. Job was implemented and directed by John F. Burlingame, Manager of Engineering (second from left). Other program administrators (from left) are: E. J. Benman, Manager Reliability & Design Assurance Engineering; Dr. S. T. Jutila, Program Moderator and Lecturer; and author L. K. Singer

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<b>SEMINAR I</b> Introduction	<b>Orientation—Familiarization</b> J. F. BURLINGAME, Manager-Engineering, General Electric Co., Light Military Electronics Dept., Utica, N. Y.
The Engineer as an Economist	H. F. SMIDDY, Member of the Board, EBASCO, Retired Vice-President, Management Consultation Services, General Electric Company.
Economic Considerations in Design Process	Dr. S. T. JUTILA, Syracuse University Faculty, EE and IE; Visiting Professor in Mathematics, Cornell University; Consulting Engineer, Electronics
<b>SEMINAR II</b> Company Accounting—Practices and Philosophies	<b>Engineering Accounting Logic</b> W. C. GAYGAN, Consultant, Government Accounting; General Electric Co.
Government Accounting—Practices and Philosophies	J. RUTTENBERG, Asst. Director, Technical Policy in the Office of the Auditor General of the Navy (Contract Audit Div.), Washington, D. C.
<b>SEMINAR III</b> Preparation and Interpretation of Contracts	<b>Contract Law</b> D. O. STONE, Legal Counsel, General Electric Co., Light Military Electronics Dept., Utica, N. Y.
<b>SEMINAR IV</b> Reliability—A Management Problem	<b>Economics of Reliability</b> G. W. LINDSAY, Consultant-USAF, Technical Requirements and Standards Office, Aeronautical Systems Div., Wright-Patterson AFB, Dayton, O.
The Theoretical Approach to Reliability Economics	Dr. S. T. JUTILA.
<b>SEMINAR V</b> Cost Reduction and Effectiveness	<b>Cost Effectiveness Analysis</b> Dr. H. ASHER, Office of the Assistant Secretary of Defense, Department of Defense, Washington, D. C.
Functional Dollar Analysis	Dr. S. T. JUTILA.
<b>SEMINAR VI</b> Practical Producibility Engineering	<b>Producibility Engineering</b> S. B. KORIN, Corporate Manager of Manufacturing Equipment Development, IBM, New York, New York.
Theoretical Approach	Dr. S. T. JUTILA.
<b>SEMINAR VII</b> Economics of Logistics Engineering	<b>Logistics Engineering</b> COL. F. F. SWAN, Logistics Team Leader, Inspector General's Staff, USAF, Norton AFB, California.
<b>SEMINAR VIII</b> Planning and Measurement of Engineering Contributed Value	<b>Planning and Measurement Systems</b> I. M. CLAUSEN, JR., Manager-Management Systems, General Electric Co., Missiles Systems Division, Philadelphia, Pa.
<b>SEMINAR IX</b> Economics of Engineering Design—An Overall Approach	<b>Engineering Design</b> D. W. KARGER, Dean, School of Management, Rensselaer Polytechnic Institute, Troy, New York.
<b>SEMINAR X</b> Summary and Critique	<b>Program Review</b> Dr. S. T. JUTILA.

borrowed these tapes to review not only the lecture but also the discussion period which followed.

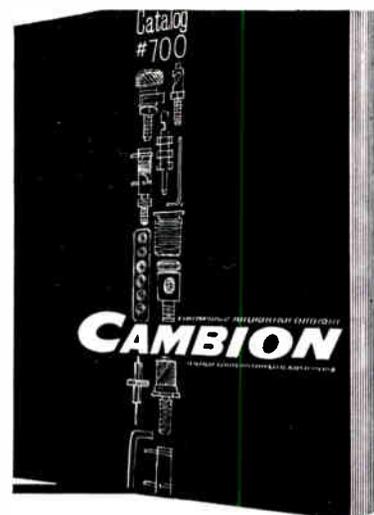
The guest lecturers were encouraged to hand out reading material, when available, in advance of the class meeting. They were also encouraged to use visual aids where desirable.

Although interest was extremely high in all the subject areas presented, the greatest response came in the non-technical areas, whose sessions frequently had to be halted when they ran far in excess of the time allotted. This confirmed our belief that engineers are vitally concerned about efficiency, costs, and economics; they are eager to get such information if it is well presented in light of responsibilities.

**Pilot Program Limited**

The number of participants in our pilot program was limited to 32 project engineers and engineering managers. In the class there were eight teams of four men each. Each team was represented by a spokesman and each team had a responsibility to prepare a paper, offering collective thoughts, criticisms, and reactions to the subject areas covered and to the quality and quantity of material presented. This paper was then presented to the class in the final session—the Program Review.

Class reactions to subjects and the program were  
*(Continued on page 160)*



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**ENGINEERING ECONOMICS (Concluded)**

constructive. A government lecturer at one seminar suggested that engineers usually gave too little thought to military logistics in designing electronic systems and equipment. This of course covers size, weight, ease of packing, shipping, service and availability of parts. To their surprise many class members agreed with the lecturer that logistics was often forgotten in engineering design.

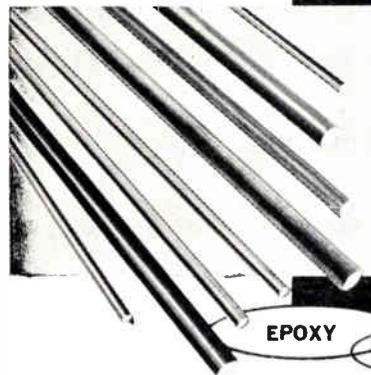
Some participants suggested modifications and changes. An outstanding refinement included in the current program series is a discussion period without the guest lecturer present. This session is held about two or three days later when the lecturer's material is pulled apart and examined closely. This sometimes takes the form of a "knock-down-drag-out-critique." At regular lectures, except for usual questions and answers, classmen must hold in their steam and let it out at the critiques.

Our work with this course is far from complete. Actually, we feel that we have only scratched the surface, as it were. We have a long job ahead of us in refining and augmenting the course to make it standard fare for our engineers.

Indeed, economic survival of the defense contractor today may well depend on how successfully he imparts the economic facts of life to his engineers.

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ELECTRONIC INDUSTRIES • May 1964

# WHAT'S NEW

## ANALOG/DIGITAL PROCESSING SYSTEM

A STORED-PROGRAM data processing system, the Ambilog 200, uses hybrid computation techniques which combine analog and digital logic. This machine is designed especially for data acquisition and reduction systems involving one or more analog inputs and analog and/or digital outputs.

According to its manufacturer, Adage Inc., Cambridge, Mass., the signal processor is a true hybrid—it exploits the potential of fully hybrid operations.

The system is organized with parallel use of multiple hybrid arithmetic units. A typical operation time for simultaneous addition and multiplication or division is  $10\mu\text{sec}$ . A wide variety of input-output capability is provided in both analog and digital domains by solid-state multiplexers, analog signal conditioners, typewriter, and punched-paper and magnetic tape units.

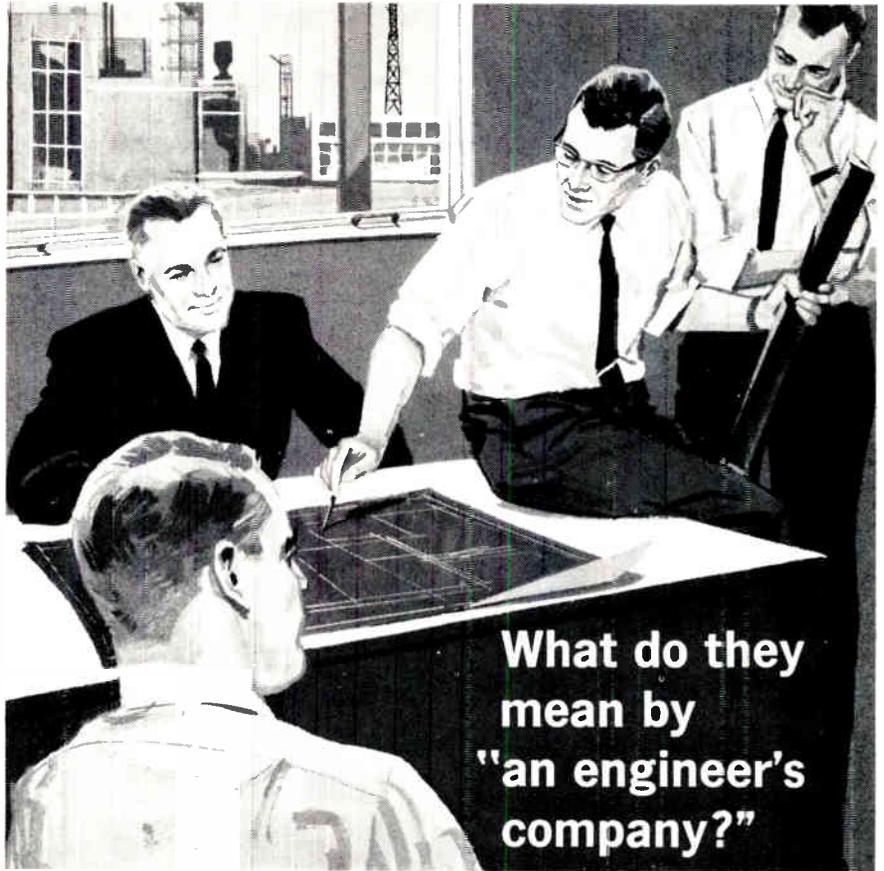
The stored program design means unusual flexibility for the user. Modular design and organization of the hardware also allows easy expansion to meet increased future problem requirements. Use of completely standard subsystems leads to lower manufacturing costs and lower prices than less flexible one-of-a-kind systems.

Complete software support provided by the manufacturer permits effective application of the system to solve specific user problems.

### PURDUE LISTS SHORT COURSE

New concepts and terminology of communication theory from recent breakthroughs in science and engineering will be offered in a short course at Purdue University.

The course, "Modern Aspects of Communication Theory," will be held at the University's School of Electrical Engineering from June 1 to June 12.



What do they mean by "an engineer's company?"

Some very successful companies are "sales oriented"—others, equally successful, receive their primary impetus from accounting, legal or business-management directions. Probably because of the highly technical nature of its product, Motorola has always been a company wherein engineering has been the moving force. At any management conference at Motorola, you'll find men think like engineers, and talk like engineers, because so many in the management echelon *are* engineers.

At Motorola the engineer achieves full professional status—because he is working in an environment where the state of the art has progressed to the point where only an "engineering oriented" management can direct the flow of achievement.

In this dynamic atmosphere, of course, the challenges are great—but equally rewarding for truly qualified engineers. Would you like to talk to us?

**LABORATORY MANAGER** direct group of engineers and support personnel in complex R & D communications activities, airborne and mobile.

**CRYSTAL ENGINEERS** advanced R & D in Filter networks, frequency control, phase shift networks, involving quartz crystal applications.

**SYSTEMS ENGINEERS** advanced R & D in radio communications systems related to Two-way, portable, mobile and radio-telephone equipment.

**CIRCUIT DESIGN ENGINEER** advanced R & D related to circuit synthesis, Laplace transforms,

magnetics and solid state Physics.

**SYSTEM DESIGN** analysis and synthesis of complete systems for operation in airborne, missile and spacecraft applications.

**EQUIPMENT DESIGN** high performance solid-state receivers, transmitters, and data processing equipment for radar, communications, command and control, tracking and telemetry.

**FAMILIARITY WITH STATE-OF-THE-ART** statistical communications theory, advanced signal processing techniques, solid state r. f. techniques, ultra-reliability, antenna systems, advanced structural and thermal designs.

Excellent opportunities also available in Phoenix, Ariz.

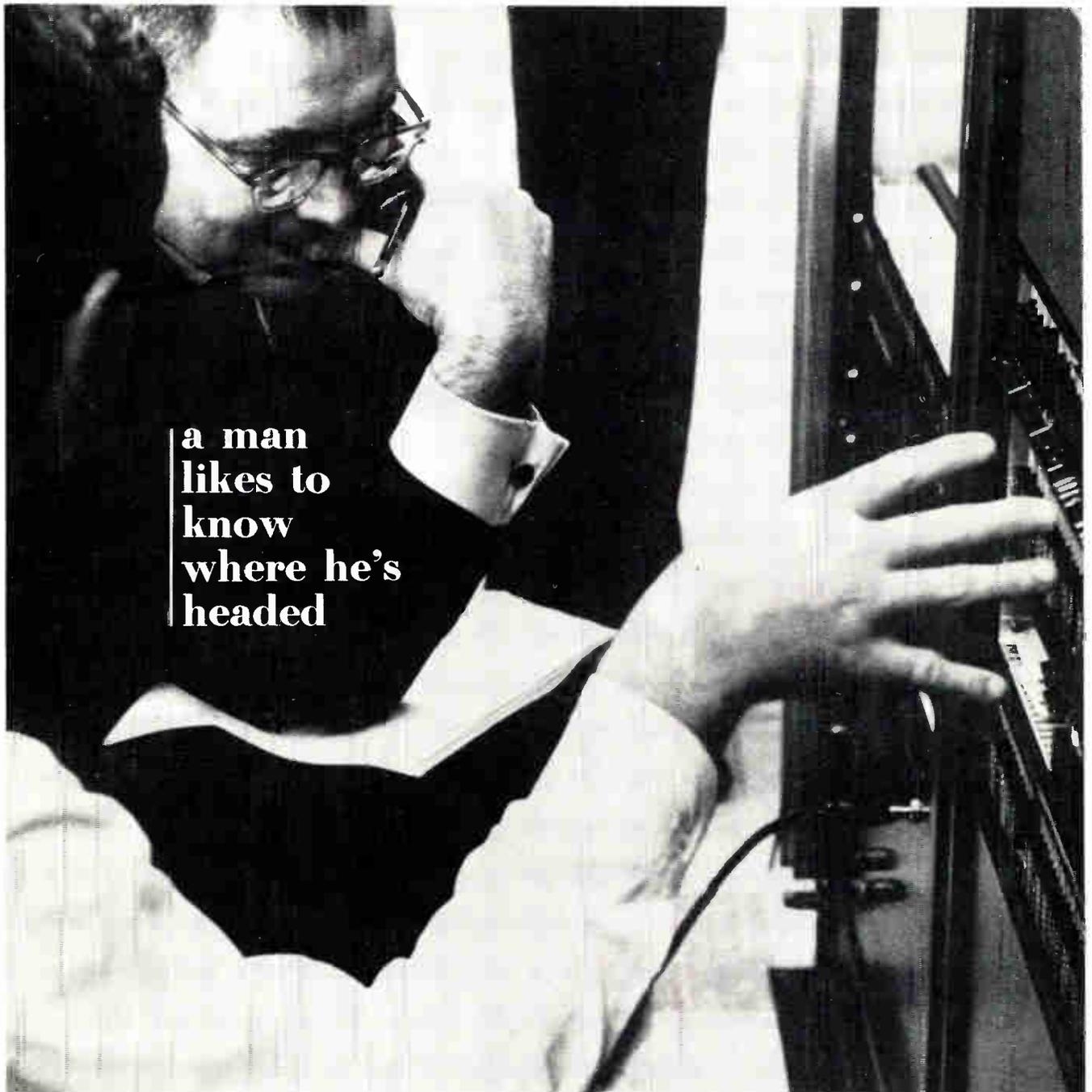
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It isn't always easy to find opportunities like this. Perhaps you've felt restlessness from not being able to make full use of your talents. Maybe you've found yourself going off in a direction which held no particular interest for you. Or which didn't challenge your ability. Or spark your imagination. Or

get you excited over the potential and possibilities.

Whatever your engineering interest might be, we'd like to talk with you. We make this broad statement because the scope of our work is broad. The challenges presented in such diverse fields as Space Communication, Data Processing, Avionics, Microwave, Antenna Systems and HF, VHF and UHF Communication to mention a few, offer you creative opportunities in every area of engineering activity.

If you'd like to get your career back on course, or if you'd like to be assured

of heading in the direction you've already chosen, Collins offers you an opportunity to do so. Write in confidence to our manager of professional employment. Dept. 120.

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# The **ELECTRONIC INDUSTRIES** Marketing Assistance Program

## America's Fastest Growing Market!

From an estimated total output of \$15.3 billion in 1963, the electronic industry expects \$22 billion or more by 1970!

Though military spending may decline a little each year, government spending, especially in space activity, will still be comparatively large. Helping to hold up the curve will be slight and gradual increases in consumer sales, replacement parts and an expected acceleration in component sales.

How do you determine the potential of your share in this original equipment market? How do you analyze sales territories? How do you locate new markets or prospects?

Hundreds of electronic firms have used **ELECTRONIC INDUSTRIES'** Marketing Assistance program to help develop guide lines.

## **ELECTRONIC INDUSTRIES**

### Marketing Assistance Program

#### The Tools

#### 1. CENSUS OF ELECTRONIC PLANTS

96% of Your Market: The **ELECTRONIC INDUSTRIES** Census—developed and maintained at a cost of more than \$250,000, reports in depth on over 6,100 electronic plants which account for 96% of the total annual sales of electronic products.

2,926 Distinct Classifications: **ELECTRONIC INDUSTRIES** unique classification system (The E.I.C. Code) identifies electronic manufacturers in 77 specific categories, with an average of 38 subdivisions under each major heading—over 2,926 distinct classifications, with complete information, plant by plant, on each industry product manufactured.

The complete findings of the **ELECTRONIC INDUSTRIES CENSUS** have been transferred to punched cards.

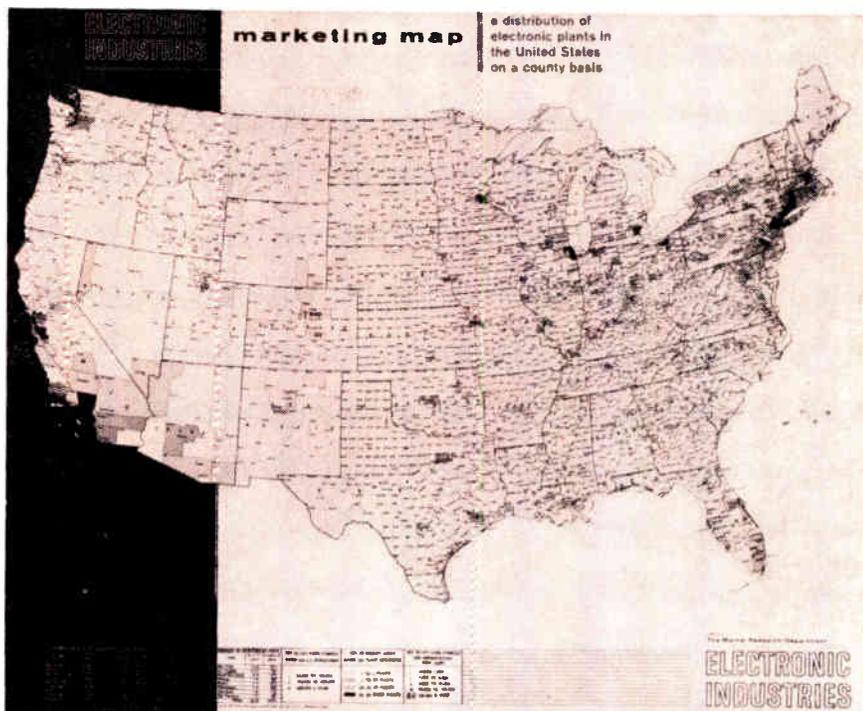
#### 2. MARKETING MAP

Unique Wall-Size Map: The **ELECTRONIC INDUSTRIES** Marketing Map shows the distribution of electronic plants in the U.S. on a county basis.

Plus tables showing the distribution of electronic engineers and plant locations in the most concentrated states. Indispensable for efficient marketing management.

#### 3. MARKET STUDIES

A complete Market Research Department at Your Disposal: The services of **ELECTRONIC INDUSTRIES** Research Department are available to you, together with a staff of over 250 experienced,



**ELECTRONIC INDUSTRIES** magazine—a Chilton Publication—is the pioneer and leader in the producing of marketing assistance tools for companies serving the electronic original equipment market. This pioneering is now backed by years of experience and has produced this exclusive Marketing Map. A brief description of this and other marketing tools are listed.

strategically located, field interviewers. Through mail, telephone and personal interview type surveys, they can help you determine:

Sales Potentials by industry and territory.

Buying influences.

Product recognition and acceptance.

Standing of competitors.

New Product applications.

Buyers' job interest and aptitudes.

... and virtually any other information essential to the effective marketing of your company's products.

#### 4. PROCESSING OF READER INQUIRIES

**ELECTRONIC INDUSTRIES** Computer Center can offer rapid analysis of reader inquiries.

They can be analyzed by specific products and by geographic areas.

#### 5. DIRECT MAIL SERVICE PROGRAM

**ELECTRONIC INDUSTRIES** automated system of inquiry processing now offers a new technique of developing the most "live" mailing lists available. Through the use of E.I.C., it is possible to compile a list of all editorial inquiries in a specific product classification.

A complete mailing service is offered by **ELECTRONIC INDUSTRIES** to help

you reach these prospects.

This service has been designed specifically for **ELECTRONIC INDUSTRIES** advertisers and is limited to their use only.

#### 6. MARKETING STATISTICS

What is the market trend for components?

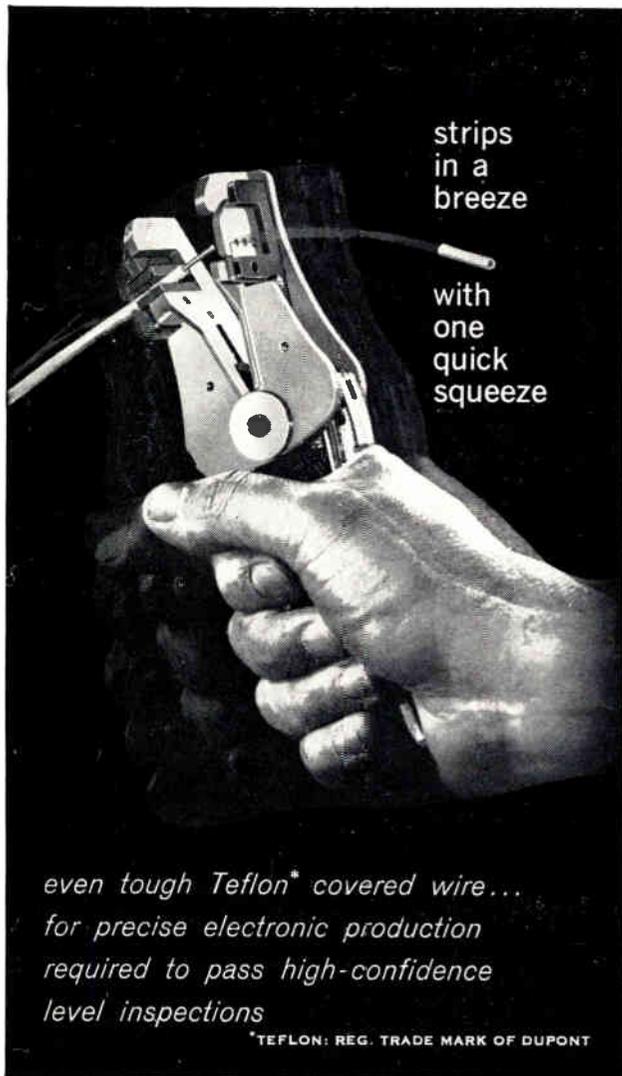
How many microwave tubes were manufactured last year?

What is the latest information on the industry dollar volume for test & measuring equipment?

These and many other questions can be answered for you through the facilities of **ELECTRONIC INDUSTRIES** research library.

All available facts and figures collected from numerous sources are yours for the asking at no charge.

To learn how you can take advantage of our marketing program write to Edward Shaud, Marketing Manager, **ELECTRONIC INDUSTRIES**, 5611 Chestnut St., Philadelphia, Pa. 19139. Ask for the description of our program. If you prefer, write or call your nearest "EI" advertising representative. They are listed in SRDS-40.



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## NO STRIPPING OR SOLDERING

A NEW MODULAR FLAT CABLE AND CONNECTOR SYSTEM, called Scotchflex, requires no stripping or soldering for uniform and reliable connections. The cable system, designed for electrical and electronic harnessing and inter-connecting uses, has all the advantages of flat cable: light weight, good heat dissipation, uniform capacitance, and easy circuit tracing.

The system features two advantages not presently available in flat hook-up cable: round wire and self-stripping connectors. The cable is a parallel-conductor, round-wire system of 48 wires, which can be slit to any multiple of six wires. Connections are made to the round wire in the cable with a self-stripping U-element. The U-elements in each connector pierce the cable insulation and grip each wire when the component halves are pressed together with a parallel-jawed pliers-type tool. Strain relief is introduced at the same time.

Connector components are designed on a six-wire module basis and can be stacked vertically by pin and recess fitting of adjacent connectors. The interchangeable connector design eliminates large inventories. By stocking a minimum of components, the user can build what he needs. Multi-wire connections, tap-offs, and transitions can be made quickly and positively.

The cable is manufactured with No. 28 gauge (AWG) solid-copper wire embedded in 0.001 in. polyester surface films with a bonded polyethylene filler. Other gauges and insulations have been designed. 3 M Co., Dept. F4-118, 2501 Hudson Rd., St. Paul, Minn.

## COMMUNICATIONS SYMPOSIUM

THE FIRST INTERNATIONAL SYMPOSIUM ON Global Communications—GLOBECOM VI—will cover "one of the most comprehensive programs on worldwide radio, satellites and computers ever presented."

Site of the three-day Symposium will be the campus of the University of Pennsylvania, and the Sheraton Hotel, Philadelphia, June 2-3-4. More than 120 speakers from different nations will present some 87 papers accenting close ties of communications and data processing in the space age. Nations represented will be the United States, France, Germany, Japan, Brazil, the Netherlands and the United Kingdom.

A highlight will be a keynote session on worldwide communication systems and services here and in the United Kingdom, Japan and France.

The U. S. military services and Department of Defense will offer reports on satellite communication techniques and command-control systems. Network and satellite survivability in hostile environments will be

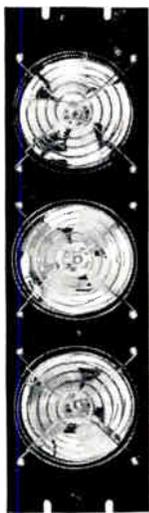
reviewed. Computer control, data transmission and data handling will be discussed at length by representatives from government and industry.

Major advances in radio transmission for global ranges will be outlined by U. S. and European speakers. The growing use of industrial communications and control will be emphasized in a five-paper session. Subjects include air traffic and computer techniques in the newspaper industry and plant networks.

General session topics include traffic analysis and systems simulation; cable transmission; communications, coding and modulation theory; switching systems; data transmission systems; military satellite communications; traffic routing, control, input/output technology.

Economic factors in system design, reflected in domestic and overseas operations, will be surveyed at GLOBE-COM VI. Papers will cover economics of commercial satellite systems, submarine cables, high-speed data transmission, LF-VLF system design, and economic relations for multiple access.

GLOBECOM VI sponsors are the Institute of Electrical and Electronic Engineers Professional Groups on Communications Systems and Electronic Computers, the Communications Division Technical Operating Committee, IEEE Philadelphia Section, and the University of Pennsylvania.



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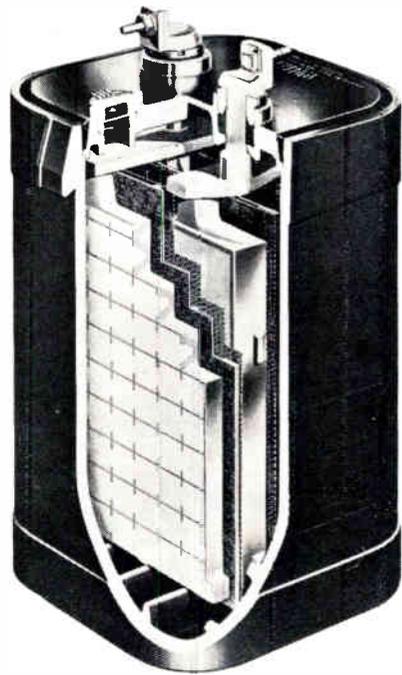
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**DAYTONA MARINE ENGINE CORP.**  
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The outstanding support given us by this industry-minded community has been a major factor in our growth and our presence in the area, and has made us feel a real part of the community.

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## COMPUTER FEATURES

THE SYSTEM 360 INTRODUCES A NEW GENERATION of computing equipment. The system combines micro-electronic technology, which makes possible operating speeds in the nsec. range, with significant advances in the concepts of computer organization.

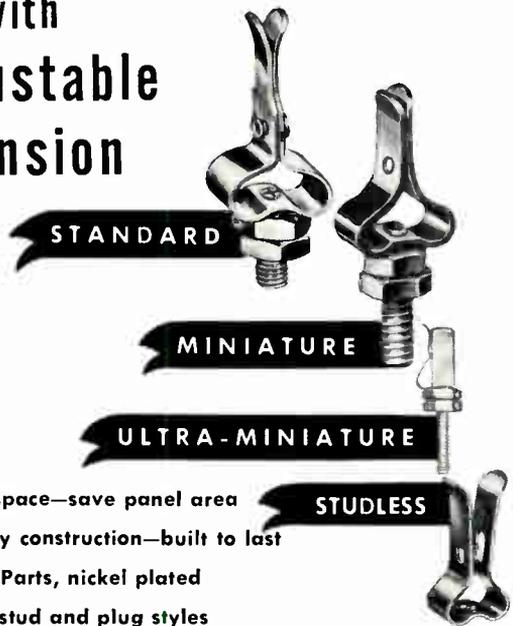
### A Single System

The 360, developed by IBM, is a single system spanning the performance range of virtually all that company's computers. It performs data-handling jobs encompassing all types of applications. The unit processes both business and scientific problems. The central processor can handle both batch-processing and real-time processing concurrently. The system includes in its central processors 19 combinations of graduated speed and memory capacity. Incorporated with these are more than 40 types of peripheral equipment which store data and enter it into and retrieve it from the computer. Built-in communications capability makes it available to remote terminals, regardless of distance. The equipment is supported by programs which enable the system to schedule its own activities for non-stop



The system shown here is one configuration of a single system spanning the performance range of virtually all IBM computers being used. The flexible high-speed unit requires no reprogramming to accept programs currently used on IBM systems.

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## MICROELECTRONICS

computing that makes most efficient use of system capabilities.

Internal processing power of the largest configuration is about 50 times greater than that of the smallest. The machine cycle time ranges from 1msec. to 2msec. Core-storage capacity ranges from 8,000 characters to more than 8 million. Data-storage devices linked to the system can store additional billions of characters and make them available at varying speeds.

Microelectronic circuits make up the system's basic components. The circuits, which carry and control the data pulses, operate at speeds ranging from 300 to 6msec. Transistors and diodes mounted on the circuits are 28 thousandths-of-an-inch square. A complete logic circuit can be contained on a single module, or several modules can be linked to form a circuit.

The central memory has storage capacity of 8,000 to 524,000 positions. The optional 2361 core storage provides 1 or 2 million character capacity with 8msec. cycle time. Up to four units of large-capacity memory can

(Continued on page 168)

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**TWIN-JAX** . . . Mounts on  $\frac{5}{8}$ " centers and up. Threaded bushings for 2-hole mounting or plain bushings with connecting strap center-tapped for single screw mounting.\*

"twin" type plugs for unique multiple patching possibilities. Far more compact, with fewer parts than any comparable function  $\frac{1}{4}$ " small commercial-type jack.

• **SURPRISINGLY VERSATILE**

6 models: 2 conductor, 3 conductor, or stereo. Threaded or plain bushings. Molded, stable thermo-setting plastic "box" body is uniquely suited to modular construction. Easiest to mount and solder: terminals come straight out, can be bent if desired. . . molded housing protects springs during mounting. Ideal for printed circuitry—stanchions in each corner for support. Bushings enable you to use the HI-D-JAX for coupling small circuit boards directly to chassis or panels.

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"Unitized" insulation assures correct internal alignment—parts can't shift. Exclusive Switchcraft integral nickel-silver springs for positive "make" and "break," exceptionally low leakage, longest life. Stamped from precision dies—require absolutely no hand adjusting. Moisture resistant. All in all, the kind of jack that helps you do your job better.

\*Connecting straps on special order— $\frac{5}{8}$ " centers and up. Single screw type mounting requires slightly larger centers. For complete details write for Bulletin No. 139 or see your local Switchcraft Authorized Industrial Distributor for immediate delivery at factory prices.



5599 Elston Avenue, Chicago, Illinois 60630  
 Canada: Atlas Radio Corp., Ltd. 50 Wingold Ave., Toronto, Ontario, Can.

\*Patent applied for

**COMPUTER FEATURES MICROELECTRONICS (Concluded)**

be attached, providing over 8 million characters of storage—all directly addressable.

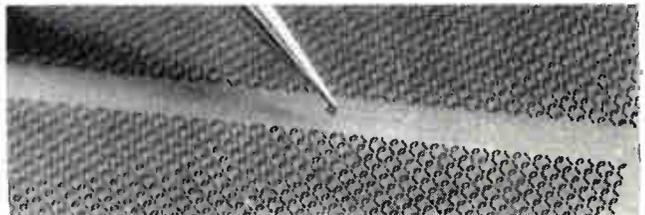
**Computer Applications**

Trucking firms can use it to continuously store, update, and transmit data such as freight bills, tractor and trailer locations, shipment status and location, delayed shipment analysis, etc. The system will do this while performing accounting functions.

Government agencies may use it to solve complex highway engineering problems at the same time it is processing tax bills.

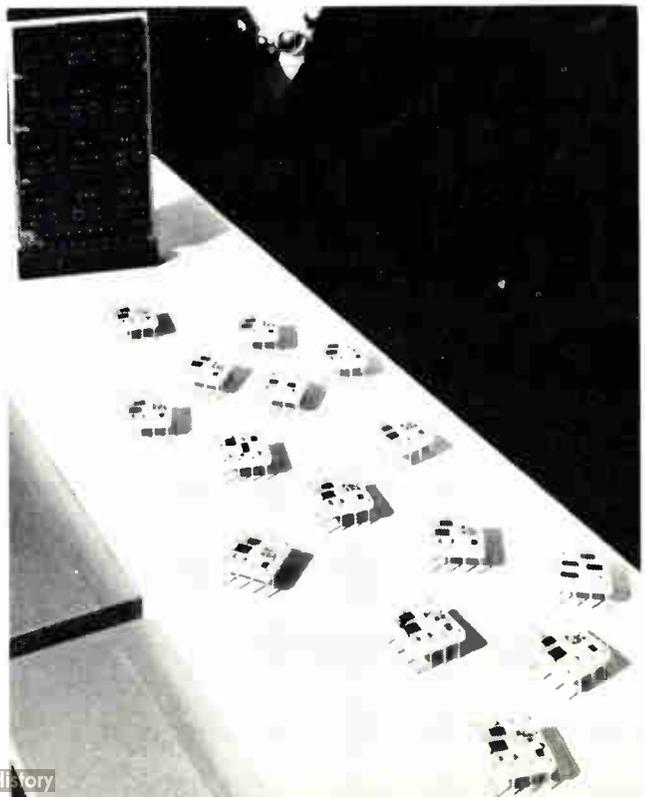
In the retail business it can control fashion and staple merchandise; handle accounts receivable payable; catalog order operations; and perform warehouse operations.

The ability of the 360 to handle batch and on-line processing simultaneously is of particular interest to banks. Now bank activities from teller window transactions to transit or general ledger can be in completely current status.



For every character of data stored in the system, nine cores—some less than  $\frac{1}{50}$  in. across—are used. Cores are arranged in planes and provide up to 2 million characters of data.

Key elements of the microelectronic circuits are transistor and diode chips which are 28 thousandths-of-an-in. sq. These chips are placed on miniature circuit modules (foreground) onto which circuit and resistor patterns are printed. The microelectronic logic card (background) contain 12 circuit modules.





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co., inc.

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914 YO 3-8850

### ADM. HORNE RECEIVES EIA MEDAL OF HONOR

Charles F. Horne, Rear Adm. USN Ret., president of the Electronic Industries Association and president of General Dynamics Pomona, Pomona, Calif., was presented with EIA's Medal of Honor at the association's Spring Conference.

Mr. Horne, who is in his second term as president of the association, was cited for "outstanding contribution" to the electronic industry. The medal, highest award offered by EIA, has been presented yearly since 1952. Recipients are selected by the association's board.

The award was presented by L. Berkley Davis, vice president and general manager of the Components Division, General Electric Co.

As he presented the medal, Mr. Davis noted that Mr. Horne's association with electronics began as a "ham" operator as a high school student.

### ITT FEDERAL LABS DEVELOP MULTIPLE-PATIENT-MONITOR

Biomedical Electronics Group of ITT Federal Laboratories has developed a Multiple-Patient Monitor for full-time remote observation of post-operative or critically-ill patients.

The ITTFL system is designed to provide continuous monitoring of patient physiological aspects, and to present continuous quantitative display of parameters at bedside. The system also will give continuous quantitative displays at a central station, and record selected parameters in graphic form.

Major functions of the Medical Patient Monitor System include: transducers; a bedside unit containing electronic signal conditioning equipment and quantitative bedside display; data transmission system; data recorder; and central display.

### TEL AVIV FAIR TO SHOW U.S. ELECTRONIC PRODUCTS

U. S. electronic firms can make cash sales, line up profitable trade contacts, and gain a solid foothold in a new and expanding market at the Tel Aviv International Trade Fair, June 16 to July 17.

The Department of Commerce announced that it has invited electronic manufacturers to take part in an official U. S. exhibit to be mounted at the Tel Aviv Fair.

# AMPERITE

## Thermostatic DELAY RELAYS

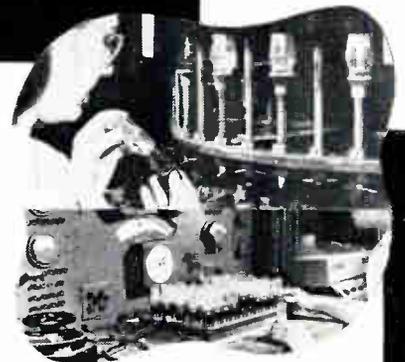


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2 to 180 seconds**

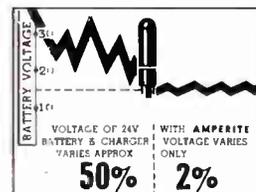
Actuated by a heater, they operate on A.C., D.C., or Pulsating Current . . . Being hermetically sealed, they are not affected by altitude, moisture, or climate changes . . . SPST only—normally open or normally closed . . . Compensated for ambient temperature changes from  $-55^{\circ}$  to  $+80^{\circ}$  C. . . Heaters consume approximately 2 W. and may be operated continuously . . . The units are rugged, explosion-proof, long-lived, and—inexpensive!

TYPES: Standard Radio Octal, and 9-Pin Miniature.  
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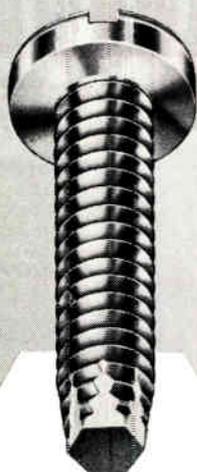
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MACHINE SCREW DEPARTMENT  
Bridgeport, Connecticut

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## OUTSTANDING



Dr. Donald C. Forster, Hughes Aircraft Co. research scientist, was named "Outstanding Young Electrical Engineer" for 1963 by Eta Kappa Nu, national electrical engineering society. Award is for research and accomplishment in low noise and microwave tubes and also in millimeter wave power sources.

### DATA SENDING BY PHONE HAS SHARP RISE IN 1963

The business trend to rising use of data sending for faster, more reliable management information showed strong gain in 1963. There are signs of an even sharper rise this year, a Bell Telephone spokesman reports.

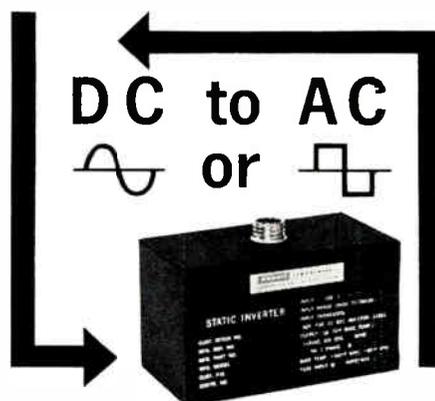
"Expanded applications of telephone facilities for data transmission will continue to highlight developments in the field of business communications," says Edgar C. Gentle, Jr., AT&T administrator of data communications planning.

A substantial gain was made in 1963 in growth of Data-Phone service, the Bell System's facility for sending information between machines over regular voice-grade networks, Mr. Gentle reports.

### U. S. ELECTRONIC EQUIPMENT TO BE SEEN AT SWISS FAIR

Electronic products will be featured at a U. S. export promotion exhibit to be staged by the Bureau of International Commerce at the 1964 Swiss Import Fair in Zurich. Department of Commerce announced that the exhibit will appear June 5-14.

Marketing studies indicate that Switzerland offers a ready-made market for U. S. manufacturers of high quality electronic control, measuring, recording and related instruments.



- Frequencies from 400 cps to 5 KC
- Output voltages from 5-500 VAC
- 50, 100, 200 VA Standard

Designed to change low voltage DC power to sine or square power, these small-size, transistorized inverters can be supplied in a wide range of output voltages and frequencies. Units feature regulation to 1/2% for input 24 to 30 VDC, short circuit protection, and meet the environmental requirements of MIL-E-5272C. Prices range from \$185. to \$595. Delivery of most units from stock.

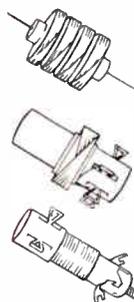
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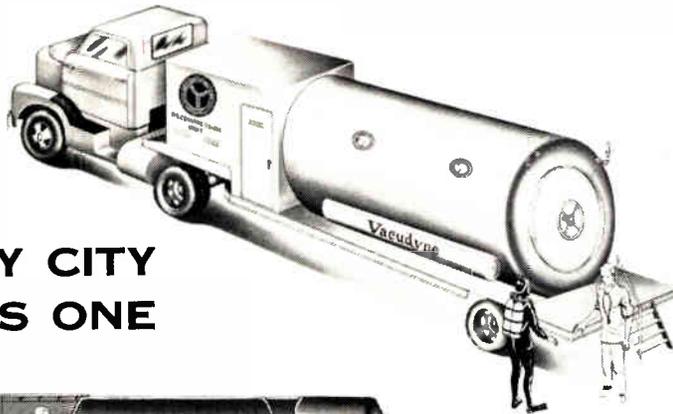
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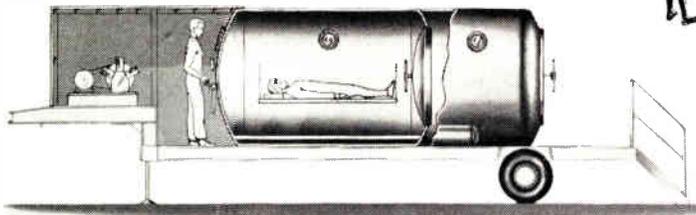
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### VIDEO TYPEWRITER



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### 15,867 COMPUTERS INSTALLED IN U. S., REVIEW INDICATES

About 4,000 computers have been installed in the last six-month period ending December 31, 1963, according to the semi-annual industry review published by The Diebold Group.

A total of 15,867 EDP units have been put in place; the total installed figure for the July, 1963 review was 11,926. These figures may be compared with the number of computers on order which dropped from 5,889 in July, 1963 to 5,465 in the last six-month period.

The largest increase was in computers renting for under \$12,000 per month, and the increase was caused largely by deliveries of the IBM 1401 and 1440.

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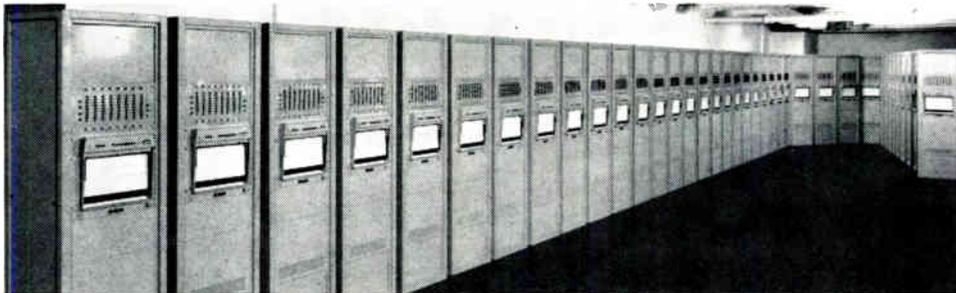
MTBF, 4321 hrs.  
CL = 99.5% !!

Over 1000 MARK 200's  
in use  
7,500 channels

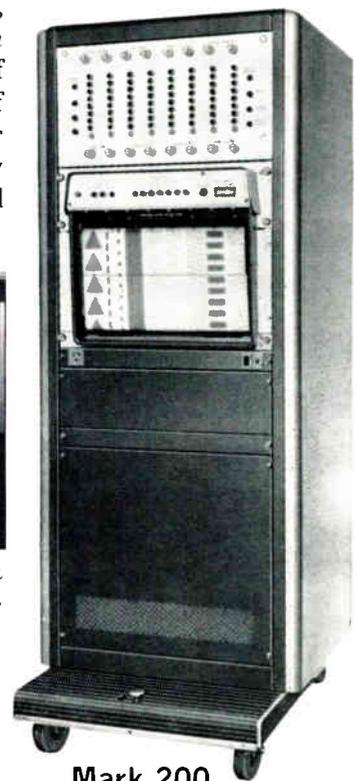
17 users  
100 Systems  
137,861 Operating hours  
 $\frac{137,861}{19} = 7255$  hrs. MTBF

## Here's reliability you can pin down 7255 hours MTBF... FIELD PROVED!

This documented figure, from 137.861 operating hours of field experience, is accepted by the Apollo PACE Program. This is a *Mean Time Between Failure* almost double the reliability requirement specified for this type of instrumentation by the Program. 7,255 hours MTBF is the equivalent of operation at peak performance for 181 weeks at 40 hours per week . . . or 3½ years! This field-proven reliability and unmatched precision and clarity of trace is inherent in all Mark 200's . . . whether for MIL or commercial applications. Write for complete story.



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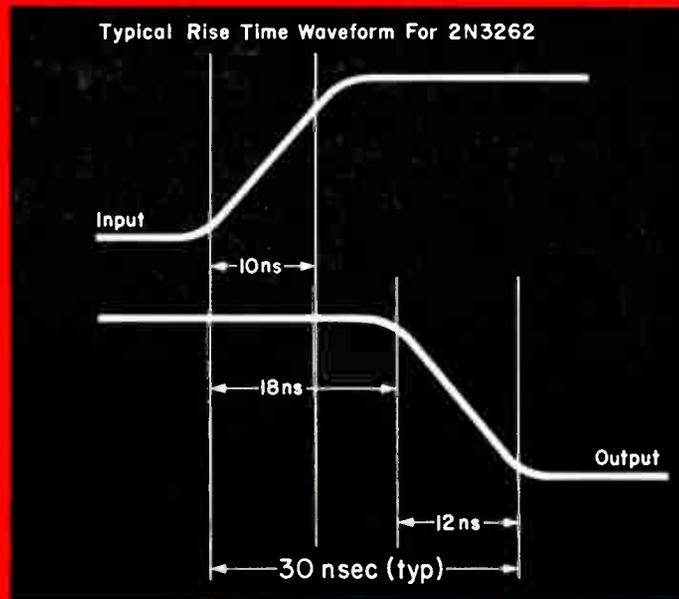


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Max. Ratings	2N3262	2N3119
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$V_{CEO}$ (sus)	80V	80V
$I_C$	1.5A	0.5A
$V_{EBO}$	4V	4V
$t_{on}$ (max.)	40 nsec	40 nsec
$P_T$	8.75 watts @ 25°C Case	4 watts @ 25°C Case

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