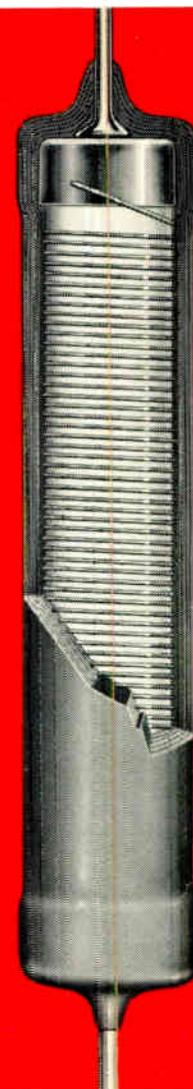


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OCTOBER 1964

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Circle 98 on Inquiry Card

What's New in Power Supplies!

TWO YEARS AGO THIS MONTH, ELECTRONIC INDUSTRIES presented a special "State-of-the-Art" report on Power Supplies. We believe you will find the new reports in this issue of timely interest.

The difficulties we reported then—of non-uniform and non-standard definitions, terminology and specifications—largely remain. For instance, "load regulations" are still specified differently by various manufacturers. The same applies to ripple, noise factor and transient response. And, as a result, supplies are being purchased that subsequently prove unsatisfactory in spite of glowing specifications by the manufacturers.

The specifications are factual enough—but can be misleading! They point up the virtues, and play down the limitations.

What little progress has been made toward standardization has been largely through the efforts of the National Electrical Manufacturers Association (NEMA). In the latest move, NEMA has put together a "skeleton" set of proposed standard definitions and circulated them to power supply manufacturers for comment. A few manufacturers are cooperating, but response from the others is not encouraging. Most want to "go it alone." No one wants to tip his hand to competitors. As a result, more large companies are developing in-house capabilities for power supply design and production.

One large systems company has a firm policy: "If we can buy the needed supplies and they meet the program specifications, we buy them. If we can't get the type of power supply specified we will make them, after a decision to do so has been made by our 'make or buy' committee."

Present power supply designs are almost entirely solid state. The rapid development of high power transistors, diodes and silicon controlled rectifiers (NEMA has standardized on the term "Thyristor"), and related devices, has enlarged the solid state power supply applications considerably. There has been a

trend toward high voltage laboratory supplies and toward plug-in modular supplies for computer applications. With the large scale use of transistorized equipment and its portability features, battery power has taken on new dimensions. Longer life batteries are the result, and further developments in life, performance and size can be expected.

Since there are few standard specifications for power supplies, the engineer who needs a supply must know exactly what he needs and spell out his requirement to the vendor in minute detail. To help in this regard, we are listing on page 54 the various factors most important for him to consider. We suggest you save this for future reference as a check list when a power supply is needed for a specific job.

It was pointed out by one manufacturer that "Engineers don't know what they really need." We have suspected this, too, and submit that a thorough analysis and understanding of the need before contacting power supply vendors will materially assist in getting the proper supply at the right price. High price usually results from over-specifying. Don't ask for more regulation than you need. Don't ask for a range of line voltages or frequencies greater than will be experienced. Do ask for everything you really need—no more.

Special Priority Request

This is the name of our new reader service facility which begins in this issue. It is a service for those who are in immediate need of additional information on products advertised or mentioned editorially in ELECTRONIC INDUSTRIES.

If you refer to the product literature cards on pages 103 and 105 you will note the special area at the bottom of each card that has been set aside for this service. Write out the desired reader service numbers in the boxes provided and mail the card. We will send your request to the manufacturers involved immediately for priority handling.

Bernard F. Obatala

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Circle 61 on Inquiry Card

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Circle 64 on Inquiry Card

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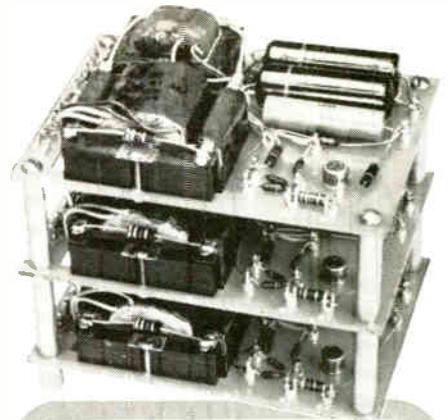
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Circle 68 on Inquiry Card

ELECTRONIC INDUSTRIES • October 1964

For complete technical data, write for engineering bulletins on the resistors in which you are interested to: Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

45R-166-63 R1

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COVER

To illustrate the many-sided problem of specifying power supplies, our cover designer built this unusual polyhedron. The symbols on the faces cover the traditional components that go into power supply construction. For more information on this field, see the "State-of-the-art" features on Supplies beginning on pages 38 and 47, and the articles on VR's on pages 78 and 81.

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



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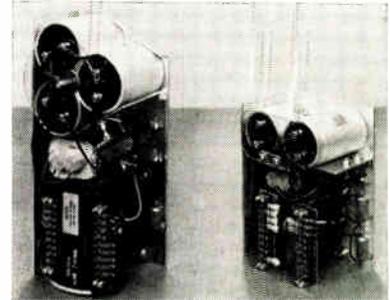
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MODERN POWER SUPPLY DESIGN FOR COMPUTERS 38

Until recently, a power supply for a micro-miniaturized circuit or computer might have cost twice as much as the circuits it supplied. It might have been five times as large and several times the weight. Designers of modern power supplies can avoid these situations.



Power Supply Design

UNUSUAL POWER SUPPLY APPLICATIONS 47

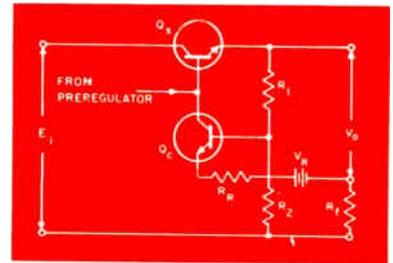
Power supplies have become very sophisticated in the past few years, performing many unusual tasks. Their applications are limited only by the designer's ingenuity. Here are some unique uses for power supplies with details on how they do it. Information is also given on what to specify for power supplies.



Choosing Photoconductive Cells

CHOOSING PHOTOCONDUCTIVE CELLS 72

A discussion of photoconductor characteristics offering a general working knowledge of photoconductive cell capabilities and limitations to help the designer intelligently choose the right cell.



Voltage Regulators

DESIGNING AND ANALYZING VOLTAGE REGULATORS 78

Here is a simple method, regardless of circuit complexity, for analyzing, by sections, series-type transistorized voltage regulators. Quick evaluation of different types of circuits is stressed to find the best one to use.



NEC/NEREM Shows

1964 FALL ENGINEERING SHOWS-NEC/NEREM 94

Keeping abreast with the latest technological developments is the general theme of this year's National Engineering Conference and Northeast Electronics Research and Engineering Meeting. This is pretty well reflected in the refresher seminars being held, and the increase in tutorial papers. It is also interesting to note the emphasis being placed on bio-medical and nuclear electronics at the NEC.

MEETING THE CHALLENGE OF LEVELING DEFENSE MARKETS 108

As the government trims back its defense budget, contracts become fewer and smaller. The trend among electronic firms is to expand operations in the industrial and consumer markets. Firms choose various ways to overcome diminishing defense markets, but they are united in direction.



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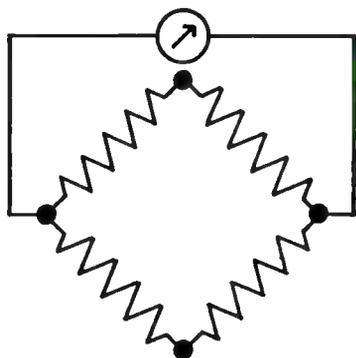
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Step 4. When the galvanometer reaches the zero point, the operator reads amount of resistance in ohms required to balance the bridge.

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

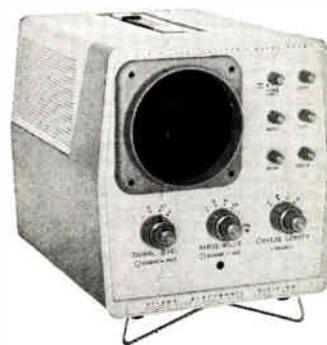
Step 6. Operator calculates resistance of that gauge cable in ohms-per-feet.

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.

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

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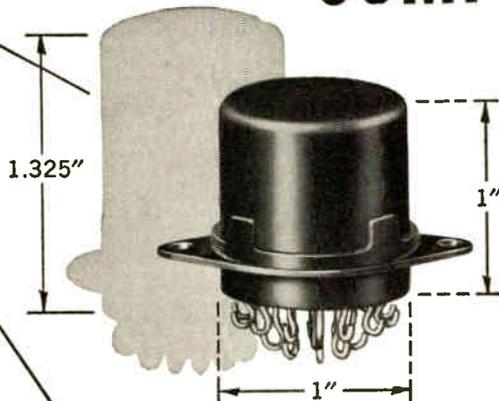
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With its 170-volt DC operation, the displayed characters are controlled by changing segment potential by 50 volts, an operation that can be easily done with transistors. A binary (hold) circuit can be provided by combining switching stages with a second transistor.

Your Sylvania sales engineer can give you more complete information on display devices. Call him today, or write directly to Electronic Components Group, Sylvania Electric Products Inc., Box 87, Buffalo, New York 14209.

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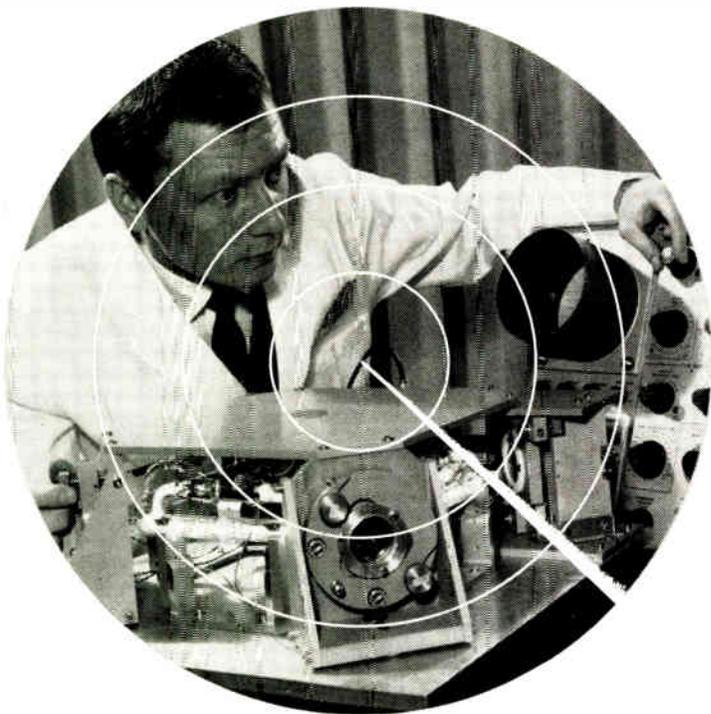
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Circle 4 on Inquiry Card
 World Radio History

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



MINIATURIZED LASER GYRO

Small version of Sperry Rand laser gyroscope is set up for testing at firm's Electro - Optics laboratories. The unit is less than a foot square, weighs under 30 lbs. It is one-fourth of weight, stronger and more stable than earlier models. Gyros will aid in tracking Saturn boosters. Unit uses 3 eight-inch helium-neon tubes on 1.15 microns.

VELOCITY SENSING is being done by a new technique at GPL Division, General Precision, Inc., using a CW laser beam and a special optical receiver. The system has potential for industrial process control as well as self-contained navigation systems for air, space and land vehicles. Called Optical Diffraction Velocimeter, measurement depends on variations of laser light diffraction patterns scattered back from surfaces. System may be useful for extremely precise motion-sensing and measurement over extended surfaces for both distance and velocity.

FIBER MEASUREMENT at high accuracy has been attained by optical-electronic system developed by Paton Hawksley Electronics Ltd., Bristol, England. Device measures fine fibers of 0.001 in. dia. to 1% accuracy. Optical scan magnifies fiber 100 times onto revolving mirror. Image is focused through slit in front of photo-multiplier tube. Mirror causes light-dark-light-dark dc levels. Center light level is caused by lens effect of fiber with higher light intensity in center of image. Plus and minus pulses are processed and used to open and close gate of millisecond timer.

MPD GENERATOR, developed by Martin Co., has produced output of 1.57w. Device is low-temperature (1,300°F), closed-cycle magnetoplasmadynamic (MPD) generator that produces electricity by shooting ionized gas through magnetic field. Martin engineers believe MPD principle could lead to more reliable and economical electricity producing method.

ONE-WATT OUTPUTS have been measured for a helium-neon laser at 6328Å at Bell Labs. This is reportedly the highest continuous power obtained so far for gas lasers, and a tenfold increase in output power over previous systems. Dr. E. I. Gordon, head of Bell's Optical Device Department, said contributing factors are extremely low-loss mirror (by Bell) and the 5.5-meter length of the discharge tube. Input power is 500w dc. The laser's efficiency is 2/10ths of 1%.

BULLET'S SOUND when entering water may be the key to an auxiliary navigational and signaling system, according to C. B. Leslie, of the Naval Ordnance Laboratory, Silver Spring, Md. Oscillations and collapse of air bubble made by a bullet generate the sound. Variations in shape and caliber may produce different sounds. System would be useful for planes flying in fog over the sea. A plane or a surface ship could also use bullet sounds to signal a submarine.

PERMANENT MAGNET MATERIAL, developed by Indiana General Corp., achieves energy product of up to 9.5 million and coercive force of at least 1,400 oersteds. Called Alnico IX, it provides minimum size and weight, maximum level of energy, and extreme resistance to demagnetization. Typical uses: Straight field focus devices, PPM TWT stacks, high performance holding, repulsion and torque transmitting devices.

ECONOMICAL "LIGHT PIPES" must be developed before lasers can be used for world-wide communications, according to Westinghouse engineers. Earth communications will demand advances in multiplexing for full bandwidth use, and practical and economical "light pipes" will have to be developed to provide an all-weather capability over long earth distances.

ELECTRONIC CIRCUITRY that can operate for long periods in strong nuclear radiation have been tested successfully at General Electric for the Air Force. Two miniature tape recorder amplifiers using a new type of ceramic vacuum tube were the first pieces of vacuum tube circuitry known to function continuously, amplifying a signal below 100kc, while bombarded with pulsed gamma-neutron doses of nuclear radiation. There was minor interruption of the signal below 100kc, reports engineer H. L. Olesen.

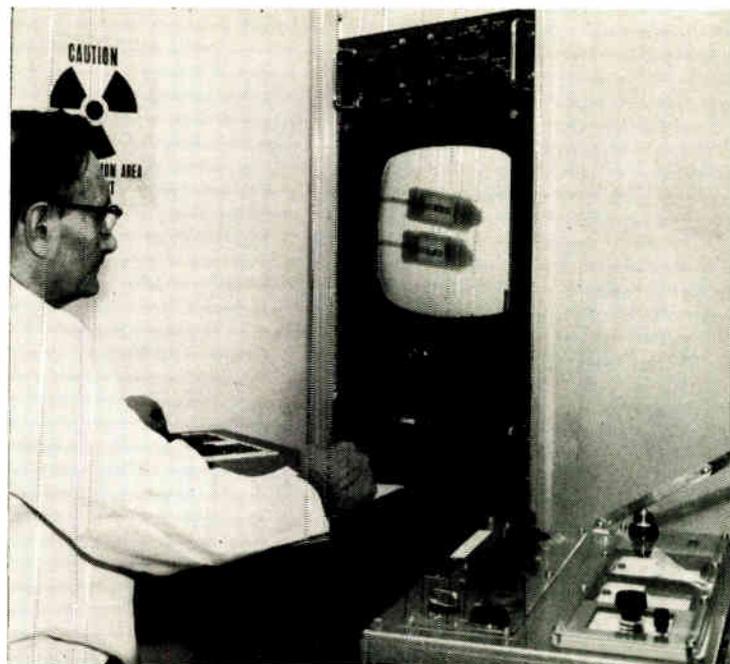
MULTIPLIER PHOTOTUBE with four simultaneous outputs for tracking devices developed by ITT Industrial Labs. Separate signals put out by new quadrant-type detection device will depend on location of input image within one of four quadrants of the photocathode area. Unique feature: No dead areas where input signal might momentarily be lost. Tube can deflect into any of four multipliers.

ANALOG-TO-DIGITAL converters have achieved record performances in two separate test programs. Three units, size 18, in one test have passed 18 million revolutions and are still performing noise-free and counting perfectly, report engineers at Norden Division of United Aircraft Corp. Five units, also size 18, under test at Norden, had accrued 8.3 million turns when removed from life testing for shock, vibration test.

IMPURITY IONS with random distribution in semiconductor crystals can be measured directly with a recently developed technique. Researchers examined random spatial distribution of impurity atoms near a semiconductor p-n junction by causing the space charge region to sweep through the distribution under a reverse bias potential AD 423 372 (\$1.50) OTS, US. Department of Commerce, Washington 25, D. C.

DEEP-SEA SOUND PROFILING SYSTEM

Don Willig, underwater engineer for ACF Industries' electronics division, displays principal components of ACF deep-sea sound velocity profiling system. In addition to sound velocity-depth sensor, held by Willig, system includes data processing and display console, transmission cable and winch. The Navy is on the list for one.



TELEVISION X-RAY WATCHDOG

Tiny diodes the size of rice grains are enlarged 30 times for X-ray television inspection at Astronautics division of General Dynamics. Don Gonzalez examines parts using searchray X-ray-television equipment developed by Philips Electronic Instruments. High-resolution X-ray sensitive TV camera and lead-lined exposure room are included.

DRIVE-AMPLIFIER, stable and transistorized, with low distortion and noise levels, developed by S. E. Laboratories Ltd., Feltham, Middlesex, England, for driving hf galvanometers from low power sources such as telemetering amplifiers, audio oscillators, and playback discriminators. It can be used to check switching surges in electrical systems and motor starting circuits. It amplifies hf signals without raising noise level.

SINGLE X-RAY TUBE for motion pictures has been developed by Field Emission Corp. Economical new system can be used to study flow of metal in casting, burning of solid rocket propellants, human heart valve action, and other events in short distance motion. Rapidly repeated X-ray pulse for "stop motion" exposures of 30 to 100nsec on moving film is basis for radiograph sequence. Portable system uses cold cathode field emission X-ray tube and a choice of pulsers from 100 to 600kv depending on desired penetration.

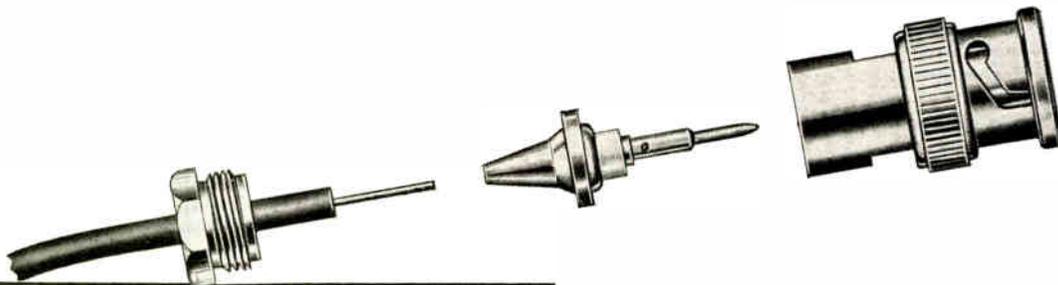
HIGHEST PEAK POWER per pulse for high-repetition rate laser demonstrated at Raytheon's Laser Advanced Development Center jointly with Baird-Atomic, Inc. Ruby laser Q-switched synchronously with Electro-Optic Light Modulator (Pockels Cell) produced 100megw peak power in pulse widths of 10nsec. at rates greater than one pulse per second. Without Q-switching, device puts out average 50w up to 10 pulses per second. It uses 18-kw xenon flash lamp. Ruby, elliptical cavity, and lamp are water-cooled.

(More RADARSCOPE on Page 13)

RF CONNECTORS

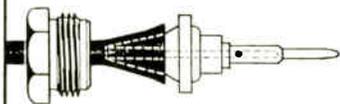
Another first from **DAGE**

A PERFECT, WEATHERPROOF CONNECTION in 30 SECONDS

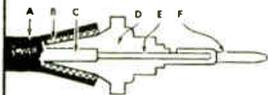


ASSEMBLY IS THIS SIMPLE:

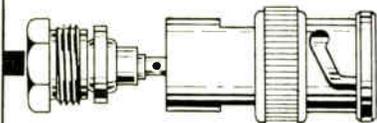
1. Take one clean square cut through cable insulation, braid and dielectric, exposing $\frac{1}{4}$ " of conductor. Slip nut onto cable.



2. Insert conductor into tapered, self-clamping sleeve and contact sub-assembly; force edge of sleeve between dielectric and braid until insulation rides well onto taper. Solder conductor to contact at solder hole. See detail.



A = Insulation D = Self-Clamping Sleeve
B = Braid E = Conductor
C = Dielectric F = Contact



3. Fit contact sub-assembly into connector body; screw nut into body, binding insulation and braid tightly against tapered sleeve . . . thus forming a strong, weatherproof connection.

All illustrations enlarged for clarity

DAGE SQUARE CUT[®] **RF CONNECTORS**

(Only 3 Parts . . . No Special Tools Required)

Again DAGE solves a major problem for equipment builders! New DAGE Square-Cut RF Connectors reduce *assembly time* by as much as 50%-75% . . . produce weathertight seals with a pull test of 50 lb.!

No need to comb, flair or taper the braid . . . just one clean *square cut* prepares the cable, then all you do is push, solder and tighten. As simple as that!

Now available for popular cable sizes in choice of silver, gold or NT-34 (Non-Tarnish) finishes.

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• **FIRST in Ideas** • **FIRST in Quality** • **FIRST in Service**

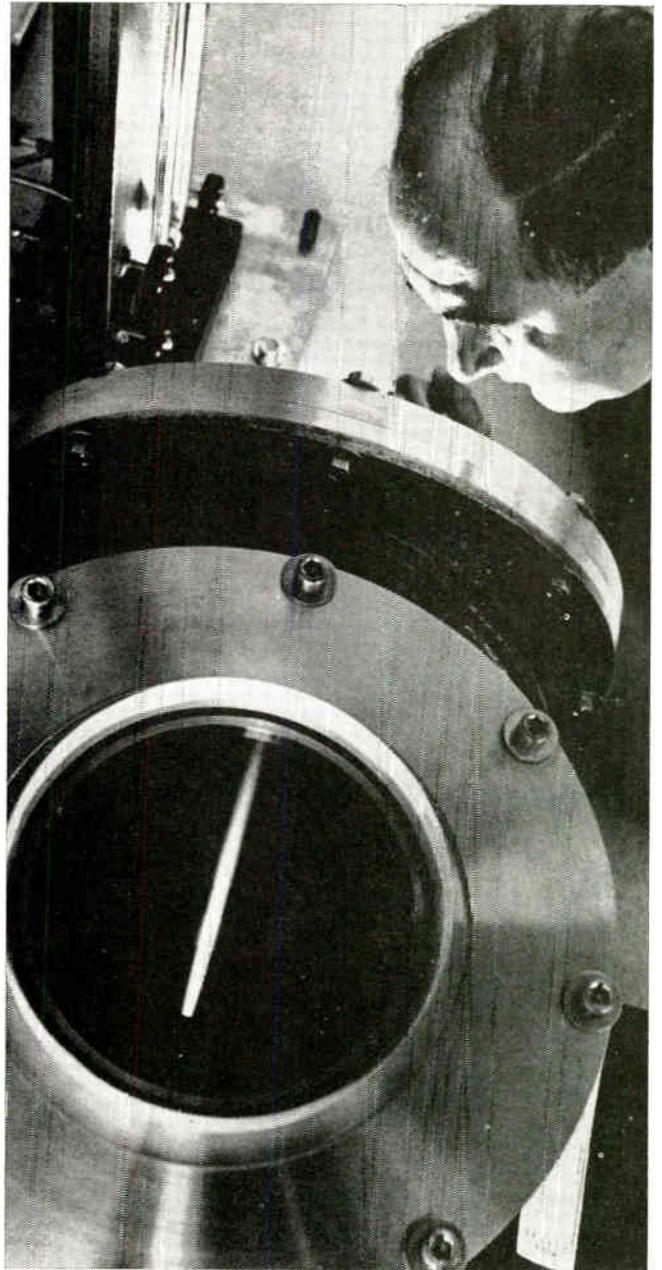
NEW PLANAR PROCESS, called Planar II, is disclosed by Fairchild Semiconductor. New process development represents final control of the surface effects in semiconductor devices, according to company officials. With the process, a single chip measures less than one-fiftieth of a square inch. The new process permits greater packing density for components on a single chip. Fairchild announced that several new lines of products will spring from the new Planar II process.

U. S. SCIENCE LIBRARIANS are set to tour Soviet libraries and information centers this spring to find out how Soviet librarians, if at all, are solving worldwide problems of scientific information lag. U. S. tour is to be financed by a National Science Foundation grant. Awarded to the Special Libraries Association, the grant will contribute to the current U. S.-USSR agreement on scientific and cultural exchanges. To complete the exchange, a group of Soviet science librarians, financed by the Soviet Union, will visit U. S. libraries later in the year.

PULSED VOLTAGE SOURCE integral circuit capable of unprecedented switching speed and power has been developed at Norden Division of United Aircraft Corp., Device accepts a low-level logic pulse signal, typically from the collector of a NOR gate or buffer, and provides at output a 2-volt pulse, into a 50 ohm load, shunted with 62pfd. Unit may have great application in computers where fast switching time, small size and reliability are essential.

SOUND ECHOES IN SOLID have been observed by Sperry Rand scientists. Pulses of sound energy injected into crystal at room temperature produced usual waveform plus an unusual trailing wave. This was identified as "second sound"—a heat wave that combines sound and heat properties. It is a collection of random sound waves moving slower than normal sound. Phenomenon may offer new way to carry energy through solids, and eventually mean simpler radar, sonar, and computer systems.

COLOR FROM MONOCHROME in TV is a recent disclosure at GPL Division of General Precision, Inc.'s Aerospace Group. The method uses a standard black and white TV camera to give multi-color pictures. Instead of viewing things as black or white, GPL's DataColor system "sees" objects as different shades of grey. A color discriminator assigns a choice of 6 colors to the greys. The system may have many uses in defense command and control, aerospace mission control, medical electronics, and in industrial uses.



SATELLITE-STEERING JET

Operating in vacuum chamber at Westinghouse Research Labs., this specially designed arc plasma jet may stabilize and control attitude of long-lived earth satellites. Jet is easily turned on and off, the arc is stable, and has low-voltage operation. Helium is used for the jet. Engineer H. C. Ludwig, jet developer, observes operation.

PULSE CODE MODULATION may soon enable soldiers to relay telephone calls across battlefields in computer language instead of by vocal sounds. Now being produced by Raytheon Co. for the U.S. Army Electronics Command, the PCM equipment is designed for use with present Army radio relay equipment. PCM systems will also be used with future radio gear now being developed. According to Raytheon officials, PCM is destined to become the standard multichannel transmission equipment for Army communications. The PCM equipment will permit as many as 96 voice messages simultaneously on cable or radio channels. Transmission will be up to 240 miles using repeaters.

(More **RADARSCOPE** on Page 14)

Tried tuning forks to solve frequency or optical control problems?

Latest advances from **BULOVA**—
the leader—can help you!

AMERICAN TIME PRODUCTS, now a part of Bulova Electronics, has pioneered just about every major advance in the use of tuning forks in the last 20 years. AMERICAN TIME PRODUCTS—ATP for short—leads the industry with the most complete and advanced group of units to meet your frequency needs. For example, only ATP gives you:

- Fork units up to 25 kc.
- Complete fork oscillators in sizes as small as .35 cu. in. or in flat cans only .35 in. high for circuit board mounting.
- Operating temperature range from -65°C to 125°C —higher, if necessary.
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- Forks that withstand vibration and shock better because of unique construction.
- Tiny iso-elastic Accutron forks.
- Both magnetic or dynamic drives.
- All this, with stabilities as high as .001%.

This is what BULOVA does! Want to see how tuning forks can solve your problems? Just drop us a line—or better, call us—and outline your needs. Address: Dept. EI-11.

Light Chopper! Dark Chopper!

Want to manipulate a beam of light? Or invisible ions? Chances are you'll do it better—or only—with an AMERICAN TIME PRODUCTS Optical Chopper. Using the balanced, vibrating tines of a tuning fork, the ATP chopper offers these advantages:

- No lubrication needed
- Minimum space requirements
- Extremely lightweight—3 ounces max.
- Minimum power requirements—as low as 300 MW
- Operating temperature range of -65°C to 125°C
- Reference signal voltage available
- No wearing parts

It's so new, here are some of the uses to date:

- Star trackers • Spectrophotometers • Horizon sensors
- Film deposition control • Industrial process control
- Colorimeter • Densitometer

Call or write us to discuss your problem. We'll make a unit to fit your needs.

RADARSCOPE

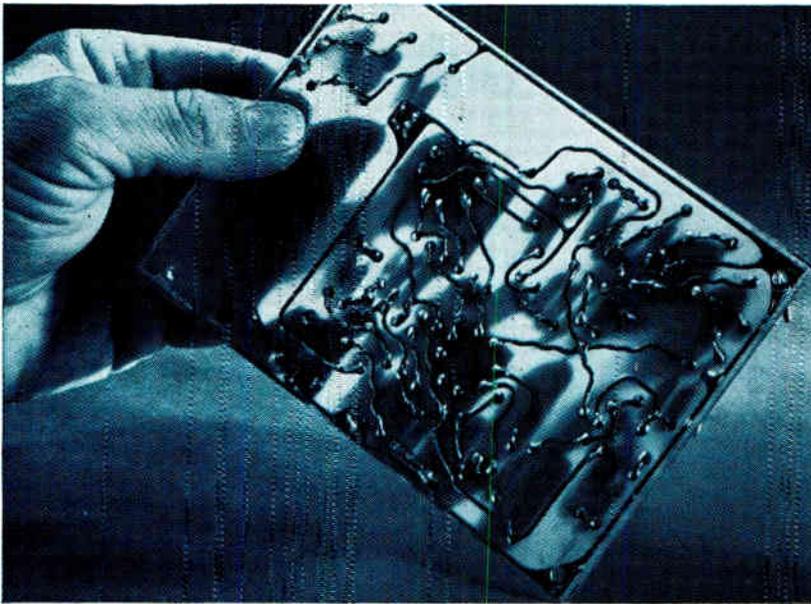
CONTINUOUS SOLID-STATE optical maser operating at room temperature developed from rare earth aluminum garnets at Bell Labs. Device needs only fraction of pumping power previously required, and can be pumped with tungsten lamp with rated life of thousands of hours. Using lamp with 360w input, Bell engineers observed room-temperature continuous operation at 1.06 μ in neodymium-doped yttrium aluminum garnet crystal. Reported as major step in putting solid-state masers on equal footing with gas optical masers in area of continuous operation and output.

TUNNEL DIODES of the self-stabilized or substructured variety are not practical in trying to overcome difficulties of extending power capabilities of diodes at microwave frequencies, says the Air Force. Proposed use of skin-effect to provide hf coupling of a built-in stabilizing impedance is not possible. More promising alternative still using tunnel diodes is their use in conjunction with multi-terminal Hall isolators. Thin-source liquid epitaxy should be developed independent of tunnel diodes. AD 602 255 (\$2.00), OTS, U.S. Department of Commerce, Washington 25, D. C.

MHD GENERATOR prototype produces 11 million watts output for brief periods at Avco-Everett Research Laboratory. New magnetohydrodynamic generator is expected to reach output of 35 million watts when fully developed. Called "Mark V," device has self-excited magnet. The generator has gross output of 11.2 million watts. Of these, 8.4 million watts are used to maintain the magnet. Mark V burns oxygen and fuel to create 5,000 $^{\circ}\text{F}$ plasma gas. This travels 2,700mph and it exhausts from burner into a channel, interacts with magnetic field, and generates current. Device is designed to produce great power cheaply from seconds to hours.

BULOVA / **ELECTRONICS DIVISION**
WATCH COMPANY, INC. 81-20 WOODSIDE AVE., WOODSIDE 77, N.Y., 212 NE 9-5700

Preserve high Q with silicone laminates



CIRCLE READER SERVICE CARD NO. 25

In printed circuit boards, in terminal boards and strips, antenna connectors . . . wherever Dow Corning® silicone resin laminates are used in electronic packaging, they assure greater performance and reliability by maintaining high Q in the unit.

Because of their continued low dissipation factor across a wide temperature range and across a broad band of frequencies silicone laminates assure circuit performance as designed. These laminates maintain reliability despite moisture, aging, vibration or rapidly changing ambients. They are especially reliable in transmitting equipment because of their exceptional retention of electrical properties at high voltage and high temperature.

Silicone resin laminates are easily machineable . . . can be sanded, drilled, punched or molded into complex shapes. They easily withstand soldering heat, too.

Fuel resistant rubber insulates and protects components



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These connector inserts of Silastic® brand fluorosilicone rubber were designed to meet MIL-C-26500, the toughest performance specification for any connector in use today. Fluorosilicone rubber has proved to be a highly sophisticated solution to interconnecting problems posed by extreme aerospace environments.

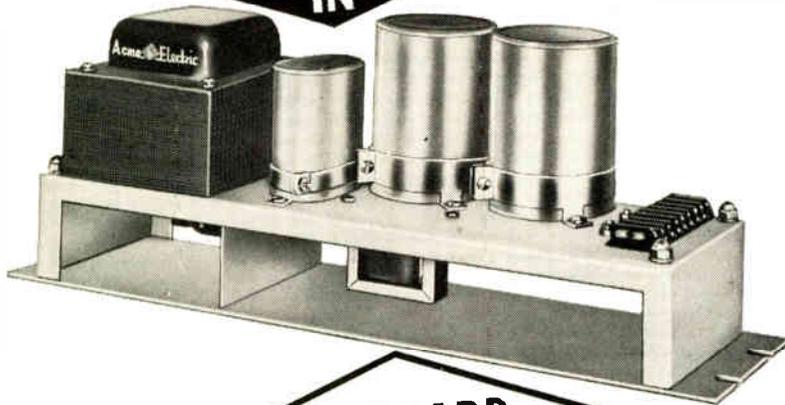
Other electronic parts such as O-rings, gaskets and vibration dampers that must withstand demanding environments, even immersion in volatile liquids, can now be molded from high strength, fuel resistant fluorosilicone rubber.

With tear strength to 175 ppi and tensile strength to 1200 psi, Silastic fluorosilicone rubber retains good rubbery characteristics and solvent resistance over a temperature range of -90 to 350 F. It also offers the basic properties of silicone rubber including resistance to sunlight and ozone as well as to thermal and mechanical shock.

We'll be pleased to forward full information on these and other materials that aid reliability and performance. Just write Dept. F310, Fabricating Materials Department, Dow Corning, Midland, Michigan.

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CUSTOM-DESIGNED
PERFORMANCE
IN



STANDARD
STOCK MODEL

REGULATED D. C. POWER SUPPLIES
AT NO ADVANCE IN PRICE

Acme Electric magnetically regulated power supplies were designed for industrial control and systems applications where high reliability of performance is of prime importance.

Simplicity of design, employing a minimum of components, avoids the possibility of failure present in more complex circuits. Components are conservatively rated for continuous duty at full output under conditions of industrial use.

All solid state components for stability and reliability. Convection cooled—no fan or other moving parts. May be paralleled in operation for multiplying current capacity. Fast response to line and load changes.

Regulation: Line: $\pm 1\%$ for $\pm 13\%$ line voltage change. Load: $\pm 2\%$ for any load change between $\frac{1}{2}$ load and full load. Ripple: 1% RMS maximum. Operating temperature range: 0°C. to 50°C.

PARTIAL LISTING OF STOCK MODELS AVAILABLE
SINGLE PHASE, 100-130 VOLTS; INPUT, 60 OR 50 CYCLES

CATALOG NUMBER	D.C. OUTPUT			CATALOG NUMBER	D.C. OUTPUT		
	Volts	Amps	Watts		Volts	Amps	Watts
PS-47509	10	4	40	PS-47638	28	8	224
PS-47508	15	2	30	PS-47712	28	25	700
PS-41422	24	2	48	PS-41424	48	4	192
PS-41423	24	6	144	PS-47519	48	10	480
PS-47125	24	15	360	PS-47718	100	4	400
PS-47173	24	25	600	PS-41425	125	2	250
PS-1-47127	24	50	1200	PS-47457	125	6	750
PS-1-47461	24	75	1800	PS-41426	150	2	300
PS-1-47200	24	100	2400	PS-41427	200	1	200
PS-47202	26	4	104	PS-41428	250	1	250

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 STATIC POWER RECTIFIERS
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 VOLTAGE REGULATORS

COMING EVENTS

OCTOBER

- Oct. 11-14: 1964 Fall URSI-IEEE Meeting; Univ. of Ill., Urban, Ill.
- Oct. 11-15: 126th Mtg. Electrochemical Soc.; Sheraton Park Hotel, Washington, D.C.
- Oct. 12-13: 2nd Annual Energy Conversion & Storage Conf., Oklahoma State Univ.; Oklahoma State Univ., Stillwater, Okla.
- Oct. 12-14: Conf. on Electrical Insulation, NAS, NRC; Union Carbide Corp., Cleveland, Ohio.
- Oct. 12-15: 19th Annual Int'l Instrument-Automation Conf. & Exh., ISA; New York Coliseum, New York, N.Y.
- Oct. 14-16: 1964 Sonics & Ultrasonics Symp., PTG-SU IEEE; Miramar Hotel, Santa Monica, Calif.
- Oct. 15-16: Systems Science Conf., SC-TC, Univ. of Pa.; Univ. of Pa., Phila., Pa.
- Oct. 15-17: Symp. on Aerospace Frontiers in New Mexico, ASME; Univ. of New Mexico, Albuquerque, N.M.
- Oct. 19-21: Nat'l Electronics Conf., IEEE, et al; McCormick Pl., Chicago, Ill.
- Oct. 19-23: Metals/Materials Exp. & Congress, ASM; Convention Ctr. and Bellevue-Stratford Hotel, Phila., Pa.
- Oct. 27-29: Fall Joint Computer Conf., AFIPS (IEEE-ACM); Civic Ctr., San Francisco, Calif.

'64-'65 HIGHLIGHTS

- 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.
- WESCON, Western Electronic Show & Conv., Aug. 24-27, IEEE, WEMA; Cow Palace, San Francisco, Calif.

- Oct. 28-30: 11th Nuclear Science Symp.-Instrum. in Space & Laboratory, G-NS IEEE; Sheraton Hotel, Phila., Pa. & General Electric Valley Forge Tech. Ctr., Valley Forge, Pa.
- Oct. 29-31: 10th Annual Electron Devices Mtg., IEEE; Sheraton-Park Hotel Washington, D.C.

NOVEMBER

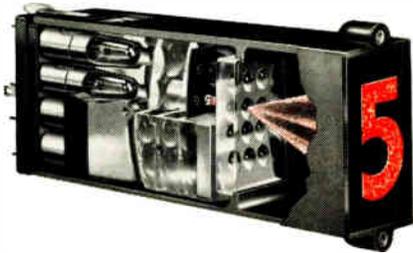
- Nov. 3-5: Fall Data Processing Conf. & Business Exp., DPMA; Hilton Hotel, San Francisco, Calif.
- Nov. 4-6: Northeast Elec. Res. & Eng. Mtg. (NEREM), IEEE; Commonwealth Armory & Somerset Hotel, Boston, Mass.
- Nov. 16-18: 15th Annual Machine Tools Ind. Conf., MTI-TC; Statler Hilton Hotel, Hartford, Conn.

SOME COMMON SENSE OBSERVATIONS ON READABILITY OF READOUTS

WHAT GOOD IS A READOUT THAT'S SEEN BUT NOT READ?

That may seem like an odd question, yet daily we're finding examples of readouts that provide far less than the best in readability. Yet, what's a readout for, if not readability of the highest order? The whole purpose of readouts is translation of electrically transmitted information into easy-to-read messages.

This cut-away of a typical IEE readout will give you some idea how the device operates to provide optimum readability:



First, the presentation is single plane: only the message that's "on" is visible. What's even more important, the message is projected from a film. Hence, an IEE readout can display anything that can be put on film, including numbers, letters, words, even colors and symbols. Thanks to this display versatility, you can order your IEE readouts with a character style that has been proved by human factors engineers as being most legible to the average reader. A section from our sample type sheet gives an example of a commonly used type style. Since these readouts can display anything that's photographically reproducible, any type style may be used. This enables us to meet every military and human engineering specification known.



Compare these big, bold characters with the segmented characters used for most electro-luminescent and incandescent bar segment readouts. These readouts contain a matrix made up of a number of segments with selected ones lighted to make up the display. As a sample, the next sentence is composed

of these characters, photographically reproduced here without any change:

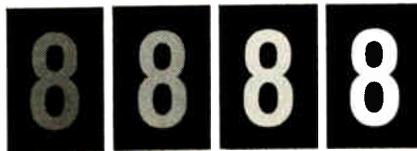
SPEED AND ACCURACY OF READING DROPS BECAUSE ALL OF THESE CHARACTERS ARE SIMILAR

There's another serious problem with this type of readout. Suppose that the reading calls for a figure 8. If a specific segment fails, the indication will show 5. Or, if a different segment fails, the figure 8 could show up as 9 — project this situation to a digital altimeter in an aircraft. Then hope that the difference between say a reading of 9,000 feet and an actual 8,000 doesn't involve contact with a mountain peak! We can only conclude that a readout should be seen but not mis-read.

THE BC RATIO FOR READABILITY

B is for Brightness, C is for Contrast — the two work together to give you a crisp, highly legible message. One won't do without the other, and in proper ratio at that. Consider the gas ionization readout with its glowing filaments: you get plenty of brightness but where is the contrast? But let's take them one at a time:

BRIGHTNESS

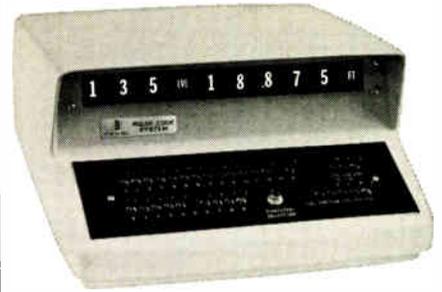


This is a reasonable facsimile of how character brightness affects readability despite a constant strong background contrast. IEE readouts offer up to 90 foot lamberts of brightness. But brightness can't be the sole basis for measuring readability...

CONTRAST



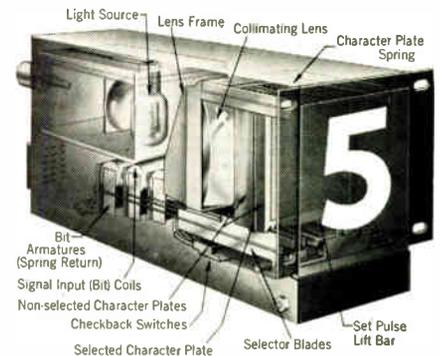
Here we've kept the character brightness constant but varied the background until we achieve proper contrast at far right. It's quite obvious — brightness without contrast doesn't do much for readability. IEE readouts provide the proper ratio of brightness and contrast for visual crispness and unmistakable clarity at wide angles, long viewing distances, even under adverse high ambient light conditions. In short, IEE readouts are the most readable readouts made. That's part of the reason we're so partial to them.



PULSE CODE RECEIVER BY VAREC, INC. Subsidiary of Microdot Inc. VISUAL TRANSLATION BY IEE

The Varec/Dynel Pulse Code Receiver decodes and displays liquid level, pressure, flow rate, and temperature data gathered from remote locations by their high speed telemetering system. Giants of the chemical, petroleum, and food processing industries have installed this system for continuous control over things that bear some watching. To make sure that the watching is highly watchable, Varec engineers specified the most readable readouts made. We made the readouts.

THIS IEE READOUT DECODES, DISPLAYS, REMEMBERS



IEE Bina-View® is a binary input, self-decoding readout with a complete alpha-numeric capability. Decoding is entirely self-contained; no external translators, relays or diodes are required.

Its 41-message capacity permits additional display of colors, symbols, words. Floating decimal points are available from a separate lamp circuit.

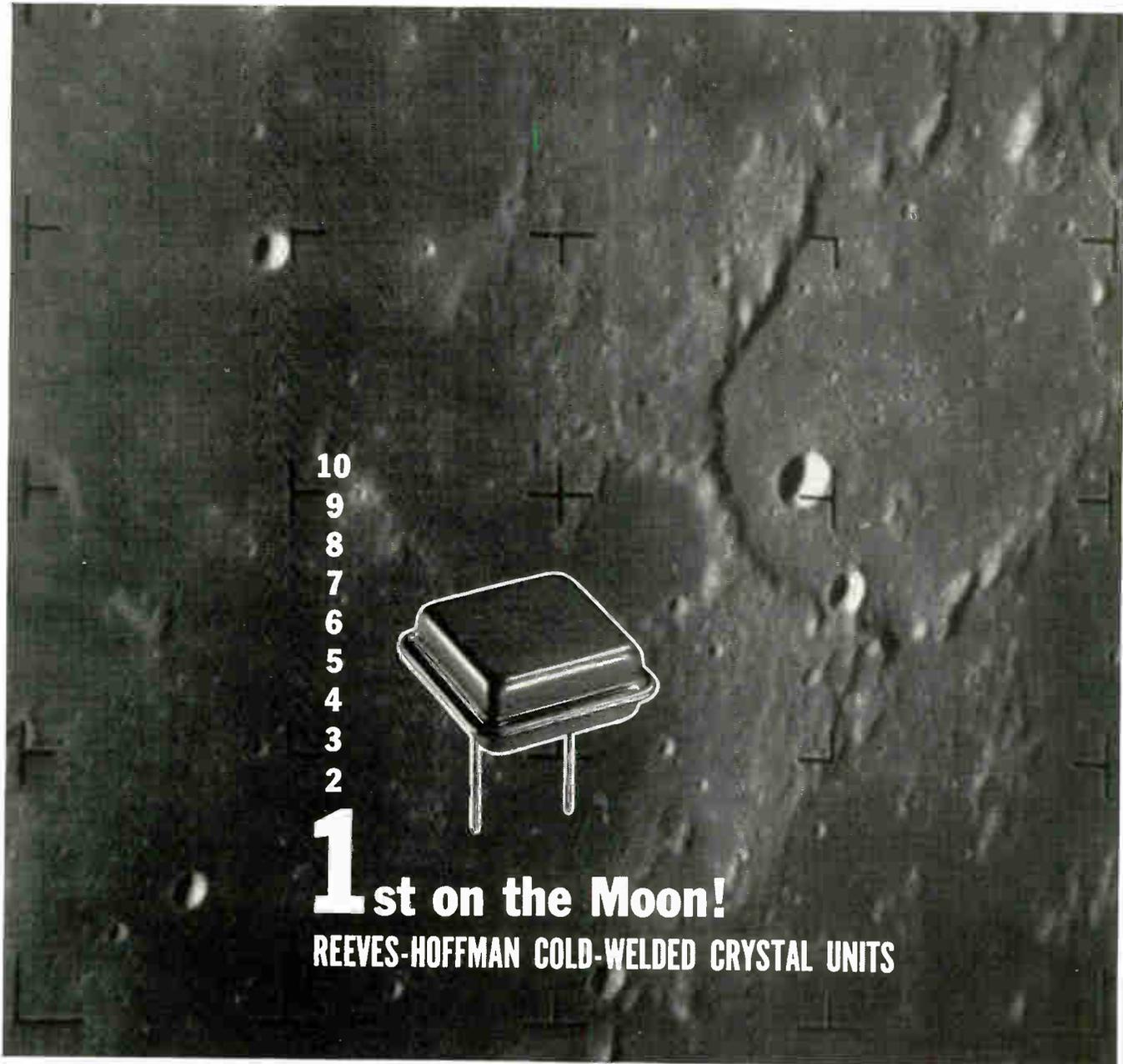
Bina-View also provides automatic memory and retains the last message displayed after signal and set-pulse power have been removed. As an optional feature, Bina-View may also include auxiliary contact closures that can be used for check-back to verify input signals and to transmit input signals back into source equipment.

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10
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1st on the Moon!

REEVES-HOFFMAN COLD-WELDED CRYSTAL UNITS



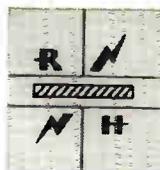
A leak rate reliability more than 100,000 times better than the requirement of MIL-Spec 3098 is provided by Reeves-Hoffman cold-welded crystal holders. The miniaturized crystal-controlled dual filter shown above contains two crystals in cold-welded holders.

When NASA's Ranger VII blasted off, cold-welded crystal units supplied by Reeves-Hoffman went with it. These units, which are now spread across the moonscape, functioned perfectly in Ranger VII's central controller and sequencer. They were selected by engineers at the Jet Propulsion Laboratory because they provided the needed reliability in the smallest possible package. It is because of this reliability and miniaturization that cold-welded units are not only on the moon, but also in use in submarine cables and in many other applications where main-

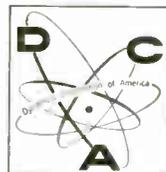
tenance is impossible or extremely difficult.

Reeves-Hoffman's new cold-welding process eliminates solder, and attendant flux and heat, removes undesirable damping and corrosion, solves problems of thermal isolation. The results: substantial increases in the reliability and stability of crystal units, oscillators and filters; further opportunity for miniaturization; faster delivery; lower cost.

For space, undersea or "down-to-earth" applications, get complete information on Reeves-Hoffman cold-welded units.

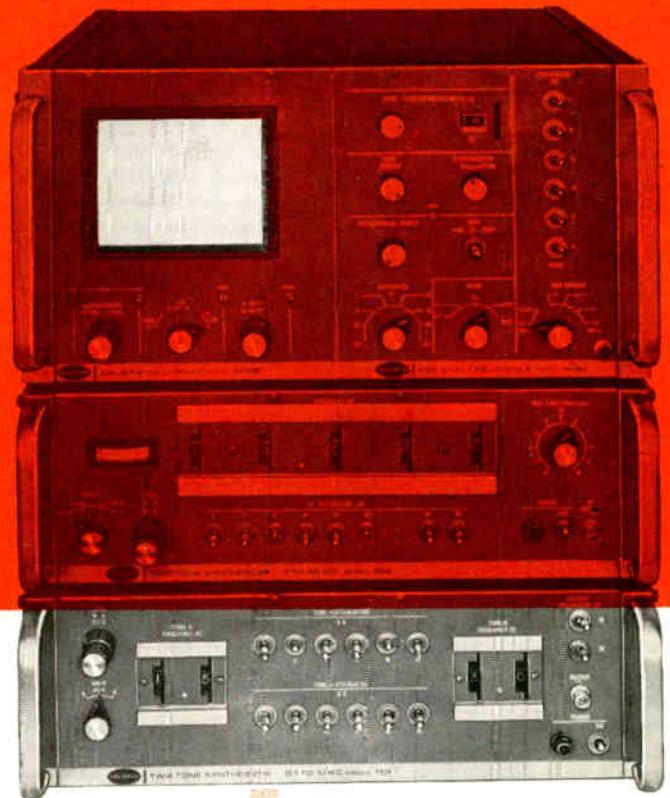


REEVES-HOFFMAN
DIVISION OF **DCA**



400 WEST NORTH STREET, CARLISLE, PENNSYLVANIA

one-eyed jack (of all tests)



MODEL 2936
SSB ANALYSIS TEST SET
10 cps to 40 mc

From the transmitter exciter to the receiver audio output, this compact package of test capability provides every test facility required for complete evaluation, test, and alignment of an SSB communications system.

It takes just four of Polarad's new universal modules to do the job: the Model 2000 Display Unit, the Model 2436 Analysis Module, the Model 1102 2-tone RF Synthesizer, and the Model 1101 2-tone Audio Generator. Buy all four... buy only two... or three... tailor the test system to your requirements, and expand it later when and if necessary. Each module is independent—and independently useful.

Hard to believe that all this versatility can be yours for only \$5700—far less if you need less? Let us prove it. Write for Catalog P11 and be convinced. Better yet—call your local Polarad Field Engineer, and arrange for a demonstration; but be forewarned: once you see this instrument, you will find it hard to resist.

■ **Modular Economy**—From 2 to 4 modules implement SSB testing; many other applications, too!

■ **Unique Pure-RF Method**—Exclusive Polarad continuously-tuned 2-tone pure-RF signal synthesizer ensures test validity.

■ **2-Tone Audio Too!**—Continuously tuned from 0-10 KC, independently attenuated, true calibrated 2-tone AF signal.

■ **Automatic Optimum Resolution**—Plus manual continuous dispersion from 7 cps to 30 KC.

■ **Widest Level Range/Resolution**—Cascaded precision step attenuators on RF, AF, and IF interfaces provide over 200 db range of sensitivities and level resolutions.



POLARAD ELECTRONIC INSTRUMENTS

Division of Polarad Electronics Corporation • World Leader in Microwave Instrumentation

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MORE SPACE CONTRACTS—NASA has agreed on 29 contracts with industry for studies of advanced manned spaceflights to follow a U. S. moon landing. Other contracts are in works to determine what programs are most urgent after lunar set down. Some 17 of these are concerned with launch vehicles.

NEW DEFENSE CONTACT — DOD has started a Business-Labor division under Assistant Secretary Arthur Sylvester. It's supposed to increase information flow in both directions and provide better participation by other DOD divisions. First order of business is a new, single, all-inclusive publication.

FCC RESTRICTS CB — Unauthorized chatter by some 700,000 licensed users of citizens' band radios must stop, FCC warns, or it will switch off the service. CB was permitted only for necessary contact between people with no technical knowledge; it was not meant for hobbyists or unlicensed hams. Businessmen, boaters, campers, garages, and others can go on using CB when needed. Chatter between kids, housewives, etc., must cease as of November 1, or else!

REPORT INTERPRETATION NIGH — Look for government-funded programs soon at cross-nation centers to explain to businessmen—especially in electronics—the industrial implications of myriad government reports. Example—U. S. Government Research Reports issued twice a month. They are chock full of data and information that could have great commercial use and application—with a little interpretation.

"FLEET READINESS" DATA SYSTEM

Network of RCA computers and mass memory units will link key industrial naval air stations, assuring fleet readiness for aircraft and missiles. Viewing dispersal map of system are: Rear Adm. Frank L. Pinney, Jr., (right), Capt. James A. Laurich, (left) both of the Bureau of Naval Weapons. Center is Arnold K. Weber, head of RCA EDP.



NASA WILL DROP COST-PLUS — Following DOD footsteps, NASA will reduce number of cost-plus contracts. Top NASA officials are attending seminars on the incentive aspect in Washington and at 13 NASA field centers. Agenda: profit motivation, work definition, and incentive structure—to emphasize advantages.

SEMICONDUCTOR STUDY DUE—Department of Commerce may have the long-delayed compendium of semiconductors ready by year's end. The listing has been in process for many months. It has suffered continual setbacks for more "urgent" projects.

NEW RELIABILITY GOALS — Government is planning still higher goals for reliability and quality in electronic products. Dr. George E. Muller, head of NASA manned space flight program, freely praises electronic engineers and manufacturers for quality work on Apollo (manned moon shot), but warns that future space dealings will and must exact higher goals.

GI SATELLITES LOOM—The Pentagon wants its own system of communications satellites. Contracts will be let soon, and a satellite network should be operating by early 1966. Cost: about \$200 million.

BIGGER NASA BUDGETS? — Ranger VII's Moon victory gave space agencies confidence to put the bite on Congress for even more than the current \$5.3 billion next year. Scuttlebutt had been about taking hefty cuts. Then came Ranger VII. Budget men now know that future space hits could be used to pry loose more funds from a grateful Congress.

COMSAT BIDS FOR STATIONS — Commercial Communications Satellite Corp. (COMSAT) wants to block competition from other common carriers, and is asking FCC for exclusive rights to own and operate initial U.S. ground stations. Once, COMSAT had noted that other firms might want to own stations, at a cost of \$17 million to \$20 million. AT&T has shown interest in owning all or part of one or more stations. COMSAT has asked for a fast decision.

WIDER TV TOLERANCES — Electronic Industries Association hopes to soften FCC proposal to severely reduce tolerances for radiated power of VHF aural transmitters. EIA wants tolerances from no less than 20% to no more than 30% of peak radiated power. FCC had proposed 10-20%. Even the EIA proposal would be a sharp change from original 50-70 ratio, or the recently adopted 10-70. FCC proposed 10-20% after manufacturers opposed wide range 10-70.

SELECTED FOR THE MINUTEMAN PROJECT

More than 6 million El-Menco Dipped Mica Capacitors have been used in the Minuteman ground support and control equipment.

After 64,000,000 ACTUAL TEST unit-hours at 85°C with 225% of the rated DC voltage applied, no failures of any type occurred.

The accumulated 64×10^6 test unit-hours without any failures can be used to calculate many different failure rates depending upon the confidence level desired. However, we shall explore the meaning of the results at a 90% confidence level.

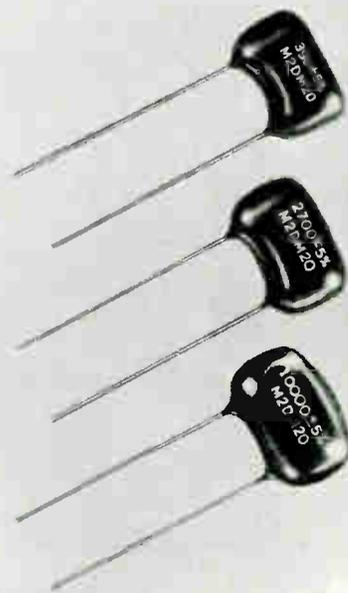
Assuming no acceleration factor for either temperature or voltage, we have verified a failure rate of less than 0.004% per 1000 hours. (Actually, there is a temperature effect and it has been found that, with the DC voltage stress remaining constant, the life decreases approximately 50% for every 10°C rise in temperature. There is also a voltage effect such that, with the temperature stress remaining constant, the life is inversely proportional to the 8th power of the applied DC voltage.)

Assuming no temperature acceleration factor and assuming the voltage acceleration exponent is such as to yield an acceleration factor as low as 100, we have nevertheless verified a failure rate of less than 0.00004% per 1000 hours.

Assuming no temperature acceleration factor and assuming the voltage acceleration factor is on the order of 250 (test results are available to confirm this) we have accumulated sufficient unit-hours to verify a failure rate of less than 0.000015% per 1000 hours!

All above failure rates are calculated at a 90% confidence level!

Write for a complete reliability study on your company letterhead.



**DIPPED MICA
CAPACITORS
TYPE M2DM**

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CROWDED DEFENSE MARKET IS CONTRACTOR WOE, SAYS NORTH

Dr. Harper Q. North, president of the Electronic Industries Association, summed up the state of defense procurement. He said that increased competition, rather than reduced defense spending, causes "probably the greatest impact on the individual contractor."

More companies are competing for fewer dollars, added Dr. North, who is vice president for R&D at Thompson Ramo Wooldridge, Inc.

Thomas L. Shubert, manager of market planning, Goodyear Aerospace, said that the defense procurement market will continue far into the future, but we must be ready "to ride a very rough competitive sea."

He reported that military construction has already been cut to near minimum. Operation and maintenance, however, will rise with newer and more costly weapons inventory, even with some military bases closing.

CRT'S, RECEIVING TUBES SHOW FIRST GAIN SINCE MARCH

Factory sales of TV picture tubes and receiving tubes showed monthly gains for the first time since March, reports the Electronic Industries Association. The increase in receiving tubes fell far short of closing the 19.6 million-unit gap between 1964 and 1963 sales.

Sales of TV CRTs in June brought \$11,822,997 for 673,283 units, compared to \$13,462,906 for 707,541 units in June 1963. January-June picture tube sales tallied 4,460,774 units valued at \$82,538,954, against 4,469,122 units worth \$83,607,723 during the same six-month stretch in 1963.

Receiving tube sales totaled 28,673,000 units this June, compared to 34,506,000 units in June 1963. Cumulative figures for January-June 1964 totaled 177,070,000 units, against 197,741,000 units for 1963.

FIRST RUN AIRBORNE MOVIE HOUSE FOR PASSENGERS

Barbara Williams, Continental Airlines stewardess, demonstrates how an Ampex Corp. portable Videotape Playback system will bring first run movies to passengers. The new service, called Golden Marquee Theater Entertainment, will include high fidelity stereo semi-classical and popular music for passengers on selected non-stop Golden Los Angeles-to-Chicago jets.



World Radio History

COMPONENTS UP IN '63, DROP IN 1ST QUARTER '64

Dollar volume for factory shipments of electronic components from U. S. firms was about \$4 million for 1963, up about 2.6% over 1962, while shipments for the first quarter of 1964 took a slight drop of 1% below the fourth quarter of 1963. First quarter shipments, however, remained unchanged from first quarter 1963.

From a recent report by the U. S. Department of Commerce, Business and Defense Services Administration, figures show that a substantial gain of nearly 9% in the value of 1963 non-defense shipments was offset by a drop of nearly 8% in sales of defense components.

Largest increases in sales from 1962 to 1963 were in complex components (83%); quartz crystals (18%); and TV picture tubes (15%). Semiconductor dollar sales rose about 4% and connectors about 3.6%. Receiving tubes decreased in dollar volume by 11.4%, while power and special purpose tubes fell by 7.4%. Other outstanding decreases in dollars were transformers (8%); resistors (5.7%); capacitors (4.8%); and relays (2.8%).

Average unit value of semiconductor diode and rectifier shipments fell from about \$0.46 in 1962 to \$0.33 in 1963,

while transistors dropped from \$1.18 to \$1.03. Power and special purpose tubes fell off from \$35.37 to \$31.19 in unit value.

In the first quarter of 1964 TV picture tubes were up nearly 24% from the previous quarter, mostly because of increased proportion of color tubes.

Other components showing small percentage gains in sales from the previous quarter (4th quarter, 1963) were transformers, capacitors, quartz crystals, semiconductor diodes and rectifiers, and relays. Substantial drops from last quarter 1963 were reported for connectors (13%); complex components (12%); transistors (7%); power and special purpose tubes (5%); and receiving tubes (2%).

Defense shipments declined nearly 10% from previous quarter, while non-defense shipments gained 4%.

MEASURE INSTRUMENT SALES RISE 7% IN FIRST QUARTER

Shipments of electrical measuring instruments by U. S. industry totalled \$47 million in the first quarter of 1964, a 7% increase above \$44 million for first three months of 1963, according to U. S. Department of Commerce.

Total shipments in 1963 amounted to \$128 million, 6% below the peak of \$194 million set in 1962. The 1963 volume was 3.8 million units, with military procurement accounting for 14% of the unit volume and 24% of shipment value, reports Business and Defense Services Administration.

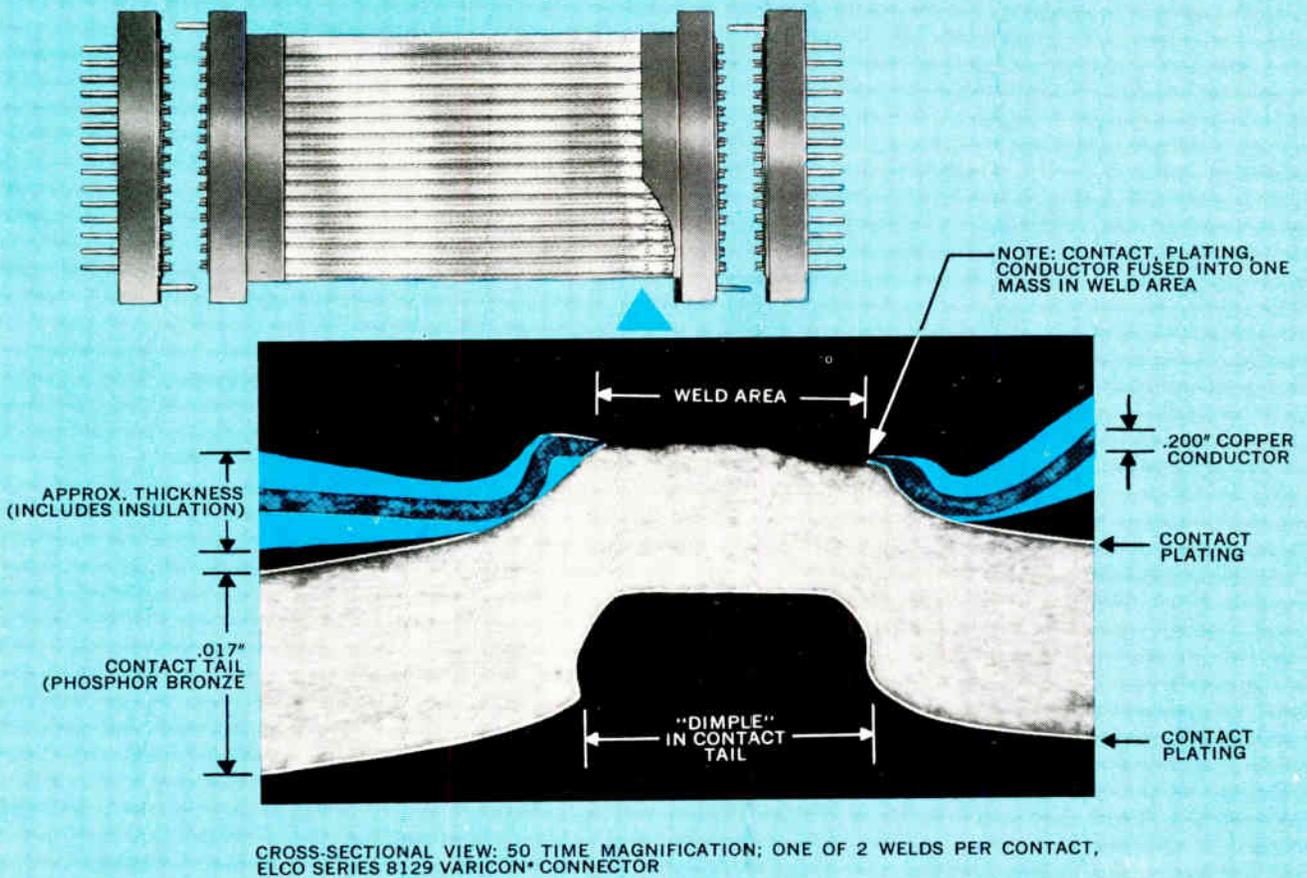
MONOCHROME, COLOR SALES CONTINUE ON UPWARD TREND

Monochrome television distributor sales showed an increase in June, reports Electronic Industries Association. There were 613,124 sets sold in June, compared to 396,528 sold in May.

In the first half of 1964, some 3,443,073 monochrome sets were distributed, against 2,956,808 during the same 1963 period. Total monochrome and color output for June 1964 was 835,510. The to-date total was 4,492,801. In June's total production, 711,785 sets were monochrome, compared to May's 487,148. January-June total for monochrome sets produced was 3,893,456; the figure for last year is 3,459,921. In June 1963, 665,004 monochromes were sold.

Year-to-date totals for all-channel production were 1,741,157 sets in 1964, and 433,339 sets in 1963. Color TV sets produced in June 1964 were 123,725 units. Total color output for January to June, 1964, is 599,345 sets.

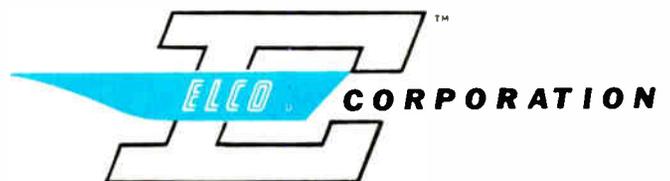
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ELECTRONIC INDUSTRIES • October 1964

Circle 12 on Inquiry Card

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COUNTER-TIMERS

Anadex offers two standard counter-timers designed for general purpose counting, timing, and frequency measurement. The CF-200R Series offers frequency, period and multiple period, and time interval measurement. For applications requiring a universal counter-timer, the CF-250R Series features complete flexibility in frequency period, time interval and ratio measurement. Priced from \$895.00.

FREQUENCY COUNTERS

The Anadex Frequency Counter Model CF-203R is designed for frequency measurements in the 0 to 120KC range and features 10 mv sensitivity. Typical applications include use with turbine flowmeters, tachometers, oscillators, and other frequency generating devices. Time bases of 0.1 and 1 second are standard, with ten seconds available as an option. Priced from \$625.00.

PRESET COUNTERS

Anadex Preset Counters are designed to perform control functions such as high-low alarm systems, time control, quantity control, etc., as well as limit detection and process control. Models available include single preset with or without display and dual preset with or without display. Priced from \$460.00.

BI-DIRECTIONAL COUNTERS

Designed for applications such as position indication, flow-blending, speed synchronization, etc., the Anadex Bi-Directional Counter Model CF-400R accepts add-subtract information from two different sources, from the same source on separate lines, or from quadrature signals. It is available with 4, 5, or 6 wide-angle Nixie displays plus polarity sign. Input frequency range is 0-30KC. Maximum reversal rate is 10KC. Priced from \$850.00.

VARIABLE TIME BASE COUNTERS

Anadex Variable Time Base Counters translate frequency data into engineering units and present a visual display such as gallons per minute, revolutions per minute, pounds per hour, etc. 10 mv RMS input sensitivity allows use with low voltage output transducers without intermediate amplifiers. Time base is selectable from 0.0001 to 9.9999 seconds for the Model CF-201R and from .0001 to 99.99 seconds for the Model CF-202R. Frequency range is 0-120KC. Priced from \$995.00.

TOTALIZERS

Anadex builds a line of solid state totalizers designated as the DC-200R Series. Any number of decades from 3 to 6 may be specified. The front panel is 1 $\frac{3}{4}$ " high and contains input terminal, sensitivity control, reset push button, manual gate switch, and power on-off controls. Priced from \$395.00.

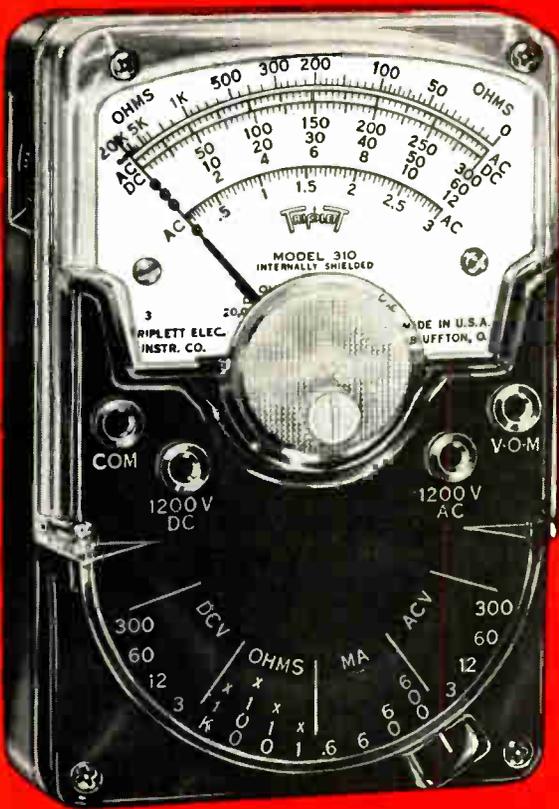
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SELF-SHIELDED Bar-Ring instrument; permits checking in strong magnetic fields. FITTING INTERCHANGEABLE test prod tip into top of tester makes it the common probe, thereby freeing one hand. UNBREAKABLE plastic meter window. BANANA-TYPE JACKS—positive connection and long life.

Model 310—\$37.50 Model 310-C—\$44.50 Model 369 Leather Case—\$3.20

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310-C PLUS FEATURES

1. Fully enclosed lever range switch
2. 15,000 Ohms per volt AC (20,000 O/V DC same as 310)
3. Reversing switch for DC measurements

MODELS 100 AND 100-C

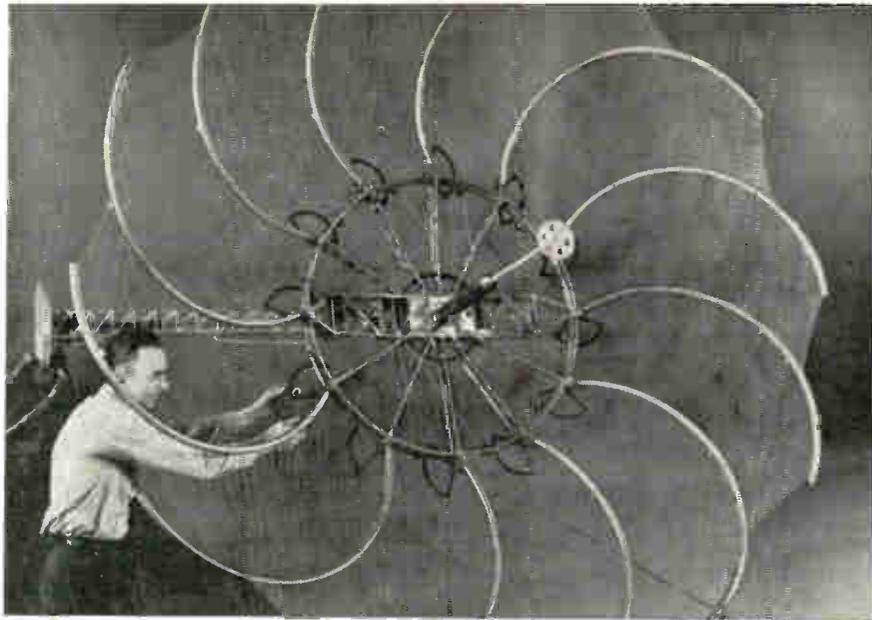
Comprehensive test sets. Model 100 includes: Model 310 V-O-M, Model 10 Clamp-on Ammeter Adapter; Model 101 Line Separator; Model 379 Leather Case; Model 311 leads. (\$67.10 Value Separate Unit Purchase Price.)

MODEL 100—U.S.A. User Net. \$64.50

MODEL 100-C — Same as above, but with Model 310-C. Net. \$71.50



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SPACECRAFT ANTENNA

Research model of a spacecraft antenna developed by Goodyear Aerospace Corp. (Akron, Ohio) is made of wire mesh as thin as human hair and paper-thin metal supports. It was built for Jet Propulsion Laboratory, prime contractor for NASA interplanetary space probes.

ATLAS "SWITCHBOARD"

Diane Dows, assembler at the Astronautics Div. of General Dynamics Corp., checks connections on the electrical distribution kit for the A. F. Atlas SLV-3. Kit is a central distribution point for electrical power.



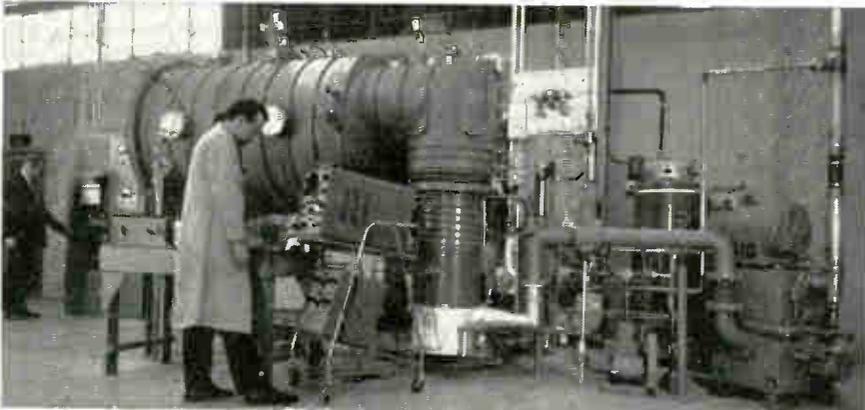
GROUND SUPPORT EQUIPMENT

New ground support equipment for Ryan Aeronautical Company's 124E Firebee jet targets is shown being checked out in firm's San Diego, Cal., plant by engineers William Riley and Earl Neff prior to delivery to U. S. Army's White Sands Missile Range, N. M. The new checkout console is used for functional tests of all systems in Army Firebees after they have been flown, recovered by parachute and restored for further missions.



SIMULATION CHAMBER

Space Simulation Chamber at Associated Testing Laboratories, Inc., Wayne, N. J., simulates altitudes equivalent to 1,500,000 ft. or 1×10^{-9} Torr. Thermal shroud temperatures of -300°F to $+500^{\circ}\text{F}$ are obtainable. Chamber is 3 by 5 feet in diameter.



MICROWAVE ANTENNA

Antenna developed by PRD Electronics, Inc., Brooklyn, N. Y., increases transmitting range of portable TV systems. Entire unit includes the camera, transmitter, antenna and battery.



ELECTRONIC SNAPSHOTS...

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



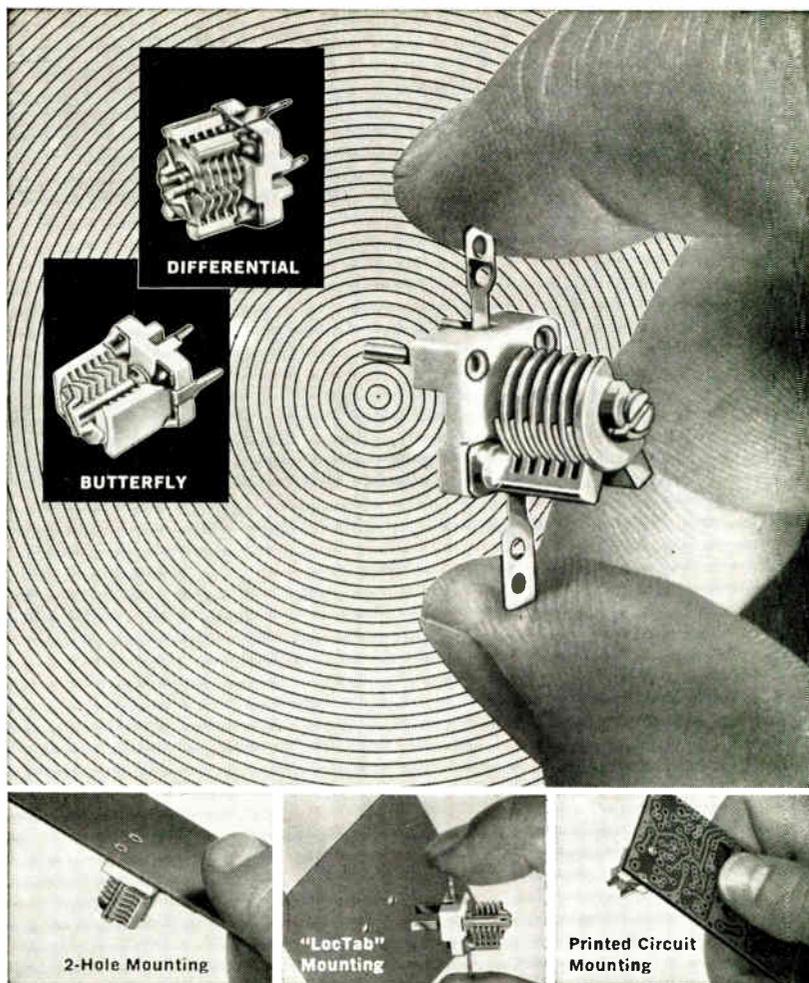
ELECTRONIC "EYE"

Marilyn Miano examines electronic "eye" similar to ones used in TV cameras of NASA's Ranger spacecraft. Ranger (scale model in

background) was equipped with six TV cameras which took more than 3000 pictures of the moon. Ruggedized, high resolution camera tube was designed by engineers of the RCA plant at Lancaster, Pa.

Cut costs — save valuable space with these

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



Precision machined for high reliability—exceptional mechanical stability!

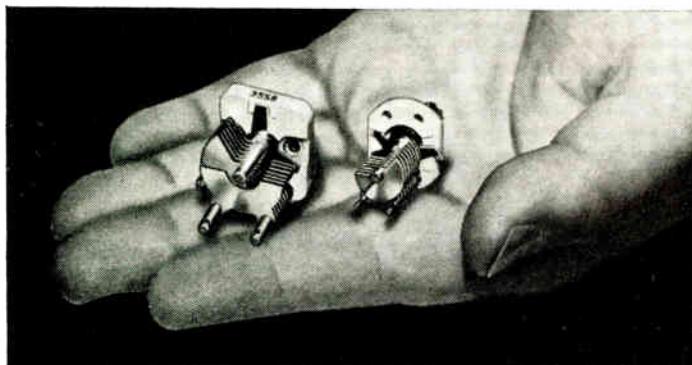
- HIGH “Q” — GREATER THAN 1500 AT 1 MC! • HIGH TORQUE-TO-MASS RATIO — 2½ TO 10 INCH OUNCES!
- LOW TEMPERATURE COEFFICIENT — PLUS 26 ± 20 PPM/° C!

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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 is on the job



Photo courtesy of Robertshaw Controls Company

Increased vibration in machinery often means a mechanical malfunction. The Robertshaw Vibraswitch® acts as a "policeman" that senses excessive vibration and either sounds an alarm or automatically shuts down the machine before serious damage can occur.

Robertshaw uses the GR Vibration Meter both to determine existing vibration levels accurately and to find the optimum mounting position for their Vibraswitches in critical installations. The Meter's unique Flip-Tilt cabinet/carrying case and complete portability make it a convenient tool for these "on-location" measurements.

The GR Type 1553-A is the *complete* vibration meter. It measures all important vibration parameters (the only meter of its kind to do so) including displacement, velocity, acceleration, and jerk (the third derivative of displacement). It offers the choice of peak-to-peak, peak, or average measurements and displays readings directly in the units of the parameter being measured. It is rugged, battery operated, and completely self-contained in its handy carrying case; output is available to drive recorders, analyzers, oscilloscopes, and stroboscopes.

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	Range (true peak-to-peak indication)	Frequency*
Jerk	30-300,000 in./sec ³	2-20 cps
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Velocity	0.03-30,000 in./sec	2-2000 cps
Displacement	0.0003-30 in.	20-2000 cps
	0.003-300 in.	2-2000 cps
	Peak and average indications also provided	

*With Type 1560-P52 pickup supplied, measurements possible to 20 kc with other accelerometers.



Type 1553-A Vibration Meter, calibrated in English units; also available is 1553-AK calibrated in Metric units . . . \$740 (in U.S.A.) for either model.

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ORIENTED T (Oriented)	1 to 6 mils	< 4 mils-12 ³ / ₈ " > 4 mils-13 ³ / ₈ "	CARLITE
ORIENTED TS (Super-oriented)	4 mils	13 ³ / ₈ "	CARLITE

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In addition, as reports from users confirm, Armco Thin Electrical Steels have the best overall magnetic quality you can obtain.

To help you make full use of their advantages, a 58-page design manual containing design curves is available at no cost. Write us for complete information on Armco Thin Electrical Steels and your copy of the manual. Armco Steel Corporation, Steel Division, Dept. A-3784, P. O. Box 600, Middletown, Ohio 45042.

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LETTERS

to the Editor

About Tunnel Diodes . . .

Editor, ELECTRONIC INDUSTRIES:

In your June issue, Dr. Delbert Van Winkle gives three reasons why it is unclear to him to what extent tunnel diodes will come into extensive usage. I do not think that any of these are valid reasons for not using tunnel diodes.

(1) “There is no isolation between input and output circuits.” The development of the 5 port circulator has solved this problem. Adequate isolation is available for bandwidths up to an octave.

(2) “Small parameter shifts can cause a large change in the device operating point.” Computer analysis of typical amplifier designs at this laboratory show that variations of 10% in diode parameters are easily compensated by simple tuning adjustments. This has been corroborated by experimental evidence. Diode manufacturers can now hold such tolerances.

(3) “The tunnel diode . . . must operate into low impedance external circuitry.” This was true in the early days of the tunnel diode. Now, however, the diodes have more convenient parameters. Tunnel diode amplifier circuits use transmission lines with characteristic impedance in the neighborhood of 50 ohms.

I hope you will not allow system designers to gain the impression from your magazine that tunnel diodes are not practical devices. Stable amplifiers and oscillators are now available from several excellent sources.

Jack H. Lepoff

Sylvania Electronic Systems
P.O. Box 205
West Mountain View, Calif.

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Editor, ELECTRONIC INDUSTRIES:

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No discussion of Arizona Electronics could be complete or accurate without a reference to our ultra-modern, 160,000 sq. ft. research and manufacturing facility.

How could you overlook such a dynamic and important member of the Arizona electronic community?

John Kosek,

Public Information Coordinator

Sperry Phoenix Company

P.O. Box 2529

Phoenix, Arizona

Ed. Note: We apologize for the oversight though the material was not staff-written.

Engineer Registration

Editor, ELECTRONIC INDUSTRIES:

A while ago I read an article in your magazine explaining to engineers how they might become registered and the advantages of registration. There is one problem which confronts many engineers, however, and hinders them in achieving this goal. That is, how to prepare for the examination. Many engineers who would like to become registered have become so rusty throughout the years of specialization, management, sales, or just trying to make a living, that they are afraid to sit for the examination. These men need help in reviewing. They need a refresher course, and the best place to obtain such a course is from a university.

To be truly effective, such refresher courses must be available to all engineers, regardless of location, and must be programmed so that each engineer can fit the course into his own individual schedule. There is one possible solution to these difficulties, and one university has gone a long way toward it.

The University of California, through its Correspondence Division, has made available a correspondence course on Engineering Fundamentals. This course reviews the undergraduate curriculum, with emphasis on engineering principles and their application. It has satisfied the need for a refresher course for many engineers.

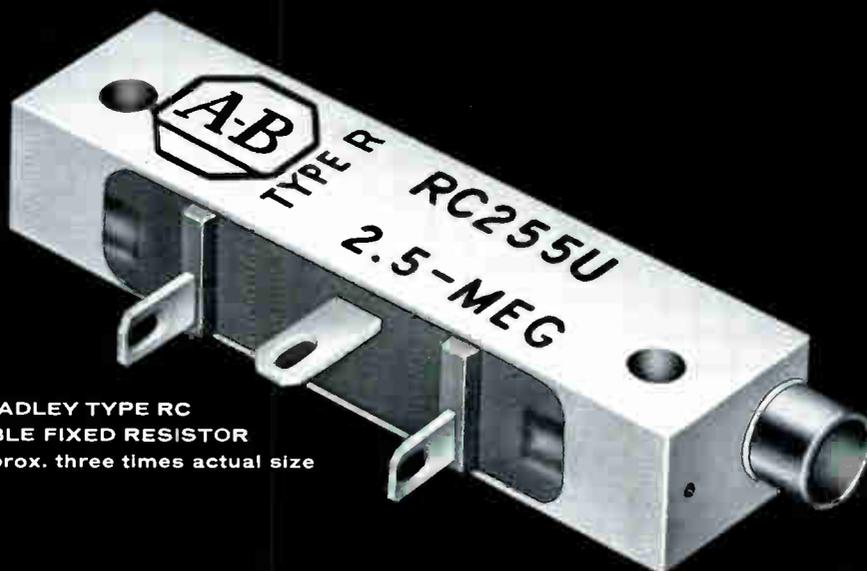
Engineers who are interested can get more information from the Correspondence Div., University of California, Berkeley 4, Calif.

Lloyd M. Polentz, P.E.

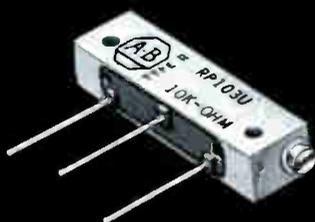
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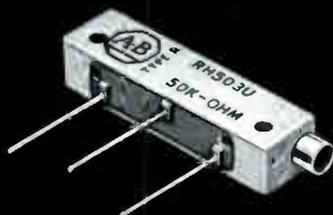
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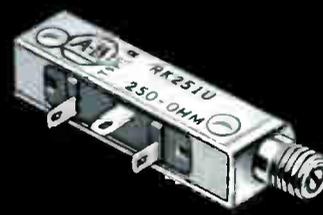
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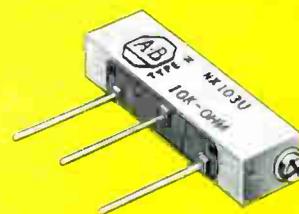
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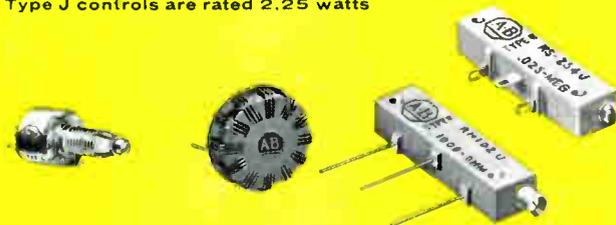
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Type J controls are rated 2.25 watts



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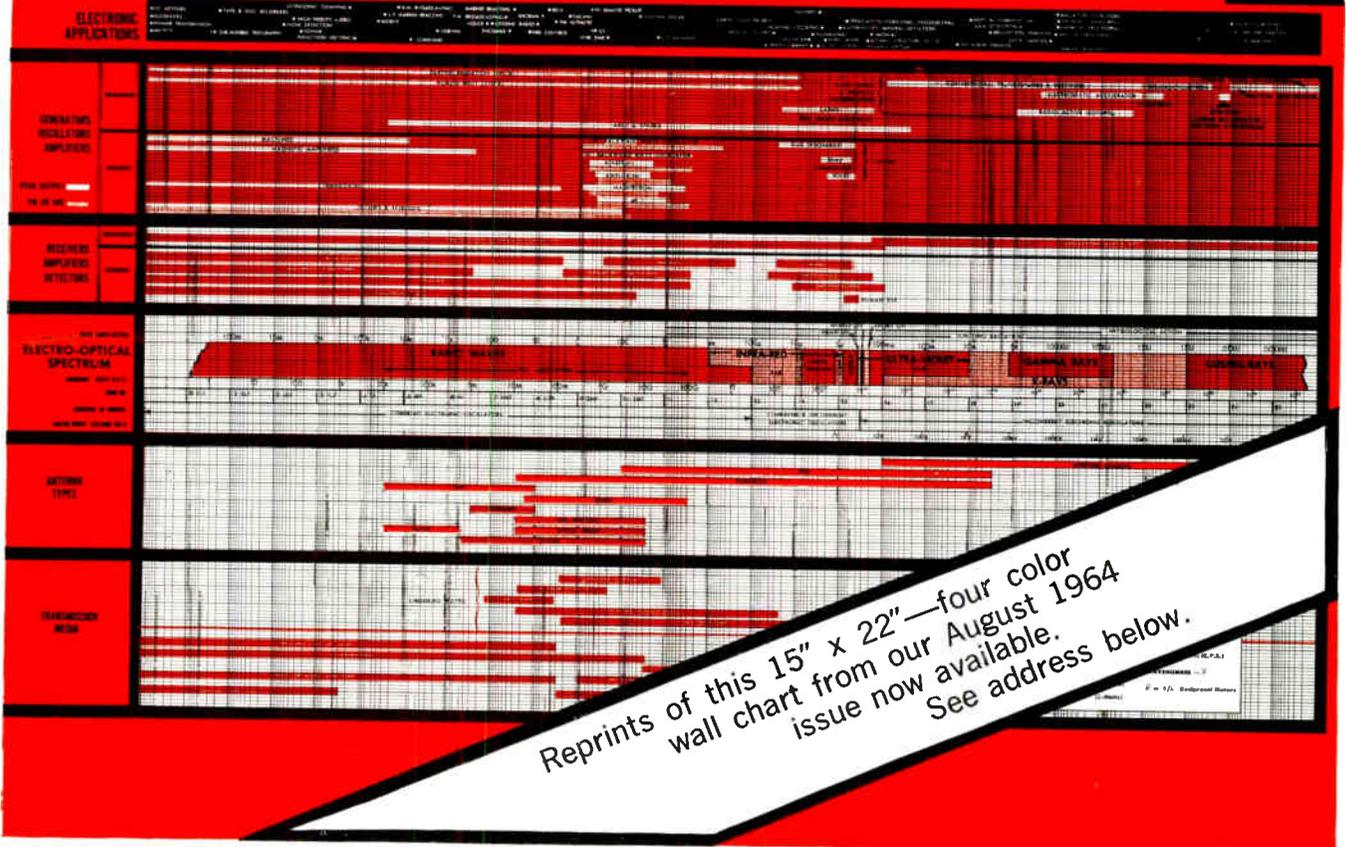
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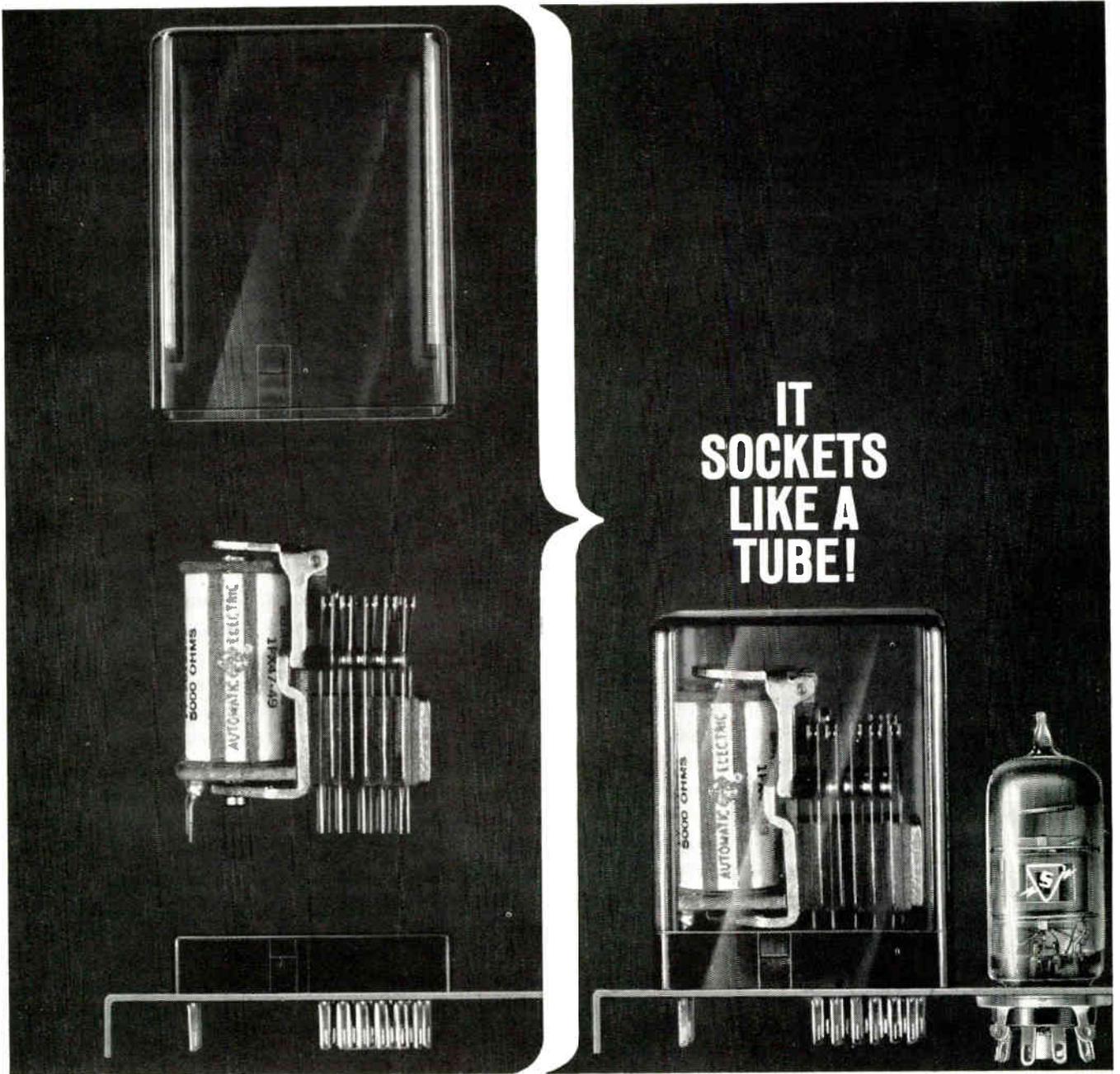
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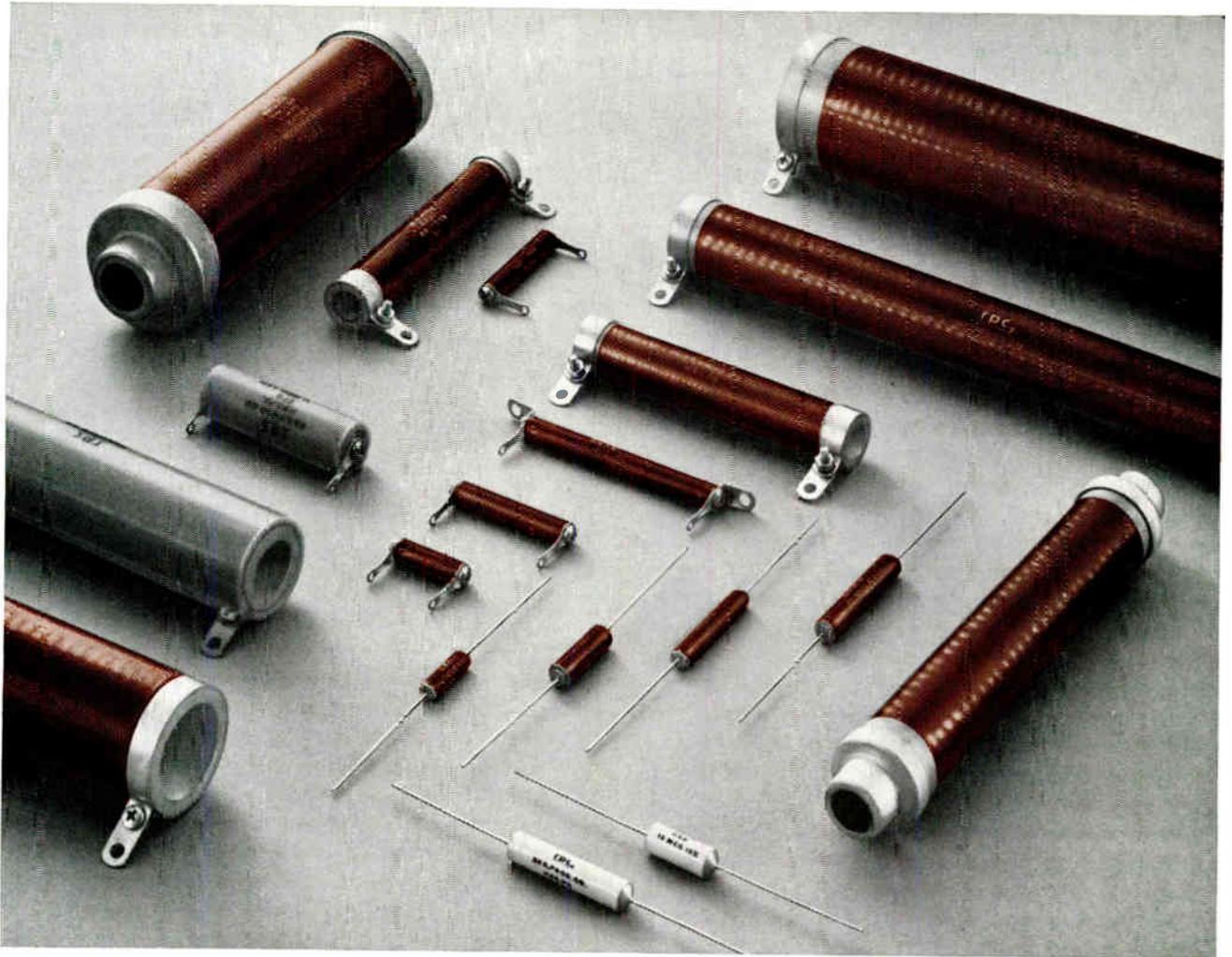
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Modern Power Supply Design for Computers



A short time ago a power supply for a micro-miniaturized circuit or computer might have cost twice the price of the circuits it supplied. It might have been five times as large and several times the weight. Designers of modern power supplies can avoid these situations, this article tells how.

By **DANIEL R. HOCH**, Development Engineer, Data Systems Division, IBM Corporation, Kingston, N. Y.

POWER SUPPLY DESIGNS in the modern day computer involve consideration of factors of utmost importance to meet the challenges of modern technology in the business world. This article gives emphasis to major considerations in the design of today's power supplies with special attention on the IBM System 360 power supplies.

* * *

The work that is being done in the circuit area, the devices, the methods and the materials available to make circuits faster, smaller, lighter and more economical is astronomical. This type of effort is needed with equal diligence in power supply development to keep pace with computer circuit technology.

With this thought in mind, let us delve into some design considerations required of modern power supplies and specifically discuss the power supply designs used in the IBM System/360, a modern computer system.

Design Considerations

During the design of any computer power supply we must consider the technical parameters of ripple frequency, temperature, line and load variations and

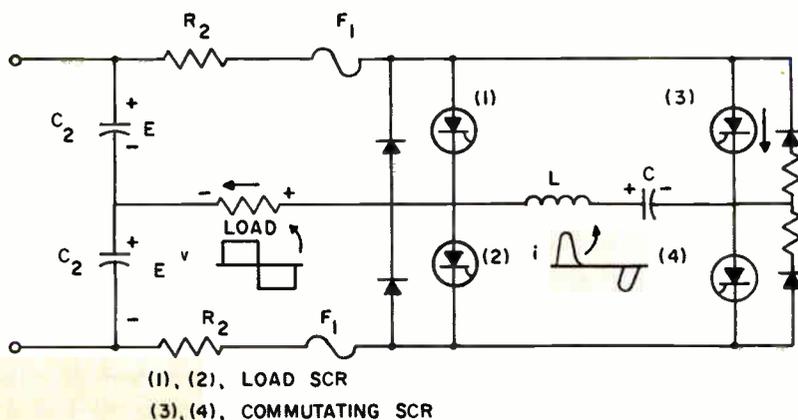
the like. In addition, there are four other broad areas towards which our attention should be focused. These items are requisites in the design of any computer power supply, and rank in importance as noted:

(1) *Reliability*—This item must rank first, for an unreliable power supply jeopardizes operation of the entire system. Reliability must be built into every power supply design in the form of quality devices and design safety factors. Redundancy is tolerable only when economically feasible.

(2) *Economics* — To be attractive to the business world the modern computer and consequently its power supply must be economical in the sense that it most efficiently performs its required functions for the fewest dollars. This poses a burden on the designer, particularly after having mentioned the previous important factor of reliability. The design thus requires intensive analysis to remove extraneous redundancy and achieve circuit optimization. In addition, the proper use of standardization in circuits, packages and frames is essential to drive quantity up and hence, costs down.

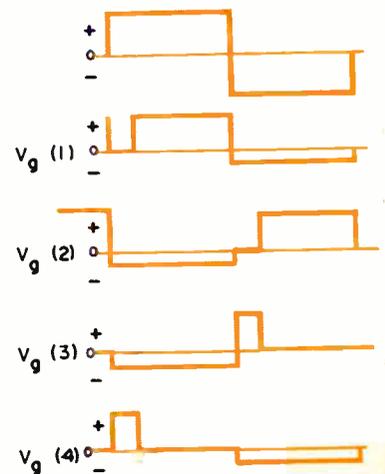
(3) *Volume* — What is the value of a square inch

Fig. 1: SCR inverter power circuit.



SCR GATE VOLTAGES

2.5 KC Square Wave Gen.



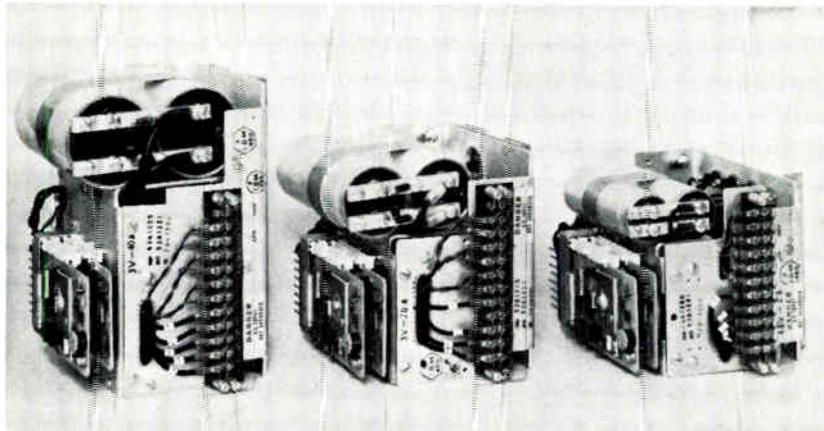


Fig. 3: Typical h-f/dc modules.

of space? A debatable question, but a rather obvious one when one considers the bulk of a power supply module compared to a circuit module. To achieve volume reduction we might ask what it will cost in economics and reliability, but remembering that these are previous goals—the challenge becomes more binding. The major aids to the power supply designer are the proper selection of devices and design approaches.

(4) *Servicing* — As mentioned under reliability, we cannot afford to have the power supply inoperative; if necessary, we must insure that this is minimal. To achieve this goal, servicing methods must be fast and efficient. The power system must indicate immediately to the field engineer where to look and must lend itself to easy repair and/or replacement.

It can be seen that the power supply design is no easy task, particularly when it is realized that no mention of technical problems has been made.

To sum up, we are in quest of power supplies for today's computers that are reliable, yet low in cost, are packaged optimally to achieve small volume, yet are easily serviced and must meet all technical requirements.

It is realized that this is not an ideal world, but we can at least strive to achieve our goals. Let us now discuss these results in the power systems used in the IBM System/360.

System/360 Power Supplies

Before considering the basic tenets which have been established, we should first review some of the philosophies of System/360 and the needs that were imposed by the system on the power supply. One of the basic concepts of the system was to make it such that it covers a wide range of uses for many customers and yet provides for a single customer's individual computer growth as his business grows. To achieve this end, a degree of standardization including components, speed, and programming was needed. To be compatible with this thinking, the power supply was given three ground rules:

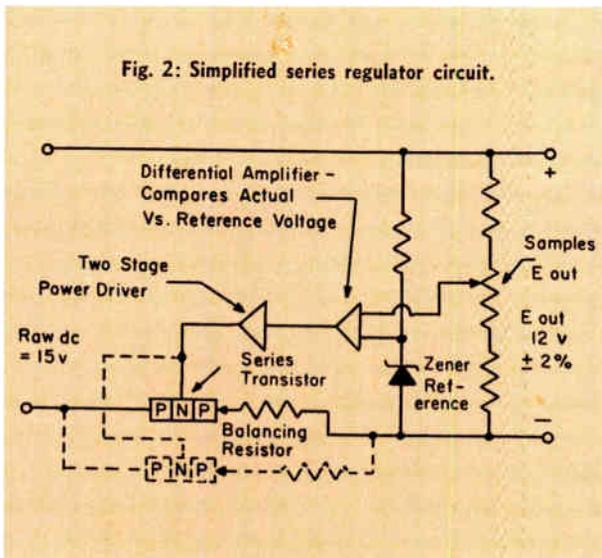
- (1) A minimum number of power supply modules covering the range of needs from the smallest to the largest CPU (Central Processing Unit) would be developed. These modules would be identical in all physical respects except where component size varied to meet electrical ratings.
- (2) A common driving source capable of handling the largest possible power consumption for a given CPU was required so that growth would not entail additional driving sources.
- (3) A concept of miniaturization and modern technology by virtue of SLT (Solid Logic Technology) circuit modules was embraced in the system and in essence dictated a similar power supply course.

High Frequency Approach

Application is for CPU Power (See Figs. 3 and 4). After a review of several approaches, the conclusion was reached that a reduction in magnetic component size would be the major item in reducing the size of the power system. Hence, a 2.5kc high frequency (h-f) approach was used.

In simplified form the supply consists of a converter-inverter section which converts from either
(Continued on following page)

Fig. 2: Simplified series regulator circuit.



COMPUTER POWER SUPPLY (Continued)

50* or 60 cycles line voltage (208/220 or 230v.) to dc voltage and then inverts the dc through the action of an oscillator controlled SCR (Silicon Controlled Rectifier) chopper circuit which generates 2.5 kc at a high distribution voltage:** On the using end this high voltage, high frequency is re-converted by means of magnetic amplifier modules to provide the needed dc output voltage as specified in the SLT circuit criteria.

While ac to dc conversion is achieved by normal 3-phase rectification-filtering methods with minor modifications, the inverter circuit is more complex, see Fig. 1. Once voltage is present on either SCR and a gate potential is achieved, the SCR will conduct. Like a thyatron, it will remain in the conducting state until its current becomes small or it is reverse biased. The turn-off circuitry then becomes complex. Let us define SCR's 1 and 2 as the Main or Load SCR's and 3 and 4 as the Commutate SCR's. The action is as follows: Assume that SCR's 1 and 4 are initially conducting in their normal mode of operation, capacitor C will charge to a voltage 2E at which time SCR4 will turn off since no further current-flow through it will exist. SCR 1 will continue conducting since it is also carrying load current. At the proper time, as determined by the oscillator, SCR 3 will be gated on and discharge capacitor C through the diode across SCR 1 thus reverse biasing the SCR to shut it off. During this interval the discharge current of capacitor C will also flow through the load thus maintaining the proper output until SCR 2 conducts to carry the load.

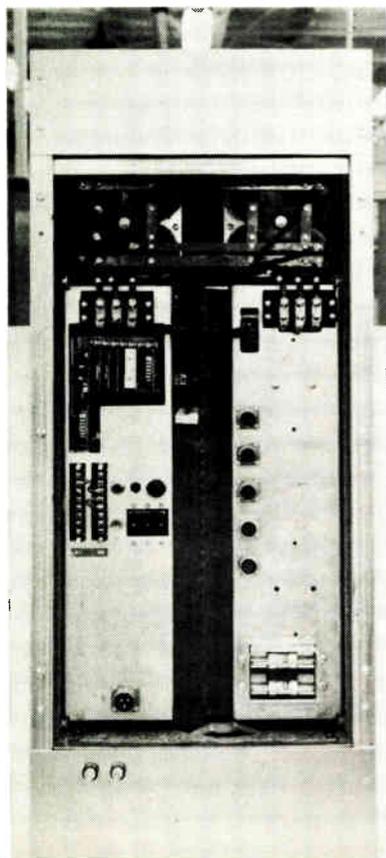


Fig. 4: High frequency 10 kva converter/inverter.

After SCR 1 has been shut off, SCR 2 will be gated on, capacitor C will charge and the process will repeat as noted above.

Magnetic Amplifier Module

Basic operation of the bridge magnetic amplifier can be best understood by a reference to Fig. 6. Consider the magnetic core windings W_{G1} and W_{G2} as switches, and the circuit initially at a half cycle when Point A is positive with respect to B, (V_L being the h-f input from the converter-inverter). W_{G1} remains "open" for a portion of the half cycle then "closes" (driven into saturation) delivering power to the L-C filter and load, R_L , through D1 and D4. At the beginning of the next half cycle, W_{G1} "opens," W_{G2} "closes" at some time during the half cycle, delivering power to the output circuit through D2 and D3. This is called the gating cycle. In steady state operation the portion of the half cycle that W_{G1} and W_{G2} are in saturation is such that:

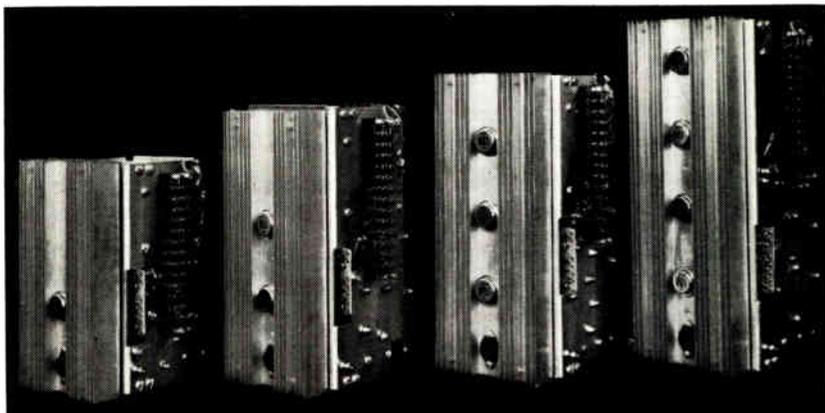
$$\frac{T_{on}}{T/2} \times V_L = V_o, \text{ where } T_{on} = \text{Time } W_{G1} \text{ or } W_{G2} \text{ is in saturation and } T/2 = \text{Time of half cycle}$$

The average (or dc) value of the voltage applied to the L-C filter is the output voltage. During the period when both W_{G1} and W_{G2} are unsaturated (reset cycle) the output load current flow is maintained through D2 and D4. Regulation of the output voltage is accomplished by sensing V_o , comparing it to a reference V_r and using the difference (error, $V_o - V_r = E$) to control the "ontime" of each core. The L-C filter provides the desired ripple reduction, and the output capacitance also provides energy storage for transient load variations. The windings which carry the power and control the re-set are called the gating, W_G , and control, W_C , windings, respectively. In addition a bias winding W_B , is placed

* One of the automatic ground rules in the design of any power system in IBM is the consideration of the World Trade market.

** For the IBM System/360, a 2.5kw and a 10kw converter/inverter are available.

Fig. 5: MPS-Typical ac/dc modules.



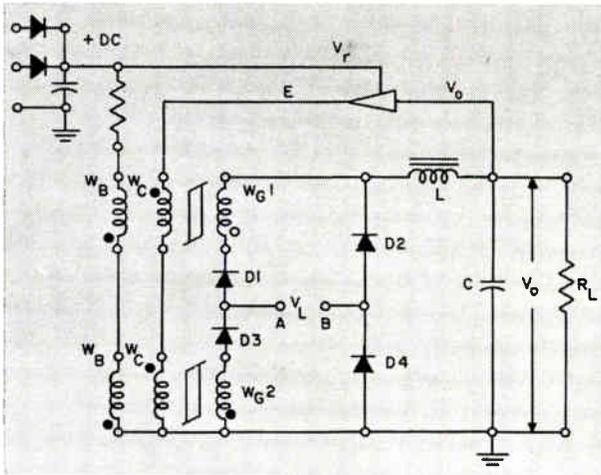


Fig. 6: Bridge magnetic amplifier.

in every core. This winding, as the name implies, biases the core in every re-set cycle. In particular the bias point chosen in the modules is such that if no power were applied to the control winding the cores would not reach saturation during the gating cycle. Thus no power would be delivered to the load. Desirability of such a biased point shows up in the consideration of fault protection.

While much of the finer points and features of the design have been eliminated for brevity, this in essence, basically describes the technical aspects of the h-f system.

Now let us determine the adherence to the design considerations.

Reliability

Reliability in this system was achieved by the proper selection and specification of each individual component within the system. In addition, major emphasis was placed on provision for safety factor in the timing circuitry and in the achievement of the regulation requirements.

Economics

This system offers one of the most potentially possible cost reduced power supplies yet evolved. This statement is made in view of the fact that vendors are continuing to improve semiconductor components and manufacturing processes to a point where cost reduction in these devices is obtainable at far greater strides than heretofore possible. The same can be said of the magnetic amplifier section where semi-automatic methods are used to their maximum to reduce manufacturing costs.

Volume

In a large unit (CPU) the h-f system is predominant in reducing volume since many modules, previously needing large 60 cycle magnetic components, now use small 2.5kc replacements.

Servicing

In the h-f system one large package for the con-

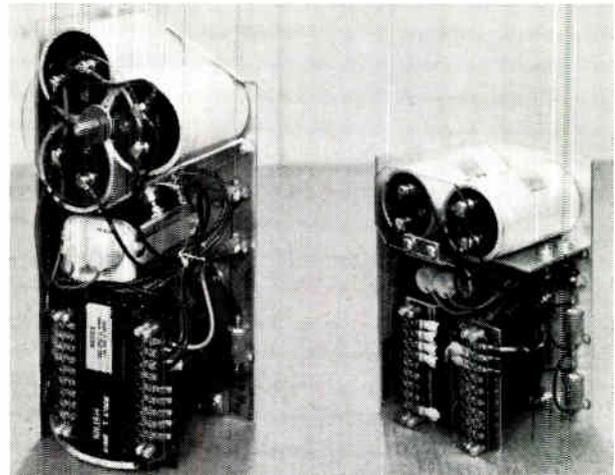


Fig. 7: Statistically Rated Ferroresonant Regulated Supplies.

verter/inverter, which has access areas for test points and the removal of complex electronic circuitry on cards, has been established. The h-f to dc modules are similarly modularly packaged for quick replacement in the field. Thus, the modular concept is used throughout the h-f system to satisfy the need for proper field servicing.

Medium Power Standard

Application is for I/O power (See Fig. 5).

In the System/360 there are many input/output (I/O) devices which use the medium speed 30nsec. SLT circuitry. The h-f system technically could provide this need. But, it was designed to handle units whose power is 1kw or above, since it is in this range that the system yields its major advantages. For the lower powered I/O equipment, then, a series regulator approach called Medium Power Standard (MPS) was developed.

The basic concept used was to design a modular system which could be adaptable to any I/O equipment and be expandable to handle any other special circuitry in different voltage ratings. The key advantage to the approach is that each module stands alone, that is, it has its own ac input voltage for 115, 208 or 230v. Thus, it is, not dependent upon other machine needs and makes for a flexible system. It has its identical 50 cycle counterpart in the same physical size with basically the same circuitry other than the magnetic components. Space in the 60 cycle design was reserved to accommodate the larger 50 cycle units so that interchangeability with IBM World Trade System/360 machines could be achieved.

Circuit operation can best be described by reference to Fig. 2. The input voltage is transformed to the proper low ac voltage as needed by the circuit. This voltage is rectified and filtered using normal methods to produce a "raw" dc voltage which is applied to one or more series transistors (connected

(Continued on following page)

COMPUTER POWER SUPPLY (Concluded)

in parallel as current needs increase). Assume a constant current through the series transistors. As the output voltage tends to increase (for a decrease in load) it is compared to a fixed reference voltage (zener reference) in a differential amplifier. This error signal is further amplified and applied to the base of the series transistor. The drive of the series transistor is then reduced, causing a greater series drop and hence, reducing the output voltage back to its specified value. A similar analysis may be made by considering the effect of input changes. From this simplified description, it can be seen that any change either in output or input voltage is readily compensated for by the action of the transistor circuit. The circuit also serves as an effective ripple filter, providing temperature compensation and other advantageous features for use in this application. In essence, this brief description describes the Medium Power Standard system. Again let us now review its compliance to the Application Considerations.

Reliability

Reliability of a series regulator system has been tested time and again in IBM equipment. It has been proven in the past that series regulated devices are one of the most reliable precision power supplies used in the business today. This is due in large part to the safety factors and worse case design philosophy used as well as to the reliability of solid state and brute force devices used in this type system.

Economics

In this range of power and for this particular regulation requirement cost studies have shown that the series regulator approach is the most economical power approach since its design has been optimized through vast usage.

Volume

While the individual volume of each power supply module is much larger than an equal h-f power supply module, the total volume per I/O machine will be reduced in view of the fact that the converter/inverter section will not be needed for small systems.

Servicing

As described previously in the discussion of the h-f system, the same basic modular concepts have been used throughout the MPS system.

Stat Ferro Approach

Application is for I/O power (See Fig. 7). The so-called "slow speed" 700nsec. I/O equipment is basically used in the document handling machines such as card readers, card punches and printers.

Regulation requirements for this circuit family is $\pm 9\%$ considering worse case circuit variation to end of life. For all of the various conditions of line and load, temperature, ripple and frequency, ferro-resonant supplies are considered to have a regulation, worse case, of $\pm 7\%$. It can be seen that such a supply theoretically just meets the worse case needs if one were to consider a normal voltage distribution of $\pm 2\%$, (static and dynamic).

It has been proven through the use of various statistical methods that the occurrence of all worse case considerations to produce the theoretical $\pm 7\%$ regulation is virtually impossible, whereas regulation of $\pm 5\%$ is more typical. On this basis a sufficient safety factor allows usage of the Stat (statistical) Ferro approach.

This type supply basically is designed to overcome the disadvantage of poor line regulation normally associated with an unregulated or transformer-input supply. In normal operation a worse case, $\pm 10\%$, line input variation can be expected to regulate the ac secondary voltage of the ferro to within $\pm 2\%$. This is best explained by consideration of basic "ferro" action: When low voltage is applied to the primary, the resultant flux generated induces a voltage in the secondary about equal to the turns ratio as in normal transformers. But, when the input voltage increases, a point is reached where the inductive reactance of the secondary winding approaches the value of the capacitive reactance of the capacitor. At this point the circuit becomes resonant and the secondary voltage "jumps" to a stable value higher than the turns ratio. This is referred to as the "jump" phenomena. The secondary is now saturated and any further increase or decrease in the input voltage within the design limits of the unit will not appreciably affect the value of the output voltage. In reality a magnetic shunt path provides the actual transfer of energy from primary to secondary; thus any change in input line results in a larger or smaller transfer of energy from the primary to the secondary as the condition warrants. As load changes, the primary and secondary voltages will shift out of phase. The shunt will again be called upon to "make-up" the energy difference and hence the output voltage will tend to essentially remain constant. Once again let us note our adherence to the design considerations.

Reliability

Without question this type supply is one of the most reliable supplies in use, mainly because it contains very few components and has been engineered over the years with reliable results.

Cost

In view of its simplicity, and in view of manufacturing methods used over the years, the cost of this system is without question one of the most economical in use today for the regulation needed in this power range.

Volume

Again, due to the simplicity of the system and the fact that convection cooling is allowable, the volume for a given need as we find in this circuit family is certainly at a minimum.

Servicing

As with all the other systems previously described, the same modular concept is used. In addition, the supply lends itself to an open construction which simplifies the servicing problem by providing access to the unit such that repair time is minimal.

Comments

It can be seen from the discussions on power in the System/360 that many different power methods are needed to satisfy the same basic design considerations. The other key point is that these standardized approaches are not limited to use in this system but rather are designed to meet given ranges of power and regulation needs. While these power systems satisfy the bulk of the requirements in the System/360, other special supplies were also designed to satisfy unique needs such as high voltage, precision, and low current uses. Each of these designs were similarly obliged to follow the design considerations which have been mentioned.

A Look to the Future

Major design considerations as expressed earlier in the article are certain to appear in the future with increased emphasis. The day of the integrated power supply and logic circuit appears inevitable. We can hope to see the power supply residing on a circuit board, card, or module as the case may present itself. Circuits are going to be faster, volume is going to be smaller. A cry to the component industry for higher power, miniaturized, low cost devices, must go out along with stepped-up development effort and attention by computer manufacturers to the powering problem. The sophistication and technological advances of our power scientists and engineers will be of utmost importance to the computer industry.

It is true that fuel cells and thermionic devices may afford us some relief in this area; but, their cost must be drastically reduced and they must be technically refined to be of practical value in commercial computer equipment.

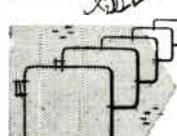
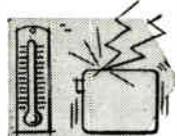
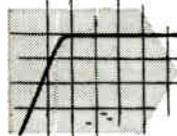
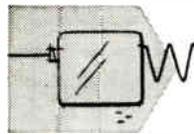
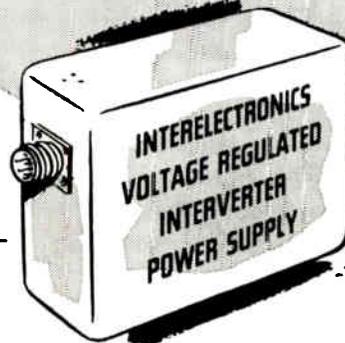
We are sure to see increased emphasis in the power supply field in the next decade to keep pace with the parent computer.

Acknowledgements

The author wishes to acknowledge the development achievements of the IBM Endicott, Poughkeepsie, and Kingston Power Groups whose efforts made this article possible.

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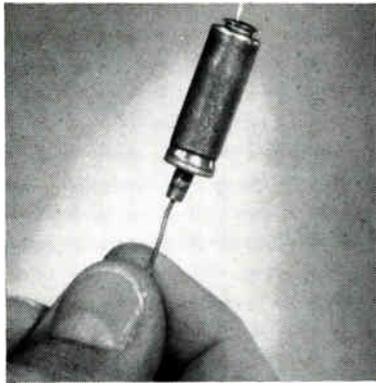
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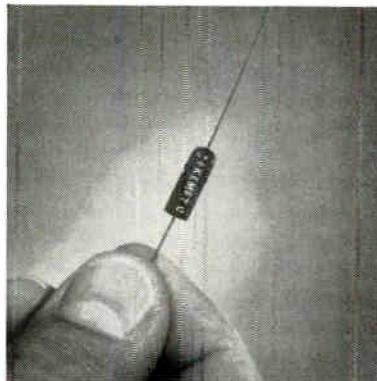
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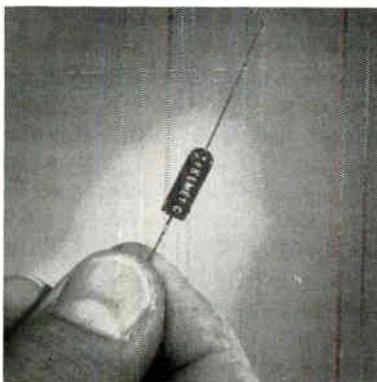
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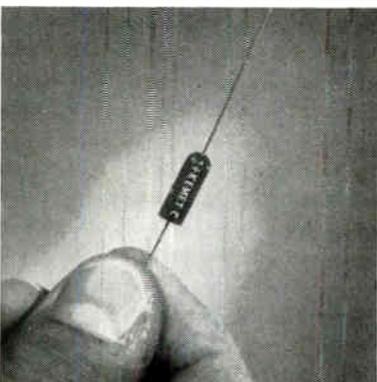
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			309 Ohms	499 K Ohms	402 Ohms	348 K Ohms	1 Meg	402 Ohms	237 K Ohms	1 Meg	365 Ohms	237 K Ohms	2 Meg
Temp. Coeff. } -55°C	0 ± 25	7.93	-8.0 to -10.7	-5.1 to -12.5	-0.5 to -12.0	+0.3 to +5.8	-0.1 to -8.7	+0.3 to +10.6	+1.6 to -10.5	-7.9 to -13.6	-7.0 to -25.0	-1.0 to -19.0	-0.6 to -20.0
PPM/°C } +175°C	0 ± 25	17.79	+14.8 to +18.2	+10.5 to +23.7	+21.1 to +24.9	+13.0 to +25.0	+15.1 to +24.0	+18.2 to +23.0	+14.0 to +24.0	+6.6 to +24.5	+7.0 to +15.0	+6.0 to +21.0	+15.3 to +24.3
Load Life %ΔR After 1000 Hrs. @ 125°C	± 0.5	0.107	-0.017 to +0.250	-0.002 to +0.407	+0.014 to +0.404	+0.051 to -0.149	+0.049 to +0.069	+0.009 to +0.360	+0.147 to +0.387	0 to +0.129	+0.057 to +0.117	+0.025 to +0.172	+0.004 to +0.115
Short Time Overload %ΔR	± 0.25	0.019	0 to -0.104	0 to -0.043	0 to -0.005	0 to -0.003	-0.003 to +0.010	+0.004 to +0.069	0 to -0.077	0 to -0.010	-0.088 to -0.151	0 to -0.009	0 to +0.009
Moisture Resistance %ΔR	± 0.5	0.058	+0.035 to +0.432	+0.039 to +0.222	+0.024 to +0.034	+0.011 to +0.017	+0.009 to +0.039	-0.030 to -0.065	+0.008 to +0.029	0 to -0.050	+0.021 to +0.032	+0.012 to +0.337	+0.039 to +0.084

NOTE: 440 Units Total Tested; 40 Total for Each Resistance Value; 10 Each Test.

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Unusual Power Supply Applications

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Power supplies have become very sophisticated in the past few years, performing many unusual tasks. Their applications are limited only by the designer's ingenuity.

Here are some unique uses for power supplies with details on how they do it.

Information is also given on what to specify for power supplies.

REGULATED POWER SUPPLIES are feedback controlled devices designed to control the electrical parameters of voltage or current. In some power supplies the regulation control loop can be extended to include a variety of physical elements. When this is done, the power supply can be made to regulate position, speed, color, temperature, pressure, chemical activity or the like.

Assuming the necessary transducers and sensors, a servo control mechanism can easily be constructed for any of the above. A bridge-controlled programmable power supply is the heart of the system. It is used to drive a transducer and is, in turn, programmed by the difference—or error—which results from a comparison of the sensor's output with a reference.

* * *

Since bridge-controlled power supplies are readily voltage-programmed, it is usually convenient to convert the sensor's output to a voltage to carry out the comparison.

Voltage Gain

To demonstrate the process of servo regulation, it is necessary to show how a bridge-controlled regulated power supply is capable of dc voltage gain. Consider the simple drawing shown in Fig. 1. In this circuit, the output voltage of the supply E_o is compared to a reference source E_R through the ratio of resistors R_{vc} (the "voltage control") and R_R (the "reference resistor").

Assuming that the gain of the amplifier "A" is very large, the equation for this circuit is $E_R/R_R = E_o/R_{vc}$ which can be re-written $E_o = (R_{vc}/R_R) E_R$. E_R is commonly the 0.2 v. drop across a precision zener diode built into the power supply. Since E_o can be made almost any value from zero to thousands of volts, (depending upon the design of the power section), the term R_{vc}/R_R can be considered the

"gain" of the bridge.

In effect, the reference potential E_R is amplified to any desired E_o . Should an external source be substituted for E_R it would also be amplified by the ratio R_{vc}/R_R , and will appear at the output. If external resistors are substituted for R_{vc} and R_R , it is possible to treat the bridge controlled programmable dc power supply as a high power, high gain, dc amplifier. Using operational notation, R_{vc} becomes R_f , the feedback resistor, and R_R becomes the R_1 , the input resistor. E_R becomes E input, see Fig. 2A. Fig. 2B is another way of representing this circuit.

The triangle symbol is taken to include all of the remaining power supply elements, the raw power sources, pass elements and comparison amplifier. The operational gain G is the ratio R_f/R_1 , and for many power supplies can be adjusted as high as 1000 or more. Thus, the bridge regulated programmable power supply can be used effectively with external operational circuits.

Referring to Fig. 2C and using operational notation, with a reference (or command) input E_c and a feedback sensor voltage E_h the amplifier equation becomes $E_o = (E_c - E_h)(R_f/R_1)$. If the operational gain R_f/R_1 is made sufficiently large, the difference $E_c - E_h$ becomes quite small, and is designated ϵ , the error.

Describing Control Circuits

To illustrate this unconventional view of the dc power supply, several relatively simple control circuits will be described. Like all such mechanisms the

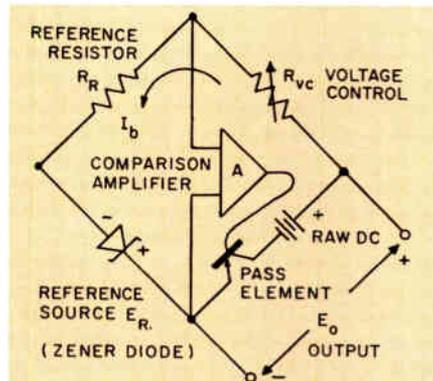


Fig. 1: Simplified power supply comparison bridge schematic. Note: This and all other drawings in this article are drawn for all-transistor power supplies. Hybrid units would require that the polarities be reversed

POWER SUPPLIES (Continued)

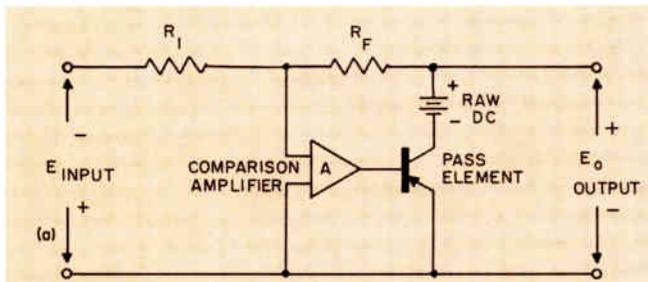


Fig. 2(a): Power supply bridge drawn for external R_f and R_i .

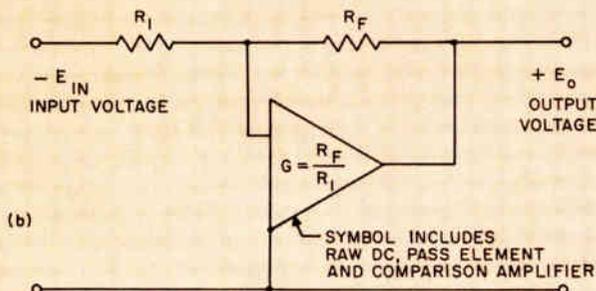


Fig. 2(b): Internal structure of bridge, pass elements, raw dc supplies and comparison amplifier absorbed into single symbol.

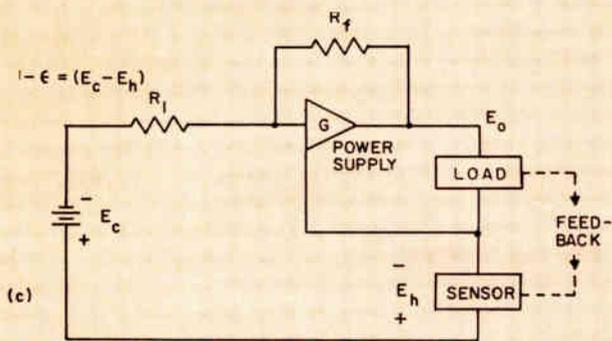


Fig. 2(c): Power supply used in a feedback controlled system.

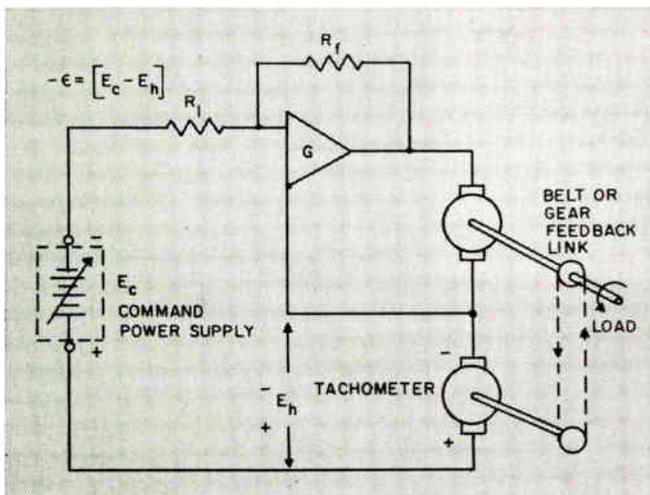


Fig. 3: Speed control using 2 power supplies and tachometer.

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actual execution in practical form requires attention to the finer points of control system engineering. Questions such as transient behavior, stability and the like will not be treated here. The literature on control systems engineering is fully applicable.

Speed Control

Motor speed control is a common engineering problem. Often dc motors are used with an adjustable dc power supply to obtain a range of speed control. Unfortunately such an open loop control circuit does not correct for variations in shaft loading or other factors which can tend to upset the speed. To detect such speed changes, an appropriate sensor is required. A permanent magnet tachometer-generator makes a convenient speed sensor. Its dc output is in a form that can readily be used for feedback purposes.

A speed control mechanism is shown in Fig. 3. It consists of an appropriately rated, programmable, dc power supply connected to run a dc motor. This power supply is depicted in operational notation. The dotted "feedback" line represents belt or gear coupling between the load shaft and the tachometer whose output E_h is proportional to the motor shaft speed. A second, small, dc power supply, E_o , is connected series-opposing the tachometer output, so that their difference serves as the input to the main motor-drive supply. This signal $E_c - E_h = \epsilon$, is amplified through R_f/R_i to drive the motor. For a large gain, R_f/R_i , output disturbances are greatly diminished by the feedback E_h . If R_f/R_i is large, ϵ is small, and E_h will about equal E_o . As E_c is varied (by changing the setting of the command power supply E_h follows. Should E_o be increased, the error, ϵ , increases, which ups the motor drive by $(R_f/R_i)\epsilon$. This, in turn, speeds the tachometer increasing E_h . The error differential ϵ is thus diminished, regulating the motor drive and thus its output speed. Any tendency for the shaft speed to change, including the effect of load variations, will be corrected by this control circuit.

Regulating Light Intensity

Another common control problem is the regulation of light intensity. The problem often involves filament, xenon or arc lamps. The uniform illumination of a monochromometer is a typical objective. There are several sensors whose output can be used. Photo multiplier tubes and photo voltaic or photo resistive semiconductors are among the most commonly used for feedback control.

Photo voltaic silicon photocells are perhaps the most convenient sensor. Their output, usually requires some voltage amplification before it can be summed differentially with the reference or command potential, E_c . A small dc power supply connected operationally for program-by-voltage serves conveniently to amplify the feeble photocell output. Since this amplifier/power supply is in the feedback loop,

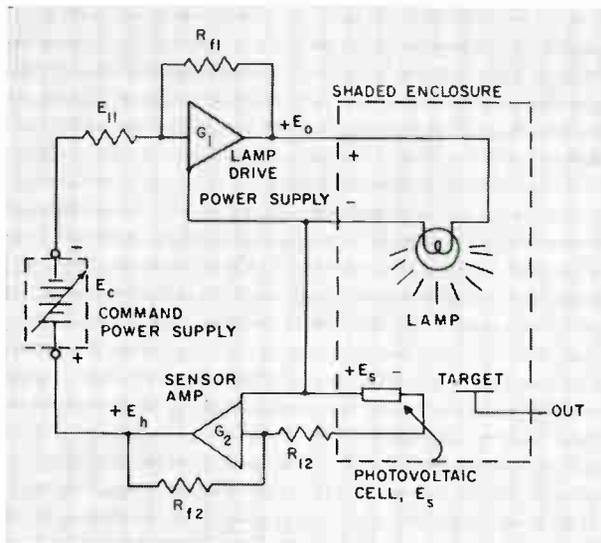


Fig. 4: Illumination control using photo-voltaic sensor and power supply as voltage amplifier G_2 , loop gain is $G_1 G_2$.

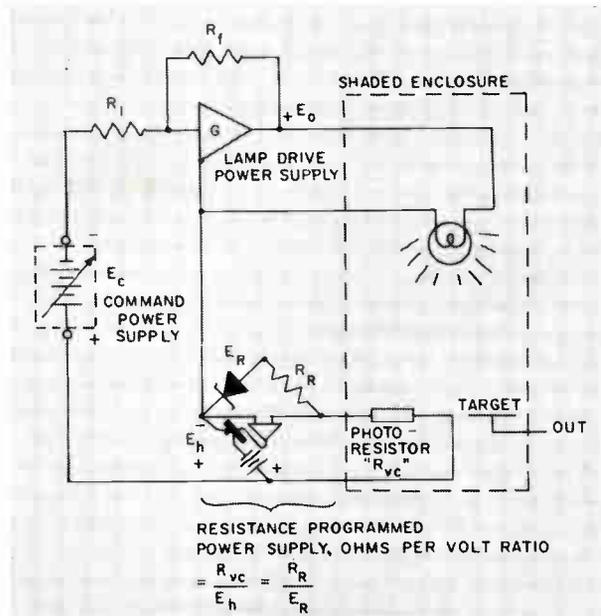


Fig. 5: Illumination control using photo-resistive sensor with programmed power supply as resistance-to-voltage translator.

its gain contributes to the loop gain and thus improves the light intensity regulation. Fig. 4 depicts an illumination servo using a photo voltaic feedback sensor.

Photo resistive cells might also be used to sense the light intensity. Such a cell generates a variable terminal resistance as a function of the incident illumination. This introduces a translation problem, *resistance to voltage*, for which programmable power supplies are well suited. A power supply is resistance-controlled by connecting the external resistance—or photo resistive cell in place of the voltage control R_{vc} . (or R_f in the operational notation). The built-in reference voltage and resistor E_R and R_R combine to pass a "bridge current" through the programming resistance $I_b = E_R / R_R$. This power supply is said to be controlled at an ohms per volt ratio equal to the reciprocal of the bridge current. Thus for $I_b = 1$ ma, the control ratio is $1000\Omega/v$. For every 1000 ohms change in the photo resistance, the controlled supply yields 1 v. change in output, which voltage can be used as described previously, to form a comparison null with a convenient E_o command reference. E_c is adjustable and also serves as an intensity control. Such a system is sketched in Fig. 5.

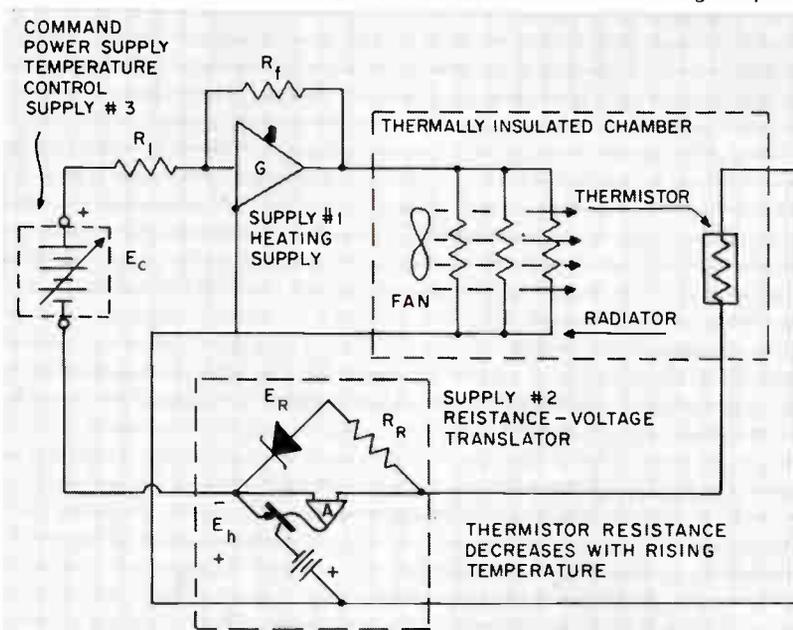
Temperature Control

Temperature control is another interesting dc power supply use. Here, the output of an appropriate programmable supply can be used to generate heat directly as the dissipation in suitable re-

sistors. With fans to circulate the air, resistive radiators can be driven by a feedback controlled power supply to produce very precise temperature control. A thermistor, or a group of thermistors, within an insulated thermal chamber, are used to form the temperature feedback sensor. Again as with the photo resistive sensors, a small power supply can be resistance programmed by the thermistor. The feedback voltage E_h would be the sensitivity of the thermistor in ohms per $^{\circ}C$ divided by the ohm per volt ratio of the translating power supply.

A three-power supply arrangement as shown in Fig. 6 provides excellent temperature control. Supply 1 is the heating supply whose output drives the

Fig. 6: Temperature control using thermistor sensors. Feedback connections are reversed because thermistors are neg. temp. coef.



POWER SUPPLIES (Continued)

resistor radiators within the insulated chamber. Supplies 2 and 3 are connected in series opposing to form the voltage differential input to Supply 1. Supply 2 is resistively programmed by thermistors spotted around the interior of the temperature control chamber and produces E_h . Supply 3 provides the command reference E_c which serves as the adjustable temperature control. With a forward gain in Power Supply 1 between 150-200, temperature control to better than 0.1°C can be achieved for very long periods.

Chemical Analysis

Another, related, power supply application involves the field of chemical analysis. Many electro-chemical electrolytic processes are designed to proceed at a rate governed by the voltage appearing at an immersed reference electrode, often calomel. This may be done so as to control which of two possible electrode reactions will occur. Such a process is known as a controlled potential electrolysis and the apparatus designed for the purpose are potentiostats. A potentiostat is easily made using a dc power supply in a simple feedback circuit. As shown in Fig. 7, a programmable power supply is employed to pass current through an electrolyte. The voltage appearing between the "reference" electrode and the working electrode is compared to the output of a command supply, E_c . Their difference serves to control the output of the main electrolysis supply.

An interesting feature of this control arrangement, and one that is essential to the concept of potentiostat, is that the main electrolysis power supply does not

Fig. 7: Potentiostat used for controlled potential electrolysis.

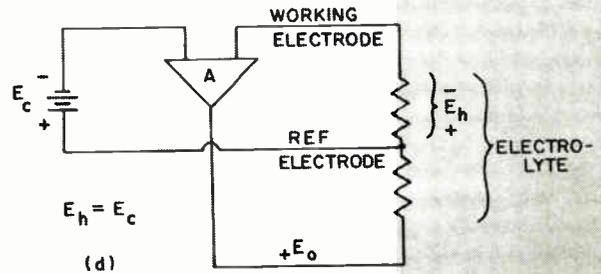
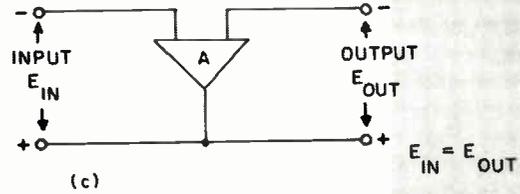
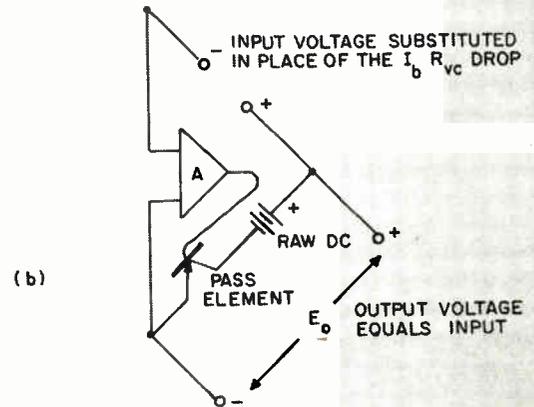
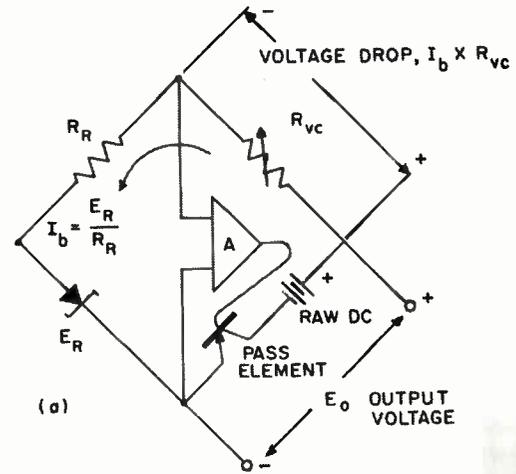
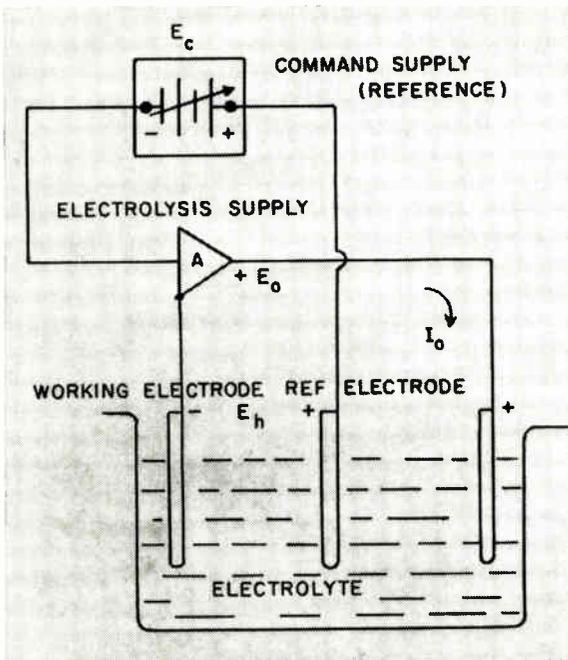


Fig. 8: Using the operational notation of a simple triangle representing the raw dc supply, the pass element, and the comparison amplifier, the "half bridge" becomes a voltage follower, impedance transformer. Fig. 8(d) is a potentiostat.

draw any current from the reference electrode. Any current into or out of this electrode would, of course, upset the accuracy of the experiment. The connection that permits this is called a "half-bridge." How it works can be seen from Fig. 8. Recall, that in the more conventional full bridge or the operational connection, a control bridge current, I_b , flows. As shown, I_b equals E_1/R_1 or E_R/R_R , depending on how the

(Continued on page 53)

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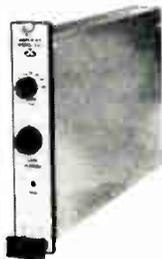
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high-gain/performance amplifiers for low-level, wideband systems at lowest cost. Completely transistorized, these state-of-the-art amplifiers use field-effect transistors in place of mechanical choppers to achieve lowest drift rate, freedom from microphonics and maximum reliability. Gain range to 3000 and a continuously adjustable 10-turn vernier control are provided as standard features. Two differential models with ± 10 ma or ± 100 ma output current from a low impedance can drive long lines, A to D converters, multiplexers, galvanometers or tape recorders. Transfer characteristic is optimized to provide wide frequency response with minimum overshoot, fastest settling and overload recovery times, and minimum phase shift. Common mode rejection is greater than 120 db with up to ± 300 volts dc or peak ac common mode voltage.

All models have built-in power supplies, feature drift less than $1 \mu\text{V}$ per week, wideband noise less than $4 \mu\text{V}$ rms, linearity better than 0.02%. Can be used either separately or in the same rack module with Model 1155 Universal Signal Conditioning Unit or Model 890 Electronic Filter to form complete, isolated signal conditioning channels.

Model 885-135 Differential Amplifier to drive multiplexers, tape recorders and A to D converters.

GAIN RANGE: 1 to 3000
INPUT RESISTANCE: 100 megohms
BANDWIDTH: dc to 10 kc
OUTPUT: ± 5 volts at ± 10 ma
DRIFT: $\pm 1 \mu\text{V}$ for 40 hours
TEMP. COEFF: $\pm 0.2 \mu\text{V}/^\circ\text{F}$
NOISE: $2 \mu\text{V}$ rms



Model 885-235 Differential Amplifier to drive data systems, long lines and galvanometers.

GAIN RANGE: 3 to 3000
INPUT RESISTANCE: 100 megohms
BANDWIDTH: dc to 10 kc
OUTPUT: ± 10 volts at ± 100 ma
DRIFT: $\pm 1 \mu\text{V}$ for 40 hours
TEMP. COEFF: $\pm 0.2 \mu\text{V}/^\circ\text{F}$
NOISE: $2 \mu\text{V}$ rms



Model 1155 Universal Signal Conditioning Unit

Uses plug-in circuit cards to supply excitation or bias, attenuation, circuit completion, balancing, filtering and calibration. Used with low-level or high level signals from thermocouples, strain gages, resistance temperature sensors, thermistors, potentiometers and voltage sources. Can function separately or in same rack module with Models 884 or 885 Amplifiers or Model 890 Filter to provide complete conditioning, calibration and normalizing of transducer signals.



Model 126-101 Charge Amplifier. All solid-state unit with internal dynamic calibration.

INPUT RESISTANCE: 10,000 megohms
INPUT RANGE: 1 to 10,000 psi, g lbs
GAGE FACTOR RANGE: 1 to 11 or 10 to 110 pcomb per psi, g or lb, continuously adjustable
FREQUENCY RESPONSE: 0.3 cps to 150 kc
STATIC CALIBRATE MODE: Extends response virtually to dc for dead weight testing.



Model 120 Nanovolt Amplifier gives you high-gain/low-noise amplification for seismic transducer signals, cryogenic studies, thermocouple or strain gage signals.

GAIN RANGE: 200 to 1,000,000
BANDWIDTH: dc to 100 cps
NOISE: $0.05 \mu\text{V}$ rms
INPUT RESISTANCE: 1 megohm
OUTPUT LEVEL: 0 to ± 5 volts at ± 5 ma



Model 121Z Nanovoltmeter provides $0.1 \mu\text{V}$ full scale bridge balance detector or thermocouple indicator for standards and calibration work, in the field and in laboratories.

FULL SCALE RANGES: $\pm 0.1 \mu\text{V}$ to ± 100 mv
INPUT RESISTANCE: 1 megohm
ZERO SUPPRESSION: $\pm 0.5 \mu\text{V}$ to ± 5 mv
AMPLIFIER OUTPUT: Gain 30 to 3 million, delivers ± 5 volts at ± 5 ma
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HR40-750*	0-40	0-0.75	0.05% load	0.15 mv	\$149
SHR20-3A	0-20	0-3	0.01% line 0.01% load	0.5 mv	\$225
HR20-5A	0-20	0-5			\$299
HR20-10A	0-20	0-10			\$379
SHR40-1.5A	0-40	0-1.5			\$199
HR40-2.5A	0-40	0-2.5			\$299
HR40-5A	0-40	0-5			\$349
SHR60-1A	0-60	0-1			\$235
HR60-2.5A	0-60	0-2.5			\$379
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- **CONSTANT CURRENT OPERATION** with adjustable voltage limiting.
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POWER SUPPLIES (Concluded)

elements are labeled. I_b also flows through R_{vc} (or R_f as the case may be) and develops a voltage drop across that resistor. The polarity of the voltage across the voltage control or feedback resistor is seen in Fig. 8. Since the amplifier maintains the voltage across its terminals at a virtual zero, or null, the voltage across the output terminals of the power supply must equal the drop across the voltage control. This fact suggests that if a voltage of the correct polarity were applied *in place* of the voltage control/feedback resistor, there would be no need for the bridge current. The output terminals are, of course, a low impedance source and the comparison amplifier ideally draws no current. The result is a form of impedance transformer or voltage follower. An impedance transformer, half bridge, power supply configuration, is a unity gain, 1:1 form of programming where the input impedance is exceedingly high, and the output impedance is very low.

In the potentiostat setup, the reference electrode voltage drop, which is a fraction of the total output voltage, is compared directly with the output of the command supply. To maintain the null, the power supply varies the electrolysis current to regulate the reference electrode voltage. Here, the loop gain equals the open loop gain A of the power supply's comparison amplifier, typically 10^4 - 10^5 , see Fig. 8d.

The voltage follower has another useful application to electrochemical electrolysis. In particular, when *constant current* electrolysis is attempted, it is often desirable to monitor the reference electrode potential

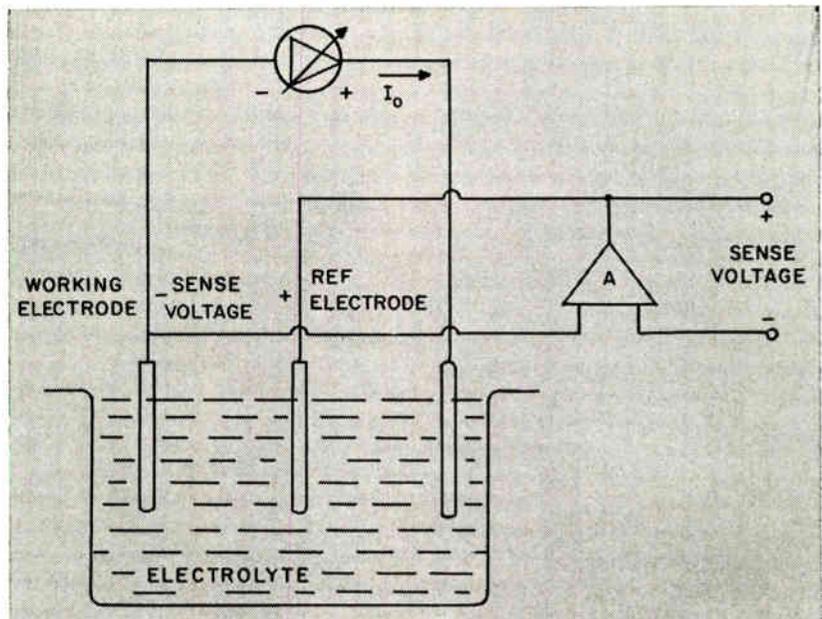


Fig. 9: Constant current electrolysis using power supply to repeat the sense voltage between reference and working electrodes.

in order, for example, to be able to detect the depletion of one or more elements in the electrolyte. Here, a separate, small, programmable supply is connected as a voltage follower to repeat the reference electrode voltage. The voltage, when it appears at the output terminals of the repeater is identical to the reference potential except that it is at low impedance, capable of delivering substantial current to monitoring or other control apparatus without drawing any significant current from the reference electrode itself. See Fig. 9

This article has attempted to show some of the ways sophisticated dc power supplies can be used to solve a number of control problems. In every instance, the power supply is used to take advantage of the exceedingly high-gain comparison amplifier built-in for precision regulation. The coupling of a high-gain dc amplifier with the high-power capabilities of the supply's output circuit, provides a unique capability for signal processing and system control.

How to Specify a Regulated Power Supply

It is recommended that numerical values be provided for all the following characteristics, where applicable, so that no doubts can remain in the mind of the buyer or supplier. In addition to the standard specifications tabulated the nature of the load, programming requirements and any special performance requirements should be stated.

The following can be con-

sidered the standard specifications:

Output Voltage Range: (Corresponding to specified current range, or with stated derating)

Output Current Range: (Corresponding to specified voltage range, or with stated derating)

Specifications: Voltage Regulation Mode

Regulation: Line (percent change of output voltage for stated change in line voltage)

Regulation: Load (percentage and millivolt change of output voltage for no load to full load change in load at any output voltage)

Stability: (Percentage and millivolt change of output voltage over a stated period e.g. 8 hours after warmup, measured at constant line voltage, load condition and ambient temperature)

Temperature Coefficient: (Percentage change in output
(Continued on following page.)

How to Specify a Regulated Power Supply (Concluded)

voltage per degree C change in ambient temperature)

Ripple: (Maximum ac component of dc output expressed either in peak-to-peak or rms terms unless specified separately, ripple includes all unclassified noise.)

Recovery Time: (The time required for the output voltage or current to return to a value within the regulation specification after a step load or line change expressed in fractions of a second)

Output Impedance: (The internal impedance of the power supply at its output terminals at any frequency from dc up to some upper frequency, usually 100kc)

Specifications, Current Regulation Mode:

Output Range: (Regulation range in percentage of maximum output and in milliamperes. Indicate figures for internal sensing and external sensing if different)

Compliance: (Compliance of output voltage as load resistance is changed in percentage of maximum rated output. Indicate figures for internal sensing and external sensing if different)

Regulation, Internal Sensing: (Independent specifications for line and load regulation in percentage and current for stated changes in line voltage and at any current from no load to full load)

Regulation, External Sensing: (Same factors as for Internal Sensing, above)

Stability: (Output current variation in percentage and milliamperes over a stated period e.g. 8 hours after warmup, measured at constant line voltage, load conditions and ambient temperature)

Temperature Coefficient: (Output current change in percentage per degree C.)

Ripple: (AC current component in percentage of any output current setting)

Specifications, General:

Input Requirements: (Required input voltage, frequency range and number of phases)

Ambient Operating Temperature: (Permissible ambient range in degrees centigrade without derating. State any derating)

Storage Temperature Range: (Permissible storage temperature range in degrees centigrade)

Isolation Voltage: (Voltage which can be tolerated between either output terminal and chassis ground)

Specifications, Performance:

Controls: (Type and resolution)

Programming: (Types of programming which can be used and ranges of programming voltage, current or resistance)

Automatic Crossover: (Sharpness of crossover from voltage to current and vice versa. Crossover signals when supplied.)

Remote Error Sensing: (Availability and remote line voltage drop toleration)

Cooling: (Type of cooling)

Voltage Overshoot: (Amount of transient caused by turn off or turn on of the power supply falling outside regulation specifications)

Specifications, Physical:

Meters: (Size and accuracy when furnished)

Terminals and Controls: (Front panel controls and terminals. Terminals and similar provisions on rear of chassis or cabinet)

Dimensions: (Overall size)

Finish: (Type and color)

Mounting: (Type of mounting)

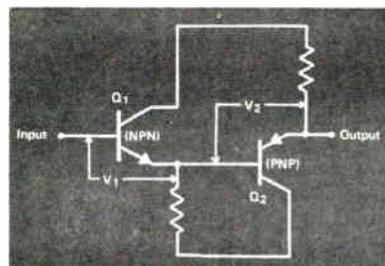
Accessories: (Accessories available)

STABILIZED EMITTER-FOLLOWER

THE OUTPUT OF A TRANSISTOR used in the conventional emitter-follower circuit varies with environmental temperature changes. Hence, the need for a temperature-stabilized circuit.

The problem was solved by using an npn and a pnp transistor. Voltage variations due to temperature changes in the first stage are canceled by variations that are equal and opposite in the second stage.

The two transistors are connected as shown in the diagram. An increase in temperature will cause the base-to-emitter voltage V_1 of npn transistor Q_1 to become less positive. The base-to-emitter voltage V_2 of pnp transistor Q_2 will become less negative to a nearly equal degree, so that the temperature-induced variations in V_1 and V_2 will tend to cancel. As a result, the output voltage will remain essentially un-



affected by temperature changes within a prescribed range.

In tests using a 2N780 transistor (Q_1) for the first stage and a 2N869 transistor (Q_2) for the second stage, the maximum output voltage variation was 30mv. over the range of -20°F to 200°F . No attempt was made to match the transistor characteristics for the test.

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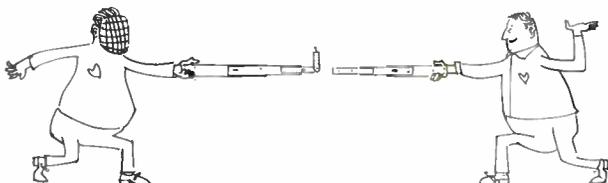
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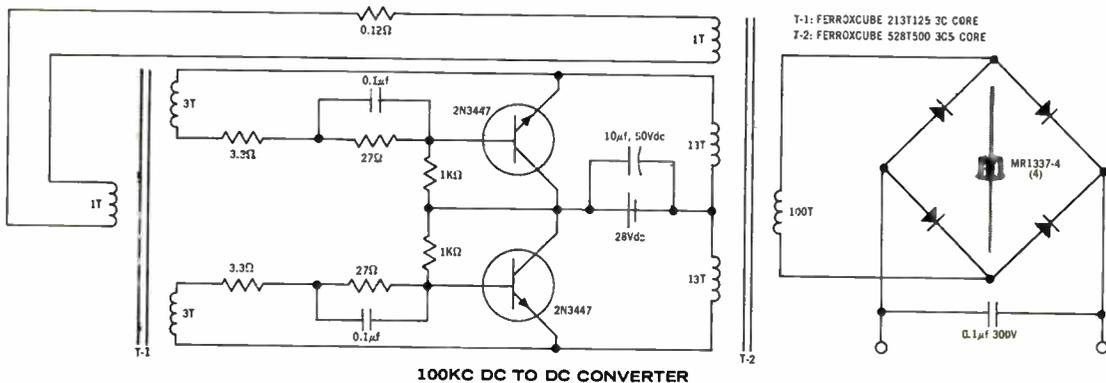
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2. Because, secondly, Jack is a real tiger when it comes to getting top efficiency out of high frequency equipment — he's one of many very capable, very imaginative engineers in Motorola's Applications Department, a group *you* are free to call upon for assistance, any time.

COMPARE PERFORMANCE CAPABILITY...

Characteristics	Motorola Fast Recovery Rectifiers	Conventional Rectifiers
Practical Frequency Capability (Limit)	300 KC (Typ.)	1 KC (Typ.)
Typical Reverse Recovery Time (Switching $I_s = 1A$; $V_R = 30V$)	$T_{rr} = 0.1 \mu\text{sec}$	$T_{rr} = 5-50 \mu\text{sec}$
Turn-on time measured in:	nanoseconds	microseconds
Weight of filter components required for typical 3-amp load	4 lbs. (at 300 KC ~ Typ.)	30 lbs. (at 1 KC ~ Typ.)
Weight and size of power transformer required (at typical operating frequencies)	1/7 to 1/10 the size normally used	...

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New Motorola fast recovery rectifiers are available now off-the-shelf from your local Motorola semiconductor distributor. For more information write: Department TIC, Motorola Semiconductor Products Inc., Box 955, Phoenix, Arizona 85001.



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Prices start at \$65. Every time you specify one of these supplies, instead of a comparable germanium unit, you save considerable money. If you're using commercial supplies, typical savings-per-unit are about \$40. For military supplies it's much more.

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	SPECIFICATIONS		ALL MODELS
	STANDARD MODEL	"A" MODEL	
Total Regulation (Line and Load)	±0.5%	±0.05%	105-125 v ac, 47 to 440 cps
Ripple (rms. max.)	10 mv	1 mv	75°C ambient max. 95°C base plate max.
Temperature Coefficient	0.07%/°C	0.03%/°C	10 microseconds
			Certified to meet the environmental requirements of MIL-E-5272 and the RFI requirements of MIL-I-6181



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Circle number 37 for product data and general information. Circle number 118 for complete details and visit with engineering representative.

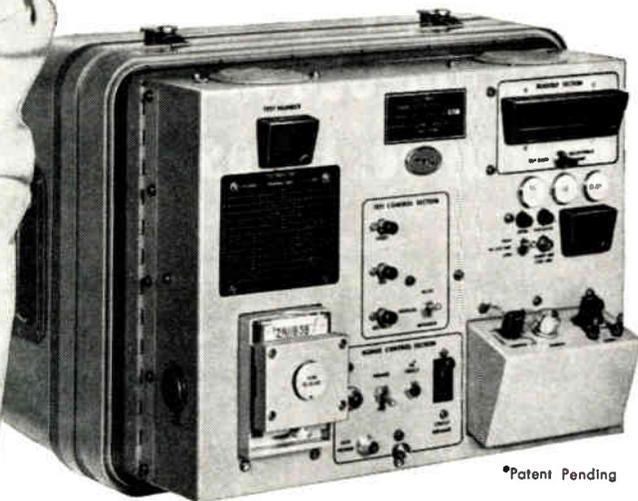
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MODEL 236



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The remarkable new AEL Model 236 Automatic Transistor Tester is a completely portable instrument that automatically tests... with complete safety... transistors, diodes, and other 2-, 3-, and 4-terminal semiconductors out-of-circuit, or transistors and diodes in-circuit.

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The Model 236 is designed for making either precise quantitative measurements or qualitative inspection of semiconductors in Incoming Inspection, Quality Control, Engineering, Production and Receiving. It displays digital readout of measured test data and acceptance limits along with "GO", "NO-GO" indication — and provides graphical readout of automatic lead selection by displaying lead orientation, material and polarity.

PUNCHED CARD PROGRAMMING

450 prepunched program cards, representing 450 different types of semiconductors are supplied... plus 50 unpunched cards for custom programming. When a unit is being tested, the correct card is selected and simply inserted in the punched card reader. The test is then automatically conducted with the card establishing the complete test routine and acceptance limits.

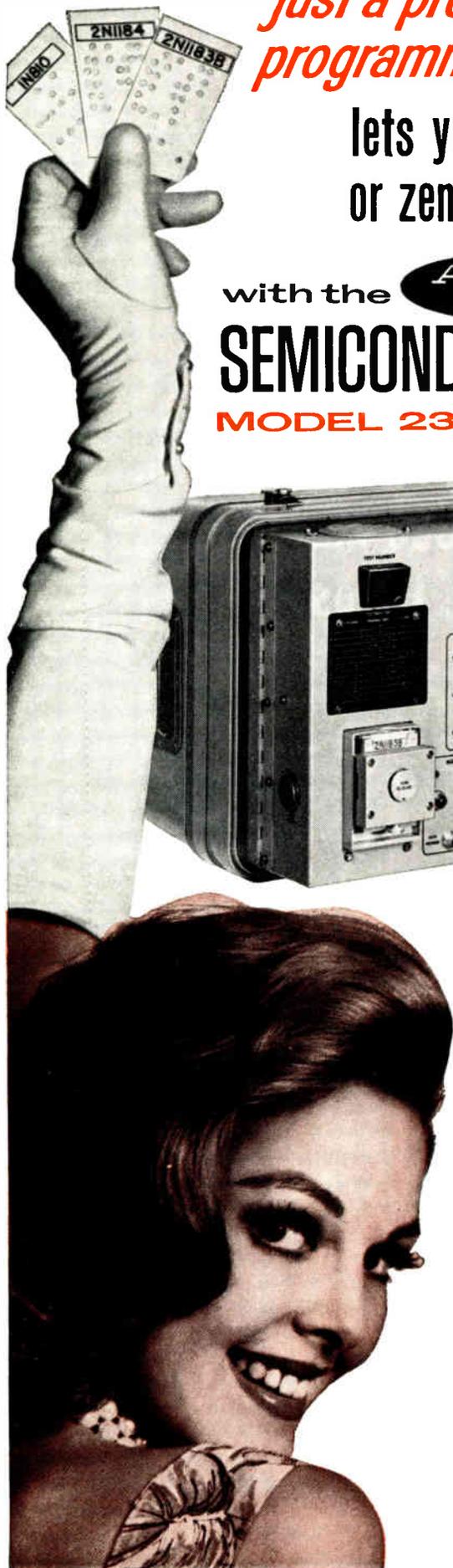
AUTOMATIC LEAD SELECTION

By a sequential logic test, the automatic lead selector determines the transistor or diode material, its lead polarity, and lead orientation.

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In-circuit checks of transistors and diodes are made with shunts as low as 250 ohms for germanium and 500 ohms for silicon devices. No prior knowledge of lead orientation or polarity is required. Indicating lights tell whether the device is Good, Open, NO-Gain or Short.

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CHARTING RELIABILITY FOR MAXIMUM EFFECTIVENESS

That the leaders of the aerospace/electronic community recognize the rising importance of reliability is without question. Techniques they use in implementing effective programs, however, should be questioned. Some do's and don'ts in reliability are covered here for either a non-divisional firm or a large product division.

By **HAROLD M. GORDY**

Corporate Manager of Reliability & Quality Control
Giannini Controls Corp.
Glendale, Calif.

ASSUMING THAT A COMPANY-WIDE reliability program has been established, perhaps the most pressing question becomes: Where in the corporate organizational chart does reliability belong? Who does what to whom?

There is no simple answer. But the corporate success that hangs in the balance makes it mandatory that the question be searchingly examined, both objectively and subjectively. Most certainly, different companies will arrive at different "right" answers, for the trade-offs are legion. Before examining this question, let me make a case for centralizing the reliability function.

The reliability organization does not consist mainly of reliability engineers, although there are a few of these. It consists of specialists: Test engineers, component engineers, statisticians, data processing specialists, process engineers, metallurgists and design analysts. They combine their efforts in what is usually termed: "The Reliability Program." Their work must mesh to be effective.

Thus, the circuit design analyst works closely with the component engineers, so that he can get good part derating information as one criteria for his analysis. The statistician adds validity to his models through the use of the data-processing specialist's ability to produce "real-world" data.

Combines and Balances

Finally, the reliability engineer combines and subtly balances all the contributions of the specialists and allocates reliability funding to produce the most reliability per dollar.

The reliability organization has the technical diversification and, we assume, the incentive to solve complex reliability problems which other functional organizations might be at a loss to attack. For example, can an electronic design organization attack a failure

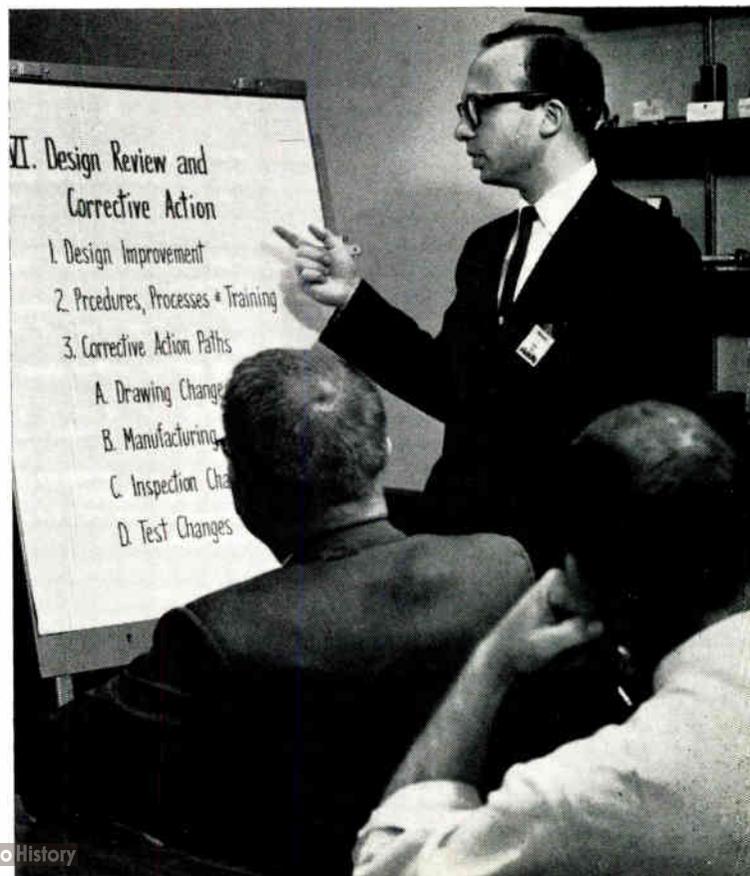
problem which involves overheating of a part in an equipment? Can a mechanical design department do so? Not separately. But a reliability organization will be able to make a basic determination of the interactions of circuit parameters (over-current, over-rating, etc.) with equipment cooling parameters, and pinpoint the problem for corrective action by either or both design organizations.

What this interdependence means is that reliability should be centralized. That is, in any single product division or non-divisional firm, there should be only one reliability organization servicing all design, manufacturing and quality assurance organizations.

Single Organization

One reliability organization will have the following advantages:

1) It will produce a powerful tool for reliability assurance by combining the talents of many specialists, not separating them. *(Continued)*



Author Harold M. Gordy—"A manager who is already progressive and objective, who can lend already-strong friendships and respect to reliability work within his organization, will help his reliability manager overcome hostilities and prejudice. Result will be an effective and integrated reliability program."

CHARTING RELIABILITY (Continued)

2) It will provide an inherently good flow of reliability information among all specialists involved in reliability tasks.

3) It will attract more of the rare reliability engineers, who feel out of place in design organizations.

4) It will allow the building of reliability capability, leading to future sales.

5) It will provide a single source of specs, standards, and reliability information, rather than several sources, all different.

6) It will make reliability funding far easier, for an entire reliability program sells better than its pieces and parts.

Now, what are the disadvantages? Here are a few:

a) Reliability specialists are further away from the designers and line personnel of other organizations, and are less familiar with their problems.

b) Reliability personnel are not as "project-oriented" as they would be if each were attached to a project or design organization.

c) Reliability may build an "empire" because its

number and type of personnel are not subject to control by anyone in the design organizations.

What is clear is that each of the disadvantages can be overcome: Reliability specialists can develop a close liaison with design and other personnel through helping them technically, and through friendly personal relations. Project reliability engineers in the central organization can coordinate work on each project, and instill project orientation into reliability.

Stop 'Empire Building'

Finally, a good reliability manager and good management above the reliability manager can stop "empire building." Thus, the major disadvantages of reliability centralization can be overcome. Its advantages, on the other hand, cannot be gained in a decentralized form.

Now, where in the organizational chart does a centralized reliability unit belong? Bear in mind that reliability performs three administrative functions:

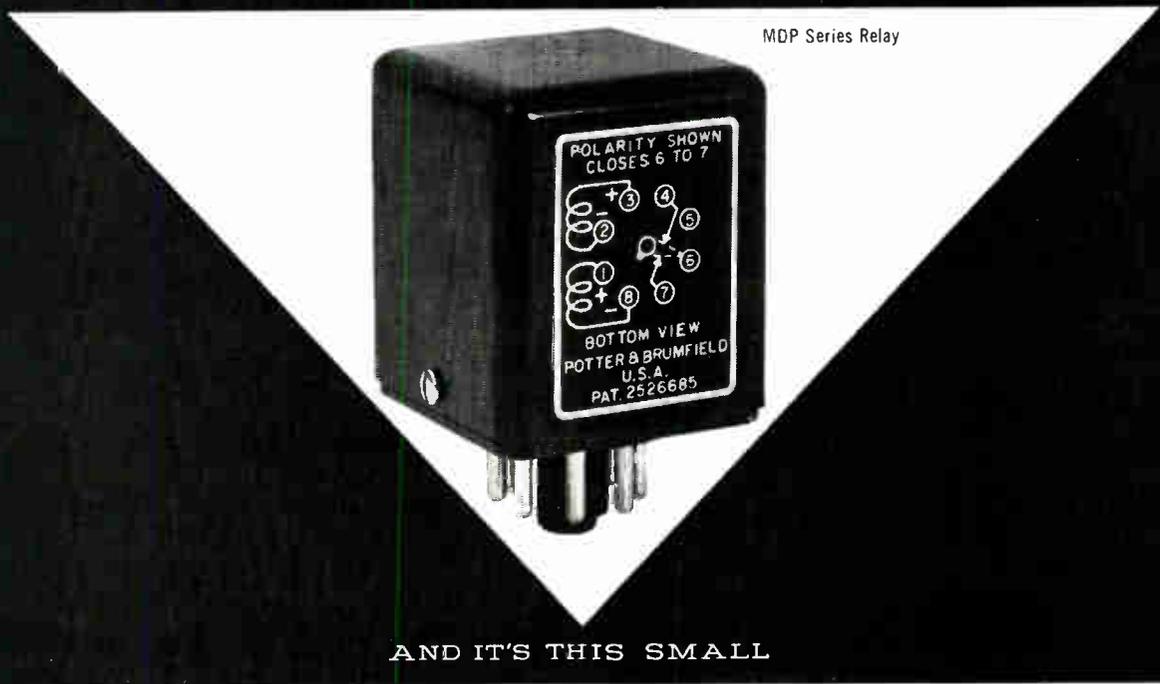
Control—The function of reliability control is exercised by approval authority for parts usage, by design review, by reliability demonstration, and by failure analysis and corrective action. All of these provide control information to, or exercise a direct controlling influence on, line managers.

Table 1
Advantages and Disadvantages of Reliability Placement

Reliability Manager reports to:	Advantages	Disadvantages
General Manager or President	<ol style="list-style-type: none"> 1. Reliability authority and prestige are high. 2. There is more communication with management. 3. More communication with customers. 4. Facilitates funding. 	<ol style="list-style-type: none"> 1. Communications with design engineers are stretched. 2. Reliability may take on a "spy" image with line managers. 3. It stretches president's or general manager's already strained time. Will find himself directing reliability efforts, and planted in many difficult decision areas.
Engineering Director or Chief Engineer	<ol style="list-style-type: none"> 1. More communication with system and design engineers. 2. Reliability professionals are considered 'engineers.' Professional prestige and morale are raised. 3. Chief engineer or engineering director becomes reliability conscious; finds himself defending reliability. 	<ol style="list-style-type: none"> 1. Dilutes reliability control over other line functions. 2. Reliability support less likely to be used in other line functions. 3. Impairs independent reliability audit of engineering organization.
Major Project Engineer	<ol style="list-style-type: none"> 1. Project will have good reliability support and analysis. 2. It will have sound reliability control because of the commitment of project manager to reliability man. 3. There will be unified objectives. 	<ol style="list-style-type: none"> 1. Other projects will not get good support. 2. Less knowledge of reliability will be retained. 3. Building of capability for reliability in depth will be discouraged.
A director or manager of quality assurance or product assurance (reliability and quality control on an equal level).	<ol style="list-style-type: none"> 1. An integrated reliability program is possible, from design to field use, in one organization. 2. Reliability can influence manufacturing factors which degrade inherent reliability. 3. Malfunction and QC defect reporting can be combined. 	<ol style="list-style-type: none"> 1. Thought of as a branch of QC, reliability prestige falls in engineering organization. 2. Needs of reliability in terms of equipment, manpower, administration may be submerged since QC is usually larger and problems more pressing. 3. Reliability control over engineering will decline. 4. Technical competence may suffer if reliability wage rates reflect QC organization. 5. Reliability work often concentrated in production-type 'fire drill' problems, rather than on factors affecting inherent reliability.

• A REPRINT of ANY ARTICLE in this issue is available from ELECTRONIC INDUSTRIES Reader Service Department.

THIS P & B POLARIZED RELAY IS SENSITIVE (TO 50 MICROWATTS) FAST (UP TO 300 CPS) AVAILABLE WITH MULTIPLE COILS



MDP Series Relay

AND IT'S THIS SMALL

THIS RELAY IS IDEAL FOR INSTRUMENTATION AND CONTROL CIRCUITS

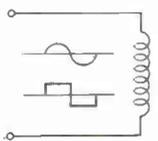
Instrumentation and data or process controls must operate with speed and reliability . . . often on extremely low levels of power. These relays were designed for such applications . . . and their small size make them compatible with modern miniaturization programs.

Sensitivity is in the *microwatt* range. Response speeds reach 300 cps. A choice of one to four coils adds to the relay's versatility. Life expectancy ranges up to one billion cycles, depending upon adjustment required and contact material.

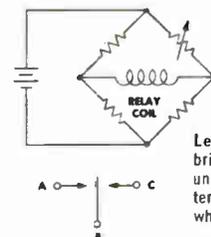
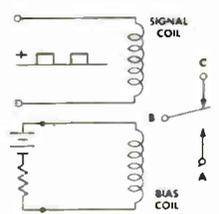
MDP relays are especially suited for: telegraph equipment, pulse code circuits, differential controls, telemetering, servomechanisms, computer circuits, and circuit unbalance sensing. For complete information, call your P&B representative or write direct.

TYPICAL MDP CIRCUIT APPLICATIONS

Right: Sine wave or alternating square wave can be used to drive relay coil. Armature follows signal changes and alternately closes contacts A-B and B-C. Several coils may be connected in series.

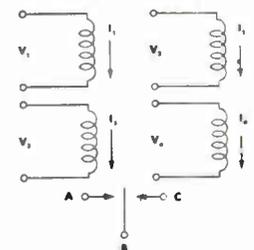


Right: Relay driven by pulse input of one polarity which closes A-B. Contacts B-C are closed by bias coil current. Single-Side-Stable form can be used instead of electrical bias.



SENSING OR CONTROL DEVICE

Left: Relay connected in bridge circuit to indicate unbalanced condition. Center-stable contacts are open when bridge is balanced.



Left: Multiple coil relay connected so that differential of coil currents will close contacts.

Now available at leading electronic parts distributors.

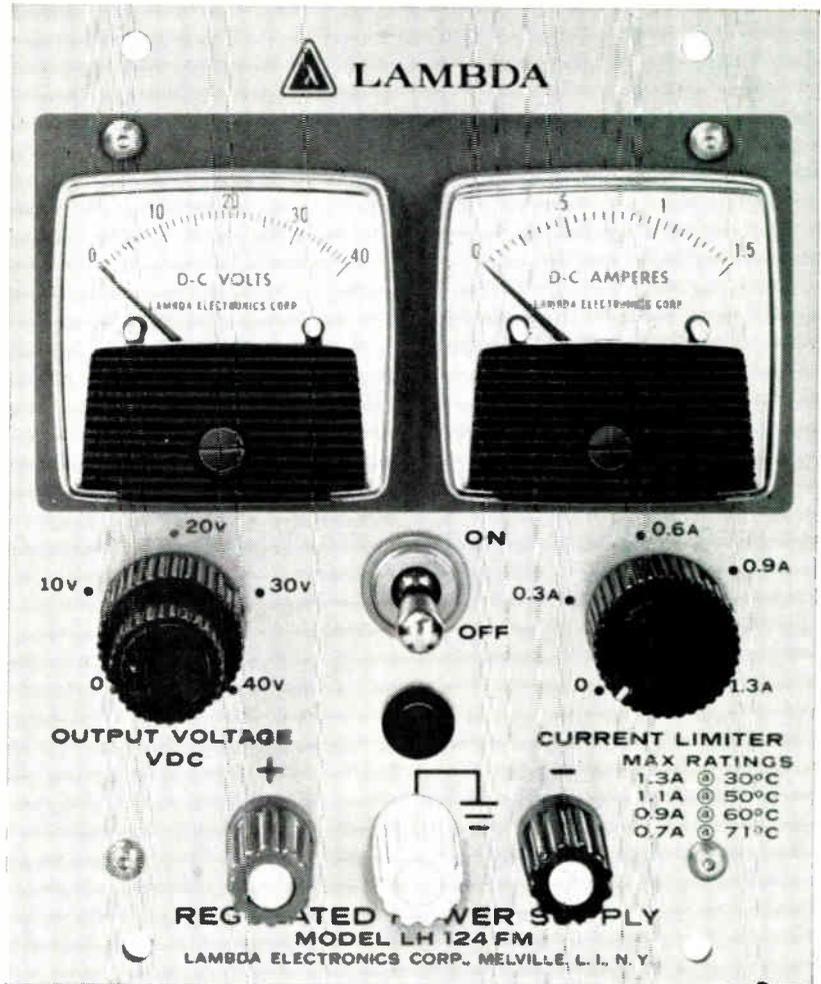


POTTER & BRUMFIELD

Division of American Machine & Foundry Company, Princeton, Indiana
In Canada: Potter & Brumfield, Division of AMF Canada Ltd., Guelph, Ont.

Circle 40 on Inquiry Card

World Radio History



PATENTS PENDING



**Only
Lambda
offers**

**¼
4**

rack

power supplies

with multiple current ratings

- Now LH Series is available in 0-10 VDC as well as 20, 40, 60 VDC ¼ and ½ rack models.
- Multi-Current-Rated™ up to 71°C.
- Modular-Subrack design for bench, chassis and rack use.

- Regulation—.015% or 1 MV (line or load)
- Ripple—250 microvolts rms, 1MV P-P
- AC Input — 105-135 VAC, 45-480 CPS.
- Size: LH 118, 121, 124, 127 — 5 3/16" x 4 3/16" x 15 5/16"
LH 119, 122, 125, 128 — 5 3/16" x 8 3/8" x 15 1/16"

Model	Voltage Range	CURRENT RANGE AT AMBIENT OF: (1)				Price (2)
		30° C	50° C	60° C	71° C	
LH 118	0-10VDC	0-4.0A	0-3.5A	0-2.9A	0-2.3A	\$175.00
LH 119	0-10VDC	0-9.0A	0-8.0A	0-6.9A	0-5.8A	\$289.00
LH 121	0-20VDC	0-2.4A	0-2.2A	0-1.8A	0-1.5A	\$159.00
LH 122	0-20VDC	0-5.7A	0-4.7A	0-4.0A	0-3.3A	\$260.00
LH 124	0-40-VDC	0-1.3A	0-1.1A	0-0.9A	0-0.7A	\$154.00
LH 125	0-40-VDC	0-3.0A	0-2.7A	0-2.3A	0-1.9A	\$269.00
LH 127	0-60VDC	0-0.9A	0-0.7A	0-0.6A	0-0.5A	\$184.00
LH 128	0-60VDC	0-2.4A	0-2.1A	0-1.8A	0-1.5A	\$315.00

(1) Current rating applies over entire voltage range. DC OUTPUT Voltage regulated for line and load.

(2) Prices are for non-metered models. For metered models and front panel controls, add suffix (FM) to model number and add \$25.00 to the price. For non-metered chassis mounting models, add suffix (S) to model number and subtract \$5.00 from the non-metered price.

SEND FOR LAMBDA CATALOG



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SALES OFFICES AND REPRESENTATIVES CONVENIENTLY LOCATED IN MAJOR CITIES

Circle 41 on Inquiry Card

Support—Reliability acts as a service organization by providing parts application data and specifications to design engineering organizations, by performing environmental tests, and by analysis of failure data, to pinpoint engineering, manufacturing, and other problems.

Line—Reliability contributes directly to the development of hardware by providing systems reliability analyses, evaluating parts, and conducting engineering problem investigations.

A Few Don'ts

In establishing the optimum organizational site for reliability, a few "don'ts" are worth mentioning:

1) Don't change the organizational location of an existent reliability organization unless its effectiveness is really shown to be very low, and every effort to increase this effectiveness has failed. Changes in location create an unstable condition in terms of unclear reliability authority, lowered morale of reliability personnel, and addition of previously undeveloped organizational hostilities.

2) Don't begin a reliability organization inside a service organization. This will result in the premature decapitation of all reliability authority.

3) Don't lump every miscellaneous homeless function into the reliability organization. Functions like configuration control and PERT planning will bleed off reliability efforts.

4) Don't put the reliability organization under quality control. First, quality control is only one of the many functions which must be controlled by reliability! Second, and more important, quality control tends to take its technical direction from engineering. Reliability must exercise certain controls over engineering design, and would obviously be in a poor position to do so under a QC organization.

5) Don't establish reliability under a specific design department. If reliability is centralized in engineering or the chief engineer. Specific design departments (such as "Circuit Design") will slant reliability to one type of task (such as circuit reliability) and will reduce reliability control over other functions.

Examine Some Do's

With these "don'ts" out of the way, some of the "do's" can be examined. Table 1 lists advantages and disadvantages of putting a centralized reliability organization at various places in the aerospace or electronic firm. It should be emphasized that the "firm" being discussed is either a large product division or a non-divisional firm. Any attempt to establish a reliability organization of anything more than a staff director and 2 or 3 people at the corporate level of a large, multi-divisional firm will result in insoluble problems of communication and control.

However, study of the organization, using Table 1, is not enough to determine the optimum decision. Personalities of the prospective, or actual, reliability

manager, and the other line managers will play a great part in the decision. Much of this type of thinking will be subjective, but certain guidelines can be used, if the functional disadvantages and advantages null out.

Positive Pointers

Here again are a few more positive pointers, be sure to:

- Assign the reliability organization to a superior with the most functional breadth in his background.
- Assign the reliability organization to a superior who is most progressive in his acceptance of new ideas.
- Assign the reliability organization to a superior who shows the greatest ability to coordinate with his co-managers.

With careful thought, the top manager responsible for assignment or reassignment of the reliability organization can balance the above guidelines to arrive at the person to whom reliability should report. Often, this is as important as where it reports functionally.

A manager who is already progressive and objective, who can lend already-strong outside friendships and respect to reliability work within his organization, will help his subordinate, the reliability manager, to overcome organizational hostilities and prejudices. The result will be an effective, integrated, reliability program.

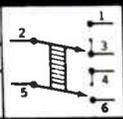
MINIATURE

3-POSITION ON-ON-ON

TOGGLE SWITCH

FOR UNIQUE APPLICATIONS

WITH HANDLE TO THE KEY WAY	CENTER	WITH HANDLE OPPOSITE SIDE OF KEY WAY
ON	ON	ON
1-2 4-5	2-3 4-5	2-3 5-6



First of its kind! Ultra-miniature 1/2" size. 5 amps @ 115VAC. In stock. Write for details.

ALCOSWITCH

Lawrence, Mass. Dept. J-46

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MINIATURE

MOMENTARY PUSH BUTTON SWITCH

Exceptionally high current — 5 amps @ 115VAC — is incorporated in the new, compact ALCOSWITCH. Positive snap-action with fast make and break contacts. Available as a DPDT, useable as either a Normally Open or Normally Closed switch. Solid silver contacts and terminals.

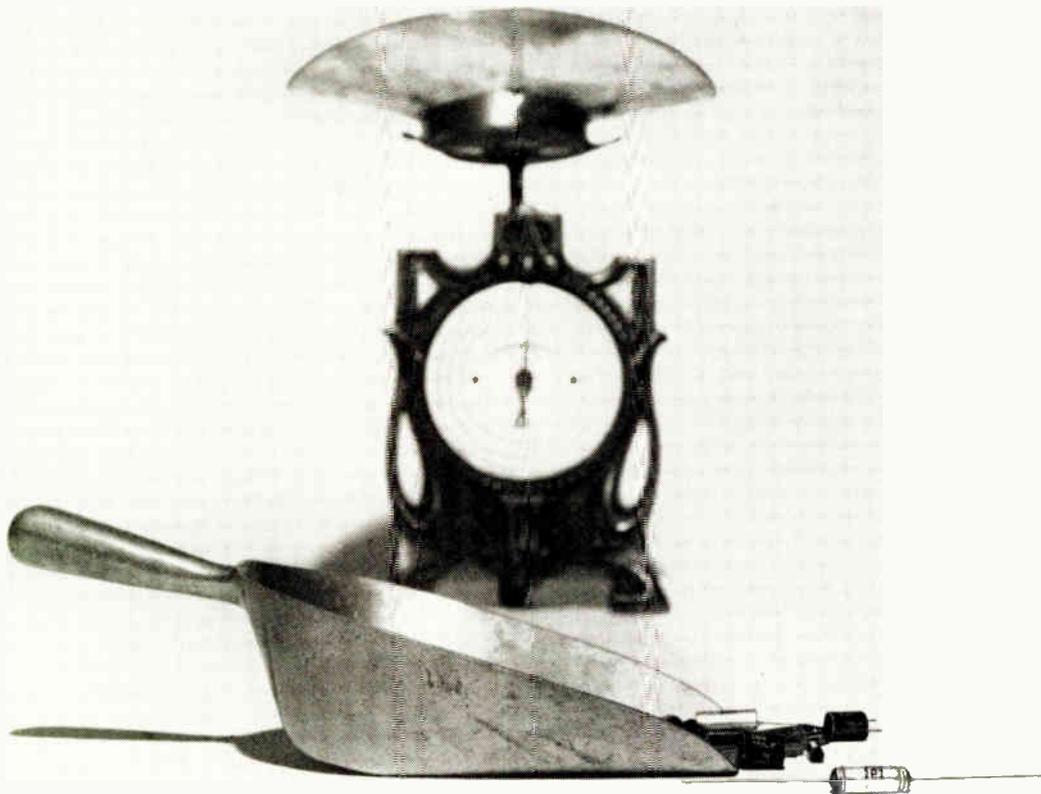
ALCOSWITCH

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The last full measure of performance is built into every IEI design.

Today, progressive engineers in every field of electronics count on IEI to provide capacitors which will invariably deliver the superior performance required as modern circuits grow more and more sophisticated.

IEI has consistently and successfully pioneered the newest developments in aluminum and tantalum foil capacitors. In both wet and dry slug tantalums, IEI performance curves dramatically demonstrate a decided superiority over the usual MIL spec requirements.

IEI engineering starts where typical specifications leave off. Poured into every design are extra measures of research . . . materials . . . workmanship . . . test proce-

dures to provide quality far beyond the most stringent MIL specs.

Automated and other advanced manufacturing techniques assure better and faster production . . . high quality repeatability. A separate quality control department provides a 100% checkout for all capacitors of the five critical parameters with automatic QC instrumentation.

At IEI, **Quick Reaction Capability** is not just an empty phrase. Engineering and production facilities are geared to **deliver**—unbelievably fast! Let us demonstrate on your next requirement—whether routine assignment or special design problem.

Write for complete information.



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POWER & HEAT

15-WATT, 265°C
TRIMPOT MODEL 3030

15W at 25°C, 10W at 100°C. Max. operating temp., 265°C. All-metal case for rapid heat dissipation. Ideal for power supply, electrical circuit applications. 1.065" x .52" x 1.27". 10 ohms to 10K.



RADIATION & HIGH TEMPERATURE

RADIATION-PROOF, 350°C
TRIMPOT MODEL 3040

Specifically designed to operate in high-intensity radioactive environment: will withstand 150 Megarad total gamma radiation, 5×10^{13} fast neutron/cm² total neutron radiation. Max. operating temp., 350°C. $\frac{3}{8}$ " x $\frac{1}{4}$ " x $1\frac{1}{4}$ ". 5W at 70°C. 500 ohms to 20K. No organic materials used.



POWER & HUMIDITY

5-WATT, HUMIDITY-PROOF,
TRIMPOT MODEL 3020

Meets humidity requirements of MIL-R-27208A, has excellent temperature stability to 200°C, offers a die cast aluminum body with high power dissipation in conventional size. 5W at 25°C, 3.75W at 70°C, 2W at 130°C. $\frac{3}{16}$ " x $\frac{1}{4}$ " x $1\frac{1}{4}$ ". 100 ohms to 50K.



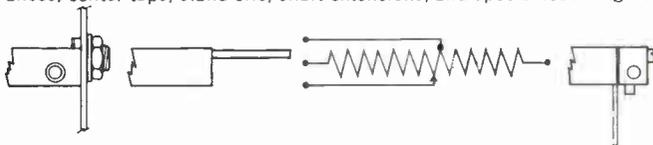
DUAL OUTPUT

DUAL-ELEMENT,
TRIMPOT MODEL 209

One adjustment controls 2 separate potentiometer outputs. Each element dissipates 0.5W at 70°C. Max. operating temp., 135°C. $\frac{3}{16}$ " x $\frac{1}{2}$ " x $1\frac{1}{4}$ ". 10 ohms to 50K. Resistance elements can be the same or different values.

That difficult potentiometer requirement of yours, which you thought was a "special," may already be designed, produced, and waiting for shipment. Take the wirewound TRIMPOT® units above, for example. Each model, besides meeting a special need, undergoes individual inspection for guaranteed physical and electrical characteristics. Every one has the indestructible SILVERWELD® multiwire termination that eliminates the chief cause of potentiometer failure. And every

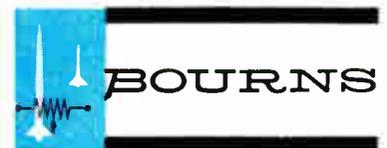
LIKE CHOICES? Most TRIMPOT® potentiometers offer you a great variety of optional features such as panel mounting, special resistance tolerances, center taps, stand offs, shaft extensions, and special lead lengths.



model is subjected to the exclusive Bourns Reliability Assurance Program—a series of sampling tests extending far beyond conventional quality control. If you're looking for hard-to-find answers, what better hunting grounds than the world's largest, most thoroughly proven line of adjustment potentiometers?

Write today for complete data and name of your technical representative.

Always Remember—
TRIMPOT means BOURNS —
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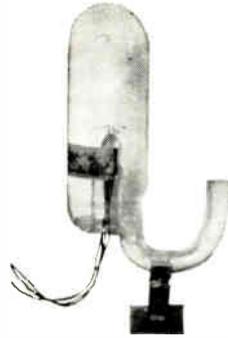


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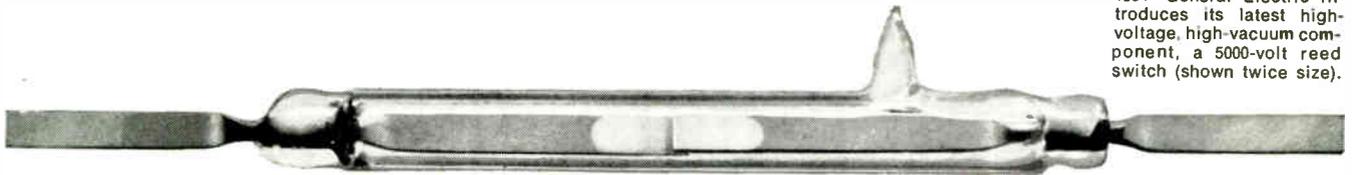
MANUFACTURER: TRIMPOT® & PRECISION POTENTIOMETERS, RELAYS, TRANSDUCERS FOR PRESSURE, POSITION, ACCELERATION. PLANTS: RIVERSIDE, CALIFORNIA; AMES, IOWA; TORONTO, CANADA

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1912—General Electric's Dr. Irving Langmuir developed this early high-vacuum tube useful in establishing laws of electron flow.

GREAT!



1964—General Electric introduces its latest high-voltage, high-vacuum component, a 5000-volt reed switch (shown twice size).

GREAT, GREAT "grandson"

Over 50 years' manufacturing experience in vacuum components backs up the reliability of this new General Electric high-voltage vacuum reed switch

Maximum ratings of 5000 volts (rms) and three amps are high for a reed switch. But this is the current-carrying capability of General Electric's new high-voltage, vacuum 2VR15. And, in spite of the high rating, this new switch offers the same long-life characteristics General Electric builds into its complete line of reed switches.

Here are some characteristics of the new 2VR15 to illustrate the point:

Voltage Breakdown.....	7000 V (RMS)
Switching Voltage.....	5000 V (RMS)
Current-Carrying Capacity.....	3 amps
Contact Resistance.....	.050 ohms
Operate.....	113 ± 20 AT
Release.....	55 ± 10 AT

Small, simple, rugged, fast-acting. There are now 17 General Electric reed switches, available in a variety

of terminal finishes, pull-ins (from 20 amp turns to 185) and drop-outs (from 18 amp turns to 60). You can get milliwatt sensitivity up to 100 million cycles or more, operating speeds less than a millisecond, and life-test results which we challenge any other reed switch manufacturer to match. This is the kind of quality which the industry's tightest assurance program produces. (Every switch you buy has run a gantlet of 14 electrical and mechanical tests including pull-in operate, drop-out release, high-voltage and leakage.)

May we send you a free folder that gives life data and specifications on our full line of reed switches? Write General Electric Tube Department, Owensboro, Kentucky.

Progress Is Our Most Important Product

GENERAL  ELECTRIC



Breaking with the traditional process of heating a metal in a vacuum until it evaporates to form a circuit, this low-energy sputtering process uses the ion gas plasma in the vacuum chamber to deposit all essential components.

LOW-COST MICROELECTRONICS

A THIN-FILM DEPOSITION TECHNIQUE has been developed to make microelectronic circuits economical enough for broad use in commercial and consumer applications. The Plasma-Vac system, by Consolidated Vacuum Corp., Rochester, N. Y., offers precision control over factors that most directly affect yields and costs—such as deposition rate, thickness uniformity, and compositional control.

The new process has bypassed the traditional approaches of heating a metal in a vacuum until it evaporates to form the circuit. Instead, an ion plasma bombardment approach, commonly called sputtering, causes atoms to fly off a source material and deposit itself on a nearby substrate.

Basically Plasma-Vac is a ready-made triode sputtering system by which plasma bombardment can be automatically controlled and the deposition rate and thickness uniformity relegated. In operation, the vacuum chamber is first evacuated to 10^{-6} Torr or less to remove residual gases and contamination. A filament is brought up to emission temperature and a positive voltage is applied to the anode. An ionizing gas, such as argon, is then introduced and the pressure is raised to 10^{-3} Torr to initiate ionization. Sputtering, however, does not occur until a third, or control, voltage is applied to the source material.

When this negative voltage is turned on, the positively charged ions in the plasma slam into the source material and, with billiard-ball effect, cause the metal atoms to fly-off, depositing on the nearby substrate. The operator can start or stop the process by the voltage switch, and thus has precise control over the film thickness.

The deposition rate is constant throughout the fabrication period, and thickness uniformity is held to within 1% over a 1 x 1-in. substrate. Film hardness and adherence are also improved since the metal or semiconductor atoms arrive at the substrate at speeds 40 times greater than that obtained by the conventional evaporation process.

WHAT'S NEW

TV FILING SYSTEM

A COMPLETELY AUTOMATED MICRO-FILING SYSTEM, which stores documents on magnetic video tape and provides fast automatic access and total flexibility in updating, has been developed by Ampex Corp., Redwood City, Calif. With Videofile, data are presented to the user either as pictures on a television screen or as printed copies. The system files, retrieves, and updates individual files at the touch of a button.

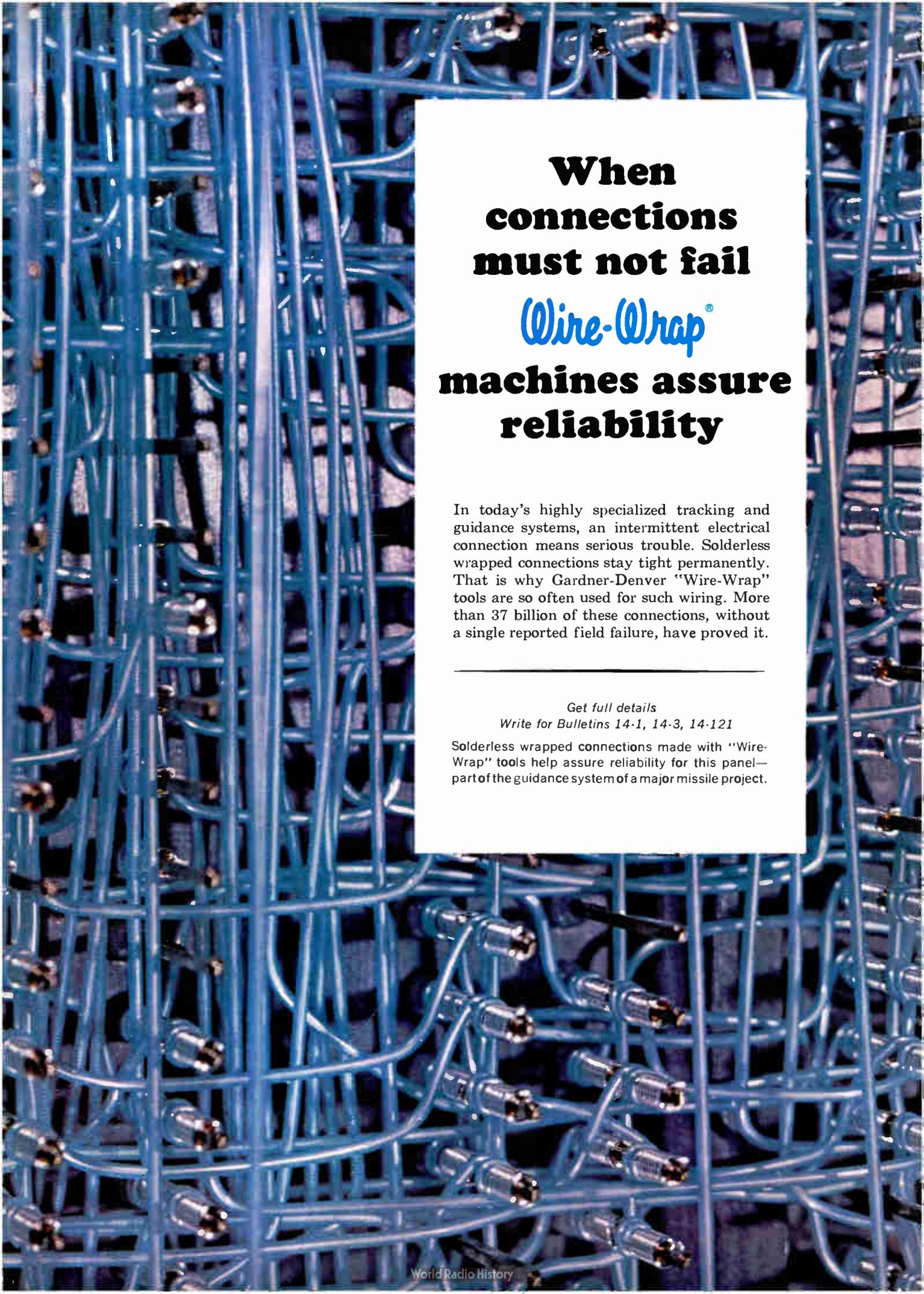
Television and TV tape recording are the methods by which the system acquires and stores material. Magnetic tape is the micro-storage medium on which TV images of document pages are recorded.

Here's how the system works. Each document is televised and simultaneously recorded on video tape. The data is then incorporated into the segment of tape containing the televised images of related previously-recorded documents. This segment of tape can be considered to be a "magnetic file folder." Each folder has an address, which is used to locate a particular document within a magnetic-tape reel.

To retrieve a particular document, the requestor dials the appropriate address through a control unit at his desk. The television recorder rapidly searches through the correct tape reel and locates the desired "magnetic file folder." The document images in this folder are then copied into a temporary storage unit, and the recorder is free to answer other requests. Documents in the temporary storage are then available for examination by the requestor via a TV screen on his desk. If desired, a printer can be tied into the storage unit to provide printed copies of each document. When the requestor is finished with the folder, images in the temporary storage are erased.

The micro-filing system enables personnel to draw on televised files at the touch of a button. Documents are presented on desk television screens or as printed copies.





**When
connections
must not fail**

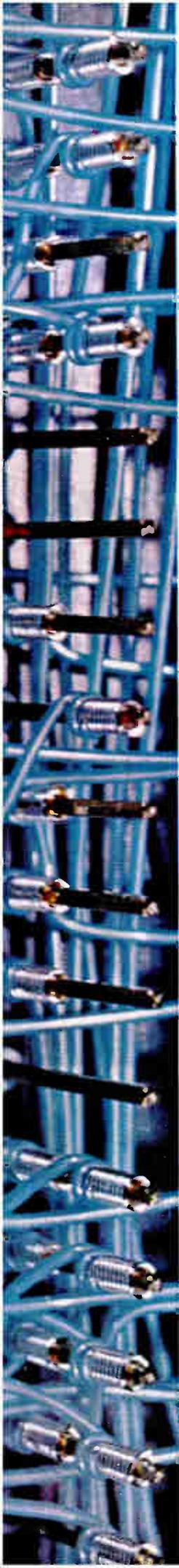
**Wire-Wrap[®]
machines assure
reliability**

In today's highly specialized tracking and guidance systems, an intermittent electrical connection means serious trouble. Solderless wrapped connections stay tight permanently. That is why Gardner-Denver "Wire-Wrap" tools are so often used for such wiring. More than 37 billion of these connections, without a single reported field failure, have proved it.

Get full details

Write for Bulletins 14-1, 14-3, 14-121

Solderless wrapped connections made with "Wire-Wrap" tools help assure reliability for this panel—part of the guidance system of a major missile project.



Miniaturization is easy with "Wire-Wrap" tools and machines that make connections on terminal spacings as small as .100"—using 30- or 32-gauge wire.



For automatic wiring of modular panels, "Wire-Wrap" machines programmed with punched cards provide maximum flexibility for immediate engineering changes and circuit modifications.

Why *Wire-Wrap*[®] tools and machines assure complete connection reliability

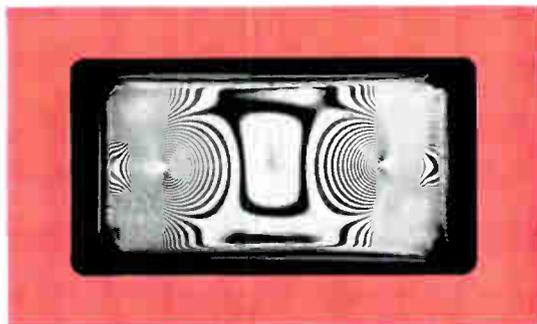
Made in less than a second (at a tremendous savings of cost and time) Solderless connections wrapped with "Wire-Wrap" tools stay tight for keeps. The reasons:



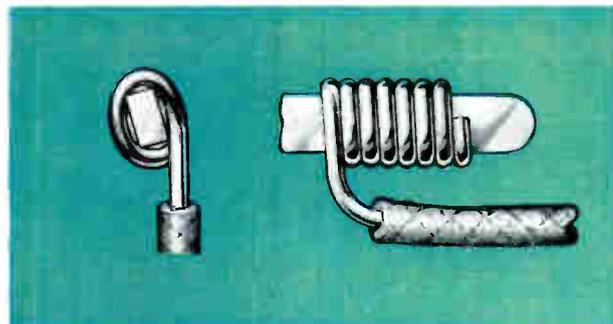
Metal to Metal Contact. Solderless connections made by "Wire-Wrap" tools, scrape off surface film from wire and terminal at each point of contact. Solid state diffusion strengthens connection as it ages.



Gastight Contact Areas. These solderless connections remain gastight when exposed to severe changes of temperature and humidity, and are unaffected by atmospheric corrosion.



High Pressure Contact. Initial wrapping pressure may go as high as 100,000 psi. The cold flow of wire causes pressure to drop to a value greater than 29,000 psi, where the metal stabilizes and pressure remains constant.



Mechanical Stability. Connections stay tight and mechanically stable under assembly and material handling. Connections are not subject to embrittlement caused by changes in metallurgical structure, since the solderless method requires no heat.



SEE WHAT AIR IS DOING NOW...SEE
GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

Circle 47 on Inquiry Card

World Radio History

WHAT'S NEW

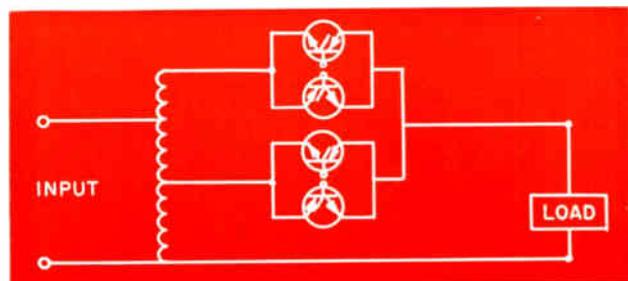
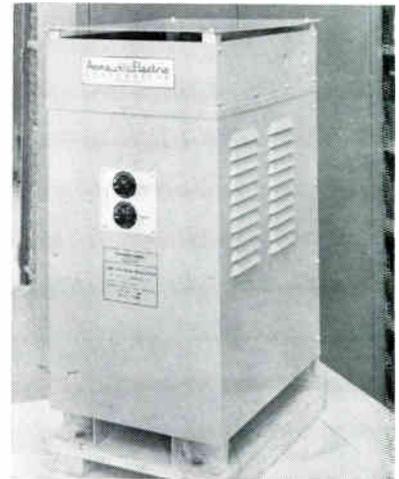
AC VOLTAGE REGULATOR

A SOLID-STATE AC LINE-VOLTAGE REGULATOR capable of single-phase outputs from 100 va to more than 25 kva has been developed by Acme Electric Corporation, Cuba, N. Y. The regulators use SCRs as phase-controlled switches, which switch voltage taps on a transformer to provide a constant output.

The transformer provides a low- and high-voltage tap. A back-to-back pair of SCRs is connected to each tap and have a common output connection. The lower tap provides the desired output voltage level when the input voltage is maximum; the high tap provides the same output voltage when the input voltage is minimum. When the input voltage is between the limits of its range, the output voltage is derived from the low-voltage tap during the early part of each half cycle, and from the high-voltage tap for the later part of each half cycle. The phase angle at which the switch from low tap to high tap occurs is determined by a feedback system. This system senses the output voltage and compares it with a reference. The voltage difference operates a phase-shift circuit which supplies gate signals to the high-voltage tap SCRs. Regulation accuracies of $\pm 1\%$ and $\pm 0.5\%$ are standard with these supplies.

The step in the output-voltage waveshape introduces harmonics. For a 10% voltage step the total harmonic content is typically 4%. Standard regulators are available which cover input voltage range of

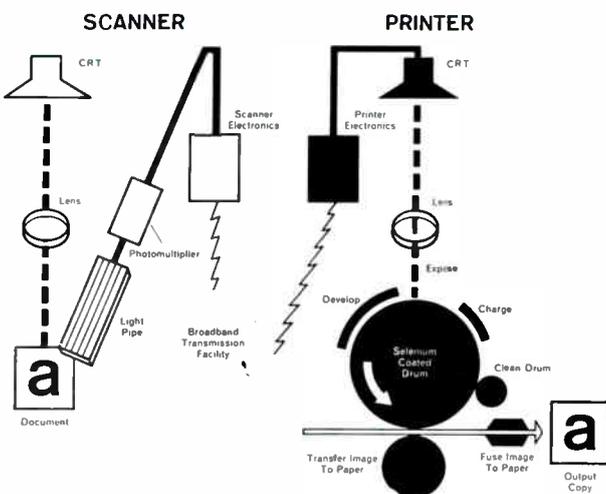
The 25kva unit operates from 460v, 60cps and gives 460v RMS.



Constant-voltage is maintained by SCRs connected to each tap. The low tap provides the output at maximum voltage input; the high tap provides the output at minimum input.

$\pm 13\%$. These regulators use three transformer taps and three pairs of SCRs. This arrangement keeps the harmonic content low by using small voltage steps, and yet allows a wider range of regulation.

LONG DISTANCE XEROGRAPHY



Documents can be fed directly into the LDX scanner and transmitted without translation into digital language.

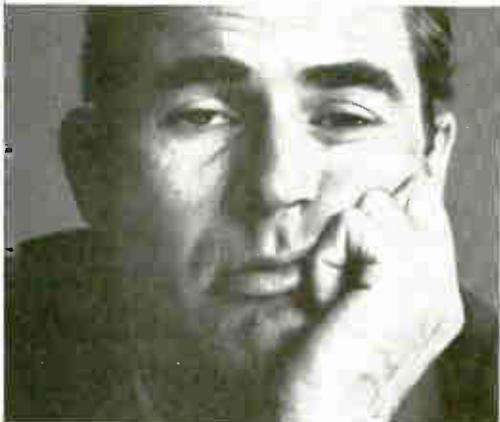
AN INNOVATION IN GRAPHIC COMMUNICATION, which could have a profound effect on information handling, is long-distance xerography (LDX).

This high-speed line copy document transmission system by Xerox Corp., Rochester, N. Y., consists basically of a scanner, a transmission link or network, and a printer. When a document is fed into a scanner its image is converted into electrical signals for transmission over existing broadband communication links. When the signals are received, they are converted back into light images, and the document is reproduced in the printer through xerography.

In the scanner, a small spot of light a few thousandths of an inch in diameter is generated by a CRT and scans across the document as it is moved through the scanner by the document transport mechanism. Where the scanning spot hits the document, the black image areas absorb most of the incident light,

(Continued on page 140)

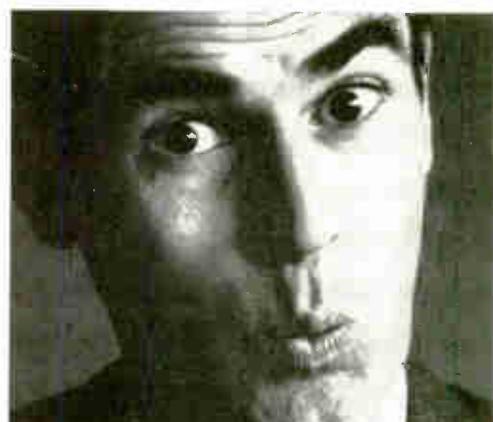
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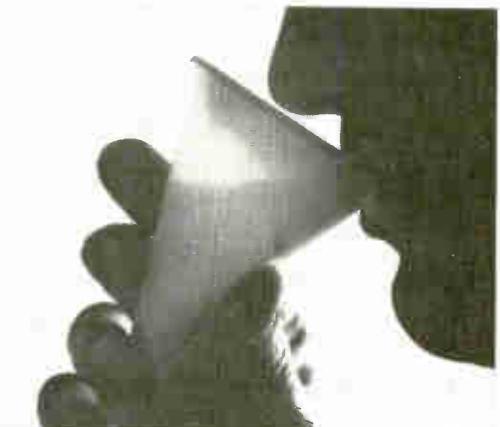
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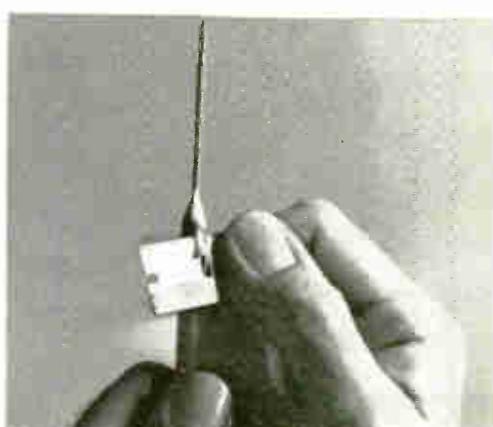
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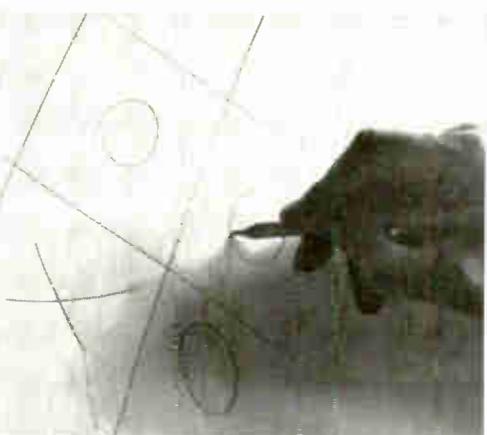
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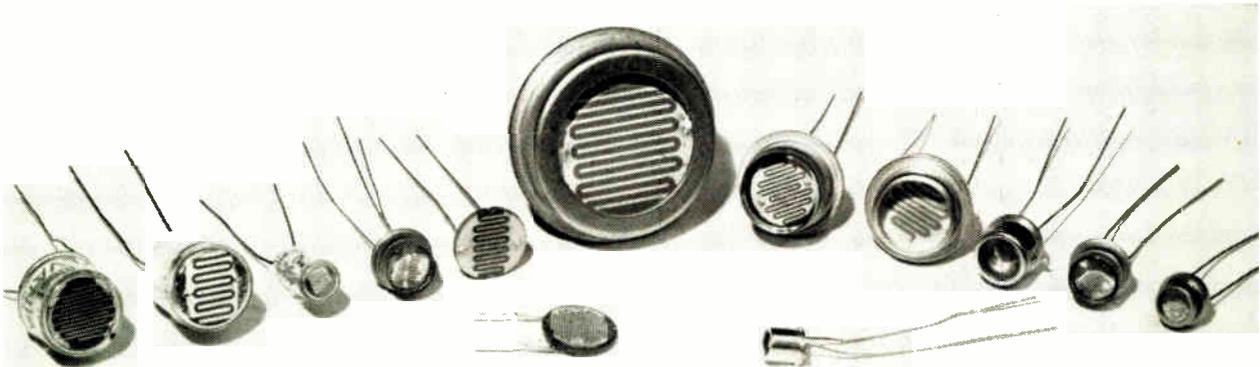
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CHOOSING PHOTOCONDUCTIVE CELLS

A discussion of photoconductor characteristics offering a general working knowledge of photoconductive cell capabilities and limitations—to help the designer intelligently choose the right cell.

By **J. W. TRAUTWEIN**
General Electric Co.
Owensboro, Kentucky



PHOTOCONDUCTIVE CELLS HAVE ADVANTAGES over gas and vacuum photocells, especially in sensitivity and circuit simplification. The photoconductive cells open the way for uses totally outside the field of the earlier photosensitive devices.

To apply photoconductive cells properly, the circuit designer should know the properties and limitations of the cells, also some of the problems faced by the cell designer. The latter knowledge helps the designer request a cell whose characteristics can be economically met.

* * *

Photoconductive cells come in a variety of sizes and shapes. All have the same general structure, although they appear to be very different from one another.

The photosensitive material is applied to a flat ceramic substrate or some similar insulating material. The coating is about 1 mil. thick. A few manufacturers press the photosensitive material into a block and use this as the substrate. On this material are applied two or more electrodes of some conducting material. When an ohmic electrode material such as indium is used, there are no polarity effects. Therefore, photoconductive cells can be used in both dc and ac circuits, since they behave as ohmic resistors.

The electrode pattern (the length and width of the photosensitive material between the two electrodes) determines the sensitivity and slope characteristics of the cell. The light energy (photons) striking the photosensitive material causes electron movement, and current flows when there is a potential between the two electrodes.

To protect the cell against mechanical and climatical influences, it is placed in a glass-metal, glass or plastic enclosure. Since the photosensitive material is easily scratched and moisture has a detrimental effect on it, the enclosure should be moisture proof.

Photosensitive material is the most important factor in the design of any photoconductive cell. Though there are many materials, only two are being used extensively: cadmium sulfide and cadmium selenide. In terms of cell operation, the differences are considerable, as shown in the photosensitive materials table.

Table 1

Characteristic	Cadmium Sulfide	Cadmium Selenide
Sensitivity	High	Very High
Dark Current	Low at Room Temp.	High at Room Temp.
Peak Spectral Response	5300-6300 Å	6800-7400 Å
Temp. Variations	Fairly Stable	Very Unstable
Breakdown Voltage	High	Medium
Life Test Stability	Good	Fairly Good
Response Time	Slow	Fast

Sensitivity and Slope

Sensitivity is the amount of current that passes between the two photocell electrodes as light energy strikes the photosensitive material. The more current a cell conducts, the more sensitivity it has. However, two types of cells that have the same sensitivity at one light level may differ at another light level. This current change is defined as slope. Three variables determine the sensitivity and slope of a photoconductive cell.

The *first variable* is the amount and type of doping ingredients of the photosensitive material, plus the type of material — cadmium sulfide or cadmium selenide.

The *second variable* is the distance across the photosensitive material separating the two electrodes (usually in the order of 0.005 in. to 0.035 in.). This is known as the gap width.

The *third variable* is the product of the gap width times the gap length of the photosensitive area. The greater the sensitive area, the other two variables being equal, the higher the photocell sensitivity. This is the reason for wavy and comb-type electrode patterns on many photocell types.

To have an accurate description of photocell sensitivity, it must be defined at two light levels: a low-level (1-10 ft.-candles) and a high level (50-100 ft.-candles). A line drawn between these two points on log-log paper (Fig. 1) approximates the actual resistance vs. illumination curve and shows the slope of the photoconductive cell. The curve is no longer linear above 100 ft.-candles, due to saturation effects in the photosensitive material. At extremely high light levels the line approaches zero resistance asymptotically.

Slopes for 4 typical sulfide types with the same physical size are also shown in Fig. 1. Photocells A and B have the same gap width, but A is made of a more sensitive photoconductive material and has a smaller photosensitive area. When testing these photocells at 1 ft.-candle, they appear to be equal, but readings at higher light levels show a difference. Thus, gap length as well as gap width is of primary importance in obtaining sensitivity. To overcome a smaller photosensitive area, photocells B and C are made of the same photoconductive material, but B has a wider gap width and a smaller photosensitive area. Photocell C has more sensitivity than B over the entire illumination range because of the smaller gap width and the additional photosensitive area.

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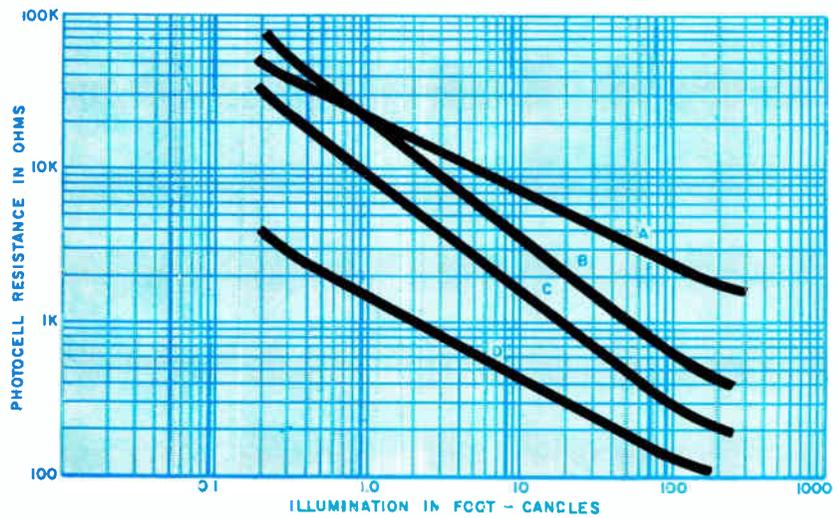


Fig. 1: Photocell Resistance vs. Illumination for 1/2 in. Cadmium Sulfide Photocells.

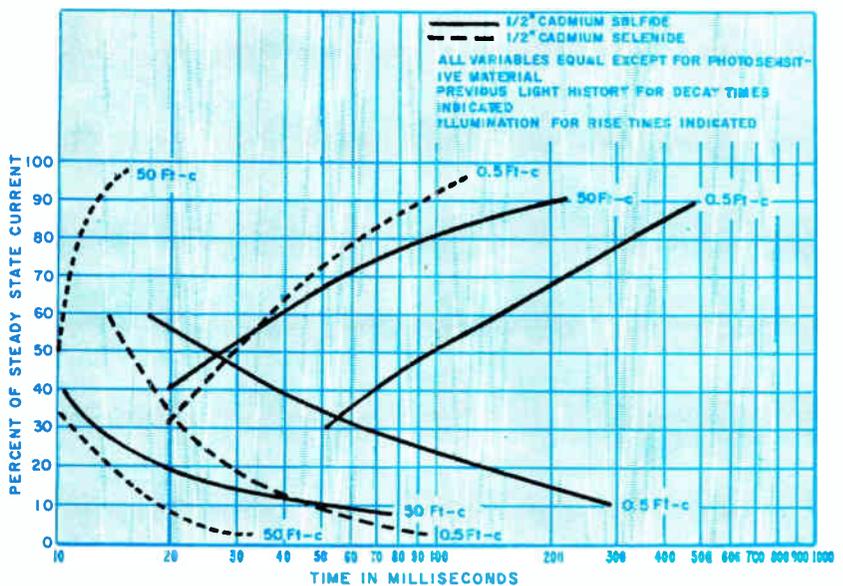


Fig. 2: Response Times for 1/2 in. Cadmium Sulfide and 1/2 in. Cadmium Selenide Photocells.

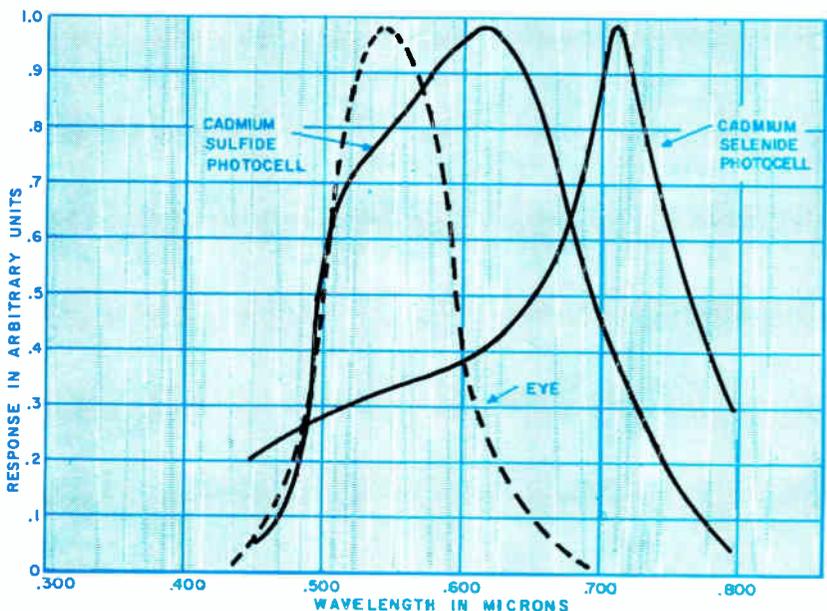


Fig. 3: Spectral Response for Cadmium Sulfide and Cadmium Selenide.

PHOTOCONDUCTIVE CELLS

(Continued)

Photocells C and D have the same photosensitive area and the same photoconductive material, but C has a larger gap width than D. At lower light levels, the gap width has more of an effect than at the higher levels. Thus, it is necessary to specify the illumination level when defining tolerances on sensitivity. Ten photocells may be within $\pm 30\%$ sensitivity tolerance at 2 ft.-candles, and within $\pm 15\%$ sensitivity tolerance at 50 ft.-candles.

Dark Current

Photoconductive materials are poor conductors in darkness. Cadmium sulfide has few free electrons and is a good insulator in the dark, but when radiation falls on the crystal, the energy of the radiation is absorbed by the lattice. A number of electrons then become free, and the material ceases to be an insulator and becomes a conductor. The amount of doping ingredients (impurities) used in the material determines the number of free electrons, and this affects the sensitivity. Any change in the three variables (gap width, photosensitive area, and photosensitive material) that increases sensitivity also increases dark current. Cadmium selenide is a more sensitive material (has more free electrons for a given light level) than cadmium sulfide. Therefore, it has more sensitivity and more dark current for a given set of conditions, all other variables being equal.

True dark current should be measured after the photocell has been in the dark a minimum of 1 hour. The photocell current decays very rapidly for the first few seconds after illumination is removed, and then slowly for about 1 hour. After this time an approximate steady-state dark current is reached. However, since it is both unrealistic to wait an hour to test the dark current of each photocell, and many uses require a certain maximum dark current of a few seconds, another method is used. A maximum

dark-current rating is usually specified a certain number of seconds after a given illumination is removed. Fig. 2 shows decay curves for both a typical cadmium sulfide and a cadmium selenide photocell. These curves show the importance of the previous light history of the photocell in reading dark current. The higher the light level history, the faster the photocell current will decay.

Response Times

Rise and decay characteristics are very critical in some uses. If on-off switching times in the 100msec.

possible for a given use, the electrode gap width should be as wide as possible but still give the minimum required light resistance. The light source can then be made bright, and when the illumination is removed the photocell current quickly decays. When the bright light is applied after the dark cycle, the photocell current rises quickly.

Photoconductive material will have faster rise and decay times if acceptor impurities are added to the mix; this also decreases the mix sensitivity. In defining response times for a particular use, the maximum required light resistance and

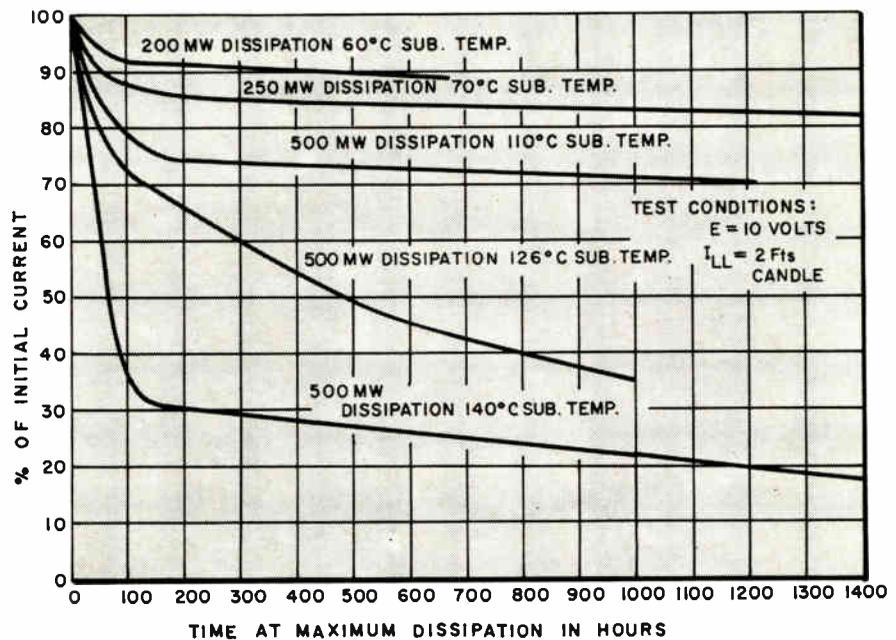


Fig. 4: Life-Test Results for $\frac{1}{2}$ in. Cadmium Sulfide Photocells.

range are needed, cadmium selenide must be used. Cadmium selenide is faster due to the higher energy level of the recombination and trapping centers of this material. The response times of cadmium selenide and cadmium sulfide photocells are shown in Fig. 2. The light history of the photocell has a direct relationship to response time. The higher the light level before illumination is removed, the faster the photocell current decays. Also, the brighter the light that the photocell encounters after it is removed from the dark, the faster the photocell current rises to its final steady-state value.

To obtain the fastest response

the minimum required dark resistance must be specified. For example, with a given gap width and sensitive area it may be easier to alter the mix to change from 1K Ω light resistance to 1 megohm dark resistance in 100msec. than it would be to make a cell that would change from 100 Ω to 100K Ω in 200 msec.

Specification data usually gives rise and decay times for the photocell only. This data is obtained by using a shutter device and, therefore, the rise and decay times of the light source are not included. In most uses, the rise and decay times of the light source must also be considered. A low inertia lamp aids in

giving fast response times in actual circuits.

Spectral Response

Spectral response is important, since photosensitive materials are selective in the wavelengths to which they respond. Curves for a typical cadmium sulfide and cadmium selenide photocell are shown in Fig. 3. Fortunately, the commonly-used tungsten filament lamp has a broad spectral response and matches both photosensitive materials well enough to give good efficiency in sensitivity. In defining sensitivity, the spectral characteristics of the light source

shifted 400-500Å by adding an excess of acceptor or donor impurities to the mix. Adding acceptor impurities shifts the peak spectral response toward the ultra-violet spectrum and decreases photocell sensitivity. Adding donor impurities shifts the peak spectral response toward the infrared spectrum and increases photocell sensitivity.

Usually, specification data gives the peak spectral response value and spectral response curve. A wide variation in the skirts of the curves of two manufacturers' photocells is usually due to different processing schedules. Therefore, two manufac-

terial and the gap width between electrodes. The more sensitive the photosensitive material is made, the lower the breakdown voltage for a given gap width. Decreasing the sensitivity of the photosensitive material by adding acceptor impurities raises the breakdown voltage. Increasing the gap width, which also decreases sensitivity, raises the photocell breakdown voltage. The rise in breakdown voltage is appreciable, but not a linear function, as the gap width is increased. For example, doubling the gap width of a given photocell will not double the breakdown voltage. Measurements have been made on a medium sensitivity cadmium-sulfide photocell with varying gap widths. The total breakdown voltage (where an arc occurs) in the dark for three gap widths is shown as follows:

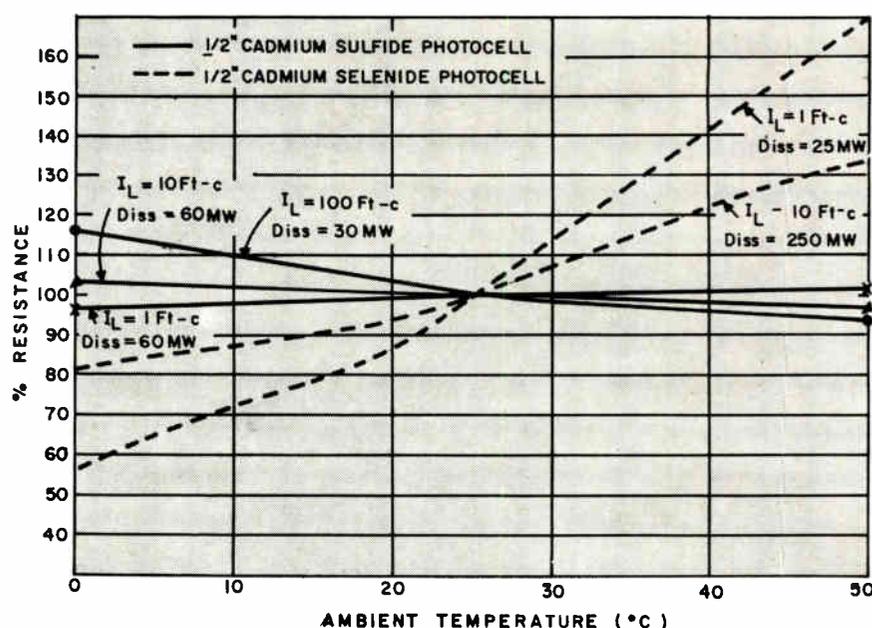


Fig. 5: Temperature Dependence Curves: Ambient Temperature vs. % Resistance.

must also be stated.

Photocells are not only responsive to visible light, but also are sensitive to radiation in the infrared spectrum. Cadmium selenide is much more sensitive to infrared than cadmium sulfide, since its peak response is located nearer the infrared region of the spectrum. Heat radiation, therefore, has much more effect on cadmium selenide than on cadmium sulfide photocells. The cadmium selenide photocell is favorable for uses such as fire-alarm control apparatus, since its light-distribution curves are maximum near infrared.

The peak spectral response of the photosensitive material can be

shifted 400-500Å by adding an excess of acceptor or donor impurities to the mix. Adding acceptor impurities shifts the peak spectral response toward the ultra-violet spectrum and decreases photocell sensitivity. Adding donor impurities shifts the peak spectral response toward the infrared spectrum and increases photocell sensitivity. A narrow spectral-response bandwidth of a photoconductive cell makes it more selective in the wavelengths to which it will respond. Such a cell will have a lower sensitivity than a cell with a broader bandwidth—assuming, of course, the spectrum of the light source is broader than the spectral response of either photocell.

Cell Ratings

Voltage—The voltage rating is affected by the photosensitive ma-

Gap Widths	Breakdown Voltage (Peak AC)		
	Lowest Cell	Highest Cell	Average
0.008 in.	650	800	710
0.011 in.	800	1100	905
0.023 in.	950	1500	1245

A safety factor is included in voltage ratings to insure that under the most adverse conditions the photocell will have enough voltage applied to reach the breakdown point and become inoperable. With the 0.023 in. gap width, small arcs begin to appear at about 750v. These arcs, which are between particles of the photosensitive area and not across the entire gap width, prevent the two electrodes from shorting and making the photocell inoperable. It would not be practical to operate in this voltage range because of the wide current fluctuations. This photocell type, with the 0.023 in. gap width, has a maximum voltage rating of 250vdc.

Maximum Dissipation—The dissipation rating is determined by the photocell substrate area, the type of substrate material, and how well the heat is removed from the substrate. The limiting factor of dissipation is the substrate temperature. After the
(Continued on following page)

PHOTOCONDUCTIVE CELLS

(Continued)

substrate reaches a critical temperature of about 110°C, the sensitivity of the photosensitive material decreases rapidly on life test. To insure a stable, long-life photocell, the maximum dissipation rating must maintain the substrate temperature below this critical temperature. To increase the dissipation rating of a photocell type, the substrate must be made larger, the radiation properties of the substrate material must be improved, or a better method of conducting the heat from the substrate must be used. The most used method of conducting additional heat from the substrate is to use external heat sinks.

Ambient Temperature — Since the limitation of maximum dissipation is the substrate temperature, the ambient temperature also becomes a limiting factor. As the ambient temperature increases, the photocell dissipation must be decreased to insure that the 110°C substrate temperature is not reached. Many photocell manufacturers specify a derating curve similar to that shown in Fig. 4. This insures that the 110°C substrate temperature is never reached.

The curves in Fig. 5 show the percentage of resistance change to changes in ambient temperature for a typical 1/2 in. cadmium sulfide photocell and a typical 1/2 in. cadmium selenide cell. The resistance of the cadmium sulfide photocell changes slightly over the ambient temperature range of 0°C to 50°C. This was with only a small amount of dissipation on the photocell. At higher dissipations the change would be less because as the dissipation increases, the ambient temperature becomes a smaller percentage of the total substrate temperature.

The two curves for the cadmium selenide photocell show that it is sensitive to ambient temperature changes even at high dissipations. This shows the advantage of using

cadmium sulfide photocells where stability with ambient temperature variations is a primary consideration.

Life Tests

Life-test data shows that the greatest change in resistance due to fatigue of the photosensitive material occurs in the first 100 hours. The resistance usually changes very little after the initial 100 hours, provided the critical temperature of the substrate is not exceeded. The life-test curves shown in Fig. 6 are for a 1/2 in. cadmium sulfide photocell. The test conditions by which the photocell current was measured were 100vdc across electrodes and a

tained, since with ohmic contacts the curve is independent of voltage. (Refer to Fig. 1.) For example, doubling the voltage would double the current, resulting in the resistance remaining constant. In deciding on life-test requirements, the dissipation and ambient temperature (which determine the substrate temperature) at which the life test is conducted and the percentage change in current acceptable at a given illumination are the main criteria to be considered. The life test, in which the substrate temperature was 140°C, shows the deteriorating effect on the photosensitive material when the substrate temperature is kept above the critical point.

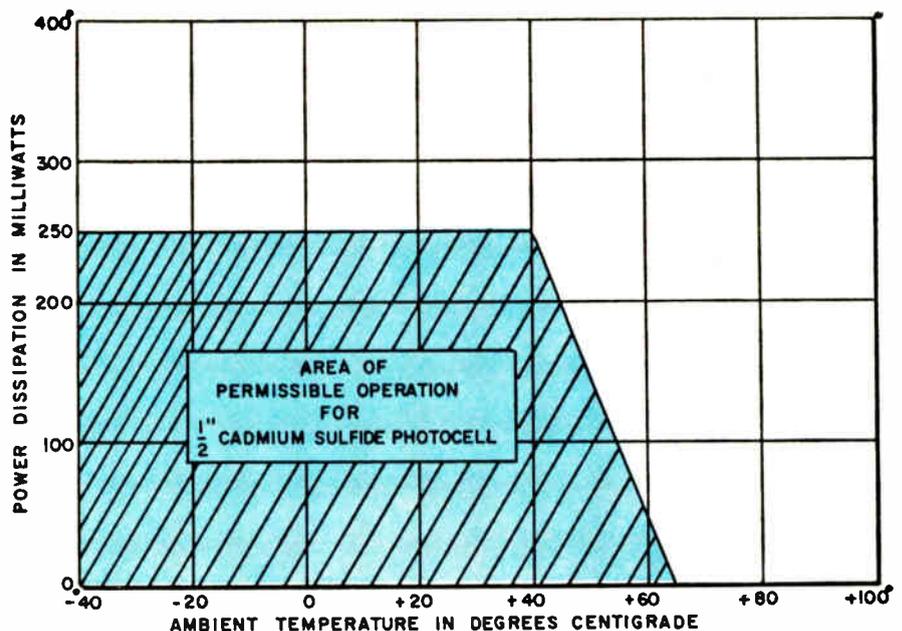


Fig. 6: Power Dissipation Rating Chart. Area of Operation is shown shaded.

2 ft.-candles illumination. The percentage of the initial current vs. hours at maximum dissipation is plotted. If the photocells had been tested at higher illuminations, the percentage change on life would have been less. It is also true that testing the photocells at lower illuminations would have resulted in greater percentage changes during life.

It is necessary to specify the amount of change in resistance on life test that is acceptable when tested at a given light level. However, it is not necessary to specify the voltage at which the resistance vs. illumination curves were ob-

Life-tests show that photocell resistance increases due to the fatigue of the photosensitive material. Hence the sensitivity of the photocell decreases during life. In some rare cases sensitivity increases for the first few hours of life test. This can be attributed to under-processing of the photosensitive material initially.

Of course, various manufacturers' photocells show varying degrees of change in resistance of life test. This is due to different processing methods, different doping impurities, etc. All photocells will generally change the greatest amount in the first 100 hours and will deteriorate rapidly in sensitivity when the 110°C sub-

strate temperature is exceeded.

An entirely different phenomenon occurs when the photosensitive material starts deteriorating because of moisture. The dark current starts increasing rapidly and the photocell soon becomes inoperative. For this reason it is desirable that the photocell encapsulant be moisture proof.

Choosing Cell

Each cell is unique in its combination of characteristics, ratings, and physical properties. Characteristics include sensitivity, slope, spectral response, speed of response, and dark current; ratings include maximum values of voltage, current, power dissipation, and temperature; and physical properties include shape, size, housing material, and type of sealing.

None of the foregoing can be ignored in choosing a cell, although consideration is usually given first to characteristics. Of these, the most important is usually sensitivity. Other characteristics, however, may be more important for some uses. If fast switching time is required, a

cadmium selenide cell should be chosen, although compromises in circuit design might be required to compensate for the greater effect of temperature variations on selenide cells as compared to sulfide cells. Primary battery operation might make standby drain the most important characteristic, and a cell with low dark current would be advantageous. For scratch-free potentiometer service, slope may be the primary characteristic.

After the required characteristics have been determined, the ratings must be considered. The voltage rating required can be determined with some degree of certainty prior to breadboarding, since the supply voltage for the cell is usually known. Power dissipation, however, depends on supply voltage, the amount of resistance in series with the cell, the cell sensitivity, and the light level. Thus only a general range of probable dissipation values can be made without measurements. Maximum cell dissipation may be calculated if we assume that at some light level the cell resistance equals the resist-

ance in series with the cell (maximum cell dissipation occurs at this point), and the light remains at this level for long periods. Physical attributes are determined by the nature of the light source, the final packaging of the device, and the environmental conditions under which the device must work.

If the use involves a small spot of light as the illumination for the cell, the cell should be of such a size that the light covers the entire exposed cell area. This is necessary because the dissipation rating of cells is based on full-area illumination, and partial illumination may cause excessive dissipation in a small area. Except for the very lowest cost applications, hermetic sealing is desirable to protect the cell from moisture and early deterioration.

Careful consideration of all of the known requirements will narrow the choice of cells drastically, and allow the final cell selection to be made by breadboarding the circuit with a relatively small range of cell characteristics.

AC-DC SCR PACKAGES

THREE-PHASE SCR PACKAGES with output ratings from 5kva to 60kva have been produced by Magnetics Inc., Butler, Pa. The units operate from 240 or 480 volts, 60 cycle, 3-phase lines and provide dc and ac outputs.

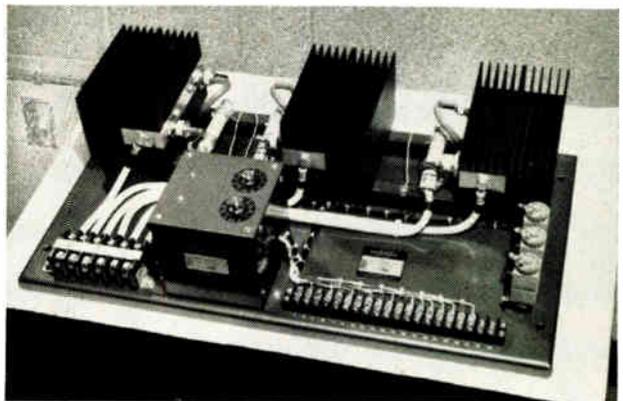
The SCR packages includes the power SCRs and diodes, heatsinks, a magnetic firing circuit, and current-limiting fuses. The fuses are in series with each controlled rectifier and voltage suppressors to protect the semiconductors from load and line transient voltage spikes. The packages operate from any load configuration (Delta or Wye) into any load configuration.

The firing circuit consists of three unsymmetrical magnetic amplifiers with the output of each terminated into a pulse-transformer primary. The pulse-transformer secondaries couple a constant-amplitude, variable-phase pulse to the SCR gates. An unsymmetrical magnetic amplifier provides phase control of the gating pulse over 210 degrees, which is essential to provide full range control of a three-phase SCR circuit. The firing circuit has five isolated signal windings of 100 turns each. The trigger circuit has a basic sensitivity of 0.1 amp.-turns and

provides full range control. A gain adjustment reduces sensitivity to match the signals available.

The advantage of the magnetic firing circuit is isolated windings, which provide multiple control-signal mixing capability. The mag. amp. SCR package lends itself to closed-loop control systems. In addition, this package requires no warm-up time, is small, has fast response and high operating efficiency. The SCR package replaces MG sets, rotating field exciters, saturable core reactors, magnetic amplifiers, etc.

Packages operate from any load configuration into any load.



Designing and Analyzing Voltage Regulators

By **VERNON R. CUNNINGHAM**

Electronic Engineer,
Collins Radio Co.,
Richardson, Texas.

Here is a simple method, regardless of circuit complexity, for analyzing, by sections, series type transistorized voltage regulators. Quick evaluation of different types of circuits is stressed to find the best one to use.

ANALYSIS OF TRANSISTORIZED VOLTAGE REGULATORS is not a difficult task. The difficulty is in choosing the correct circuit for the needed performance before the analysis begins. Too often the designer finds after analyzing a circuit that it is not the best circuit for the job. After going through such an experience, I decided that a more generalized method of design was needed. This method is presented here.

* * *

Consider the diagram of Fig. 1. Most series type transistorized voltage regulators may be considered

to be this type, if each block is defined as follows:

Preregulator—To provide as nearly as possible a constant current whose value is independent of the input voltage.

Series Element—To provide a method of making the output voltage independent of the input voltage.

Amplifier—To monitor variations in output voltage and to present a signal proportional to them to the input of the comparator.

Reference—To provide a stable reference voltage.

Comparator—To compare the output voltage to a reference potential and to provide a current proportional to variations of the output voltage.

TABLE 1

A	Amplifier gain
E_i	Input voltage to the voltage regulator
F	Regulation factor; dE_o/dV_o
G	Preregulator figure of merit; dI_p/dE_i
$H_{f\alpha}$	Common emitter forward current transfer ratio
$H_{f\alpha c}$	$H_{f\alpha}$ of the comparator element
$H_{f\alpha s}$	$H_{f\alpha}$ of the series element
H_{ibc}	Common base input impedance of the comparator element
I_o	Output current of the voltage regulator
I_p	Output current of the preregulator
I_R	Zener current (used in reference element)
I_s	Zener current (used in preregulator)
r_{bc}	Base resistance of transistor used in comparator
r_{bs}	Base resistance of transistor used in series element
r_{ec}	Emitter resistance of transistor used in comparator
r_{es}	Emitter resistance of transistor used in series element
R_A	Amplifier output impedance
R_f	Feedback resistor
R_o	Output impedance of the voltage regulator
R_R	Zener impedance of the reference element
R_s	Zener impedance of zener used in preregulator
$V_{c\alpha s}$	Collector to emitter voltage of the series element
V_o	Output voltage of the regulator
V_R	Zener voltage of the zener used in the reference element
V_s	Zener voltage of the zener used in the preregulator

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Fig. 1: Series type transistorized voltage regulator diagram.

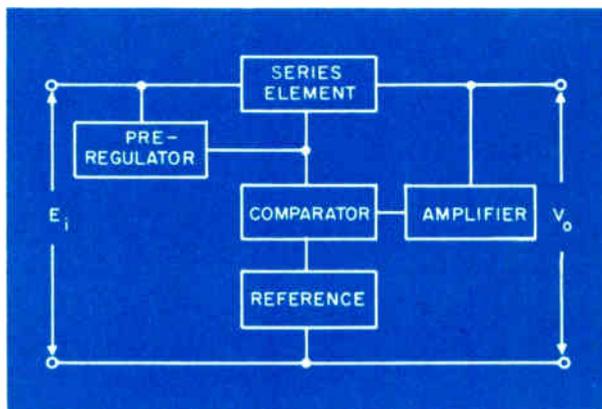
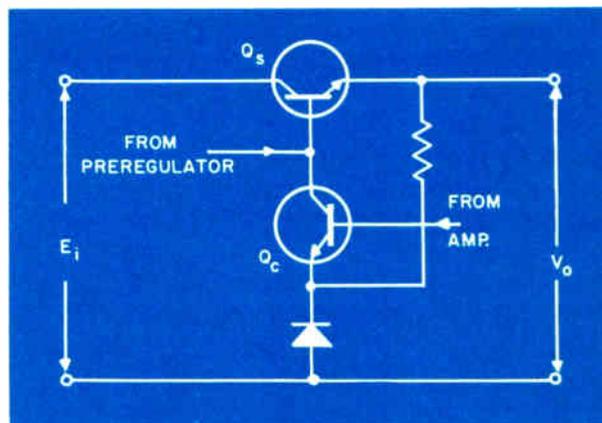


Fig. 2: Simplified voltage regulator circuit.



The Complete Regulator

First consider the complete voltage regulator system, with the goal in mind of understanding how each element affects the overall performance.

Fig. 3 shows a generalized equivalent circuit for the diagram of Fig. 1 and the simplified circuit shown in Fig. 2. It can be shown that:

$$R_o \equiv \frac{dV_o}{dI_o} = -\frac{1}{H_{fes}} \left(H_{ibc} + R_R + \frac{R_A}{H_{fec}} \right) \quad (1)$$

$$F \equiv \frac{dV_o}{dE_i} = \frac{G}{A} \left(H_{ibc} + R_R + \frac{R_A}{H_{fec}} \right) \quad (2)$$

Symbols are defined in Table 1. The negative value of R_o indicates that the output voltage decreases as the output current increases.

Consider now the terms within the parenthesis of both equations. Notice that since the zener diode will have an impedance of about 5 to 30 ohms and H_{ibc} will be from 30 to 100 ohms, the value of the terms within the parenthesis will be about 100 ohms for any reasonable value of amplifier output impedance. A useful rule of thumb would be:

$$R_o \approx \frac{-100}{A H_{fes}} \quad (3)$$

$$F \approx \frac{100G}{A} \quad (4)$$

It is now obvious that the preregulator figure of merit (G), amplifier gain (A), and forward current transfer ratio of the series element (H_{fes}) have a much more profound affect on regulator performance than do the other parameters.

Individual Elements

Other than the amplifier and series element, the most important element, performance-wise, is the preregulator. Since amplifier design is a topic in itself, and since improving the series element is simply a matter of two or more transistors in a Darlington connection for H_{fe} multiplication, the bulk of this discussion will concern the preregulator. But, before leaving the subject of amplifiers completely, notice that the amplifier need not be an active device. A passive resistor divider is used in many applications.

Two of the most often used types of preregulators are shown in Figs. 4 and 5, along with their values of G and I_p . The circuit of Fig. 5 is superior to that of Fig. 4 even without the addition of R_7 and should be considered when exceptional performance is needed. Notice that the addition of R_7 enables (ideally) G to be zero. The circuit of Fig. 4 is handicapped because it passes unregulated current from the line directly into the load, as shown by the second term in its value for G . But it is economical and is a vast improvement over the method of simply connecting a resistor from collector to base of the series element. The value of G for a resistor is simply the reciprocal of its resistance.

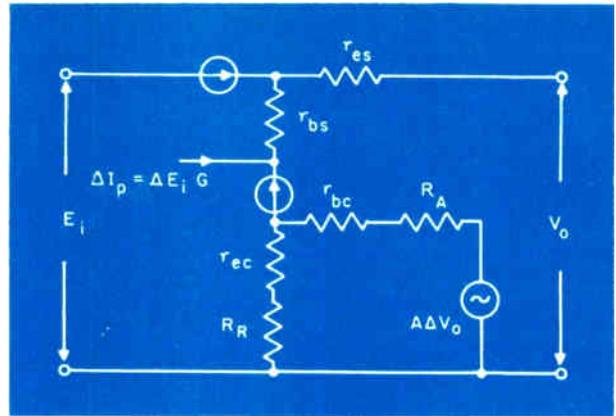


Fig. 3: Generalized equivalent circuit for the diagram of Fig. 1.

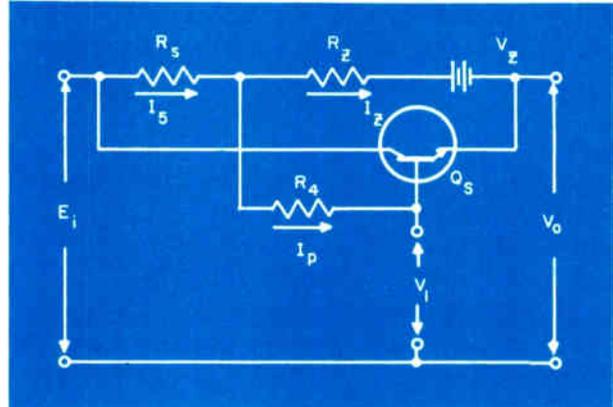


Fig. 4: A frequently used type of preregulator circuit.

$$I_p \approx \frac{V_{ces} - V_Z}{R_4}$$

$$G = \frac{R_Z}{R_4 R_5 + R_Z (R_4 + R_5)} + \frac{I_Z}{H_{fes} V_{ces}}$$

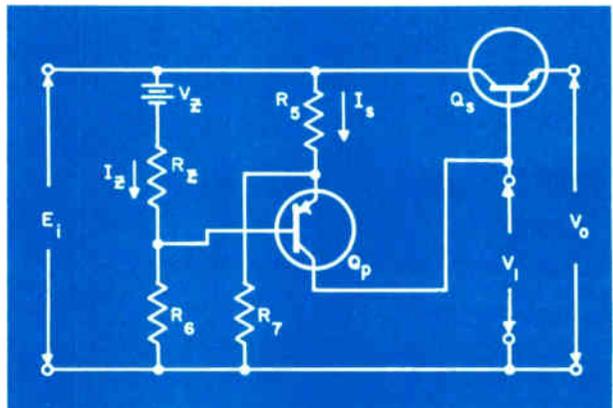


Fig. 5: Often used preregulator type superior to that of Fig. 4.

$$I_p \approx \frac{V_Z}{R_5}$$

$$G = \frac{\frac{R_Z}{R_6 + R_Z} - \frac{R_5}{R_5 + R_7}}{H_{ibp} + \frac{R_5 R_7}{R_5 + R_7} + \frac{R_6 R_8}{H_{ibp} (R_6 + R_Z)}}$$

$$\text{For } G \text{ to be zero: } R_7 \equiv \frac{R_5 R_8}{R_Z}$$

$$\text{If } R_7 = \infty \text{ Then: } G = \frac{1}{\frac{R_6}{H_{fcp}} + \left(1 + \frac{R_6}{R_Z}\right) (R_6 + H_{ibp})} \approx \frac{R_Z}{R_5 R_6}$$

VOLTAGE REGULATORS (Concluded)

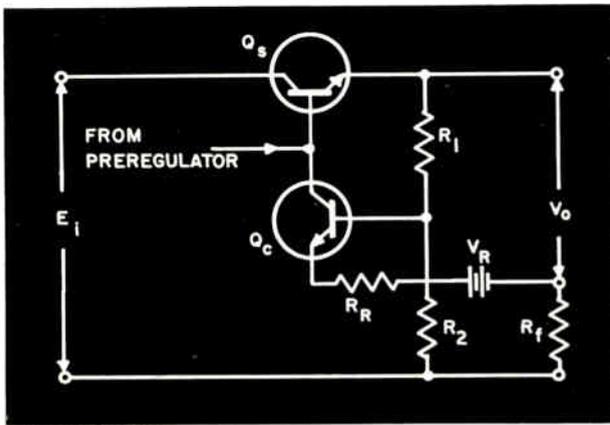


Fig. 6: Circuit of Fig. 2 modified to include a feedback resistor.

If some other type of preregulator is used, G can easily be found by expressing the preregulator output current I_p as a function of the input voltage E_i and taking the derivative.

A small improvement in performance can be obtained by minimizing the value of R_R , H_{ibc} , and R_A/H_{fbc} . Improvement here is usually made at the expense of increasing the current in the comparator element.

The Feedback Element

The output impedance of a regulator may be further improved by the addition of a feedback element if the discussion is no longer limited to the diagram of Fig. 1. Fig. 6 shows the circuit of Fig. 2 modified to include the feedback resistor. In Fig. 6

a simple resistor divider is used for the amplifier. It can be shown that:

$$R_o = \frac{1}{A} \left[-\frac{1}{H_{fbc}} (H_{ibc} + R_R + \frac{R_A}{H_{fbc}} + R_f \{1 - A\}) + R_f (1 - A) \right]. \quad (5)$$

Where, in the circuit of Fig. 6:

$$A = \frac{R_2}{R_1 + R_2} \quad (6)$$

$$(1 - A) = \frac{R_1}{R_1 + R_2} \quad (7)$$

$$R_A = \frac{R_1 R_2}{R_1 + R_2} \quad (8)$$

The value of F , for practical purposes, is unchanged from that given by Eq. 2. Notice that R_o can be made either positive, negative, or zero by properly choosing R_f . However, the value needed for R_f is highly dependent upon H_{fbc} . Since for production lot transistors over practical temperature ranges the value for H_{fbc} will vary widely, a practical choice of R_f for such conditions is difficult. Despite this, the feedback element can still be used in applications where the temperature range is not too demanding and where the feedback resistor may be selected or adjusted.

Conclusion

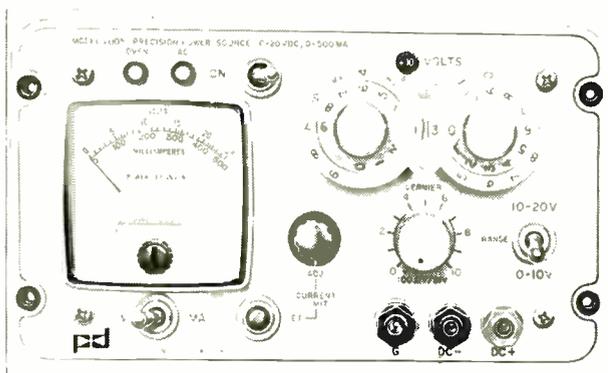
The above equations should provide the designer with a convenient method of analyzing by sections even the most complex voltage regulators as long as they fit the diagram of Fig. 1. Complex blocks can be considered as four terminal networks and the needed parameters found for direct substitution into the equations given.

HIGHLY STABLE POWER SUPPLY

THIS PRECISION POWER SOURCE takes full advantage of improved components and circuit designs to provide characteristics approaching that of a precision calibrator.

The Model 2005, by Power Designs Inc., West-

New designs and components produced a unit with the properties of a general-purpose supply and precision calibrator.



bury, N. Y., has an output of 0-20vdc at 500ma. Regulation and ripple levels are in the order of 50μv. Stability is better than 100μv./ 8 hours, and source impedance up to 20kc is less than 40 milliohms. The output voltage is adjustable in discreet 1mv. steps by means of a dual-concentric, 4-dial digital readout. A continuously-adjustable vernier potentiometer with a 10μv. resolution permits interpolation between steps.

The supply features adjustable current limiting, overload and shorting protection, remote voltage sensing, and remote programming. The unit is furnished in a half-rack structure, permitting two units to be mounted side-by-side in a standard 5¼-in. x 19-in. rack panel.

The critical amplifier stages and zener-voltage reference of this unit are maintained at constant ambient by a temperature-stabilized oven. This precludes the need for temperature-stabilized semiconductor devices.

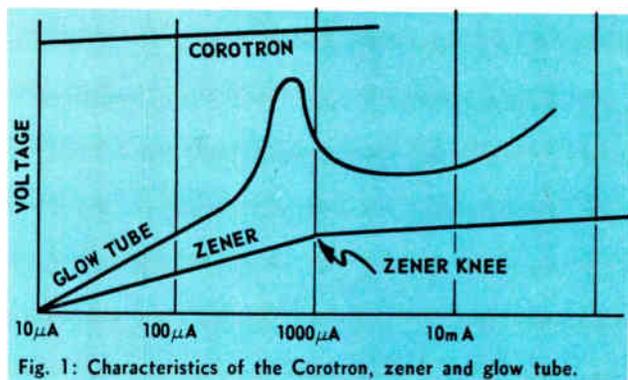


Fig. 1: Characteristics of the Corotron, zener and glow tube.

A High Voltage Equivalent of the Zener Diode

The Corotron is a high-voltage, low current device operating in the corona mode of discharge. The same techniques employed in the application of zeners to the design of low-voltage power supplies can be used with the Corotron to design high-voltage supplies.

By DONALD O. WARD,

Applications Engineer,
Victoreen Instrument Co.
5806 Hough Ave.
Cleveland, O.

TRANSISTORS AND ZENERS CAN BE USED TO DESIGN some very excellent low voltage power supplies, but their virtues diminish when the designer attempts to use them at high voltages. He frequently finds he must replace the transistor with a vacuum tube and also wishes for a high voltage Zener diode.

* * *

The Corotron™ provides the high voltage equivalent of the Zener diode. It is a miniature or micro-miniature gas tube operating in the corona mode of discharge. Its characteristics more nearly resemble those of the Zener than they do those of the well-known glow discharge tubes.

It may readily be seen that the Corotron is a high-voltage, low-current device; while the Zener is a high-current, low-voltage component. (Fig. 1)

The slope of the regulation curve for both the Corotron and the Zener is positive, so each may be considered as a d.c. voltage in series with a resistor. In the case of the Zener, the d.c. voltage is the voltage at the Zener knee, while for the Corotron, it is the voltage at which gaseous conduction begins. In both cases, the value of the series resistor is the value of the dynamic resistance of the device ($\Delta E/\Delta I$).

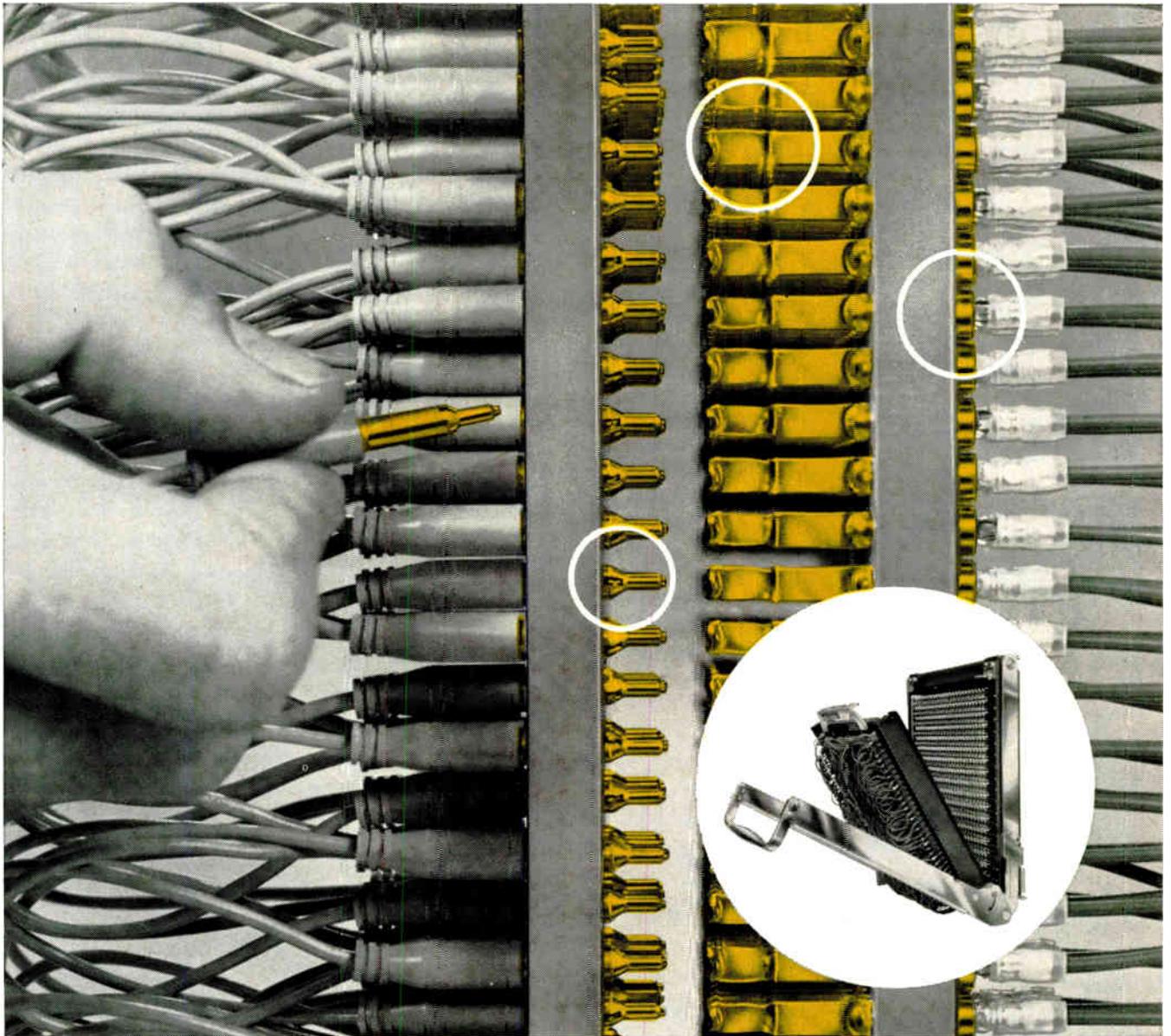
Available Voltage

Zeners are available in any voltage from a few volts to 50 or more, although the best characteristics are exhibited by those in the range of 6 volts to 12

volts where good temperature compensation is possible. Corotrons are available in any desired nominal voltage from 350 volts to 30,000 volts. Like Zeners, the Corotron may be used in series stacks to increase the total voltage.

Current Range

Originally Zeners were designed in fairly low power units but more recently, much greater current capabilities are available. However, since the Zener is useful as either a regulator or a reference, only at currents above the Zener knee, the minimum current is determined by the location of the knee. This knee generally occurs above 1 ma. Popular low power Zeners have a test point of 10 ma. This is usually selected as the point at which temperature compensation can best be affected. If Zeners are stacked for higher voltage operation this 10 ma current results in considerable power being dissipated in the reference circuit. Many types of Corotrons operate at currents as low as 5 μ a, making them economical as a high voltage reference, but restricting their usefulness to low power applications when employed as a shunt regulator. The "minimum current" listing for a Zener diode indicates the value of the current at the Zener knee and the device is useless below this region. The "minimum current" of the Corotron is the value of current below which noise may be generated. It may, however, be used



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Patchcord Programming Systems are comprised of a series of metallic contact junctions. The electrical performance of these systems is determined by the sum of the mechanical properties of these junctions.

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Ours is a modern, compact, lightweight system designed with fewer moving mechanical parts and is quality-controlled to maintain precision tolerances, resulting in increased reliability.

All contacts are gold-over-nickel plated. This, coupled with our patented double-wiping action that pre-cleans contact springs and patchcord pins, assures positive, reliable connections everytime.

Twin-Detent Patchcords, in manual or semi-permanent types, incorporate a specially designed, wholly contained spring-member that

locks the cord to board and prevents program failure by accidental dislodgement. Patchcords can be easily hand-removed to facilitate program changes.

As for rear board wiring, precision crimped LANCELOK* contacts provide maximum electrical performance and positive retention in the board through a unique locking lance design.

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Everybody craves recognition... you do, and so do we. So let's help each other. We're asking you to display a certain kind of engineering courage that is the mark of a Crusading Engineer. In return we'll award you this glorious medal with our deepest and sincerest appreciation.

Here's our problem. We've got a line of electronic counters that, by spec and performance, are better buys than anything Beckman or Hewlett-Packard make. We just figured that would automatically get us the big share of the business. We were wrong. Oh, we're doing all right (an easy third in sales) but we haven't exactly pushed those other two big companies into complete bankruptcy.

We don't want your sympathy... just a bit of recognition. Sure, we know it takes a little extra courage to consider CMC when there are those two other "big name" brands around. So all we ask is that you have the guts to compare our specs and performance against those other guys'. If you do, there's a good chance you'll see why we honestly believe we make the world's best counters... and maybe next time you need a counter you'll buy a CMC counter.



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Now that you know we exist, keep your eyes and ears open. As one of the "hottest" young electronics outfits in the business we're making big plans. We are going to compete with high-powered H-P and big, bad Beckman right up and down their full line. But that's news for later.

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Regulated Power Supply

A technical data sheet is available illustrating and describing the improved wide range TVR28-50A SCR transistor series regulated power supply. The supply is regulated to $\pm 0.01\%$ for both line and load. Output voltage range is 5 to 32vdc. The data includes description of the unit, its features, detailed specs., special features, mechanical mounting details, price, and illustration. Perkin Electronics Corp., 345 Kansas St., El Segundo, Calif.

Circle 130 on Inquiry Card

Tube Replacements

This data lists a wide variety of hermetically-sealed, silicon-rectifier tube replacements. Included are electrical ratings, base outlines, pin connections, and body outlines. Some of the more popular types covered are replacements for the 5R4, 5U4, 6X4, 866, 872, 575, 8008, 6303, 7402/X80. Solitron Devices, Inc., 256 Oak Tree Rd., Tappan, N. Y.

Circle 131 on Inquiry Card

High-Current Relay

Type 2101 is a high-capacity, 100a. mercury displacement relay. The relay is designed for use in electric furnaces, electric motors, and other types of equipment where large overload handling is essential. The 100a. relay will withstand a 100% overload for 1 min. Additional data is available from The Adams & Westlake Co., 1025 N. Michigan St., Elkhart, Ind.

Circle 132 on Inquiry Card

Voltage Standard

Data is available on a high-accuracy, cabinet-model dc voltage standard which supplies voltages from 0 to over 1100v. Model 323-01, with null meter, uses six 11-position detent dials, and a range switch to set the level of output voltage. Accuracy of the output voltage is within 0.01% of setting. Current up to 25ma is available at all voltage levels. Cohu Electronics, Inc., KinTel Div., San Diego, Calif.

Circle 133 on Inquiry Card

Relay Catalog

A revised edition of Stock Catalog 100 contains data and prices for more than 50 relay series, having nearly 600 different contact arrangements and coil voltages. It offers a broad selection of new solid-state time-relays, having nearly 600 different contact arrangements and coil voltages. The catalog offers a broad selection of new solid-state time-delay relays, a new line of small, sensitive polarized relays, and newly enclosed models of a popular, previously open, general-purpose relay. Potter & Brumfield, Princeton, Ind.

Circle 134 on Inquiry Card

Transformer Catalog

This 36-page catalog describes the Tinymax 400-cycle miniature power transformer line, which is available with ratings of 1.5va through 250va. These toroidal transformers offer good size and weight reductions combined with low temp. rise, low regulation and phase shift, negligible radiated field, and compliance with Mil-T-27, Grade 4, Class S specs. Torwico Electronics, Inc., Lakewood, N. J.

Circle 135 on Inquiry Card

Film Resistors

This 6-page folder describes a large line of glass tin-oxide film resistors for general purpose, precision, power and high reliability uses. The brochure contains a brief description of the multiple rating concept, whereby one resistor can serve 3 different ratings, for 3 different uses. Savings as high as 20% are possible by use of the concept. The folder also outlines the concepts of design tolerance and current noise screening, and gives figures on reliability levels. Corning Electronics, Raleigh, N. C.

Circle 136 on Inquiry Card

Transistor Brochure

The technical bulletin includes data on series 2N3163 through 2N3174, which are pnp, 85 and 75w. devices. These transistors are designed for power and switching applications. The brochure also includes technical drawings and graphs detailing typical electrical characteristics. Silicon Transistor Corp., 150 Glen Cove Rd., Carle Place, L. I., N. Y.

Circle 137 on Inquiry Card

Test Report

The 44-page "HP Series Test Report" describes the "staggered-finger" heat dissipators for high-power semiconductors. It provides tables to assist engineers using such transistors as the 2N176, 2N1899, and 2N1073. Tables and graphs give case and junction temps. for each transistor tested in a variety of mounting conditions, and in natural and forced convection. International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif.

Circle 138 on Inquiry Card

Toggle-Switch Indicator

Data sheet 230 describes an indicator accessory that fits over toggle switches from the panel front to signal control status of the switch. The 13LT1 provides a clearly visible color-legend display without lamps. Fluorescent colors alternately appear through windows in the device, enabling the operator to tell the toggle lever position at a glance. Micro Switch, Freeport, Ill.

Circle 139 on Inquiry Card

Power Supplies Brochure

This 8-page brochure contains photos and complete operating characteristics for a group of transistorized power supplies, which provide well regulated voltage and current outputs. Stability is 0.001%. Princeton Applied Research Corp., P. O. Box 565, Princeton, N. J.

Circle 140 on Inquiry Card

Inductor Selector Chart

Ease of selection of inductors—both fixed and variable types—is provided by use of this Inductor Selector Chart. It allows design engineers and purchasing personnel to determine visually the inductor for a specific application. Twenty-seven physical shapes and sizes are included. The drawings and photos on the chart are cross-referenced to engineering bulletins which contain performance data. Aladdin Electronics, Nashville, Tenn.

Circle 141 on Inquiry Card

Motor Speed Control

This bulletin covers all technical aspects of a sub-miniature solid-state motor speed control. The unit does not use variable resistors and variable transformers. A few of the features include: instantaneous reversing through high-surge rated silicon rectifiers; full-wave rectification; remote potentiometer, fuses and switches; and no required warm-up time. Ramsey Controls, Inc., 6 E. Main St., Ramsey, N. J.

Circle 142 on Inquiry Card

Current Comparator

The Commander Current Comparator offers calibration of current transformers, voltage transformers, and high-voltage capacitors to a previously non-attainable accuracy. A description of how the comparator works is offered from The Singer Co., Metrics Div., 915 Pembroke St., Bridgeport, Conn.

Circle 143 on Inquiry Card

Vitreous Resistors

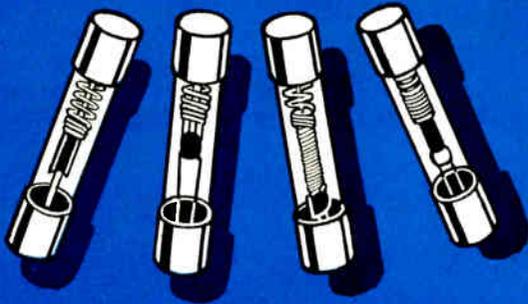
Bulletin 105 describes 2 new small sizes of "Brown Devil" resistors. These are wirewound, vitreous enameled types with narrow lugs attached to tinned wire leads. Stock values are listed. Ohmite Mfg. Co., 3624 Howard St., Skokie, Ill.

Circle 144 on Inquiry Card

New Measuring Method

This bulletin describes Ratiometrics, a new system of measurement which relies on ratio as its central principle. Ratiometrics is said to perform dc measurements faster, cheaper, more accurately and more simply than conventional techniques. Julie Research Laboratories, Inc., 211 W. 61st St., New York 23, N. Y.

Circle 145 on Inquiry Card



FUSETRON

dual-element Fuses

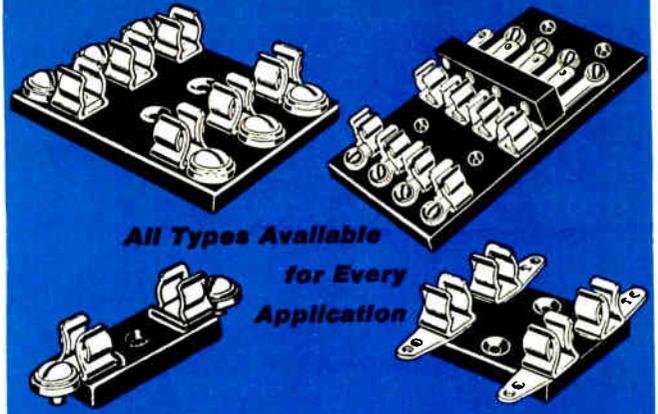
time-delay type

"Slow blowing" fuses that prevent needless outages by not opening on motor starting currents or other harmless overloads—yet provide safe protection against short-circuits or dangerous overloads.

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NEW TECH DATA

Plating Guide

A revised guide for meeting military specs. for plating precious metals, base metals, and a wide range of alloys is available. An up-to-date listing of current plating Mil/Specs tells how to meet them and also discusses end-uses of plated coatings. An analysis of required metallurgical properties is given. Lea-Ronal, Inc., 130-19 180th St., Jamaica 34, N. Y.

Circle 146 on Inquiry Card

Design Guides

Two design guides, both relating to SCRs and one to power rectifiers as well are available. "Fuse Protection of Silicon Power Rectifying Devices" (AD-513) deals with the type of fuses and associated circuitry needed to protect the silicon rectifier and controlled rectifier without degrading the performance of the rectifier assembly. The second study, "How to Solve the Rate-of-Rise of Forward Voltage Problem in Controlled Rectifier Applications" (AD-514), offers constructive suggestions for the design engineer facing the problem of accidental firing from dv/dt . Requests should be made on company letterhead to International Rectifier Corp., 233 Kansas St., El Segundo, Calif.

Circle 147 on Inquiry Card

Gasket Material

Data Sheet RF-204 describes Teckfelt, an unusual, easily-cut material for gasketing complex joints against RFI. The cohesive structure consists of randomly arranged, interlocked and co-continuous metal fibers, which are fiber-to-fiber sintered to provide positive electrical conductivity throughout the material. The brochure provides uses, limitations, RFI control rating, and material specs. Technical Wire Products, Inc., 129 Dermody St., Cranford, N. J.

Circle 148 on Inquiry Card

Control Transformers

Catalog 14-BLO3 features protected coil, end-bell enclosed-type control transformers. Complete specs. of transformers with outputs of 6, 24 and 115v. are listed. Users of this class of transformers will find the quick reference chart in catalog a time saver in selecting the proper rating of transformer to use for applications of intermittent duty. This chart shows the percent of rated current load a particular transformer will deliver for any of 210 different duty cycles, along with the percent of voltage drop of the secondary at the overload indicated. Acme Electric Corp., Cuba, N. Y.

Circle 149 on Inquiry Card

Integrated Circuits Catalog

A complete line of integrated circuits for digital and linear uses is contained in Catalog 91-000. Each circuit description is complemented by a schematic and logical drawing. Westinghouse Electric Corp., Molecular Electronics Div., Box 1836, Baltimore, Md.

Circle 150 on Inquiry Card

Bearing Catalog

Condensed catalog 7E64 covers a complete-line of miniature precision bearings. Included is data on flanged, unflanged, radial retainer, and angular contact bearings in both inch and metric sizes. Landis & Gyr, Inc., 45 W. 45th St., New York, N. Y.

Circle 151 on Inquiry Card

System Analyzer

The Model 4010A Multifunction Squib System Analyzer is a lightweight portable field-test unit. It determines, with absolute safety, operational resistance and firing current parameters of Squibs in explosive-actuated devices. Complete operating data and a photo available from Aerospace Research Corp., 7347 Baker St., N.E., Minneapolis, Minn.

Circle 152 on Inquiry Card

Coaxial Switch Catalog

High-precision DK coaxial switches are described in 12-page catalog CS-460. Described are 23 different coaxial switch series, including remote, manual, miniature, high-power, multiposition and fail-safe types. In addition to illustrations of various switch configurations, the catalog lists complete electrical and mechanical specs. for each type. FXR, div. of Amphenol-Borg, 33 E. Franklin St., Danbury, Conn.

Circle 153 on Inquiry Card

Product Bulletin

Bulletin SF-101 offers data on high-precision temp. transducers and constant-voltage and constant-current signal conditioning systems. In addition, calibration and testing services are described. Winsco Instruments & Controls Co., 1533 26th St., Santa Monica, Calif.

Circle 154 on Inquiry Card

Cable Variations

Technical Bulletin #5 covers "The Variation of Electrical Length with Temp. of 1/2-in. 50Ω Helical Membrane Cable." The bulletin devotes 5 pages to outlining the purpose, methods, conclusions and results of the test. A schematic of the set-up and performance curves offer supporting engineering data. Phelps Dodge Electronic Products Corp., P. O. Box 187, 60 Dodge Ave., North Haven, Conn.

Circle 155 on Inquiry Card

Digital Circuit Modules

A new line of all-silicon digital-circuit modules is described in this data. The L-Series circuits operate at a freq. range of dc to 5mc and have a delay time of 25nsec. The line includes: flip-flops, AND and OR gates (with NAND and NOR capabilities), amplifiers, clock generators, gate expanders, and inverters. Scientific Data Systems, 1649 17th St., Santa Monica, Calif.

Circle 156 on Inquiry Card

Microscope Catalog

This pocket-size folder, D-185, makes it easy to select and price any one of several hundred models of the Advanced DynaZoom Microscope. The folder is part of the Advanced DynaZoom literature kit. Included in the kit is a 16-page, 2-color catalog which gives complete details on the many features of this advanced instrument. Bausch & Lomb, Rochester, N. Y.

Circle 157 on Inquiry Card

Magnetic Tape Group

Model 382 Hi-Data Magnetic Tape Group unit is described in a new brochure. The unit embodies the inherent economy of multi-tape packaging in a single cluster, shares logic and circuitry, and offers a step-up to 30,000 characters/sec. data transfer rate. Radio Corp. of America, 30 Rockefeller Plaza, New York, N. Y.

Circle 158 on Inquiry Card

Oscillograph Catalog

This 12-page, 2-color catalog describes Oscillograph Series "O" recorders. Four, 6- and 9-channel recorders with interchangeable plug-in amplifiers and couplers have freq. responses from dc to 110cps flat ($\pm 1\%$) at 40 mm p-p deflection. All recorders use direct-carbon-transfer writing method and pen motors without permanent magnets. Esterline Angus Instrument Co., Inc., P. O. Box 24000, Indianapolis, Ind.

Circle 159 on Inquiry Card

Time-Mark Generator

This data sheet contain photos and specs. on the Type 781 time-mark generator. The unit uses solid-state circuits and operates on 115 or 230v., 50-400cps. Power consumption is 21w. It is a precise calibrator for sweeps and counters. Trigger-pulse timing intervals are 1, 10, 100cps and 1, 10, 100kc. Fairchild, Du Mont Laboratories, 750 Bloomfield Ave., Clifton, N. J.

Circle 160 on Inquiry Card

Transponder Oscillator

This brochure describes a transmitter oscillator for transponders that meets every requirement of the FAA. Freq. is 1090mc and operating altitude is 55,000 ft. Characteristic curves and specs. are given in this data. Trak Microwave Corp., 5006 N. Coolidge Ave., Tampa, Fla.

Circle 161 on Inquiry Card

...New Developments in Electrical Protection



For 1/4 x 1 1/4 inch fuses
Series HJ, HK, and HLD

For 1 1/2 x 1 1/2 inch fuses
Series HPC

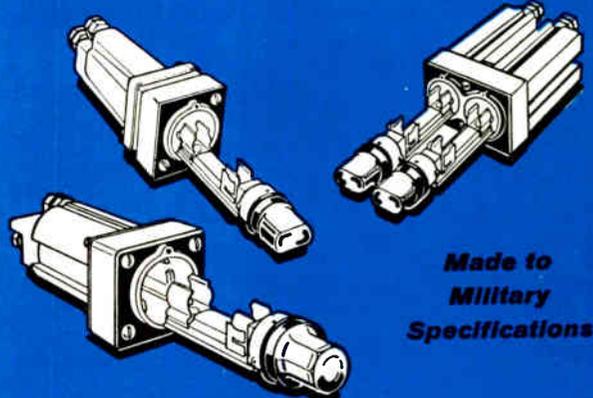
Save Assembly Time with Quick-Connect Terminals on BUSS Fuseholders

Eliminates soldering. Permits use of pre-assembled harness. Reduces assembly time.

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Circle 50 on Inquiry Card



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• LAMP INDICATING SERIES HG

Quick, positive, visual identification of faulted circuit. Transparent knob permits indicating light to be readily seen.

Fuses held in clips on fuse carrier which slides into holder and locks in place with bayonet type knob.

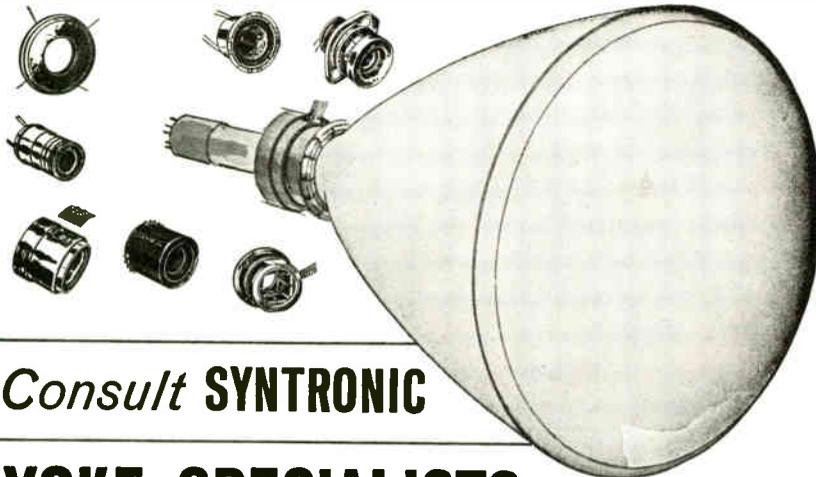
Holder designed for panels up to 1/8 inch thick.

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Circle 50 on Inquiry Card

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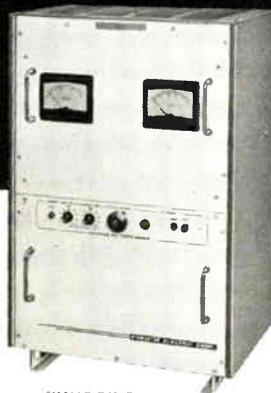
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No More Cumbersome Batteries For Critical High Current Tests

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- 50 MICROSECOND RESPONSE
- .02% REGULATION
- 1 MLLIOHM IMPEDANCE

50-100-200-250-400-600 Amps for:

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SINCE 1929

CHRISTIE ELECTRIC CORP.
3408 West 67th Street, Los Angeles, California 90043

Circle 52 on Inquiry Card

NEW TECH DATA

Connector Catalog

Catalog C-502 lists complete engineering data on in-stock models of Q-C audio connectors, microphone and Mini-Con connectors, phono plugs and jacks, and r-f plugs and jacks. The catalog also illustrates the 4-Leaf Clover Jax, Series 3511, a molded phono jack. A complete and up-to-date Audio Connector Cross-Reference Guide and Mating Chart is listed to aid the design engineer in selecting the proper connector. Switchcraft, 5555 N. Elston Ave., Chicago, Ill.

Circle 162 on Inquiry Card

Integrated-Circuits Brochure

This brochure describes a versatile approach to DTL integrated-circuits design. It explains how the circuit design engineer can design his own circuit configuration using customline circuit elements. More than 10,000 individual DTL circuit configurations can be formed using the basic elements including diode gates, gate amplifiers and NAND/NOR gates. Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.

Circle 163 on Inquiry Card

Digital Counters

This 24-page brochure describes a line of solid-state and vacuum-tube digital counters and freq. measuring instruments. Included is a description of 600 series counters, which the company says have 4 times the counting rate of competitively priced germanium transistor counters. Computer Measurement Co., 12970 Bradley Ave., San Fernando, Calif.

Circle 164 on Inquiry Card

Disconnect Wiring Block

Bulletin T-65 describes the Connecto-Blok high-density, low cost block for disconnect wiring system uses. The Connecto-Bloc terminal boards accommodate a heavy concentration of solderless plug-in, wire wrap or solder connections. Design features of the disconnect terminals are illustrated. The Thomas & Betts Co., 36 Butler St., Elizabeth, N. J.

Circle 165 on Inquiry Card

Microwave Filters

This 2-color catalog provides specs., performance characteristics and typical design criteria on a complete line of YIG single filters containing multiple stages (2 and 4 sphere). All meet applicable airborne Mil specs. Loral Electronic Systems, 825 Bronx River Ave., Bronx, N. Y.

Circle 166 on Inquiry Card

Telemeter Receivers

A new line of 4-in. strip-chart Metameter telemetering instruments is the subject of Bulletin M1720. Included are general specs., operating characteristics and design features of the Series 670 instruments. The Bristol Co., Waterbury, Conn.

Circle 167 on Inquiry Card

Parabolic Reflectors

This 6-page illustrated color brochure contains technical data on the "Spincasting" process for producing parabolic reflectors. The brochure describes in detail the method by which thermosetting plastics are poured into a spinning metal support to produce reflectors as large as 28 ft. in diameter. Units have rms surface accuracies of 0.004-in. in the center and 0.007 overall. Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles, Calif.

Circle 168 on Inquiry Card

Low-Voltage Tubes

Data is available on a special line of receiving tubes that allows operating voltages of color TV sets to be reduced from 400 to 270v. The tubes operate at 250 to 270v. B+. The lower voltage brings the operating range of color TV sets into line with black and white receivers, and will permit the use of lower-priced, lower-voltage components in color receivers. Sylvania Electric Products Inc., 730 Third Ave., New York, N. Y.

Circle 169 on Inquiry Card

Grid Thermocouples

Microminiature grid-type thermocouples, available in either free-filament or self-adhering types, are described in bulletin PD-4335-A. The units permit making highly accurate surface temp. measurements, even when used on poor thermal conductors. The bulletin describes the units, covers significant features, furnishes drawings and lists materials, sizes, prices, and other pertinent information. Baldwin-Lima-Hamilton Corp., Waltham, Mass.

Circle 170 on Inquiry Card

Conditioning Equipment

Bulletin 128 describes the 4400 Series Universal Signal Conditioning Equipment. By means of a small bound-in booklet, the engineer can compare the functional circuit representations for any one of several plug-in made cards—as though he were actually using the equipment. Endeveco Corp., 801 S. Arroyo Pkwy., Pasadena, Calif.

Circle 171 on Inquiry Card

Coil Catalog

Catalog 64A, 32 pages, describes a full line of r-f and i-f coils, chokes, filters and transformers. The catalog contains more than 1500 listings complete with specs. Eight pages are devoted to industrial prices. J. W. Miller Co., 5917 So. Main St., Los Angeles, Calif.

Circle 172 on Inquiry Card

Hybrid Tee Mixer

A series of folded H-plane hybrid tee mixers covering the freq. range 13.325-17.5gc are given in bulletin MS64-5. Detailed electrical and mechanical data are provided for all models, which feature low vswr and an extremely compact size. Microwave Development Laboratories, Inc., 87 Crescent Rd., Needham Heights, Mass.

Circle 173 on Inquiry Card



TOP SPACE AGE TOOL...

REEVES ANALOG-TO-DIGITAL SHAFT ANGLE CONVERTER SYSTEM



described in our new GIMBAL RESOLVER/SYNCHRO BROCHURE 110

Compatible with *existing* analog systems and operating frequencies.

Input impedance greater than 0.5 megohms (minimal input loading effects).

Single speed conversion to 13 bits.

Dual speed conversion to 19 bits (in conjunction with Reeves 1x & 16x, or 1x & 64x Pancake Resolvers).

Excellent multiplexing capabilities.

Modularized circuits ensure high reliability, ease of maintenance, and ready incorporation into unusual system configurations.

The Reeves A-D Shaft Angle Converter System is compatible not only with all current production systems—it is equally adaptable to new system designs incorporating a wide range of analog transducers, such as those



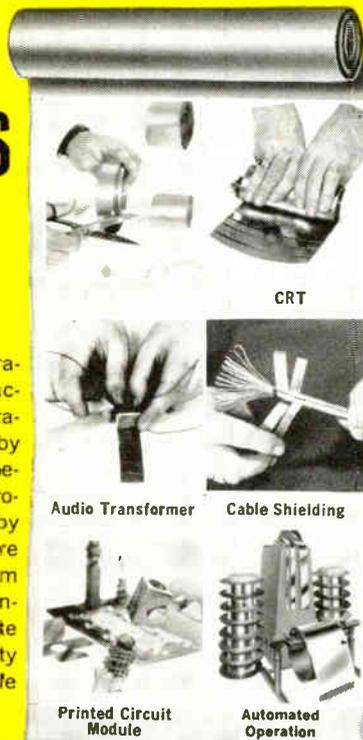
REEVES INSTRUMENT COMPANY
Garden City, New York
Division of Dynamics Corporation of America

WRAP-AROUND MAGNETIC SHIELDS

APPLIED IN SECONDS

**Cut to any size or outline
with ordinary scissors**

Co-Netic and Netic foils are ideal for initial laboratory or experimental evaluation . . . also for production applications and automated operations. Dramatically enhance component performance by stopping degradation from unpredictable magnetic fields. When grounded, foils also shield electrostatically. They are not significantly affected by dropping, vibration or shock, and do not require periodic annealing. Available in thicknesses from .002" in rolls 4", 15", and 19-3/8" wide. High attenuation to weight ratio possibilities. Every satellite and virtually all guidance devices increase reliability with Netic and Co-Netic alloys, saving valuable space, weight, time, and money.



MAGNETIC SHIELD DIVISION

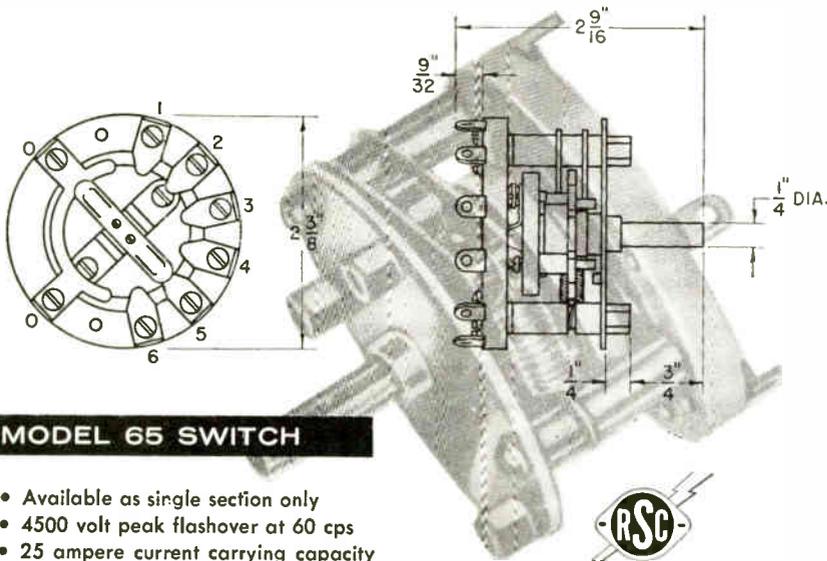
Perfection Mica Company

1322 N. ELSTON AVENUE, CHICAGO 22, ILLINOIS

ORIGINATORS OF PERMANENTLY EFFECTIVE NETIC CO-NETIC MAGNETIC SHIELDING

Circle 54 on Inquiry Card

SWITCH TO THE BEST



MODEL 65 SWITCH

- Available as single section only
- 4500 volt peak flashover at 60 cps
- 25 ampere current carrying capacity
- Current carrying members heavily silver plated
- Low loss silicone impregnated steatite stator and rotor
- Nylon detent wheel,
- Sleeve bearing



RADIO SWITCH CORPORATION

MARLBORO, NEW JERSEY
Tel. 462-6100 (Area Code 201)

Circle 55 on Inquiry Card

NEW TECH DATA

High Freq. Transistors

The 3TE150 and 3TE160 transistors are diffused silicon-epitaxial npn unit made by planar techniques. They are intended for high-gain Class B and C r-f amplifiers up to freqs. greater than 100mc. The transistors use a new mounting arrangement with the emitter connected to the case. They are ideally suited for grounded-emitter amplifier use where power gain is important. Additional data available from Clevite Semiconductor, 1801 Page Mill Rd., Palo Alto, Calif.

Circle 174 on Inquiry Card

Micro Circuits

Eleven data sheets are available which describe the following microelectronic components: 0° servo amplifier; 90° servo amplifier; 1-shot multi-vibrator; voltage amplifier; 3-line logic modulator; flip-flop; dual AND gate; dual inverter buffer; dual OR gate; dual lamp driver; and triple AND gate. Schematics and operating characteristics are given. Lear Siegler, Inc., Instrument Div., 4141 Eastern Ave., S.E. Grand Rapids, Mich.

Circle 175 on Inquiry Card

Resolvers/Synchros Brochure

Catalog RICO, 36 pages, describes a complete line of pancake resolvers and synchros. It provides design and performance specs., as well as outline drawings, on 28 different models. Single speed, dual speed, and multi-speed units are listed, including models up to 64 speed. The catalog also contains a section on the theoretical factors influencing the design and uses of the various types of resolvers and synchros listed. Reeves Instrument Co., Garden City, N. Y.

Circle 176 on Inquiry Card

Toggle Switch

The Type 40137 toggle switch is tear proof, as the bat handle must travel beyond mid-position before electrical contacts transfer. The terminals are solder type, silver-plated. The snap-action, 2-position, SPDT switch is rated at 5a. resistive and 3a. inductive at 28vdc, and 2.5a. resistive and 1a. inductive at 115vac 60 cycles. Complete information and technical data available from Haydon Switch & Instrument, Inc., Waterbury, Conn.

Circle 177 on Inquiry Card

Pushbutton Switch

A data sheet and price schedule for a 4-and 6-lamp illuminated pushbutton switch, called Lumi-Switch, is available. The data sheet includes engineering details, mounting dimensions, and complete specs. The Lumi-Switch provides 6-lamps in the same size total package as standard 4-lamp units. This feature provides a 3-color capability with 2-lamp reliability/color. Industrial Electronic Engineers, Inc., 7720 Lemona Ave., Van Nuys, Calif.

Circle 178 on Inquiry Card

Resin Wall Chart

This quick reference chart describes the line of Stycast® encapsulating and potting resins. The chart is arranged to group together similar products, e.g., low-density encapsulants, high-thermal conductivity resins or transparent systems. Both epoxies and urethanes are covered. Data on electrical properties, thermal properties, strength, and hardness are given. Emerson & Cuming, Inc., Canton, Mass.

Circle 179 on Inquiry Card

Microcircuit Assistance

This brochure describes the services offered by the Integrated Circuit Engineering Corp., an independent organization which provides a broad range of microcircuit services. The company offers services from staff education to organization and operation of a full-scale integrated circuit production facility. Copies are available from Integrated Circuit Engineering Corp., 3601 N. 7th Ave., Phoenix, Ariz.

Circle 180 on Inquiry Card

Field-Effect Transistors

Insulated-gate field-effect transistors (IGFETS), Types DPT200 and DPT201, exhibit very low capacitance characteristics and high h-f cut-off. Noise figure at 100mc is 4db, power gain is 20db. The units are 4-lead TO-18 packaged. Detailed tech. data is available from TRW Semiconductors Inc., 14520 Aviation Blvd., Lawndale, Calif.

Circle 181 on Inquiry Card

Are Filters Necessary

This 6-page guide on how to specify an r-f coaxial filter to avoid over-design, deals with the practical application—to overall system performance—of filter parameters. Topics such as cut-off freq., insertion loss and selective stop-band attenuation, plus preferred test methods, are described. Bird Electronic Corp., 30303 Aurora Rd., Cleveland, Ohio.

Circle 182 on Inquiry Card

A-F Signal Source

Model 2000 signal source will aid those involved in ultra-low distortion measurement in the audio range. Distortions are 0.05% from 63cps to 6.3kc, and 0.1% from 20cps to 20kc. This data sheet contains a photo and complete operating specs. Marconi Instruments, div. of English Electric Corp., 111 Cedar Lane, Englewood, N. J.

Circle 183 on Inquiry Card

Motorgram

"Bodine Motorgram" describes a multiple recorder which records up to 200 different variables on 1 chart. Also included is a reference chart on the probable causes of motor troubles. Bodine Electric Co., 2500 W. Bradley Place, Chicago, Ill.

Circle 184 on Inquiry Card

VICTOREEN DIODES

for regulation and reference

from 350 TO 30,000 VOLTS



GV1A Series, shown actual size, above, weighs 0.8 gm.



RELIABLE

Victoreen Corotron diodes enhance circuit reliability because they are free from catastrophic failure caused by nominal surges or transients . . . are immune to space radiation, even radiation greater than disaster levels. They are also unaffected by ambient light variations, have a very low TC, and withstand extremes of shock and vibration.



MICROMINIATURE

Victoreen Corotron diodes are compact, lightweight. Corotrons enable designers to use, at high voltages, the same simple circuitry used with Zeners at low voltages. A *single* Corotron diode can be used as a reference, shunt regulator, DC coupling element, or portion of a divider up to 30kV.



LOW POWER CONSUMPTION

Victoreen Corotron diodes minimize power drain, can operate from solar cells and other low power sources. Excellent temperature characteristics, particularly at low currents. GV1A Series is available in any desired nominal voltage from 350 to 2000 volts; other sizes available for higher voltages and currents.



VICTOREEN

THE VICTOREEN INSTRUMENT COMPANY
5806 Hough Ave. • Cleveland 3, Ohio, U.S.A.

2262-A

NEW TECH DATA

Silicon Module Catalog

A newly-revised 20-page catalog on silicon digital modules is now available. Catalog SP-147B covers 13 circuits in the silicon line, and includes accessories such as module cases, power supplies and special tools. Another section is devoted to loading charts which provide detailed data on input and output loading for each circuit. Packard Bell Computer, 2700 So. Fairview St., Santa Ana, Calif.

Circle 185 on Inquiry Card

Motor Bulletin

Bulletin XE-4708 gives operating and dimensional data of the type CLC induction and hysteresis synchronous ac motors. Units are rated to 1/20 hp at 3,600 RPM. Globe Industries, Inc., 1784 Stanley Ave., Dayton, Ohio.

Circle 186 on Inquiry Card

Telemetry Transmitter

Model 5000-TR2 has a bandwidth of dc to 500Kc and stability of 0.005%. This solid-state TWT 2200-2300mc transmitter delivers 20w. Complete specs. and photos available from Energy Systems, Inc., 3180 Hanover St., Palo Alto, Calif.

Circle 187 on Inquiry Card

Integrated Circuits

A 14-page brochure on the Utilogic line of semiconductor integrated circuits for commercial/industrial uses is now available. It contains specs. and typical sub-system uses for the SU306K Dual AND Gate, SU315K Dual NOR Gate, and SU302K J-K Binary Element. Schematics and price lists are included. Signetics Corp., 680 W. Maude Ave., Sunnyvale, Calif.

Circle 188 on Inquiry Card

Universal Calibrator

Model MC-10 is an accurate, secondary standard source of voltage, current, and resistance. It can be used to test or calibrate multimeters, oscilloscopes, VTVMs, graphic recorders, panel meters, and portable standards. Abbey Electronics Corp., 143 Old County Rd., Carle Place, L.I., N. Y.

Circle 189 on Inquiry Card

Rotary Switch Brochure

This 12-page brochure describes and illustrates a complete line of G.E.C. Uni-selector for circuit selection, timing control and special switching circuits. Uni-selector is an electromechanically operated rotary switch. Wiper contacts are rotated step-by-step over arcs of fixed contacts by a ratchet-and-pawl mechanism actuated by an electromagnet. Complete mechanical and electrical specs. are given. Intra Corp., P. O. Box 254, Cambridge, Mass.

Circle 190 on Inquiry Card

Trimmer Capacitors

Data sheet 654 describes a complete line of precision trimmer capacitors with quartz dielectrics. Standard capacitance values range from 1.8 to 16pf. Units are available in panel mount and PC styles, both sealed and unsealed. All units surpass performance requirements of Mil-C-14409B for Q characteristics. Voltronics Corp., 296 Route 10, Hanover, N. J.

Circle 191 on Inquiry Card

Design Bulletin

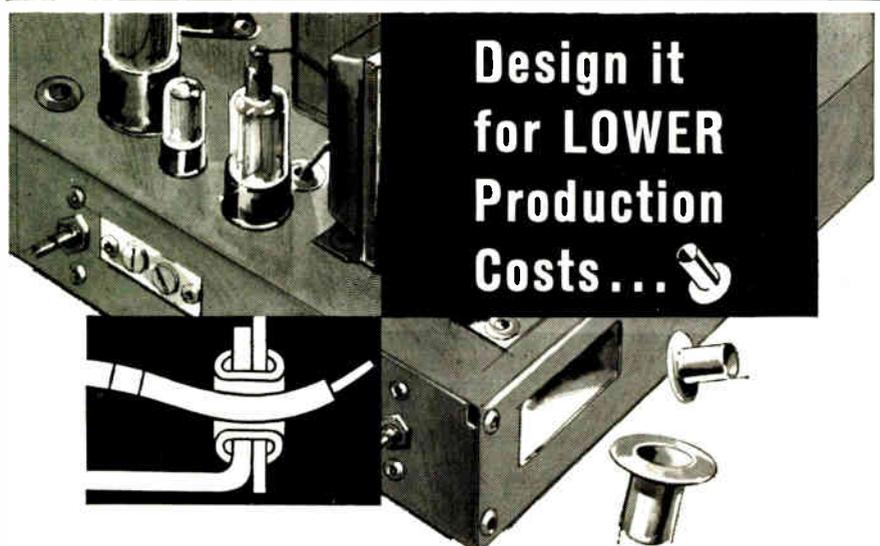
A 19-page bulletin containing 3 design articles is available. The articles include: Properties of a Bushing Filter; Assessment and Measurement of the Operating Properties of U-Cores for Horizontal-Output Transformers; and a Starting Motor Using Ferroxdure Permanent Magnets; Philips Electric Tools, Eindhoven, Netherlands.

Circle 192 on Inquiry Card

Delay-Line Primer

A combination delay-line primer and product brochure is available. One of a new series, the data discusses the relative merits of fused quartz vs. low-temp. coefficient glass compositions; compressional waves vs. shear waves; transducer equivalent circuits; measurement setups, etc. It takes up definitions important when specifying delay lines, such as carrier freq., time delay, acoustic bandwidth, spurious signals, and attenuation. LFE Advanced Component Div., Laboratory for Electronics, Inc., 1079 Commonwealth Ave., Boston, Mass.

Circle 193 on Inquiry Card



Design it
for LOWER
Production
Costs...

RIVET it with EYELETS Instead!

Every year, more and more assemblies and sub-assemblies for electric and electronic equipment are being riveted with United's Eyelets, because manufacturers are discovering that eyelets provide uniformly strong, dependable fastenings—and in addition, help cut production time and costs, because both the initial and the all-important in-place costs are far less!

When you tackle your next product design or re-design project, investigate United's Eyelets for your riveted assemblies. Chances are you'll be able to reduce production costs—and you can probably reduce your own design time too, because United offers a complete Engineering Service, ready to work with you on your specific application requirements. Phone the United Office in your area...or write direct to Fastener Division, United Shoe Machinery Corporation, 2058 River Road, Shelton, Connecticut.

United's Eyelets

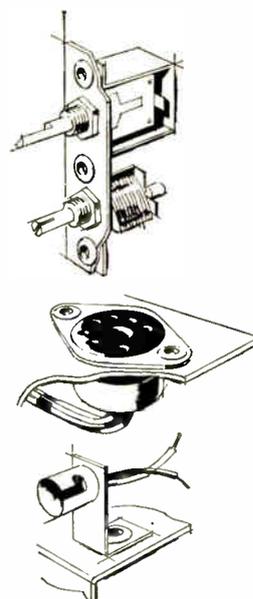
FASTENER DIVISION

United Shoe Machinery Corporation

SHELTON, CONNECTICUT

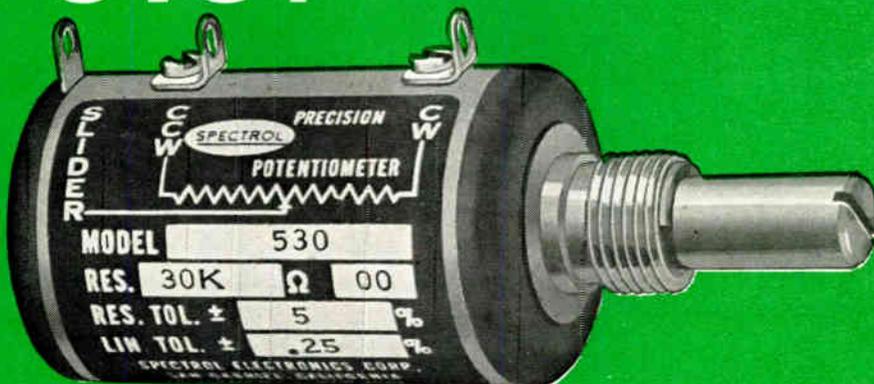


Branches: Atlanta, Ga. • Boston, Mass. • Chicago, Ill. • Cincinnati, Cleveland, Ohio • Dallas, Texas • Sun Valley (Los Angeles), Calif. • Lynchburg, Va. • Milwaukee, Wisc. • Nashville, Tenn. • New York, N.Y. • Rochester, N.Y. • St. Louis, Mo.



Circle 57 on Inquiry Card

WHAT'S NEW IN POTS?



TWO NEW 10-TURN PRECISION POTS...

MILITARY QUALITY AT COMMERCIAL PRICES

These all new 10-turn wirewound precision potentiometers use high reliability design techniques specifically adapted to high volume production to provide exceptional cost vs. performance characteristics.

Features include dimensionally stable, non-hygroscopic, sealed diallyl phthalate cases; precious metal contacts; gold-plated terminals and low tempco resistance elements.

MODEL 162 — ACTUAL SIZE, 1/2" 10-TURN, PRICE \$10.00.

The model 162 is a true 1/2" diameter 10-turn potentiometer with terminals molded into the rear lid to present a clean body configuration for those cramped mounting spaces.



MODEL 530 — ACTUAL SIZE, 7/8" 10-TURN, PRICE \$7.00.

The model 530 is a 7/8" diameter unit featuring a new dual slip ring contact design that eliminates noise problems.



Check our spec table below against any 1/2" or 7/8" 10-turn pot.

SPECIFICATIONS	MODEL 162	MODEL 530
Standard Resistance Range...	100Ω to 50K	500Ω to 100K
Standard Resistance Tolerance	±5%	±5%
Standard Linearity	±0.3%	±0.25%
Power Rating	2 Watts at 40°C	3 Watts at 40°C
Operating Temperature Range	-55 to +125°C	-55 to +105°C
Case Dimensions—inches.....	1/2 D x 1 L	7/8 D x 1 1/10 L
Prices		
1-9.....	\$10.00	\$7.00
500.....	7.00	4.90

Call your nearest Spectrol distributor for immediate off-the-shelf delivery at factory prices, or write for complete specifications. Spectrol also manufactures a complete line of trimming potentiometers and turns-counting dials.

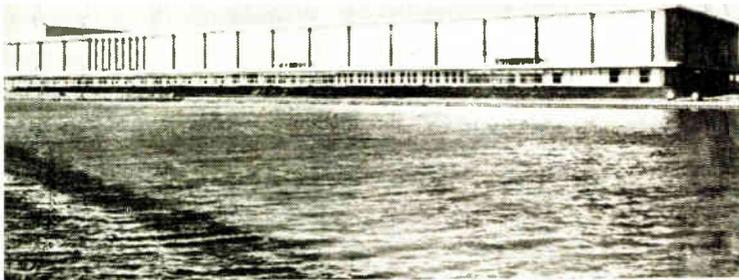
SPECTROL ELECTRONICS CORPORATION

1704 South Del Mar Avenue
San Gabriel, California

Adams Court
Plainview, L. I., New York

P.O. Box 130
Brampton, Ontario

Circle 58 on Inquiry Card



Eastern side of McCormick Place as seen from Lake Michigan.

20th Anniversary of National Electronics Conference

Some 340 technical papers and 500 exhibits will highlight this year's NEC.

The emphasis on staying abreast with new developments in the field is reflected in both the Refresher and Industrial Seminars.

MORE THAN 25,000 ENGINEERS, scientists, and top executives will meet in McCormick Place, Chicago, for the 20th Anniversary of the National Electronics Conference on October 19, 20, and 21.

This year's Conference will place emphasis on such fields as biomedical and nuclear electronics. The latest products from 500 electronics firms will be on display, and 340 papers will be presented.

Registration

Those attending NEC may register at the Sherman House Desk on Sunday, Oct. 18, from 4:00 to 8:00 p.m., or at McCormick Place on Monday, Oct. 19th.

New Products Seminars

These seminars, presented by manufacturers, will run concurrently with the Conference technical ses-

sions. Subjects will include **Precision Laboratory Instrumentation, Components and Interconnections, Computers and Data Logging, and Instruments.** Demonstration equipment and literature will be available.

Refresher Seminars

These special tutorial-type seminars will help engineers to refresh themselves in specific fields of interest, and also obtain data on the latest developments in electronics. The seminars are presented by internationally recognized authorities.

The refresher seminars have been divided into three full-day sessions. On Monday, Oct. 19, **Topics in Modern Antenna Theory** will present data on frequency-independent antennas; data-processing antennas, and array theory.

Tuesday, October 20, will be devoted to **Engineering Applications of Linear and Nonlinear Programming.** The morning session will consist of the basic theory and mathematical structure of linear and nonlinear programming. Afternoon session will be concerned with application to practical engineering problems.

The final seminar will be held on Wednesday, October 21, where **Electronic Thin-Film Technology** will be discussed. The morning session will be concerned with magnetic films and a discussion of quasistatic and dynamic properties of magnetic films, uniaxial anisotropy, hysteresis loops, switching asteroids, magnetostriction, domain structure, and applications. In the afternoon, conducting dielectric films, physical and electrical properties, deposition techniques, properties of thin-film passive components, and integrated circuits will be covered.

Industrial Seminars

The industrial seminars will be presented by firms specializing in semi-conductor devices and integrated circuits. They will be conducted in meeting rooms located in the Exhibit Area.

Motorola will sponsor **Solid-State Seminars**, which will be conducted over a three-day period. **Integrated Circuits** will be discussed Monday; **Power Semiconductors** on Tuesday; and **Solid-State R-F Amplifiers** on Wednesday.

Semiconductor Devices and Applications, sponsored by Texas Instruments, will be spread over three days. Monday will be the **Communications seminar**; Tuesday, the **Computer seminar**; and Wednesday the **Semiconductors seminar.**

A **Power Semiconductor Seminar**, sponsored by General Electric, will be held on Tuesday morning.

Siliconix is sponsoring a seminar on **Application of Unipolar Field-Effect Transistor** on Wednesday. Here the **characteristics and appli-**

(Continued on page 96)

1964 NEREM . . . Electronics— Sentry and Servant

The 86 papers to be presented at this year's NEREM reflect a definite trend in the electronic industry.

Microcircuit reliability, medical electronics, and the electronics profession in peacetime economy are a few topics to be covered.

1964 NORTHEAST ELECTRONICS RESEARCH AND ENGINEERING MEETING will be held from November 4, 5, and 6 at the Commonwealth Armory and Somerset Hotel, Boston, Mass.

Some unusual topics will be covered in the 86 papers to be presented. Communications in unusual media such as rock strata and near space, bio-medical engineering and electronics, high-power solid-state, plasmas in space, and environmental acoustics are only a few.

Evening Sessions

Two evening sessions of special current interest will be held on Wednesday and Thursday. The first entitled, "The Electronics Profession in a Peacetime Economy" will consist of addresses by Dr. J. B. Wiesner, Dean of the School of Science, M.I.T., and a former advisor to President Kennedy; J. H. Rubel, Vice-President and Director of Technical Planning, Litton Industries, Beverly Hills, Calif.; Dr. C. L. Hogan, Vice-President and General Manager, Motorola Semiconductor Products Div., Phoenix, Ariz.; and Dr. L. S. Sheingold, Vice-President for Advanced Technology, Sylvania Electronic Systems, Waltham, Mass.

Thursday's session will consist of a banquet and meeting which will be addressed by General B. A. Schriever, Commander of the AF Systems Command (AFSC), Andrews AFB, Washington, D. C. General Schriever's command is responsible for all R&D, procurement, and production actions required to place a complete aerospace system in operation.

Technical Sessions

The technical sessions, which will run from 2:30 P.M. through 5:00 P.M. on Wednesday, and from 10:00 A.M. through 5:00 P.M. on both Thursday and Friday, feature a heavy emphasis on topical subjects, as well as the tutorial-type paper. As in past years, over 80% of the papers have been solicited on specific subjects from nationally recognized authorities. Here, briefly, are a few of the papers and what they contain.

Although the initial aim of microminiaturization was to facilitate the production of compact

equipment, the problems of reliability must now be considered. In **Reliability Considerations in Microelectronics**, the impact of microminiaturization, especially in integrated circuits, will be discussed.

Circuit designers will be interested in **State-of-the-Art in Monolithic Silicon Integrated Circuits**. New isolation techniques that include a method for dramatically reducing parasitic capacitances will be discussed. Also presented will be charge-storage techniques and complimentary transistor circuit designs which increase the capabilities in monolithic logic-circuit configurations.

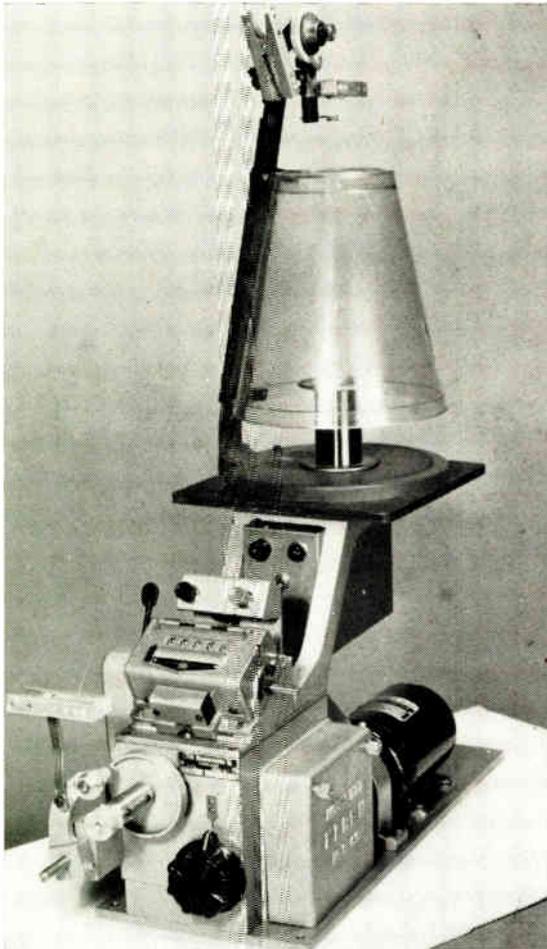


The 400 booth trade exhibition will be housed in the armory.

Something new in instrumentation will be given in **Microwave Measurements on Tunnel-Diode Parameters**. This method of determining tunnel-diode parameters at microwave frequencies is based on the input impedance characteristics of the diode. Here, all parameters are synthesized by graphical methods.

Quantum Electronics is a subject all too often neglected at technical conferences. A knowledge of this field is essential when dealing with the problems of modulating light. Two paper presentations well worth attending are **Modulation**

(Continued at bottom of page 96)



NEW Model 777

BOBBIN - WINDER

ULTRA HIGH SPEED • AUTOMATIC • FRONT LOADING • GUARANTEED 12,000 R.P.M.

Note: — Machine Can Be Set Up for Multiple Winding — Side Loading Type

TYPE OF COILS WOUND—Bobbin—Solenoid—Relay
COIL SIZE—Max. O.D. 4"—Max. Length 2 1/4"
WIRE SIZE—From #20 to #50 AWG
TURNS COUNT—An Automatic Predetermining Counter with Internal Gearing 10 to 1 Ratio for Longer Counter Life
CAMS—Heart Shaped in Range of 1/32 to 2 1/4". Made to Suit Coil Width. Note: Cams Are Ball Bearing Mounted with Ball Bearing Follower
WINDING-SPEED—Variable Up to 12,000 R.P.M.
CONTROL—Variac Speed Control—Push Button Start-Stop
WIRE GUIDE TRAVERSE—Reset by Convenient Knob at Front of Machine
GEAR CHART—Gear Combinations Calculated for Turns Per Inch, As Required for Wire Sizes from #20 AWG to #50 AWG
BENCH SPACE—Machine Requires Only 8" Width—Machines Can Be Grouped for Operation of 2 or 3 Machines at One Time
SPECIAL FEATURES—Machine Has All Revolving Shafts with Sealed for Life Ball Bearings. All Shafts Balanced for High Speed, Quiet Operation. Cam Shaft Rigid Supported at the Cam. Follower Ball Bearing Type
CHANGE GEARING—Gears Located at One Side of Machine. No Need of Disturbing Cam to Change Winding Traverse
OPTIONAL EQUIPMENT—Tail Stock at Slight Additional Cost
PRICE—Model 777 Automatic.....\$675.00
 Other types of winding machines available.

ELDEN MANUFACTURING CO.
 2712 North Elston Ave.
 Chicago, Illinois 60647

N.E.C. (Concluded)

cations of field-effect transistors will be discussed.

Discussions

The overwhelming mass of data resulting from the extensive work being done in reliability would be of great value to the engineer—if he could obtain it quickly. A discussion on **Information Retrieval in Reliability** will include specific ways to get information on defense and space programs, and also obtain data from library services and technical publications.

The **IEEE Consumer Electronics Symposium** will be included in this year's program. NEC registrants can look forward to receiving first-hand reports on the latest consumer electronics developments.

Tours

Guided tours have been arranged with the Argonne National Laboratory; Central Radar Warning System; and the Chicago Police Dept. Communication Center and Crime Detection Laboratory.

1964 NEREM (Concluded)

of Gallium Arsenide Injection Lasers, and Traveling Wave Amplitude Modulation. For the GaAs laser, experimental data on efficiency, temperature effects, and speed of response are covered. The TWT amplitude modulator for coherent light uses conventional KDP crystals. The unit produces 100% amplitude modulation for an applied 50 v., and has a bandwidth exceeding 1gc.

Power Transistors using planar diffusions and epitaxial material are becoming available. These devices have improved characteristics such as lower saturation voltages and switching times.

Planar Epitaxial Power Transistors will describe how epitaxial construction affects device parameters, and also discuss problems associated with power transistor fabrication.

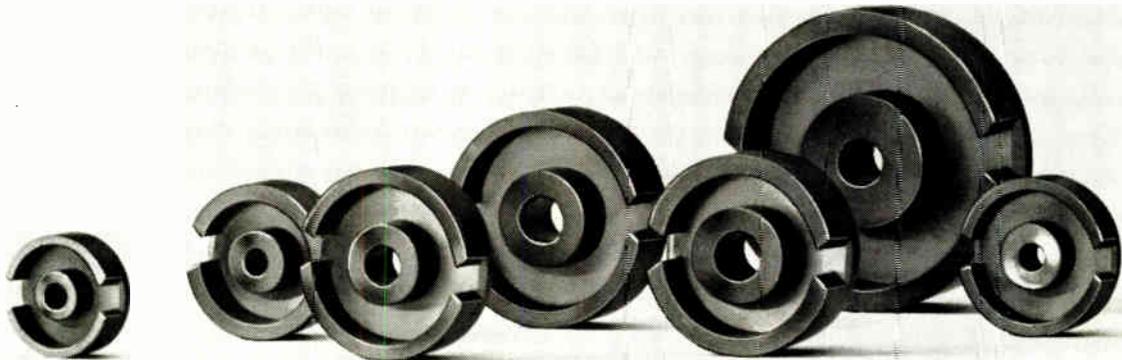
Transistor techniques and materials have given a much-needed boost to microwave diodes. The new diodes, unlike the older point-contact types, operate by means of a variety of principles. The paper **New Device Principles Used in Microwave Diodes** describes briefly the principles and performance which make the new devices possible.

Input Current Compensation for Transistor Operational Amplifiers describes several techniques proposed for temperature compensating the base current of a transistor. One technique uses a thermistor-compensating circuit to obtain an error current as low as 0.5ma or 1% of the base current.

bulletin

MAGNETICS inc.

New... Improved Line of High Purity Ferrite Pot Cores!



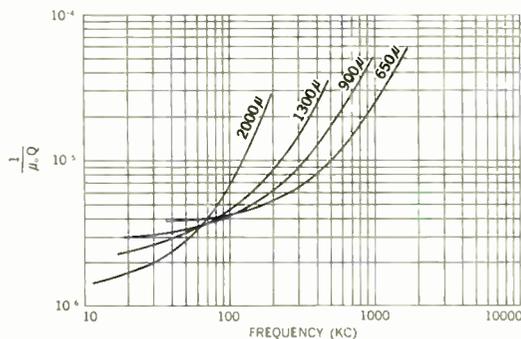
Research at Magnetics Inc. has paid off with the most *complete* line of high purity ferrite pot cores available in this country. New permeabilities and new production methods give the design engineer the very finest selection of cores for use in 1 KC to 2 MC frequency ranges.

All Magnetics Inc. ferrite pot cores are guaranteed for linear permeability over a wide temperature range (-55°C to $+70^{\circ}\text{C}$), high Q and minimum change in inductance over time.

Check our innovations in ferrite pot cores, then write for complete information.

Select from 173 Different Cores!

Design engineers can choose from all International Electrotechnical Commission sizes, plus six additional sizes—some never before available from domestic sources. Core permeabilities: 650, 900, 1300 and 2000. This chart shows typical relative loss factor characteristics.

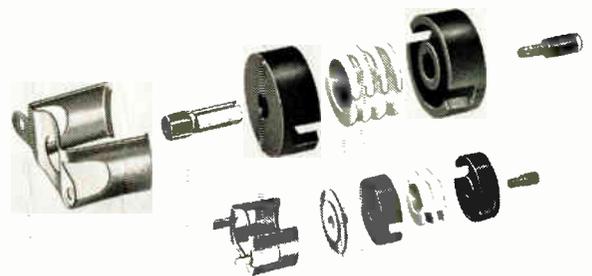


New Permeability Fills Big Gap!

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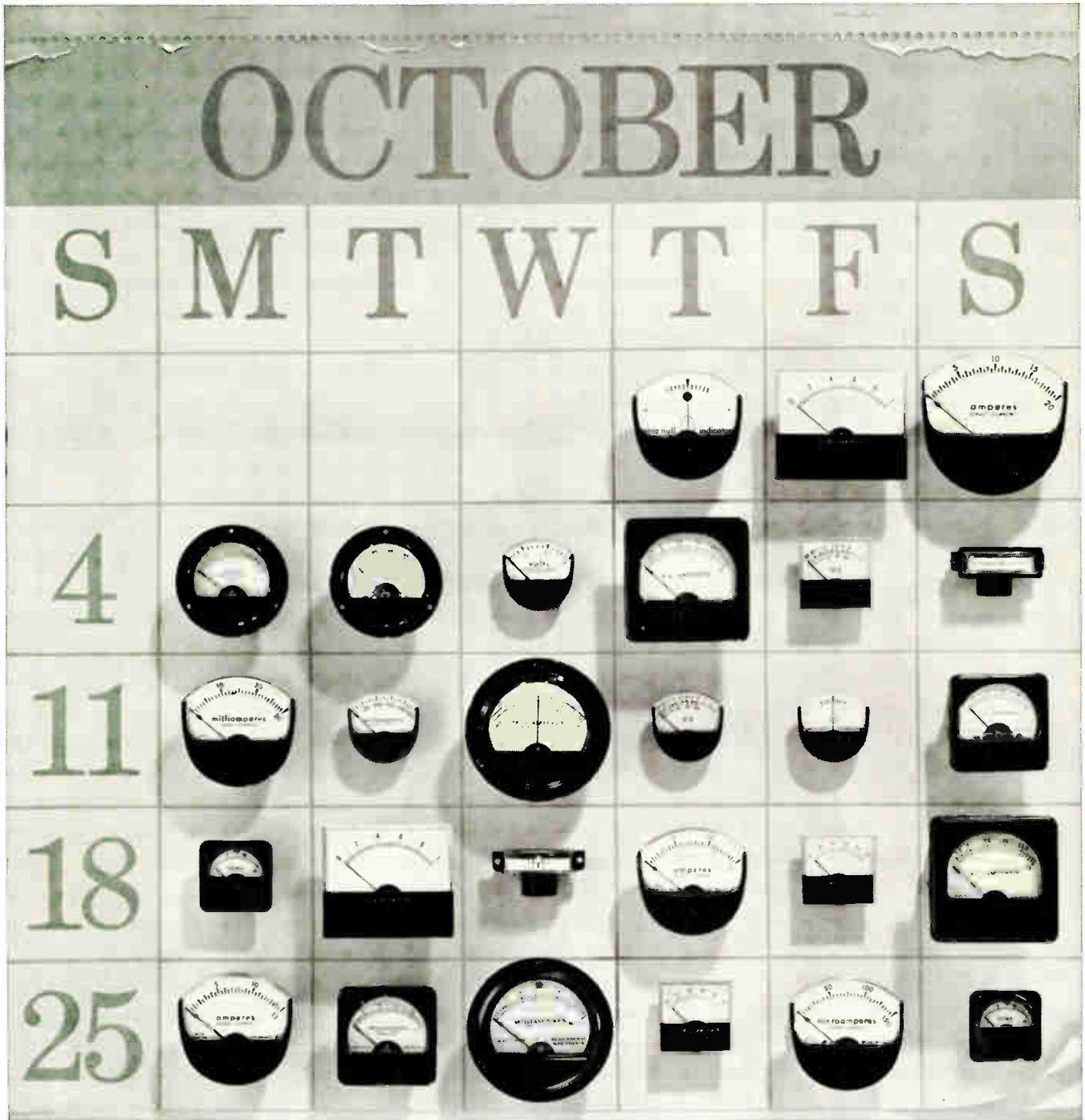
New Snap-on Hardware Cuts Assembly Time!

Here's a real assembly department time-saver. We're supplying a one-piece spring steel housing that quickly snaps into place and firmly holds the core on chassis or printed circuit boards. You can even remove the core without disturbing the clamp after it is in position.



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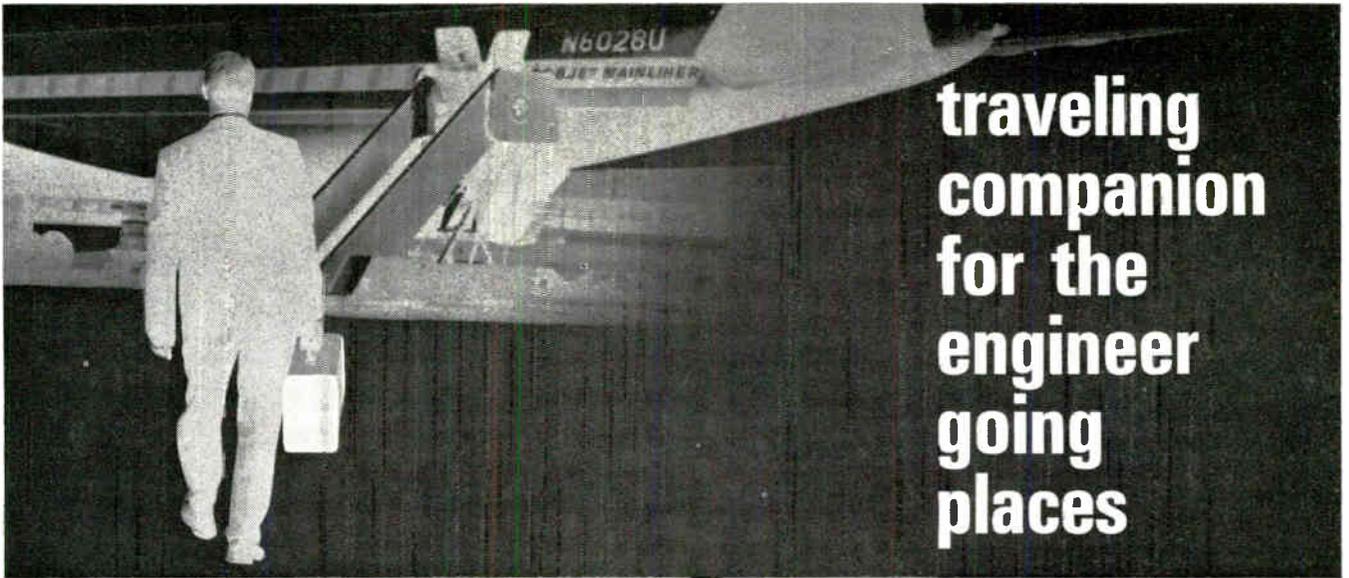
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Meet the Honeywell line. Quality meters. In every shape and size imaginable. Big meters. Miniature meters. Edgewise meters. Contemporary-styled, medallion-shaped meters (Medalist). New square-shaped meters with uncluttered dial faces for easy readout. Ruggedized meters that shrug off vibration, are impervious to moisture, dust, fumes. You can get quick, off-the-shelf delivery of any standard Honeywell meter by ordering direct from your Honeywell distributor. For the name of the distributor nearest you (or a copy of our latest catalog) write: Honeywell, Precision Meter Division, Manchester, N. H. 03105. In Canada, Toronto 17, Ontario.

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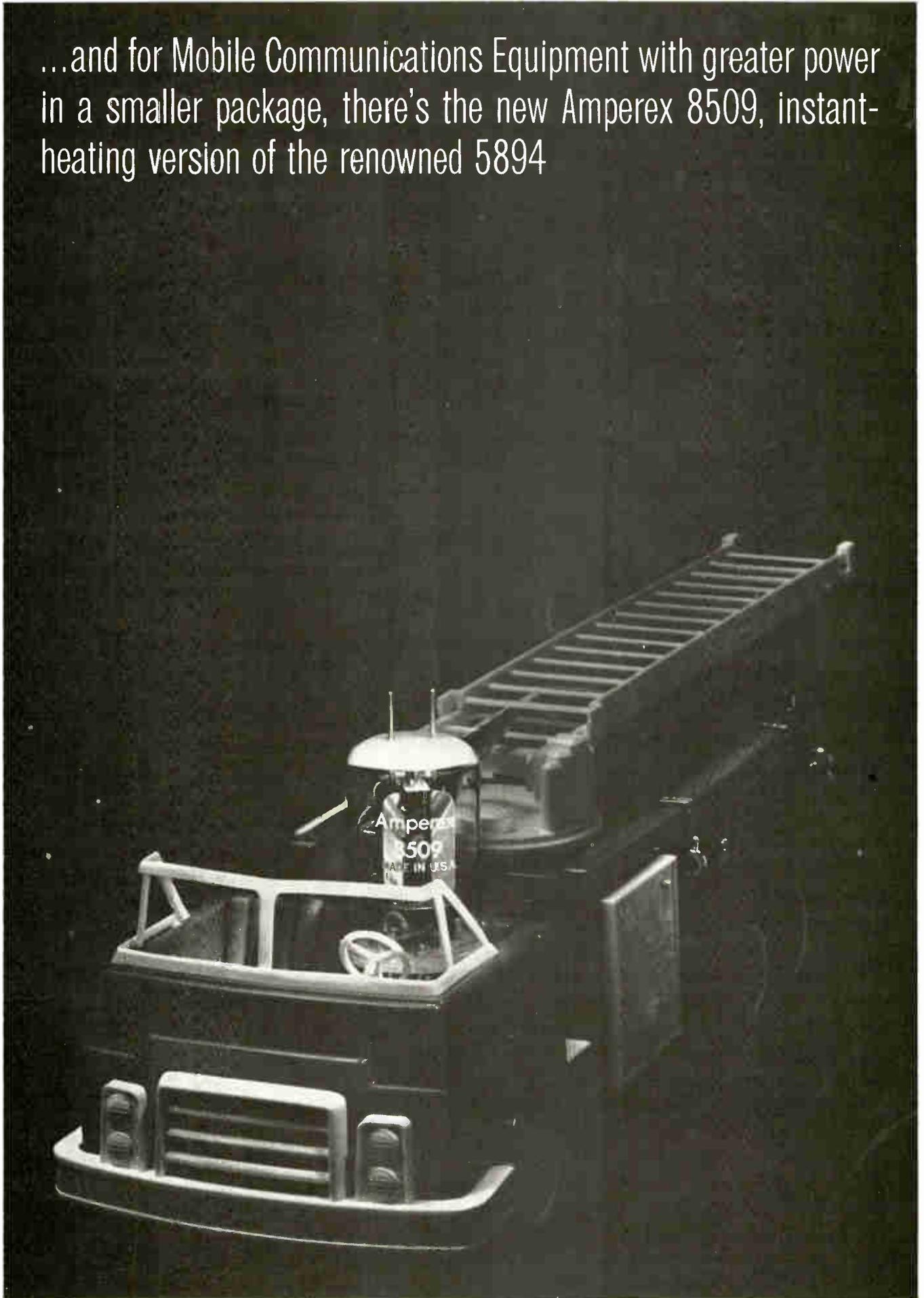
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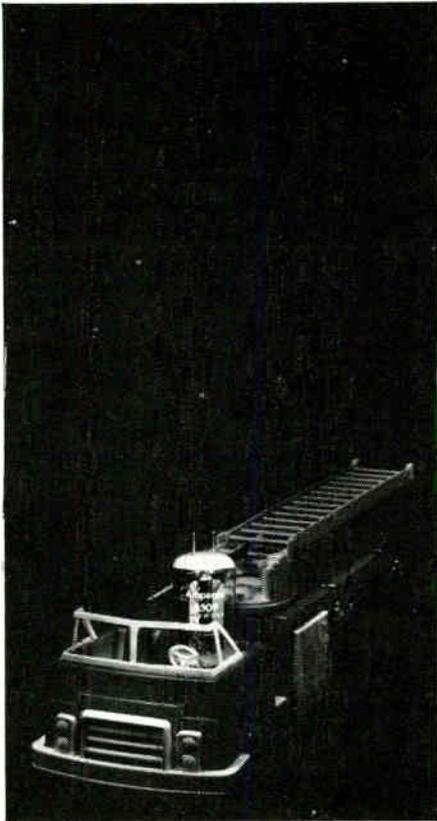
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...and for Mobile Communications Equipment with greater power in a smaller package, there's the new Amperex 8509, instant-heating version of the renowned 5894





Take the Amperex 5894, a twin tetrode widely recognized by communications equipment designers and end-product users alike for its overall superiority. Take the Amperex instant-heating Harp Cathode, the same Harp Cathode that is now proving its exceptional qualities in the rapidly growing Amperex family of instant heating communication tubes. Put the two together and the advantages to designers of transistorized communications equipment—whether its back-pack or land safety—are unbeatable.

Like the famous 5894, the new 8509 is designed for use as an RF power amplifier, oscillator, modulator and frequency multiplier. It features high-gain, unflinching uniformity and extreme reliability.

Unlike the 5894, however, and thanks to its Harp Cathode, the 8509 has an operational warm-up time of only 0.5 second thus insuring an ideal marriage with transistorized circuitry, and the reduction of battery power supply-size without sacrificing either power output or equipment efficiency.

Under Typical Class C Telegraphy ICAS operation as a Push-Pull RF Power Amplifier, the 8509 will deliver a Power Output of 96 watts at 250 mc. At reduced ratings the tube may be operated up to 500 mc.

For complete data on the new 8509 and other Amperex instant-heating communication tubes for mobile applications, write: Amperex Electronic Corporation, Tube Division, Hicksville, Long Island, New York 11802.

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IN CANADA: PHILIPS ELECTRON DEVICES LTD., TORONTO 17, ONT.

Circle 71 on Inquiry Card
ELECTRONIC INDUSTRIES • October 1964

EDITOR'S NOTEBOOK

ELECTRONIC FISH CALL: A new transistorized fish caller, marketed by K. W. Schmidt Imports, Point Pleasant, N. J. sends sound waves from 50 to 300 cps through water some 200-300 yards. Device also emits light waves for attracting fish of all species. Fish respond to sound frequencies and light waves. When the fish respond, the rest is up to the anglers.

A MATH ANSWER seven miles long. Math hobbyist Charles Fensel, Bradford, Pa., asked General Electric in a letter if a GE unit could produce the result of raising 9 to the 9th power of 9. Don Scholtz, GE Computer Department, answered with these facts: process would cover 46 hours, and 41,700 (8½"x11") pages. Pages end-to-end would extend for seven miles.

ENCAPSULATED UNIT, three-pound dc-to-dc converter, survived impact in clay and gravel after a free fall of 138 miles. The converter, protected by a room-temperature-vulcanizing silicone encapsulant, was the only component of an Aerobee-Hi space probe telemetry system still functioning after hit. The unit was in the vehicle's nose, and impact speed was about 180 mph. The converter was made by Electronic Development Corp., encapsulant by Dow-Corning.

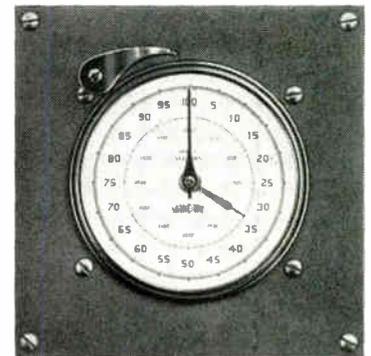
LIMP MEASURE DEVICE developed at Purdue University allows medical men to monitor forces in a person's limp. It records walker's timing, magnitude and composite force, as well as frontal, lateral and vertical forces. Developer James Barany, associate professor at Purdue's School of Industrial Engineering, said that the device is used with an electronic force platform, which can pick up even a heartbeat. Findings are plotted automatically. An analog computer translates data.

CHECK CHECKER installed by state government of Indiana believed to be first computer system to use electronic files of three banks to determine status of checks issued against state agency funds. The system is an NCR 315 which includes Card Random Access Memory units used by two banks and a magnetic tape system used by the third bank. State government in Indianapolis issues about 1.5 million checks yearly.

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with ± .001 sec.
accuracy



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Model	Scale Divisions	Totalizes	Accuracy
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST-100	1/1000 sec.	6 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.



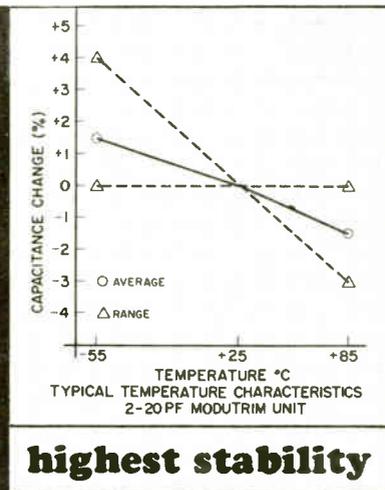
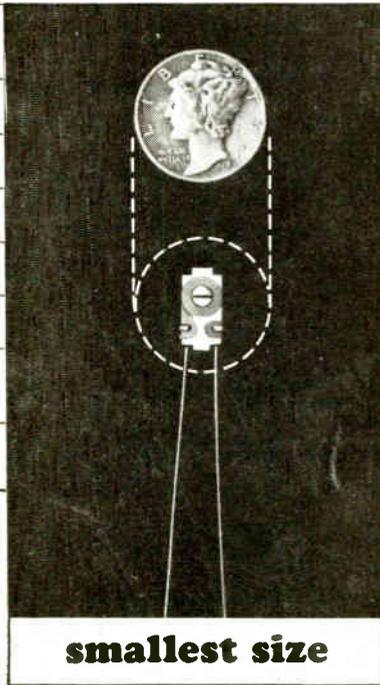
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Modutrim Model #	Capacitance Ranges (PF)
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MT 120	2 to 20
MT 130	3 to 30
MT 140	4 to 40
MT 150	5 to 50
MT-100 at 500 wvdc. All others at 50 wvdc.	
widest ΔC	



● If you are designing micromodule or hybrid circuits, this new MT Series of Modutrim micro-miniature ceramic variable capacitors offers **three** exclusive features.

(1) Note that ΔC is extended to as high as 5-50 pf. (2) **Highest stability** results from the use of both a special ceramic material (developed in JFD's own Glass and Ceramic Laboratories) and a unique monolithic rotor. (3) These Modutrim units are the **smallest** available. Standard unit size is only 0.208 in. x 0.401 in. x 0.120 in. thick.*

Other Modutrim Advantages:

1. Capacitance adjustment is approximately linear for 180 degree rotation.
2. Temperature coefficient of capacitance is -250

± 250 ppm/ $^{\circ}C$, exact values depending on the capacitance range. (Exception: Model MT150, temperature coefficient -700 ± 250 ppm/ $^{\circ}C$)

3. Capacitance drift is 0.75% of maximum capacitance for temperature cycling, from -55 to $+85^{\circ}C$.

4. Guaranteed minimum Q of 500 at 1MC. (Exception: Model MT 150 has minimum Q of 300 at 1MC)

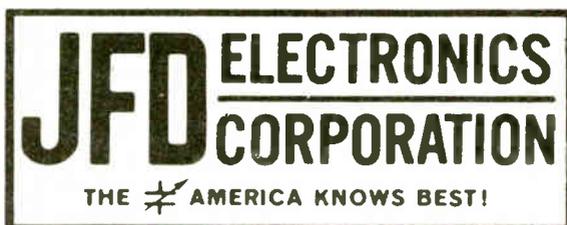
5. Adjust torque is 1 to 5 in. ounces.

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7. Modutrim units meet or exceed all requirements of Military Specification MIL-C-81A.

* (Units as small as 0.208 x 0.280 x 0.120 in. thk. can be furnished upon special order. Other configurations are also available.)

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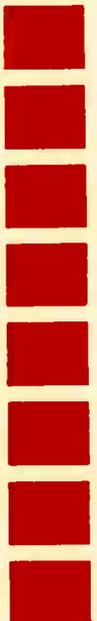
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Reporting late developments affecting the employment picture in the Electronic Industries

LIFETIME OF SCHOOLING CAN BEAT OBSOLESCENCE

There are many who believe that one of the better ways for engineers to avoid technical obsolescence is to keep going to school through their working careers.

Among these proponents is E. H. Freiburghouse, of General Electric Co. He asserts that our highly industrialized, technically based society "must abandon its concept of 'in-series' lives neatly compartmented into 20 years of school, 40 years of work, and 20 years of retirement."

Mr. Freiburghouse suggests that a more desirable pattern necessitated by economic realities will be 16 or 20 years of school followed by 40 years of work and school.

He believes that a shorter work-week can help establish such a pattern if our society can avoid the mistake of giving all free time to leisure. Personalized continuing education programs "offer a method of effectively using our impressive educational cafeteria to avoid professional obsolescence."

USES WANTS BIGGER ROLE IN PLACING PROFESSIONALS

Administrator of the United States Employment Service (USES), John C. Donovan, recommended to a House labor subcommittee that the Service be given a new charter to better serve the growing proportion of professional and technical employes in the labor force.

He sees the Service playing an important role in the "early warning system" signalling shifts in labor needs caused by technological change. He testified that the Service must be able to estimate in advance the impact of technological change and must be able to "locate or develop needed skills, and reduce adverse impact upon communities."

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 110.

AIR ACADEMY EDP



Versatile, high-speed EDP system is being installed at the U. S. Air Force Academy in Colorado Springs. It will be used primarily by the Frank J. Seiler Research Laboratory at the Academy. The system, a Burroughs B5000, will support Air Force fundamental research. Lt. Carl Hennrich (left) Dept. of Aeronautics; Mrs. Sarah Stebbins, mathematician, and Capt. Rinaldo Vachino, research associate, discuss a computer output.

EXCESS FREEDOM MAY HINDER ENGINEER WORK, STUDY HINTS

Too little freedom or too much freedom—one can be as bad as the other for the research and development engineer, according to a report by psychologists at University of Michigan.

Dr. Donald C. Pelz and Dr. Frank M. Andrews report that their five-year study of engineers and scientists indicates that the autonomous researcher did not necessarily perform better than another whose goals are determined jointly with other people. The most productive appears to be one with substantial control over his technical goals, but who also allowed those goals to be influenced by others.

The study, according to Drs. Pelz and Andrews, indicated that the best combination in terms of performance output was "self and chief." This is the situation where the engineer and his supervisor have a large mutual voice in setting the engineer's goals. In research-oriented labs, the best combination proved to be joint goal-setting by "self and colleagues."

In both kinds of labs, the condition of "mainly chief" was just as clearly unfavorable, asserts Dr. Pelz.

BROADER TRAINING IS URGED FOR ENGINEER FLEXIBILITY

Whether scientists, engineers and technicians will be unaffected or seriously affected by cuts or shifts in aerospace/defense activity depends largely upon their education, training and job experience, reports John C. Donovan, Manpower Administrator for the Department of Labor.

"The engineer with strong science background, who has kept up with the journals, presumably will have less difficulty finding another job. Students should gather as much background as possible in science, and narrow specialization should not occur at the undergraduate level," Mr. Donovan said. He acknowledges, however, past contributions of the narrowly-trained or non-degree engineer, and the limited not-well-trained technician.

Mr. Donovan said that the Labor Department is empowered by the Manpower Development and Training Act of 1962 to train and retrain unemployed workers. The Act's 1963 amendments do not cover scientists, engineers and many types of technicians.

He urged broader education and training for technical people for greater vocational flexibility.

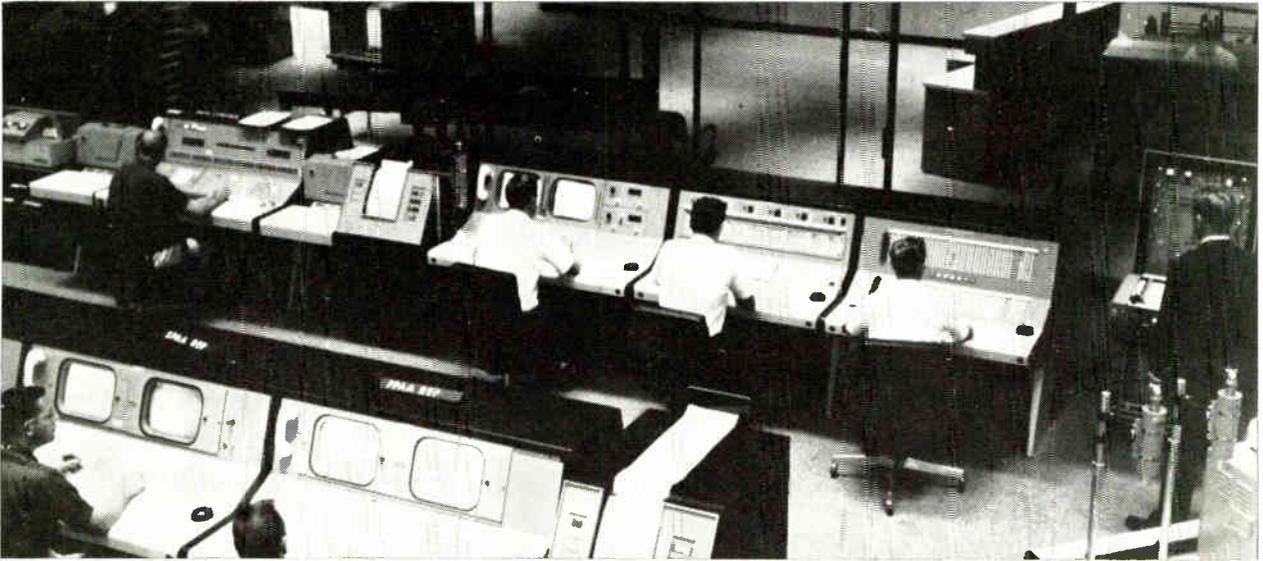
20,000-PHYSICIST SHORTAGE BY 1970, AIP PREDICTS

The American Institute of Physics predicts nearly 60,000 openings for physicists in 1970, and only about 38,000 physicists to fill them.

In its special report, "A Statistical Handbook for 1964," the Institute observes that only about 2% of those who teach high school physics are certified as public school physics teachers.

Only about 500 teachers are certified each year, and only 300 of these enter teaching. Of the 16,700 persons now teaching high school physics, many have no proper training in physics.

Aside from the shortage of working physicists, the Institute warns that lack of physics study means that most Americans leave school without any basis for "understanding the importance of R&D projects" on which billions of tax revenues are spent.



Space Flight Operations Facility for NASA at Caltech Jet Propulsion Laboratory, Pasadena, is a good example of a field of concentration for electronic and aerospace firms as the defense markets level off, with the U.S. Government spending less on defense electronic systems.

Meeting the Challenge Of Leveling Defense Markets

As the government trims back its defense budget, contracts become fewer and smaller.

The trend among electronic firms is to expand operations in the industrial and consumer markets.

Firms choose various ways to overcome diminishing defense markets, but they are united in direction.

By **SIDNEY FELDMAN**

Associate Editor, ELECTRONIC INDUSTRIES

GREATER COMPETITION AND RISK, as well as opportunity, now characterize many government and commercial electronic markets. Here are brief case studies of how five companies are responding to current conditions which threaten the defense/aerospace market in our thriving national economy.

Chief executives of Avco Corp. were concerned, despite the company's record \$514 million net sales and record \$22.4 million net profits for the year ended Nov. 30, 1963. Although their "diversified" firm is known for its defense/aerospace products, higher profits came from commercial operations including farm equipment, broadcasting, and aircraft engines. After due consideration, Kendrick R. Wilson, Jr., chairman of the board, and James R. Kerr, president, announced they no longer sought more defense business.

They reasoned that 75% of Avco defense/aerospace billings yielded 55% of profits, while 25% of its commercial billings yielded 45% of profits. Accordingly, these executives concluded, "We are looking to add subsidiaries of a commercial nature."

Avco, of Cincinnati, Ohio, first announced negoti-

ations to merge by trading stock and acquiring Delta Acceptance Corp., which last year handled \$242 million worth of loans, installment sales finance, and insurance in the U.S. and Canada. Absorbing Delta has appeal because it is a foreign (Canadian), non-defense, non-equipment "service" company that earns much-higher-than-defense-profits.

Next, Avco and Meredith Publishing Co. formed Meredith Avco Corp., to be capitalized at \$10 million. It will establish, acquire and operate community antenna (CATV) systems that also may carry pay-TV programs. Avco's subsidiary, Crosley Broadcasting Corp., operates four TV stations and one radio station under varied WLW call letters.

Further Diversified

Operations of Avco's Aerospace Structures Division were further diversified with two new contracts. Aerospace will produce office equipment for the Globe-Wernicke Co., and "Wizarc" home cooking appliances (ranges) for Western Auto Supply Co. Both contracts required adding nearly 600 employees, although a previous contract to build appliances had



TV Cameras by RCA focussed on inside of huge re-heat ovens at Jones & Laughlin steel plant, Aliquippa, Pa., give furnace charger operator a close-up of white-hot slabs as they move in furnace 100 ft. away, one of many industrial electronic systems now being produced.

expired. (Avco's Canadian subsidiary, Moffats Limited, makes gas and electric ranges and other household appliances.) Aerospace also increased its sales of Avcold and Uni-Reef shipping containers which keep foods cold over long distances without mechanical refrigeration. However, this division's biggest business is still making parts of the Saturn rocket, Titan III boosters, and assemblies for the Air Force C-141 turboprop jet transport.

Withal, Avco is not disavowing defense/aerospace business. President Kerr told a National Industrial Conference Board meeting that Department of Defense and National Aeronautics and Space Administration budgets could continue around \$55 billions annually, since East-West tensions may continue indefinitely. He also stressed need to give the government dollar-value for dollars-spent.

Concurrently, Avco announced it will invest \$1 million for seven new space research laboratories. That decision exemplified Avco's strategy to move with the big defense/aerospace markets where growth has been slowed, yet seek more profitable expansion in promising commercial-industrial fields.

Avco management outlook and approach are somewhat paralleled by those of William E. Zisch, president of Aerojet-General Corp., Azusa, Calif. His strategy is to diversify defense/aerospace operations for anticipated long-term growth—*supplemented but not replaced by new commercial business*. Aerojet does 98% of its billings with the government, including relatively minor but vital interests in electronic activities.

After current Polaris and Minuteman solid-fuel missile contracts will have been completed around 1970, Aerojet may have smaller retrofit and follow-on contracts. It also counts on making space boosters for the continuing Titan II and III programs. For the long pull, the company banks on the experimental

Nerva nuclear rocket, the M-1 liquid hydrogen rocket, and the 260" large solid rocket, plus work in space life support systems by its Space General Corp.

Acquired Shipyard

Meanwhile, Aerojet's other quasi-industrial diversified activities range from its AETRON architectural-engineering division, to its newly-acquired Gibbs Shipyard interests in electronic ship controls, oceanography, and anti-submarine warfare. Commercial diversification ranges from its Microwelder Mar II for subminiature electronic applications, to its Atlantic Division which designs materials handling systems.

But Atlantic's few-million-dollar annual sales re-

U.S. Navy fire-control technicians operate Underwater Fire Control System Mk 113, developed by General Precision, Inc., for SUBROC antisubmarine weapon system. Government contracts for such systems are fewer. Direction is toward industrial markets.



ELECTRONIC INDUSTRIES

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 Will Relocate Yes No. If Yes Another City Another State
 Salary Desired to Change Jobs in present area _____
 Salary Desired to Change Jobs and relocate in another area _____
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Mail to: ELECTRONIC INDUSTRIES—Professional Profile—56th & Chestnut Sts.—Philadelphia, Pa. 19139. This resume is confidential. A copy will be sent only to those Companies advertising for engineering personnel in this issue, whose number you circle below.

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LEVELING MARKETS (Continued)

present less than 1% of Aerojet annual sales, which peaked at \$703 million in 1963 and may ease to about \$640 million this year with the decline in ordnance sales. Mr. Zisch believes that Atlantic could expand sales to about \$50-to-\$100 million by 1970. (By comparison, Aerojet sold \$545 million worth of rocket propulsion systems in 1963.)

The Atlantic Division, in Frederick, Maryland, acquired and reorganized in 1957, helps industry identify and resolve problems to cut costs in manufacturing, supply, distribution, servicing or procedure. Its potential customers, grossing about \$200 billions annually, include transporters: airlines, railroads, steamships and truckers; express companies and freight forwarders; manufactures; department stores; post offices, and military operations. Installations for clients include a post office in Miami, railroad terminals in St. Louis and Texarkana, and REA Express terminals in Chicago and Cincinnati.

Atlantic engineers make surveys, then propose a preliminary materials handling system concept and economic analysis. This service work may lead to actual installations, implemented by Atlantic's capabilities in design, construction, installation, maintenance and financing.

Aerojet provides some equipment used in Atlantic's "SORTRAC" I, II, and III systems that automatically handle sacks and packages. However, it also buys equipment from other sources. Atlantic aims to ensure total system solution, to amortize costs in a short time. A minimum amount of capital equipment is utilized by applying value analysis, and integrating existing equipment into new systems where possible.

A noteworthy installation is the automatic mail-sack-sorting system for the St. Louis Terminal Railroad Association (TRRA). This system, which cost about \$2 million, may save about \$1 million annually by reducing to half the usual number of mail handlers. Labor union agreements, made between TRRA and the Brotherhood of Railway Clerks, have eased this transition into automation.

Electronic controls and equipment, which play key roles in various systems may account for about 20% of total costs. Atlantic engineers utilize memory equipment specially developed for sorting systems. These types include magnetic tape, electromechanical, magnetic drum, and shift register. And, in a typical modern warehousing concept, electronic data processing equipment is used to integrate customer orders, materials handling, inventory records and controls.

Government business helps Otis Elevator Co. to participated in and monitor electronic developments to be applied to industrial/commercial elevators. As early as the 1930's, Otis had used photo-cells in

elevator operations. In 1947 the company introduced electronic touch buttons to signal elevators.

In 1953, a century after Otis was founded, it established a separate facility to produce electronic bomber and navigational trainers. To help perform these government contracts, Otis acquired the Transmitter Equipment Mfg. Co., which made radio communication and special electronic equipment for government and industry. These operations subsequently became the Otis Defense and Industrial Div., Brooklyn, N. Y. The company thus enhanced its in-house electronic capabilities.

(Continued on following page)

Avco President James R. Kerr, disclosed that the firm no longer seeks defense business. "We are looking to add subsidiaries of a commercial nature." Avco reasons that 75% of its defense billings yield 55% of profits, while about 25% of commercial billings yield as much as 45% of profits. On the other hand, Avco is not disavowing defense business.



Dr. Lyman R. Fink recently brought into Otis Elevator Co. as vice president in charge of engineering, brings experience in defense equipment, X-ray, nuclear, radio-TV and other electronic fields. Otis is preparing to go big in electronic equipment and controls for elevators. Of \$368 million income for 1963, \$2.7 million came from defense.

Albert J. Eisenberg, president of Microtran Co., Inc., probed possible new markets to gain independence from variable government market. He found that small electronic firms, thinking of diversifying, must plan carefully to husband limited personnel, facilities and finances. New products were explored, tried, are produced for industrial market.



According to Donald H. Putnam, president of Giannini Controls Corp., "we're going to see a wealth of aggressive, imaginative companies with individual success prospects undimmed by current industry problems." Giannini expects industry to be its largest single customer—about 40% of sales. Defense sales are forecast at 36%, space at 24%.

The strategy of William E. Zisch, president of Aerojet-General Corp., is to diversify defense aerospace operations for anticipated long-term growth—supplemented but not replaced by new commercial business. Aerojet does about 98% of its billings with the U.S. Government, including relatively minor but vital interests in electronic activities.



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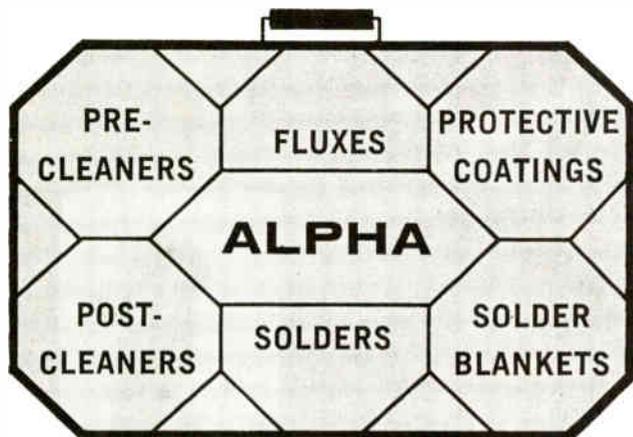
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LEVELING MARKETS (Continued)

New Elevator Controls

Innovations here include the "Electronic Detector" which enables elevator doors to close quickly without interfering with passengers. Currently, Otis is introducing "Autotronic Unlimited" elevating which automatically speeds-up service. A computer continuously senses traffic demand throughout a building, predicts elevator availability, then directs cars where needed. Since elevators anticipate calls, they make fewer in-between stops, and passengers reach their floors sooner.

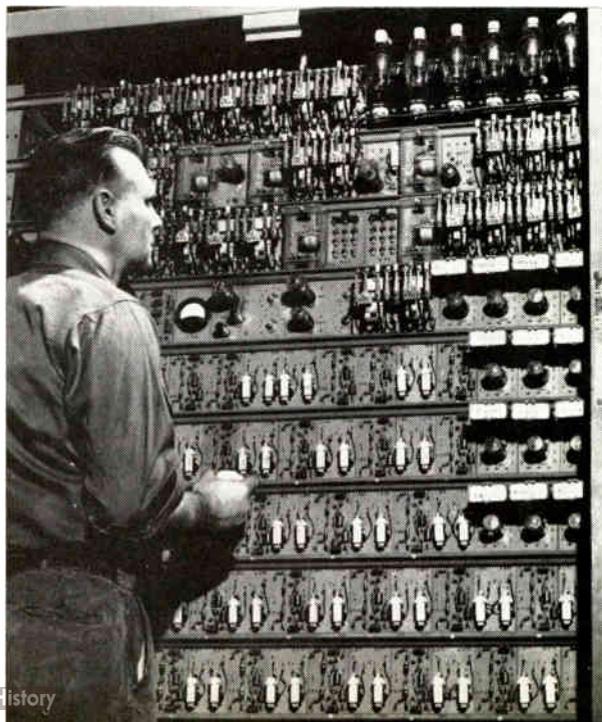
Though electronic operations at Otis contributed to major saleable elevator refinements, defense electronic operations yield minor and indirect profits. In 1963, Otis' Defense and Industrial Division operated at a significant loss—the first in its 10-year history—as bookings sagged to \$2.7 million compared with \$6 million in 1962. A return to profitable operations is expected this year.

Otis' \$2.7 million defense volume was roughly 2½% of its \$111.4 million total domestic business for new elevators and escalators in 1963. That tiny percentage nearly vanishes when compared with Otis' combined domestic and foreign business which set a new high of \$368 million in 1963.

Still, Otis management appreciates the value of its electronic capability, which it is strengthening. Otis President Percy L. Douglas observes, "It is of importance both to our defense program and to our elevator development program that our engineering staff be fully cognizant of the rapid progress being made in the field of electronics."

Exemplary of utilizing defense and commercial

Sample section of Otis elevator controls, now being installed for industrial and commercial elevator systems, which require fewer electronic parts on printed circuit boards, doing relatively the same amount of work done in the past by cumbersome relay panels.



electronic technology in the form of a human being, last December Otis engaged Dr. Lyman R. Fink as vice president in charge of engineering. Since 1937, he had served General Electric in engineering and executive capacities. He brings to Otis his experience in electrical apparatus, defense equipment, X-ray, nuclear, radio, TV and other electronic fields.

Electronic equipment is assuming an increasing share of elevator installations. For example, electronic controls now constituted about \$20,000 of the cost of a typical \$120,000 elevator installation in an office building. Such activity represents a market for electronic components, equipment and instruments used to build, install and maintain elevators.

Though Avco and Aerojet sold hundreds of millions of dollars worth of varied equipments and systems last year, Giannini Controls Corp's \$26.4 million sales were entirely in electronic and control fields. Giannini's President Donald H. Putnam characterizes these markets as ranging from "apathetic" to nearly "exuberant." He predicts, "We're going to see a wealth of aggressive, imaginative companies with individual success prospects undimmed by current industry problems."

Sees Industry Market

This year, Mr. Putnam expects industry to become Giannini's largest market with 40% of sales. That



To insure reliability for orbiting spacecraft, Aerojet-General Corp. developed its Microwelder to link micro-size components after discovery that standard bonding devices would not produce needed reliability. Workers here are producing Microwelder components.

compares with his company's sales forecasts of 36% for defense and 24% for space markets—still a neat 60% in government business. Mr. Putnam regards the flattening level of military component production as "normal, not depressed."

Yet he sees growth in systems for tactical aircraft, limited warfare, and ICBM re-entry vehicles. He considers the space market so attractive, he expects growth here "limited only by our capacity to take

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LEVELING MARKETS (Continued)

on new projects, not by size of market."

Though industrial business for the Giannini firm, of Durante, Calif., is almost entirely in capital goods," this company can be caught between the ups and downs of cyclical capital spending, and erratic swings of Congressionally-authorized defense/aerospace budgets. Here, Mr. Putnam counts upon the current "overriding effect" that: automation finally has blossomed into quick growth. He anticipates that more than 20% of future annual business capital spending will be for automated equipment.

Two areas offer unique opportunities here.

First is: specialized on-line instrumentation for continuous process industries like plastic extruding, food processing, papermaking, and oil-refining. Mr. Putnam foresees need of new basic on-line instruments to provide direct controls now often measurable only in the laboratory. The "most compelling argument for total, on-line instrumentation is the advent of computer process control."

Second is: a "uniquely bright future" for data communication products "bridging the interface between machines and their users." Giannini products here range from alpha/numerical television displays of airline departure information, to direct reading digital timers to record hours of customer use of business machines—chiefly data processing equipment.

Four other Giannini variations are noteworthy. Sometime ago, the company formed a Process Nucleonics department in its Control/Nucleonics Division to develop industrial applications of aerospace techniques. At Giannini/Powertron sales emphasis of existing ultrasonic units is being shifted from military into industrial markets which now bring 45% of sales.

Conversely, Giannini/Datex militarized its commercially-developed digital encoder which finds new markets in digital weapons, such as airborne computers. And at Giannini/New Jersey, all military component operations were transferred to other parts of the company to enable total concentration on industrial control and digital measurement systems.

Small electronic companies, contemplating diversification, must plan carefully to husband their limited personnel, facilities and finances. One case concerns Microtran Co. Inc., Valley Stream, N. Y., which has about 100 employees and specializes in miniaturized electronic transformers for defense/aerospace applications.

This company sought new markets to compensate for the leveling growth curve of transformer sales and intensifying competition. Microtran, which had available plant facilities, also probed possible new markets to gain independence from the variable government market.

These factors beset President Albert J. Eisenberg,

a graduate electrical engineer with graduate school business management training, who is also marketing manager for Microtran. He had to explore development of new products and markets, because the company is privately held and could not readily issue additional corporate treasury stock to merge or acquire another company.

Unique Sound Equipment

The major new product his firm developed was a unique type of sound equipment, to be sold by audio contractors to industrial/commercial customers. In planning this new venture, Mr. Eisenberg first conducted a product marketing survey. He analyzed the strong features of his proposed product with respect to limitations of competitive products, competitors' marketing capabilities, product proprietary protection, and categories of potential customers. He ascertained a possible \$50 million annual market for this new product, for which he budgeted a 2% share, equal to about \$1 million sales annually.

After reviewing distribution channels, Mr. Eisenberg decided to use exclusively franchised distrib-



Plant scene at Microtran Co., Inc., where workers are producing a line of printed circuit transformers, built to mil specs, but for distribution at commercial prices in the industrial-commercial markets for "many demanding automation control applications."

utors, with selected distributors in certain areas. He planned for initial investment, product pricing, operating budgets, with appropriate tools for measurement and control. By now, his contemplated return on invested capital looked "quite satisfactory."

Among countless decisions, Microtran managers joined in to determine whether a new company and a new name should be created to sell the new product. They decided to establish an autonomous division. This was done mainly to prevent product identification or confusion with the Microtran name, to control separate budgets and profitability, and not to blur commercial business into government operations which have a higher overhead.

To avoid wasteful overlapping of duties of the company's small staff, management assignments were formally designated and coordinated. Duties here comprised engineering, marketing, manufacturing, quality control, purchasing, accounting and legal. A check-off list matched operational and promotional schedules. Now it was time for the final decision: Go—or—No Go. (Continued on following page)



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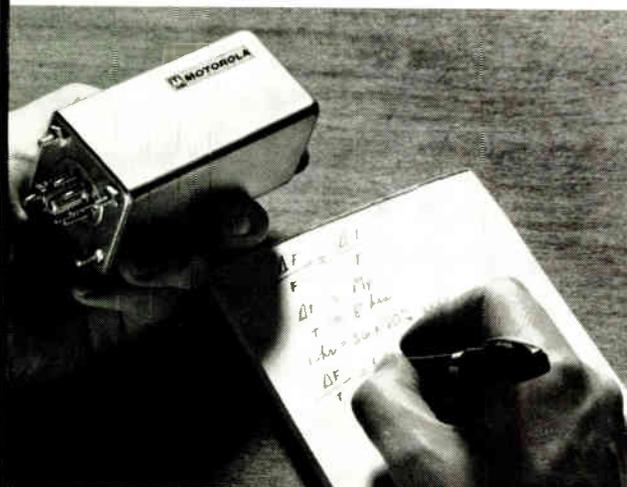
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LEVELING MARKETS (Concluded)

Despite this thorough evaluation, Microtran management felt its proposed product might be at a competitive disadvantage as a new entry in a somewhat established field. They finally canceled this project because they felt the product lacked sufficient uniqueness rapidly to develop its share of the market without extraordinary, costly promotion.

Instead, Microtran decided to use a different strategy by expanding its marketing area. Within a few months, it will establish a manufacturing facility in Los Angeles to provide closer engineering and product liaison with West Coast customers.

The firm also developed new transformer products to tap new markets where it already has proven experience. For example, Microtran developed a line of printed circuit transformers built to military specifications at commercial prices, and designed for "demanding industrial/automation control applications." It introduced additional chopper input transformers for instrumentation fields, and created specialty transformers for the sound contractor industry.

Microtran also had to deal with new market conditions of increased R&D defense aerospace activities and decreased production quantities. Here, the company broadened its line of transformer products to better serve the growing need for off-the-shelf engineered and reliable transformers for R&D short runs.

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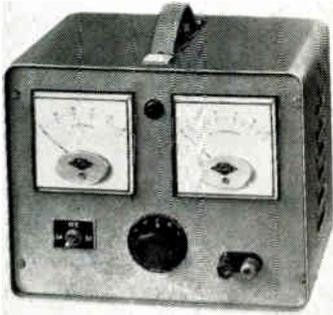
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PLATING POWER SUPPLY

Extremely accurate setting of plating currents for small parts.

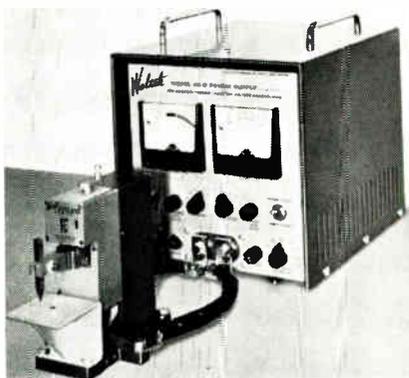


This power supply features smooth stepless control of output from 0 to 15vdc. This is provided by the continuously variable, toroidally wound, autotransformer controller. The dc output is filtered for 5% rms ripple, and all ac input circuits and dc output circuits are protected against current surges and short circuits. The silicon-rectifier power supply operates on ac input, 115v., single phase, @ 60 cycles. The Meaker Co., 75 River Rd., Nutley, N. J.

Circle 194 on Inquiry Card

AC POWER SUPPLY

Versatile unit can be used for micro-miniature welding or diffusion bonding.

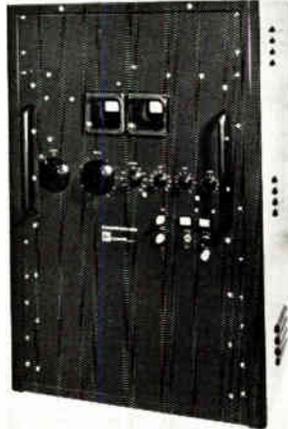


The AC-5 power supply provides a stable 1kc source, full-up slope and down-slope control, and a variable pulse from 10 to 800msec. It provides either a constant-current or a constant-voltage source. A reference for monitoring the resistance of the weld and the electrode interfaces is also provided. Input voltage is 100 to 130v., 55 to 65 cps, single phase. Weltek, div. of Wells Electronics Inc., 1701 S. Main St., South Bend, Ind.

Circle 195 on Inquiry Card

HIGH-VOLTAGE SUPPLIES

Output voltage is adjustable in 10kv, 1kv, 100v., 10v., 1v., and 0-1v.

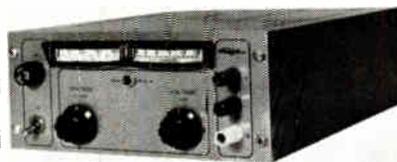


The BRE line of regulated high-voltage power supplies are designed for x-ray spectrometry, TWT and klystron uses. Performance characteristics are virtually independent of line voltage variations or load current changes. Line and load regulation is 0.1%; ripple is 0.01% rms. Universal Voltronics Corp., 17 S. Lexington Ave., White Plains, N. Y.

Circle 196 on Inquiry Card

POWER SUPPLIES

Silicon or silicon and germanium semiconductors provide large amounts of power.

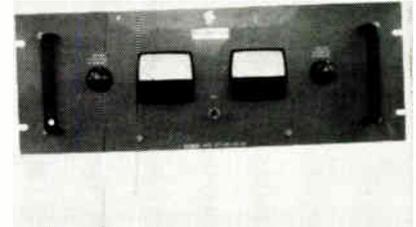


The RS Series (100% silicon) and the RG series (silicon and germanium) power supplies are system-type units for semi-fixed voltage ratings. Advanced circuitry eliminates output fuses or circuit breakers. It provides fully automatic service under all normal operating conditions, and automatic recovery after any abnormal operating situations. RS models operate at temps. up to 71°C; the RG operates to 50°C. Sixty-four RS and 64 RG models cover voltage ratings up to 56v. and current ratings to 24a. Deltron, Inc., 4th & Cambria Sts., Philadelphia, Pa.

Circle 197 on Inquiry Card

HIGH-VOLTAGE POWER SUPPLY

Features automatic crossover from constant voltage to constant current.

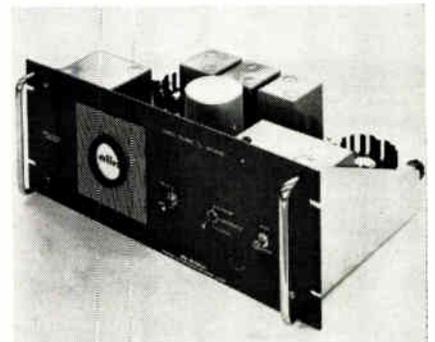


Model No. HY-CRI-36-25 has rms ripple of 1% or 360mv max., and is adjustable from 0 to 36vdc at full load of 25a. It features remote programming at 100Ω/v.; remote sensing; separate voltmeter and ammeter (2% accuracy) coarse and fine controls for both output voltage and current. The unit has a recovery time based on full load to ½ load or ½ load to full load of less than 200msec. Hyperion Industries, Inc., 134 Coolidge Ave., Watertown, Mass.

Circle 198 on Inquiry Card

SQUARE-WAVE POWER SOURCES

Freq. stability is 1 PPM; rise time is below 10μsec.; line regulation, below 0.1%.



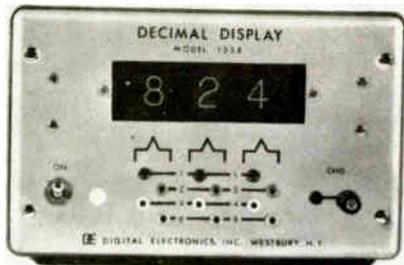
Designed primarily for gyro uses, the new MSQ series of multi-phase sq. wave sources feature transformer-coupled output to eliminate the possibility of any direct current in the gyro. Pulse shapes may be programmed to customer needs. Long-term drift checks are a special feature. Load regulation is less than 0.25%. élin Div., International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif.

Circle 199 on Inquiry Card

NEW PRODUCTS

DIGITAL DECIMAL DISPLAY

For test and data processing. Unit has its own amplifiers for low-level inputs.



Decimal Display Model 1558 supplies 3 decimal-digit in-line display from 12 lines of binary-coded-decimal input data. The numerals are illuminated using a cold-cathode indicator tube. It will also automatically convert from binary to octal with no additional modifications. Primary uses are in the test equipment as a laboratory tool and as a display device in data-processing systems. It may also be incorporated into many existing machine control devices without modification. Digital Electronics, Inc., 2200 Shames Dr., Westbury, N. Y.

Circle 200 on Inquiry Card

DIRECT-READING RECORDER

Presents a linearity up to 0.25% over a scale width of 2½ or 5 in.

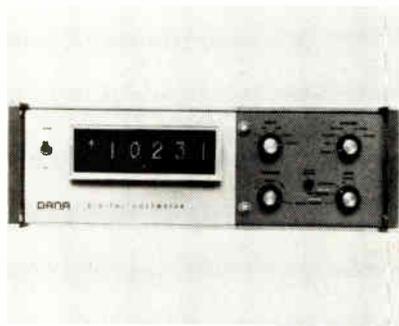


Model 300 is available as a single- or dual-channel recorder, and is compatible with pressure transducers and potentiometer transducers of all types. Freq. response is to 50 cps. Sensitivity is 10mm/mv; multiple speed ranges (1 to 50mm/sec.) is extremely stable, with zero suppression optional. According to the use, life of 500K full-scale cycles can be obtained. All mechanical linkages have been eliminated in the depth transducer, assuring greater accuracy. Computer Instruments Corp., 92 Madison Ave., Hempstead, L. I., N. Y.

Circle 201 on Inquiry Card

DIGITAL VOLTMETERS

Measures 35 reading/sec. for 4-digit model and 8 reading/sec. for 5-digit unit.

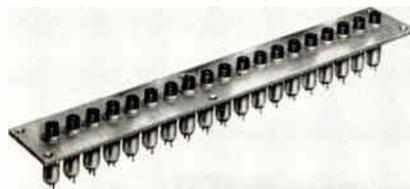


Model 4103 is a 4-digit instrument; Model 5103 is a 5. Both feature successive approximation logic and an internal telemetry link that connects the external remote-control circuitry with isolated measuring circuits. Normally, adding a remote-control connection destroys the common-mode rejection capability of instruments of this type. In these units, complete isolation is maintained; the CMR of the DVMs remains at 120db or 1 million to 1. Both units have a full-scale accuracy of 0.01%. Dana Laboratories Inc., Irvine, Calif.

Circle 202 on Inquiry Card

LIGHT MOUNTING

No conventional mounting hardware is needed. Press fitted into the panel.

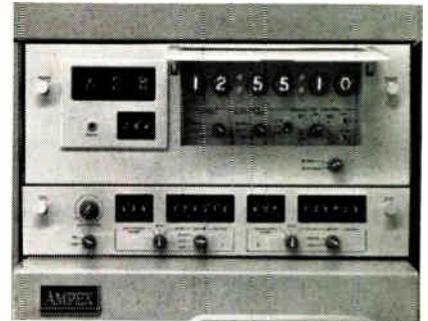


With the Bi-Pin Lampholder, panels can include an individual indicator light to over 100 units in single or multiple rows. Min. spacing between centers is ½-in. Duplicate operations can be eliminated where a series of lights is mounted on the same panel by installing them while they are being fabricated. Almost 300 neon and incandescent Bi-Pin cartridge lamps are available for use in these holders. Units meet the environmental requirements of Mil-STD-202B/Mil-L-3661A. Drake Mfg. Co., 4626 N. Olcott Ave., Chicago, Ill.

Circle 203 on Inquiry Card

TIME-CODE SYSTEM

Permits location and visual or automatic search of data recorded on magnetic tape.

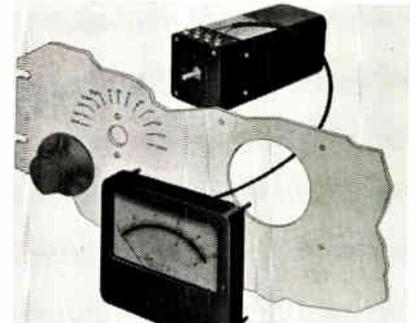


The TCS-100 places time signals, which correspond to the time scale of the phenomenon being recorded on one track of the tape, at 1 sec. intervals. Time signals appear in sec., min., and hrs. in a 6-digit display during any one of the operating modes—record, reproduce, fast forward, rewind and stop. The time track thus becomes a permanent part of the recorded data so that the original time scale is never lost, even if a portion of the tape is cut out and spliced into another tape. Ampex Corp., 401 Broadway, Redwood City, Calif.

Circle 204 on Inquiry Card

DC VOLTMETER

Unique panel-mounting design. Meter movement is separated from electronics.

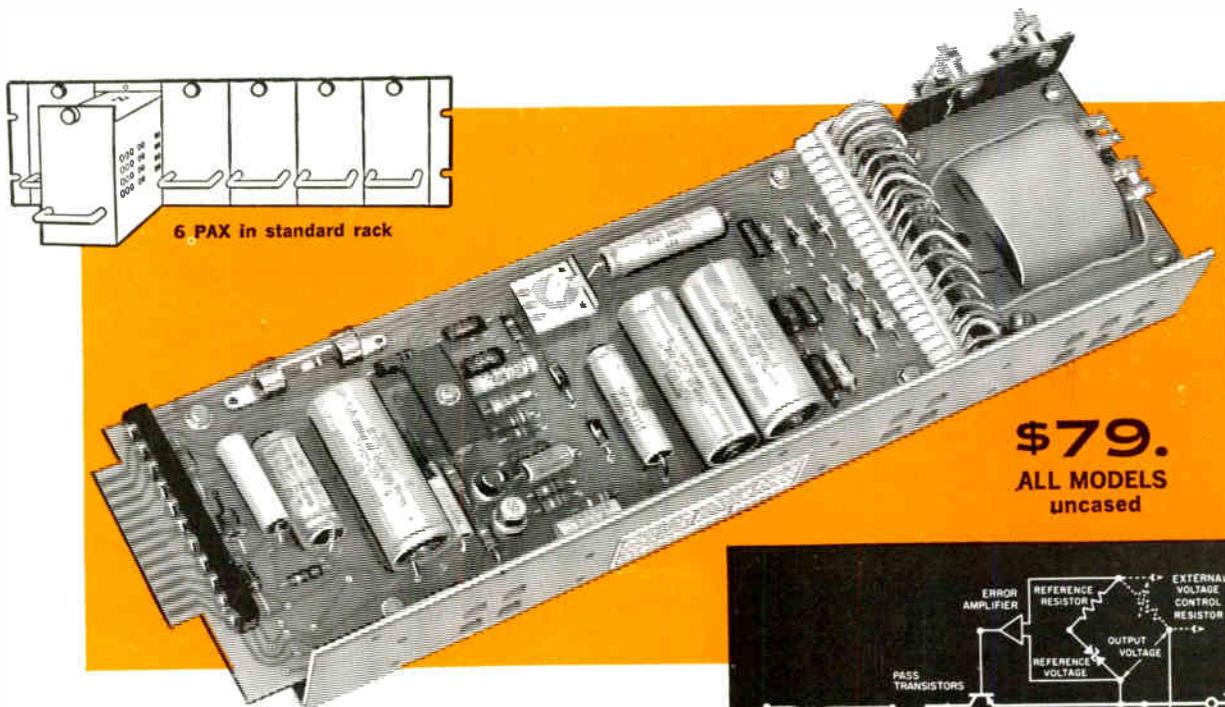


Dc voltmeter Model DCVM provides unusual physical flexibility to the designer of test equipment and control consoles. The separation of the meter movement from the electronics allows installation anywhere on the designer's panel. Featuring 2% accuracy, 2 megohm input resistance, and range selection from 10mv to 300v., the unit is fully transistorized. It will sustain a 350vac or dc overload on any scale without damage. The new voltmeter configuration finds particular use in the construction of test consoles. Theta Instrument Corp., Saddle Brook, N. J.

Circle 205 on Inquiry Card

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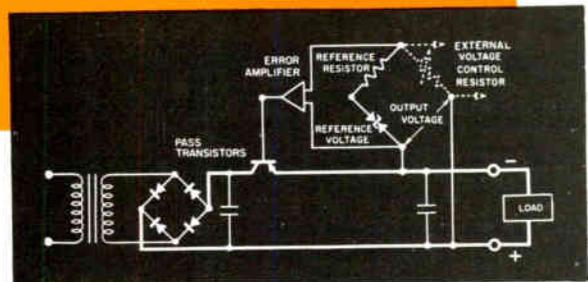


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† Applicable Patent Nos. furnished on request

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PAX 14-0.75	0-14	0-0.75	0.3
PAX 21-0.5	0-21	0-0.5	0.3
PAX 36-0.3	0-36	0-0.3	0.3
PAX 72-0.15	0-72	0-0.15	0.3

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Capacitance Range:	1.0 to 10.0 pf
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- SG 11114—Printed-circuit mount, gold-plated parts
- SG 11114/AG—Printed-circuit mount, silver-plated parts

Sample quantities available from stock. Send for data sheet.



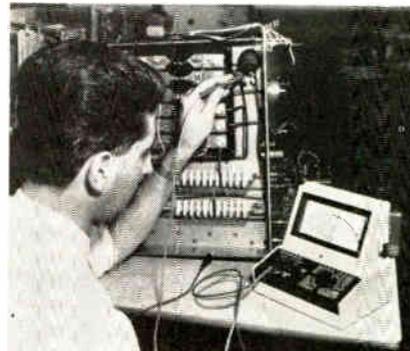
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A 1% dc and 1 1/2% ac accuracy permits measurements beyond typical VOMs.

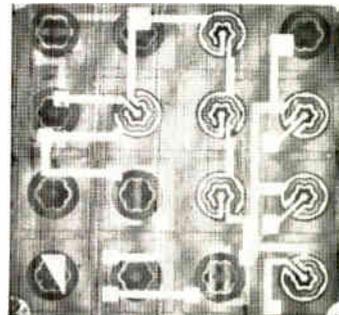


Model 80 is a portable volt-ohm-milliammeter packaged in a console-type case. It features a unique tilted meter face and a refractive anti-parallax scale. Model 80 reads ac and dc volts, dc current, and ohms. It also has an output meter scale. Dc voltage ranges @ 20KΩ/v. are: 0.25, 1, 2.5, 10, 25, 50, 100, 250, 1K, 5K. Ac voltage ranges @ 5KΩ/v. are: 2.5, 10, 50, 250, 500, 1K and 5K. Dc current ranges are: 50μa, 1ma, 10ma, 100ma, 1000ma and 10a. Weston Instruments, Inc., 614 Frelinghuysen Ave., Newark, N. J.

Circle 206 on Inquiry Card

CIRCUIT DESIGN KITS

Allows designer to arrange schematic using microelectronic state-of-the-art.



This designer's kit for the layout of truly custom integrated circuits permits the circuit-design engineer to arrange and define his own schematic in a format compatible with the microcircuit state-of-the-art. The kit approach definitely returns the circuit design function to the customer without premium price penalties. An integrated circuit technique called MO-SAIC™ uses diffused active devices with thin-filmed passive devices deposited directly upon the silicon dioxide layer covering the diffused portion. This technique offers many engineering advantages over the more common all-diffused technique. Bendix Semiconductor Div., The Bendix Corp., Holmdel, N. J.

Circle 207 on Inquiry Card

SIMPSON INSTRUMENTS STAY ACCURATE

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in the
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SIMPSON ELECTRIC COMPANY 5213 W. Kinzie St., Chicago, Ill.



DIVISION

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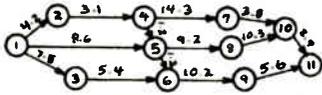
Is Your Knowledge of Computer Fundamentals &

TEST YOUR SKILLS IN THESE ELECTRONICS GROWTH AREAS

Engineers and technicians at General Electric, North American Aviation, ITT, General Dynamics, Raytheon, Philco, Douglas Aircraft, Continental Device, Automatic Electric, and other leading companies have selected 5 initial subjects in these areas for their own personal development.

Test your knowledge of these fundamental subjects. Here are some sample questions from comprehensive examinations being used in the electronics industry to measure performance in these areas. Try them yourself.

PERT

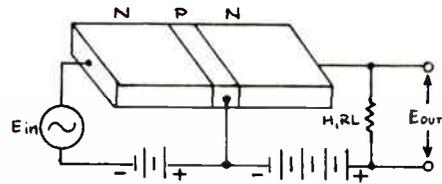


12. Examine the network you have just constructed.
- Identify the critical path by giving the sequence of events along the path: _____
 - Give the T_E which you calculated for the ending event of the network _____ weeks
 - If, for this project, the T_L for the network ending event is set equal to the T_E , what is the slack for event 7? _____ weeks
 - It is now reported that activity 6-9 cannot be completed in less than 11.8 weeks. Will it still be possible to meet T_L ? yes no
 - If the changes mentioned in (d) above would make it impossible to plan completion of the project by the time the allotted span has run out, what can he do to replan so that he does meet the schedule (EXPLAIN)?

COUNTING SYSTEMS & BINARY ARITHMETIC

3. PERFORM THE FOLLOWING ARITHMETIC CONVERSIONS.
- CONVERT the decimal numbers 85 and 35 into binary equivalents and
 - ADD their binary equivalents, then
 - CONVERT the sum back to decimal
 - CONVERT the decimal number 26 into its binary equivalent and
 - SUBTRACT it from the binary sum you found in (b)
 - CONVERT the result back to decimal
 - CONVERT the decimal number 20 into the form it would have been in number systems with a base of 2—5—8—.

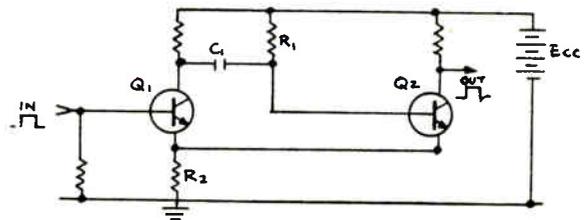
INTRODUCTION TO TRANSISTORS



- 29.
- The NPN transistor circuit illustrated above operates as a(n) _____.
 - With reference to the circuit shown above, MATCH the items below on the left with those on the right by placing one letter in each blank:

A. base-collector junction	1. _____ high impedance
B. emitter-base junction	2. _____ input impedance
	3. _____ low impedance
	4. _____ output impedance

BASIC TRANSISTOR CIRCUITS



- 27.
- The schematic diagram above shows an emitter-coupled one-shot _____.
 - In the stable state Q_1 is on off and Q_2 is on off.
 - The positive pulse turns on Q_1 which in turn: cuts off Q_2 turns on Q_2 .
 - When C_1 discharges, Q_2 is: cut off turned on.
 - When Q_2 conducts, drawing current through R_2 , Q_1 becomes _____ biased.

BOOLEAN ALGEBRA (in development)

SHOW the Karnaugh map of the function $ABD + \bar{A}CD + BCD + AB + ACD$ by SHADING the appropriate boxes in the diagram below:

AB	00	01	11	10
CD	00	01	11	10
	01	01	11	10
	11	01	11	10
	10	01	11	10

The Karnaugh map shows that the minimum inputs required for this function are _____.

Project Management Techniques Competitive?

CAN YOU REALLY AFFORD THE TIME TO UPGRADE YOUR KNOWLEDGE IN THESE ELECTRONICS GROWTH AREAS?

PROGRAMMED INSTRUCTION COULD BE THE ANSWER FOR YOU—TAKE A LOOK AT THE PERFORMANCE DATA:

Most people **can't** take the time to search the literature, return to school, or take lengthy correspondence courses. So thousands of engineers and technicians are turning to PROGRAMMED INSTRUCTION, a new teaching technique based upon the findings of behavioral psychologists.

You are led through a carefully designed and tested self-instructional program in which the subject matter is carefully structured and presented in increasingly complex steps which assure that you will attain maximum learning in minimum time. This is why Programmed Instruction is "an ideal way to train engineers in technical subjects — they learn 10% to 25% more in half the time," according to Russell S. Pease, Engineering Consultant at Du Pont.

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For example, when engineering members of the American Materials Handling Society took the PERT program at home in their spare time, they averaged 12.2 hours to complete the program and scored 90.1% on the final exam. Here is their individual performance data:

Job Title	Fore-man	Ops. Mgr.	Proj. Eng.	Supervisor		Pers. Mgr.	Chief Eng.	Traffic Mgr.
				H.S.	H.S.			
Education	H.S.	B.S.	M.S.	H.S.	H.S.	B.A.	B.S.	B.S.
Time (hrs.)	11.3	10.5	9.4	13.3	19.0	13.8	11.3	9.5
Age (yrs.)	36	22	44	48	52	47	47	50
Score (%)	94	97	97	94	92	87	80	79

FOLLOW THESE THREE SIMPLE STEPS TO FIND OUT WHERE YOU STAND:

To rate your own performance and skill needs in these subjects:

- 1) **Send for free copies of the complete final exams for these programs.**
- 2) **Take each exam.**
- 3) **If you feel you could profit from a thorough knowledge of the subject, send for the self-instructional program.**

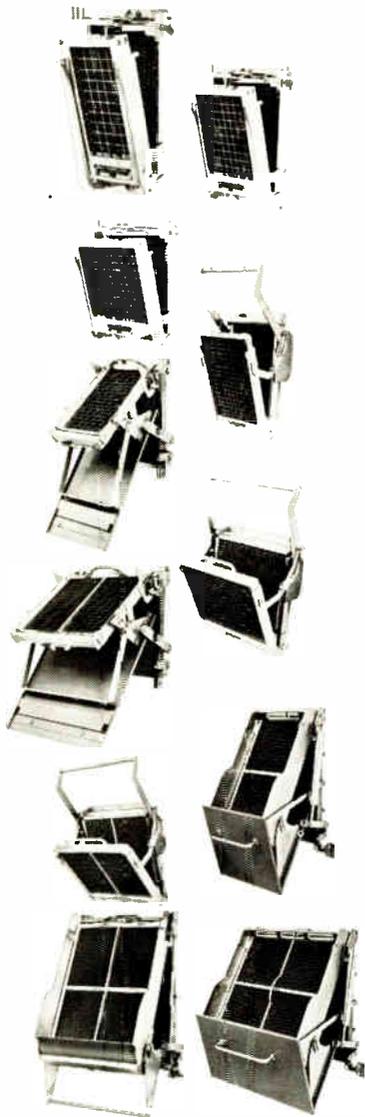
Name _____
 Title _____
 Address _____
 City _____ State _____
 Company _____

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Counting Systems and Binary Arithmetic	7.50	<input type="checkbox"/>	<input type="checkbox"/>
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BASIC SYSTEMS INCORPORATED 2900 BROADWAY / NEW YORK, N. Y.



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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.

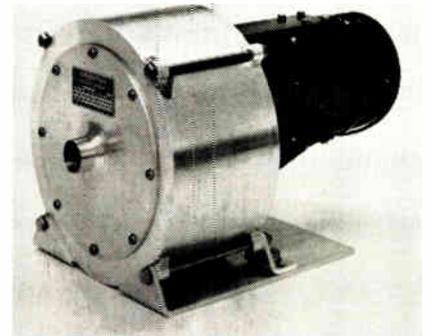
MAC PANEL COMPANY
HIGH POINT, NORTH CAROLINA



NEW PRODUCTS

BLOWER UNIT

Maintains a strong vacuum for tape slack control in computer systems.

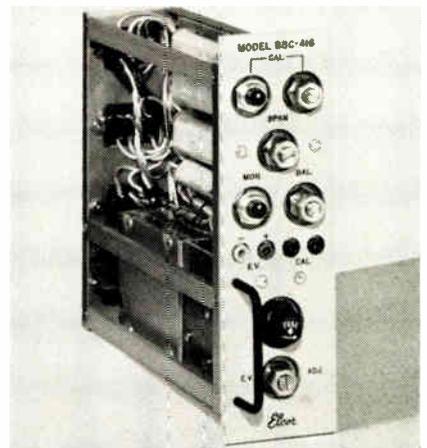


The SC-519-18848 is a multi-stage centrifugal impeller unit. A typical 3-stage model produces 16 cfm against a static pressure of 42-in. of water. The blower, which is designed for a low noise level and long life, is powered by a 2-pole, 60-cycle motor through a gear box. The Torrington Mfg. Co., Torrington, Conn.

Circle 208 on Inquiry Card

BRIDGE SIGNAL CONDITIONER

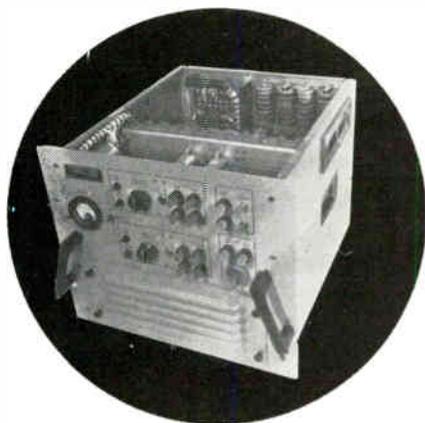
AC at 60 and 120cps coupled from power input to bridge output is approx. 1ma.



The BSC-416 Bridge Signal Conditioner uses an Isoply[®] (isolated power supply) to offer low noise and independent grounding. The unit is for use with 4 and 6 wire resistance transducer systems. The BSC-416 includes shunt calibration, balance or zero control, span or output control and excitation voltage control. Distributed capacitance to chassis ground is less than 80pf. Ground loop and ground noise problems usually associated with signal conditioning have been virtually eliminated in this highly-isolated unit. Specs. include high stability over a temp. range of 0.005%/°F from 32 to 120°F, and a regulation of 0.01%. Elcor, 2431 Linden Lane, Silver Spring, Md.

Circle 209 on Inquiry Card

computer power



COMPUTER POWER SUPPLIES FOR 465-L

465-L Global Communications Network computer system power supplies are designed and built by ITT.

These units can regulate from poor quality input and maintain MTBF of 8000 hours to 90% confidence.

ITT power for high reliability.

For further information write Power Equipment and Space Systems Department for Data File EI-1858-1.



Industrial Products Division
International Telephone and Telegraph Corporation
15191 Biedsoe Street • San Fernando, Calif. • EMpire 7-6161

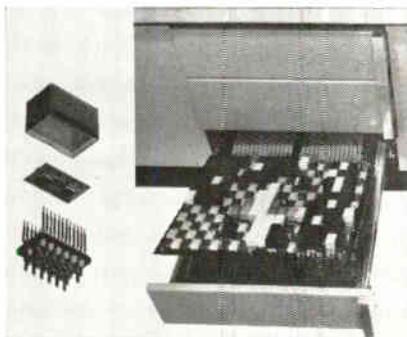
Circle 84 on Inquiry Card

ELECTRONIC INDUSTRIES • October 1964

NEW PRODUCTS

DIGITAL BUILDING BLOCKS

New approach to computer systems incorporates integrated circuits.



This system design offers advantages such as increased reliability, high-speed performance, high-noise immunity, dependable operation over wide environmental extremes, and a significant reduction in system cost and space needs. Because of the flexible modular design, practically any digital system operating from dc to 5Mc can be constructed. Each module of the system measures 1.4 x 0.8 x 1.4 in. and weighs less than 1 oz. Each contain 2 or more integrated circuits to perform logic and complex functions. Philco Corp., Western Development Labs., 3875 Fabien Way, Palo Alto, Calif.

Circle 252 on Inquiry Card

POWER CONTROL

Varies, controls, and monitors power. Controls 500 to 1kw in 3 distinct steps.



The PC-100 operates directly from the 115v. 60cps power line. The initial position permits the application of 1/3 rated power; position 2 applies full rated power; position 3 is an off position. It can be plugged directly into any female wall receptacle. A unique feature of this unit is the neon lamp indication provided which clearly tells the user, from any location or distance, the power stage being used. The PC-100 can be panel mounted and is a good means of controlling heat and power to any resistive device. Control Research Inc., 91 Rome St., Farmingdale, N. Y.

Circle 253 on Inquiry Card

Change colors of clear miniature lamps

AT WILL! AT ONCE!

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SILIKROME™ COLORED FILTERS



- EASILY SLIPS OVER LAMP
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Circle 94 on Inquiry Card

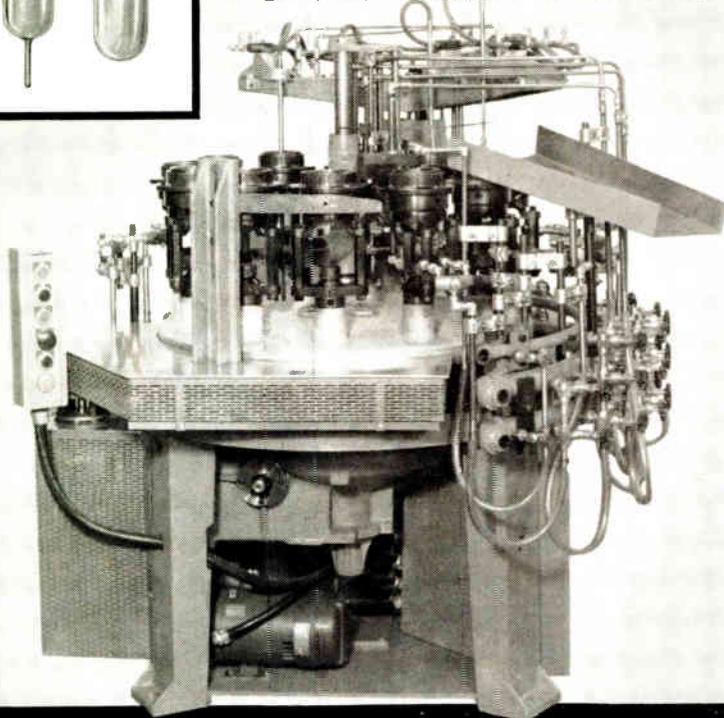
125

No Production Slow-downs with **KAHLE** AUTOMATIC EQUIPMENT

(— and Semi-Automatic, too!)



This KAHLE machine was designed and built for high speed vacuum bottle production. It pierces and tubulates the outer bottle, and when required, it is equipped to crack-off. The operator loads and unloads the work . . . ALL OTHER OPERATIONS ARE AUTOMATIC!



**Reduce YOUR Manufacturing Costs
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KAHLE Servos and Feedbacks detect rejects prior to completion of assembly

Instrumentation feedbacks and servos can be supplied that will reject faulty parts prior to assembly and product finishing . . . saving materials and time in production.

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Your equipment is run in our factory, using your materials in the presence of your engineers; the machine is not shipped to you unless you approve it!

CONSULT KAHLE—Save time and money by letting professionals build your specialty production equipment for automation!

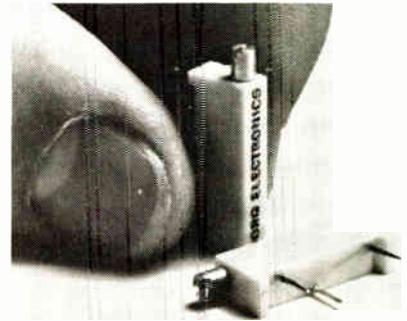


Kahle Engineering Company
3318 HUDSON AVE., UNION CITY, N. J.
Telephone: UNion 7-6500 (Area Code 201)

NEW PRODUCTS

TRIMMING POTENTIOMETER

Humidity-proof unit meets Mil-STD-202B, Method 106A spec.

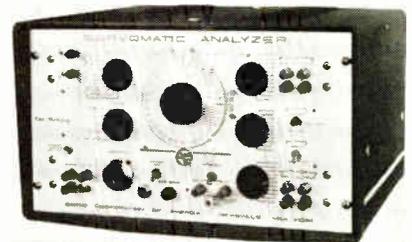


Micropot® 2610 is a low-cost, humidity-proof, wirewound trimming potentiometer. The 2610 has a single-piece wiper which withstands up to 50g acceleration and shock without effect, and a damage-proof clutch. It comes in 100Ω to 20KΩ ($\pm 10\%$). Resolution is between 0.0022 and 0.0095, which is said to be 52% better than comparable trimmers. Borg Electronics, Janesville, Wisc.

Circle 210 on Inquiry Card

SYSTEMS ANALYZER

For design, production testing, and evaluation of electronic systems.



The Model 1995 offers 2 new features. The first is a dc offset, which provides for the adjustment of the zero level to some desired bias displacement. The second feature is internal modulation, which provides a faster image with greater memory during low-speed servo analysis. Waveshapes available are sine, triangle, square, modulated sine, modulated triangle and modulated square. It has a freq. range of 0.005 to 1kc, continuously variable in 5 ranges for all waveshapes. Phase accuracy is $\pm 2\%$. It accepts carrier freqs. from 50 to 10kc. It features internal automatic synchronized sweep and sync. output at all freqs.; constant output impedance; and modulates all outputs, including sweep. Servo Corp. of America, 111 New South Rd., Hicksville, L. I., N. Y.

Circle 211 on Inquiry Card

MINIATURE SWITCH

Affords protection against conditions such as explosion and corrosion.

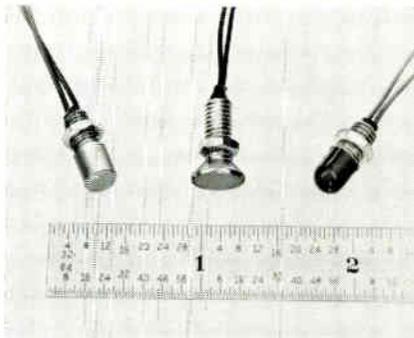


Series 2507 is a totally enclosed, explosion-proof micro-miniature rotary switch. It features 36° indexing with a 1- and 2-pole construction, 2 to 10 and 2 to 5 positions respectively. Switch meets environmental requirements of Mil-S-6807B and Mil-S-3786A. Electrical rating: 1a. resistive @ 28vdc; switching rating: 0.25a. resistive @ 28vdc and 0.25a. resistive @ 5.0 to 115vac. Janco Corp., 3111 Winona Ave., Burbank, Calif.

Circle 212 on Inquiry Card

INDICATOR LIGHTS

Three 28v. subminiature units feature 16,000 hr. operating life.

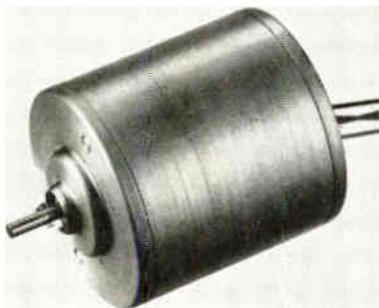


Designed for equipment requiring components of min. size and weight, the units contain fully moistureproof, integral lamp and lens assemblies molded to stainless-steel cases. Rated to consume 0.024a. @ 28v., the units contain rugged incandescent filaments that operate for an average of 16,000 hrs. Type L10,400 has a wide-visibility domed lens measuring 7/32-in. in dia. x 9/32-in. beyond the panel. Type L10-500 has a stainless-steel lens cap with a flat 0.200 in. dia. plastic face that can be engraved with a legend. Lens of Type L10,600 is flush with the panel surface when the unit is mounted in a counter-sunk hole. Control Switch Div., Controls Co. of America, 1420 Delmar Dr., Folcroft, Pa.

Circle 213 on Inquiry Card

DC MOTOR

Compact 2-in. dia. unit delivers up to 100 millihorsepower.

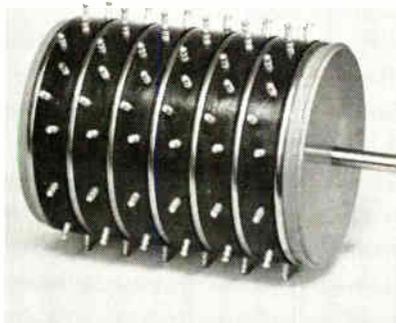


CYQM can be supplied in 4 lengths ranging from 1 5/8 to 2 3/4 in. Aluminum end caps and steel housing enclose ceramic field magnets and a 6-coil lap-wound armature. Self-aligning sintered-bronze bearings are lubricated from oil saturated felt wicks. It offers good characteristics for uses requiring high power from a small package. Electro-Mechanical Products Div., Barber-Colman Co., Rockford, Ill.

Circle 214 on Inquiry Card

PLASTIC POTENTIOMETER

Unit use conductive plastic element. Resolution is essentially infinite.



This 3-in. dia. multi-tap, multi-gang, dual-switch precision potentiometer combines potentiometer and switching functions in 1 mechanical package. Each cup of the 6-gang potentiometer contains a dual-switch section, and a conductive plastic resistance element with 12 taps is located at 30° intervals. A conductive plastic resistance element provides several design advantages. Rotational life is several million shaft rotations at high rotational speeds with virtually no increase in noise. The continuous tracking surface of the element, with no mechanical or electrical discontinuity, is free from sudden failure and provides high electrical reliability. Ace Electronics Assoc., Inc., 99 Dover St., Somerville, Mass.

Circle 215 on Inquiry Card

2 NEW MAGNETIC SHIELDING PRODUCTS

1. SHIELD MU

Tape and Foil



SHIELDMU is a new, high permeability, fully processed, ready-to-use material for shielding sensitive electronic and electrical components from stray magnetic fields.

IT OFFERS:

- 2 to 3 times more shielding efficiency than material currently available
- an easy way to form shields in place around inductive components to save space, time, expense
- ductility without significant degradation of magnetic shielding properties
- 4 levels of permeability performance; availability in a number of thicknesses, widths and continuous lengths

2. SHIELD FLEX

Flexible Tubing

SHIELDFLEX is especially designed to isolate conductors from external magnetic fields; contain the magnetic field generated by current carrying conductors; provide electrostatic shielding.

IT OFFERS:

- production economy since cable can be run through a length of Shieldflex for complete magnetic and mechanical protection.
- optimum shielding efficiency equivalent to that expected from high permeability shield structures
- 39 db attenuation in a 1 oersted, 60 cps field
- space economy since conductors can be routed very close to components or other conductors.

Write, wire or call for full details on SHIELDMU and SHIELDFLEX.



21ST & HAYES AVE., CAMDEN, N.J. 08101
Phone: 609-964-7842 TWX: 609-964-6772

■ Transformer Laminations ■ Motor Laminations ■ Tape Wound Cores ■ Powdered Molybdenum Permalloy Cores ■ Electromagnetic Shielding ■ Metallurgical Services ■

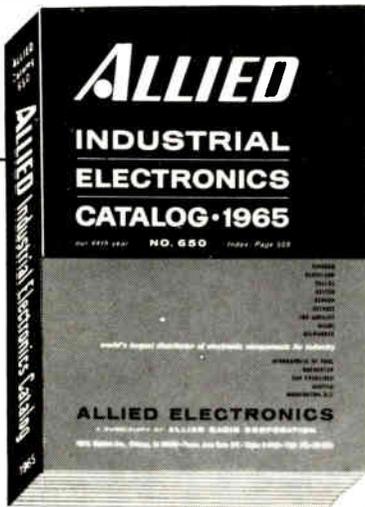
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for DC application
NON-REGULATED

Hermetically sealed—critically engineered for high reliability—built for long life. Oil-impregnated for stability—lightweight and compact. Selenium rectifiers—No tube replacement. Positive or negative terminal can be grounded to case. Long life capacitors. Standoff high voltage terminals for safe operation. Heavy steel cases plated and painted. Low ripple of 1%. Also available for 400 cps.

AVERAGE OUTPUT CHARACTERISTICS ($E_{in} = 117 \text{ VAC}, 60 \text{ CPS}$)

TYPE	OUTPUT VOLTAGE	MA	SIZE	WEIGHT
251 NR	2 KVDC	5	2½ x 3¼ x 3¼	2.75 Lbs.
551 NR	5 KVDC	5	2½ x 3¼ x 3¼	3.25 Lbs.
1051 NR	10 KVDC	5	3¼ x 4¼ x 6½	8 Lbs. 10 Oz.
1551 NR	15 KVDC	5	3¼ x 4¼ x 6½	9 Lbs. 10 Oz.

NOTE: OTHER VALUES UPON REQUEST



Write for New Catalog!



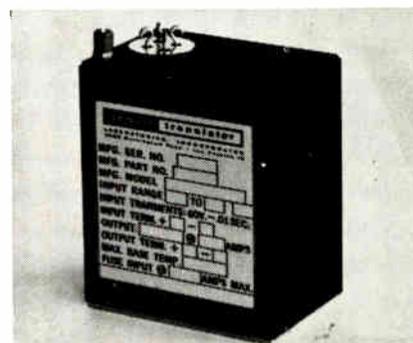
CHICAGO CONDENSER CORPORATION
3255 W. Armitage Ave., Chicago 47, Illinois

Circle 88 on Inquiry Card

NEW PRODUCTS

POWER MODULE

Converts 28vdc to any desired output voltage from 5 to 3650vdc at 10w.

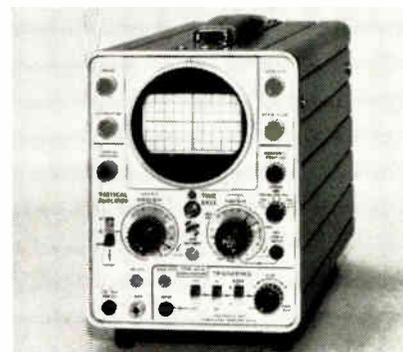


The Hi-Temp dc-to-dc converter is an all-silicon device which meets high temp. specs. of many aerospace and industrial systems. True hermetic sealing with encapsulation enables it to comply with the environment of Mil-E-5272C but at the higher temp. of 100°C. It is protected against short circuits, transients input spikes, and reverse polarity damage. Regulation is 0.2% for line variations of 24 to 30vdc input. Abbott Transistor Laboratories, Inc., 3055 Buckingham Rd., Los Angeles, Calif.

Circle 216 on Inquiry Card

PORTABLE OSCILLOSCOPE

Passband is dc to 6mc. Max. calibrated sensitivity is 10mv/¼ in. div.

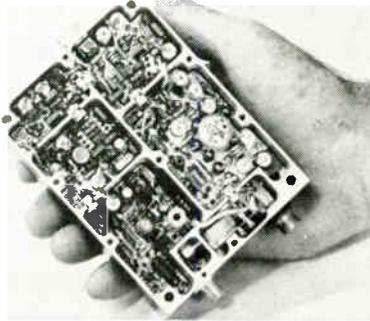


The Type 321A measures 5¼ x 8¼ x 16 in. Weight is 18 lbs. It operates typically from 4 to 4½ hrs. on internal rechargeable batteries (recharging them through its own recharging circuit), from any dc source of 11.5 to 35v., or from any common ac source, 50 to 800 cps. A wide-range time base provides calibrated sweep speeds to 0.5µsec./div.; a X5 magnifier extends this sweep to 0.1µsec./div. Adaptable triggering facilities, including automatic and free-run, +4kv accelerating potential for the 3-in. CRT, provide bright, steady traces over the entire passband. Tektronix, Inc., P.O. Box 500, Beaverton, Ore.

Circle 217 on Inquiry Card

TELEMETRY TRANSMITTERS

Holds r-f stability to within 0.01% of the assigned center freq.

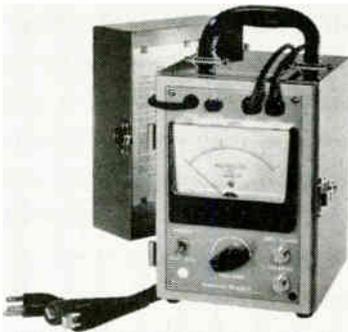


Models FM200A and FM200B operate on the standard telemetry band of 215 to 260mc and meet aerospace environmental requirements. Units develop a full 2w. of output power. They use active circuitry in all amplifier stages—including the final power amplifier. Use of this active circuitry greatly simplifies alignment and offers a further filtering of the desired signal by rejecting spurious freqs. The units require 655ma and 28vdc. Leach Corp., 1123 Wilshire Blvd., Los Angeles 17, Calif.

Circle 218 on Inquiry Card

DIELECTRIC TESTERS

Tests dielectric strength of components, harness, cables, capacitors, etc.



Three direct-current models of Hypot® Junior instruments provide a fast, accurate and safe method for non-destructive testing of insulation breakdown, current leakage, and short circuits. The 3 models and their dc working ranges are: Model 5201-0 to 1500v.; Model 5202-0 to 2500v., and Model 5203-0 to 5000v. Output is continuously variable from zero to max. on each model. Ripple is less than 2% at full load. A collapsing field type power transformer automatically lowers the output voltage as current flow increases. Short-circuit current is limited to approx. 15ma. Associated Research, Inc., 3777 W. Belmont Ave., Chicago, Ill.

Circle 219 on Inquiry Card

Dual readout— in-phase and quadrature voltage ratios —with high accuracy



CRB-8 complex ratio bridge for testing transformers, synchros, AC transducers, resolvers, tach-generators, amplifiers, and gyros.

This Gertsch bridge measures both in-phase and quadrature ratios of 3- and 4-terminal networks to an accuracy of .001% (10ppm). Voltage ratios are read from the *RatioTran** dials as rectangular coordinates (R+jX), or phase angle between signal and reference may be read directly in degrees.

Broad-band coverage—Instrument makes measurements at all frequencies from 350 to 5100 cps without using plug-in filters or networks. Completely self-contained, the CRB-8 requires no external calibration sources or detector.

Continuously tuned null amplifier drives the detector circuit so that minute values of off-null voltage can be detected without harmonics or noise. Extremely high signal input impedance minimizes loading of the device under test. Except for five tubes, instrument is designed with all solid state circuitry.

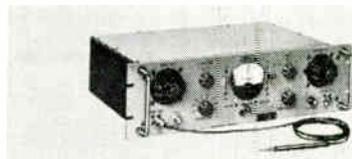
Other complex ratio bridges in the Gertsch line, available in both cabinet and rack-mounted types, include compact, fully transistorized units...militarized units designed to withstand severe environments, and a complex ratio bridge

which makes precision voltage and phase comparisons automatically, in less than 10 seconds.

For complete details and applications assistance, contact your nearest Gertsch representative or the address below, requesting Bulletin CRB.



Model CRB-6—militarized to withstand wide temperature extremes.



Model CRB-4RS—rack-mounted unit with connector for plugging in external oscilloscope.



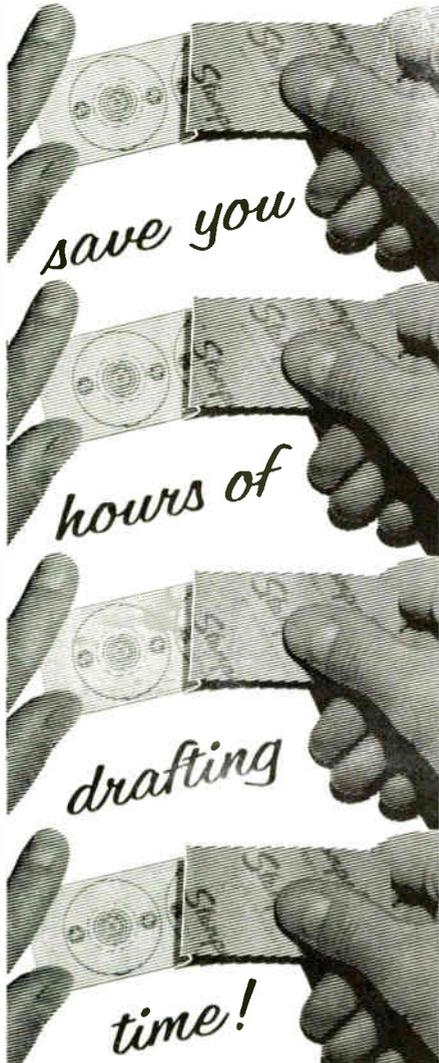
**THE SINGER COMPANY
METRICS DIVISION**

3211 S. LA CIENEGA BOULEVARD, LOS ANGELES, CALIFORNIA • TELEPHONE (213) 870-2761 • TWX 213 836 0466

Design and production of PANORAMIC • SENSITIVE RESEARCH • EMPIRE • GERTSCH instruments for measurement

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for over two decades*



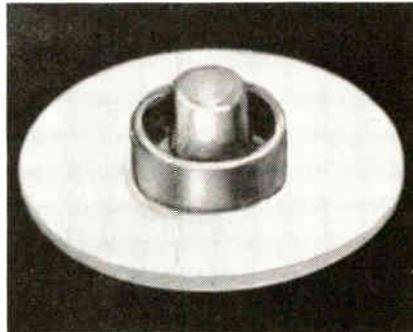
STANPAT
PRODUCTS INC.
Whitestone 57, N.Y., Dept. C10
telephone: 212-359-1693

Circle 90 on Inquiry Card

NEW PRODUCTS

DISC CATHODES

For uses requiring low power consumption. Units operate on 1v.

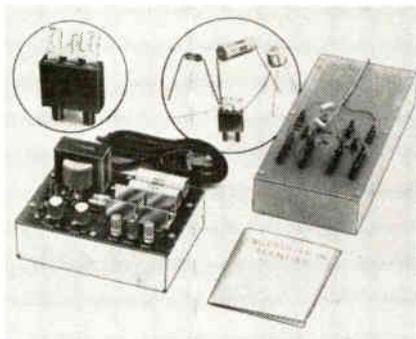


The EX270 subminiature disc cathodes are suitable for transistorized portable or regular TV receivers. One watt heaters rated at 6.3 or 12.6v. are available for use with the cathodes. Low heat loss is accomplished by using a thin ceramic spacer to minimize heat sink; designing cathode for min. radiating surface; and placing all of the shank above the spacer so that the heater is located for max. heat transmission to the emitter. Superior Tube Co., 1614 Germantown Ave., Norristown, Pa.

Circle 220 on Inquiry Card

BREADBOARD CIRCUIT KIT

For rapid, economical development of transistor circuits.

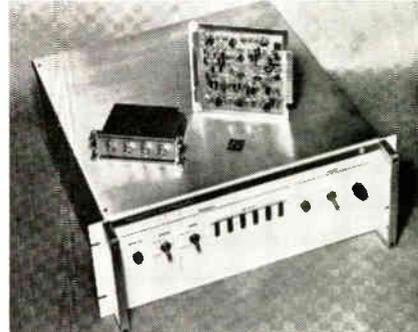


Model BB-1 solderless circuit-board kit is equipped with 2 types of plug-in connectors, a perforated chassis, and an optional dc power supply. It uses versatile, spring-clip connectors, which can be plugged into any position on the perforated chassis. The connectors grip components firmly, with no soldering required. Solder lugs are provided for final connections. Included are 40 T-3 connectors and 10 T-3S connectors, which have 3 electrically isolated lugs for accepting individual component leads. Electronics Div., Buckeye Stamping Co., 555 Marion Rd., Columbus, Ohio.

Circle 221 on Inquiry Card

FREQUENCY SYNTHESIZERS

Assembly technique reduces size 100 to 1 when compared with a conventional unit.



A practical application of microelectronics has produced a 40mc synthesizer that consumes 4mw and costs 25% less than conventional units. In this thin-film technique, all passive components and interconnecting wiring are fabricated as a part of the process. This allows entire groups of components to be handled rather than individual components. The unit provides 1kc channel spacing and has a stability of 1 part in 10⁶. Collins Radio Co., 1930 Helene Dr., Dallas 7, Tex.

Circle 222 on Inquiry Card

SPLIT INDUCTORS

Rated from 0.025hy to 0.8hy @ 8 to 0ma; dc resistance from 10.7Ω to 300Ω.



The PIL series of audio inductors are manufactured and guaranteed to Mil-T-27B. All units are hipotted @ 500v., instead of the usual 100v., for higher safety margins and reliability. These units have a complete rigid cylindrical bobbin, eliminating wire movement and stress. The turns are circular, effecting uniform wire lay and eliminating corner stress. The leads are rigidly anchored to the coil wire terminal board fashion, eliminating the use of tape, and brought out through strain relief. United Transformer Corp., 150 Varick St., New York 13, N. Y.

Circle 223 on Inquiry Card

PRECISION WIREWOUND RESISTOR HI-RELIABILITY

BEGINS HERE



... IN THE
**EXPERIENCED HANDS OF
KELVIN RESEARCH ENGINEERS**

Kelvin is the prime or sole source for precision wirewound resistors on many of the nation's most important high reliability missile and space programs. As the reliability requirements grow more exacting and stringent with each new system, Kelvin engineers are meeting the challenge through a proper balance of advanced research, quality control and reliability engineering. Kelvin resistor superiority in high reliability specifications is indicated in the following typical test data:



"HRL" Resistor Test Results*

TEST	38101/12A Maximum	"HRL" SERIES Average	Maximum
Short Time Overload	±.05%	.0012%	.0080%
Temperature Cycling	±.1 %	.0014	.0100
Moisture Resistance	±.1 %	.0072	.0192
Dielectric Strength	±.05%	.0010	.0013
Terminal Strength	±.05%	.0001	.0004
Failure Rate	±.2 %	.0150	.0240
Shock	±.05%	.0008	.0010
Vibration	±.05%	.0007	.0020

*Kelvin's "HRL" Series Resistors were designed to achieve a failure rate of .005%/1000 hours at a 90% confidence level. All data is based on life tests conducted at full rated power at 125°C for a minimum of 1500 hours. No "acceleration factors" are used.

Write for Bulletin "HR-04" for complete data on Kelvin's "HRL" Series High Reliability Resistors.

SEE OUR SPECIFICATIONS IN
VSMF
THE MICROFILM CATALOG FILE

Representatives in principal cities

KELVIN

5919 Noble Ave., Van Nuys, Calif.
Phone: (213) 782-6662

Circle 95 on Inquiry Card
ELECTRONIC INDUSTRIES • October 1964

NEW PRODUCTS

SPECTRUM ANALYZER

Range of 1gc to 44gc; variable freq. dispersion from 10kc to 100mc.

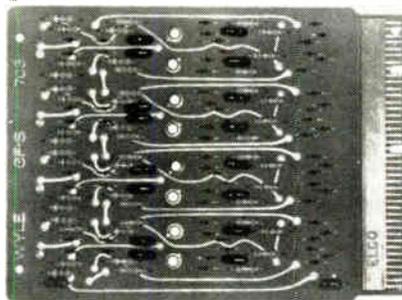


The LA-22 microwave spectrum analyzer provides full display of 0.1μsec. pulses or less. A 1 to 80kc variable spectrum resolution makes it useful for narrow-pulse analysis. It is normally supplied with precision crystal markers. The wide freq. range of this self-contained, transistorized instrument is obtained without the need of extra plug-in heads. Mount-on mixers provide versatility and prevent obsolescence caused by advancement in the state-of-the-art. This permits optimum dynamic range and sensitivity at a min. cost. Lavoie Laboratories, Inc., Morganville, N. J.

Circle 224 on Inquiry Card

LOGIC MODULES

Nineteen different card types perform any PC logic function.



This complete line of silicon logic modules are said to be equal or superior in quality to existing lines but costing from 1/2 to 1/3 less. The cards combine the many and varied module functions into the optimum economic number of card entities. Features include: high-noise rejection on inputs and outputs of all circuits; simplified loading—all inputs and outputs are defined in terms of a unit load; 41-pin connectors for max. use of all circuits; operation from -20°C to 70°C; each logic element has an active element in output circuit; operation is from dc to 1.5mv. Wyie Laboratories, 133 Center St., El Segundo, Calif.

Circle 225 on Inquiry Card

PROVEN

... DURING 70,000,000 MISS-FREE OPERATIONS

SERIES 3002 REED RELAY

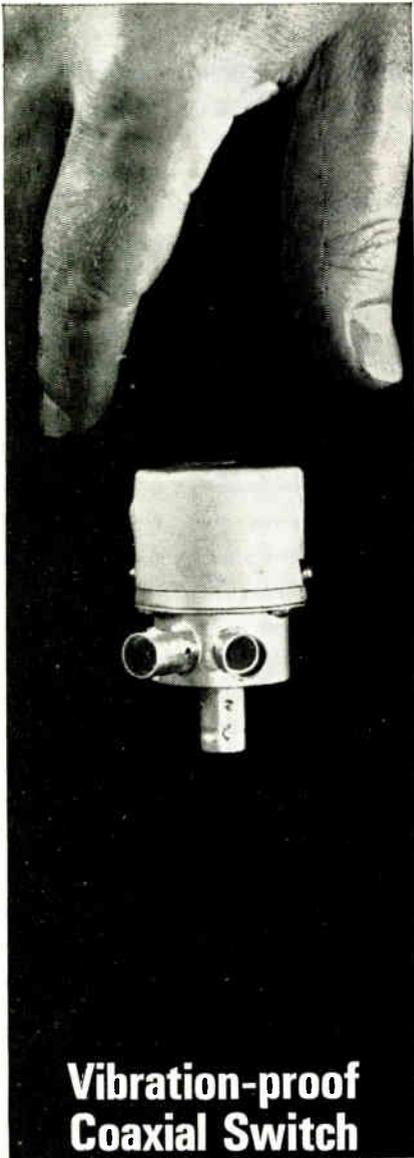
- 100% Tested
- Coil Ratings: 60 to 1500 mw
- Contact Ratings to 50W Inductive
- Operating Time: —2ms (Typical)
- Coil Voltages: 6 to 120 VDC
- "Cradled Reed" Design

NEW CATALOG describes the complete line of Wheelock Proven Glass Reed Relays. Includes capabilities, limitations, application data, mechanical and electrical specifications.



Wheelock
273 Branchport Ave.
Long Branch, N. J.
201-222-6880

Circle 96 on Inquiry Card



Vibration-proof Coaxial Switch you can drop it, too

Because it is vibration tested through 10 Gs at 2000 cps and shock-proofed to 100 Gs. Its two-inch size and eight-ounce weight make it especially useful in aero-space applications. SPDT solenoid actuation for remote control. Crosstalk and VSWR excellent through 2 Gc. Price is good, too. About \$60.

This little gem typifies the superlative quality and performance our engineers package in their coaxial switches. For complete details on this switch—and about 900 others—ask your Amphenol sales engineer for our coaxial switch catalog.

Manufactured by



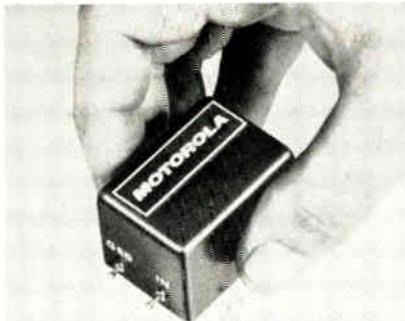
Amphenol-Borg Electronics Corp.

Circle 97 on Inquiry Card

NEW PRODUCTS

CRYSTAL FILTERS

Operate on carrier freq. of 1.75mc; have a 60 to 6db shape factor of 1.18 to 1.



This line of compact precision crystal filters measure $1\frac{1}{2} \times 1\frac{1}{2} \times 2$ -in. for SSB uses. Included are filters for upper and lower sidebands providing either symmetrical or asymmetrical attenuation characteristics. Characteristics include bandwidth of 3.2kc at 2db; attenuation rate of 2 to 60db in 600cps max.; carrier rejection is 30db min.; insertion loss 4db max. and bandpass ripple envelope 1.5db max.; operating temp. -40° to $+85^{\circ}$ C; shock 50g. The filters are completely encapsulated. Motorola Inc., Communications Div., 4501 W. Augusta Blvd., Chicago, Ill.

Circle 226 on Inquiry Card

TRANSMITTERS

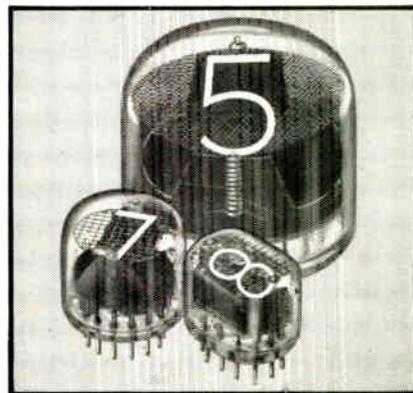
Three all-transistorized units are available in the 215-260mc range.



Models T-1125, T-2125, and TF-5 operate under the extreme environmental conditions. The T-1125 is a crystal-stabilized true FM transmitter providing 2w. nominal output. Input impedance is $100K\Omega$ shunted by 5pf. Modulation sensitivity is adjustable from 50kc/v. p-p to 250kc/v. p-p. Model T-2125 is crystal-controlled, phase-modulated and has a freq. stability of $\pm 0.005\%$. Power output is 2w nominal. Model TF-5, FM transmitter has a freq. response down to dc, and linearity better than $\pm 0.5\%$. Modulation freq. range is dc to 300kc. Vector Dept. of Norden Div. of United Aircraft Corp., Southampton, Pa.

Circle 227 on Inquiry Card

The most widely used readout system...



SPECIFY LONG-LIFE

NATIONAL[®] READOUT TUBES*

9 reasons why...

- 1 Far more gas tube engineering experience than any other manufacturer.
- 2 Bright, clear, distinct readout.
- 3 Long-life . . . 300,000 hours life and more.
- 4 Uniformity . . . both initial and long term . . . no variation in color or intensity from number to number, tube to tube.
- 5 Non-fading.
- 6 Choice of snaps . . . round or rectangular.
- 7 Wide range of character sizes (.310" to 2.0").
- 8 Simple, rugged, attractive display.
- 9 Low initial cost.

For full details, request readout tube technical data.

*Manufactured under license from Burroughs Corporation

NATIONAL ELECTRONICS, INC.

A subsidiary of Eitel-McCullough, Inc.
Phone: (312) 232-4300 • Geneva, Illinois, U.S.A.

Circle 99 on Inquiry Card

SPECIFY HANDSETS

by
Stromberg-Carlson



... for mobile radio, dictating systems, carrier, microwave and other applications.

Illustrated are lightweight models No. 33 and No. 35. Both incorporate push-to-talk switches and high-gain receivers and transmitters. These Stromberg-Carlson handsets meet a great variety of needs in a broad range of industrial applications.

No. 33 lightweight handset is furnished with a rocker bar switch.

No. 35 comes with a button switch, or with both the button and rocker bar switches.

Get technical data on these and other handsets from our Industrial Sales Department.

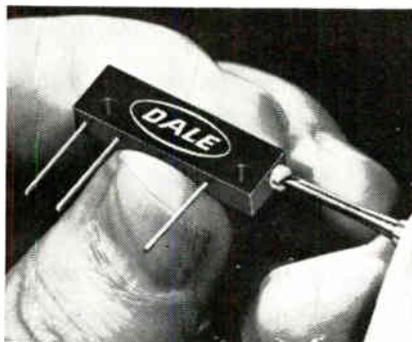
STROMBERG-CARLSON
A DIVISION OF GENERAL DYNAMICS
115 CARLSON ROAD • ROCHESTER 3, N. Y.

Circle 100 on Inquiry Card
ELECTRONIC INDUSTRIES • October 1964

NEW PRODUCTS

WIREWOUND TRIMMERS

Resistance range is 10Ω to $30K\Omega$. Rated at 1w. @ $70^\circ C$, derating to 0w. @ $125^\circ C$.

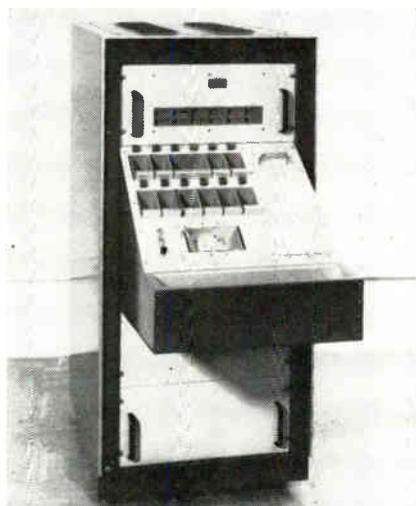


The 2200 Series are said to be the commercial counterpart of RT-10, Mil-R-27208A. The new trimmers use an all-welded internal construction. It offers exceptional stability in relation to its low cost. They are offered with a standard tolerance of $\pm 10\%$ with lower tolerances available. Dale Electronics, Inc., P. O. Box 488, Columbus, Nebr.

Circle 228 on Inquiry Card

TRANSISTOR-DIODE TESTER

Can test as many as 20 separate parameters in less than 2 sec.

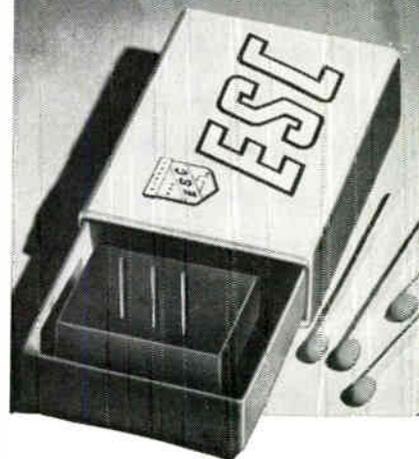


The Series 300 high-speed transistor-diode tester uses pulse-testing techniques. A wide variety of transistor, diode and zener diode dc tests are possible on a go/no go basis. Low power dc testing to high-current pulsed testing are combined to enable extended ranges of test conditions. Major uses include high-speed final production testing, 100% incoming inspection, and high-speed classification into statistical groups for distribution-curve data. Fairchild Semiconductor, div. of Fairchild Camera & Instrument Corp., 545 Whisman Rd., Mountain View, Calif.

Circle 229 on Inquiry Card

DELAY LINES

there's
no
match



to our packaging techniques for delay lines and filters

Thousands of standard delay lines and filters are available from ESC — yet, the increasing requirements for smaller high-density packaging often dictate custom designs — ESC engineers will work with you to develop prototypes to your exact specifications. Our latest filter fits comfortably in a match box ($1" \times .72" \times .62"$) — or in your circuit.

MINIATURE FILTERS FOR SONAR

Provides 60 db minimum attenuation at $1.9 \times F_c$. Ripple .5 db maximum. Maximum insertion loss 1 db. Operating temp. $-20^\circ C$ to $+85^\circ C$. Size $1" \times .72" \times .62"$.

Circle 91 on Inquiry Card



MINIATURE COMPUTER DELAY LINES

P. C. Board Mounting; delays from 10 nanosec. to 160 nanosec. or greater. 200 and 400 Ω impedance with a maximum pulse attenuation of 0.5 db — pulse rise time of 3 nanosec. to 40 nanosec. max. depending upon delay.

Circle 92 on Inquiry Card



A miniature transponder line in only 6 cubic inches. Other lines for Beacons, Tacans and Vortac Systems.

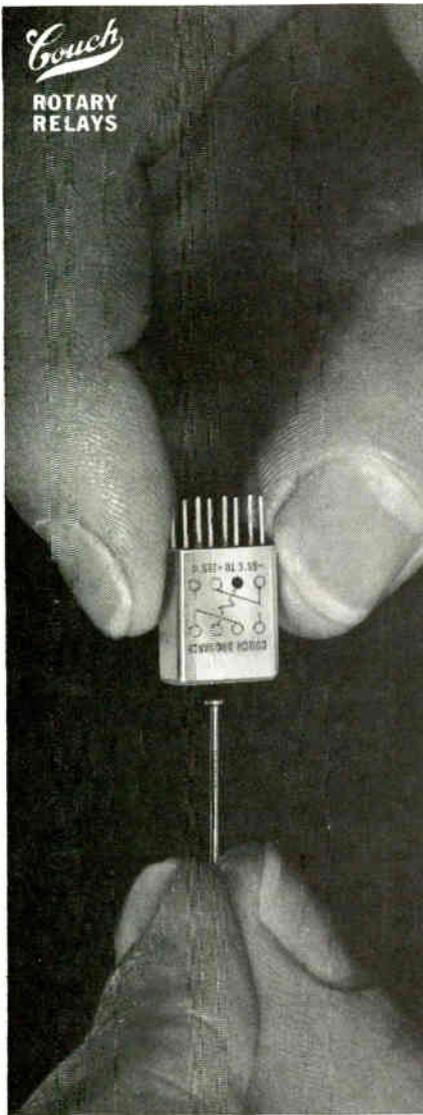
Circle 93 on Inquiry Card



ESC

ELECTRONICS CORP.

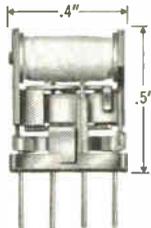
534 BERGEN BOULEVARD
PALISADES PARK, N. J.
PHONE: 201-947-0400



Couch
ROTARY
RELAYS

good and small

This new Couch rotary relay is surprisingly microminiature when you consider the rugged construction inside and the specifications



SIZE2" x .4" x .5"
TERMINAL SPACING	1/10" grid
RATING5 amp @ 30 VDC
COIL OPERATING POWER	150 mw
COIL RESISTANCE	60 ohms to 1,000 ohms
TEMPERATURE	-65°C to +125°C
VIBRATION	20 G
SHOCK	75 G

Write for Data Sheet No. 9

RUGGED ROTARY RELAYS  Dynamically and Statically Balanced

COUCH ORDNANCE INC.

3 Arlington Street, North Quincy 71, Mass., Area Code 617,
Cypress B-4147 • A subsidiary of S. H. COUCH COMPANY, INC.

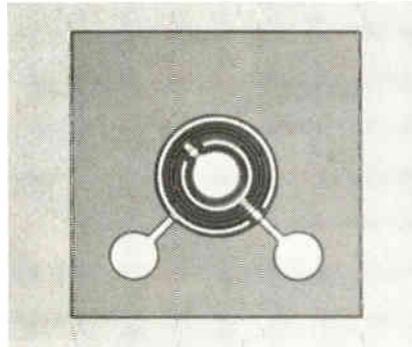
Circle 101 on Inquiry Card

134

NEW PRODUCTS

DUAL-GATE TETRODE FET

Separate signal and control gates allow automatic gain control without detuning.



Higher-freq. uses are now possible with the 3N89 tetrode field-effect transistor in a 4-lead TO-18 package. The 2-gate FET has a gain bandwidth product in the 50-75MC region. Using the unit in chopper applications reduces coupling of switching spikes; in mixers, it provides separation of signal gates. Very high gain-to-power-drain ratio reduces the number of stages in micropower amplifiers. Siliconix Inc., 1140 W. Evelyn Ave., Sunnyvale, Calif.

Circle 247 on Inquiry Card

Eisler a name to remember
in machinery
for electronics



At left:
Largest assortment
of wet and dry type
Glass Cutters.

Below:
An Eisler
precision
vertical
Spot Welder
designed
exclusively
for welding
electronic
components.
Sizes from
1/2 to 7 1/2 KVA

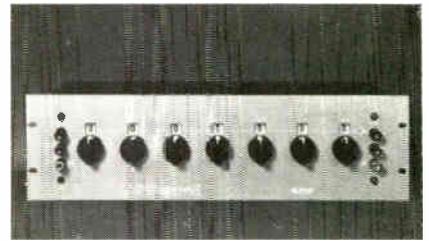


Write us today for full particulars!

EISLER ENGINEERING CO., INC.

Charles Eisler Jr., President
South 13th Street, Newark 3, N.J.

Circle 102 on Inquiry Card



Kelvin and Varley would be exultant!

(Their circuit is being used
in this ESI Voltage Divider
to give you 1 ppm accuracy.)

The Kelvin-Varley Circuit was invented while the two men were collaborating on the Project Mercury of their day—the laying of the Atlantic Cable.

It is now used to achieve state-of-the-art accuracy in the decade voltage divider above (our model RV-722). This instrument has a terminal linearity of 1 ppm.

At low settings you will be able to do even better than 1 ppm. If, for example, the first three dials are set at zero, the output voltage will be accurate to a fraction of one division of the seventh dial. Each step of that dial is *one part per ten million*.

With each instrument, you get a calibration certificate giving check-out readings accurate to 0.2 ppm. All at a price worthy of Lord Kelvin's Scottish heritage: \$900. ESI, 13900 NW Science Park Drive, Portland, Oregon (97229).

Model RV 722 DEKAVIDER Decade Voltage Divider

Circuit: Kelvin Varley Resistive Divider
Resolution: 10,000,000 divisions—0.1 ppm steps

Input Resistance: 100 Kilohms ±0.005%

Temperature Coefficient: ±0.5 ppm/°C

Power Coefficient: ±1 ppm/watt maximum

Maximum Input Power: Five watts

Maximum Input Voltage: 700 volts rms, 1000 volts peak

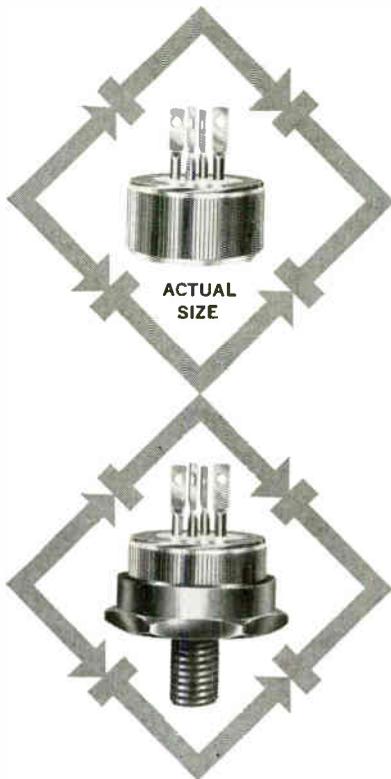
Input terminals for individual decades are provided for calibration of each decade. Paralleled switch contacts of silver alloy provide improved accuracy at all settings.



Electro Scientific Industries

Circle 103 on Inquiry Card

ELECTRONIC INDUSTRIES • October 1964



IBR*

SILICON AVALANCHE
INTEGRATED BRIDGE RECTIFIERS



2000 V. MIN.
CIRCUIT TO CASE
INSULATION

Varo's IBR* integrated full wave bridge rectifiers give you high reliability at low cost in a minimum size package.

The IBR* uses SAR* (Silicon Avalanche Rectifier) characteristics to eliminate junction perimeter destruction by causing the transient overvoltages to occur across the entire junction area. Thus decreased PRV safety factors may be used in design consideration. Maximum mounting versatility is provided by press-fit, TO-3, and single stud mounting.

Varo's 1N4436 (250 V B_{VR} min.) and 1N4437 (450 V B_{VR} min.) feature 18 amps DC output current at 50°C (T_C), and 100 amp, one cycle current surge.

*TM Varo Inc.

OEM Prices:	1-99	100-999
1N4436	\$4.15	\$3.05
1N4437	\$5.45	\$4.00

Write for complete information or order from:

varo inc
SPECIAL PRODUCTS DIVISION
2201 WALNUT ST., GARLAND, TEXAS
AC 214 / BRoadway 6-6141

Circle 104 on Inquiry Card
ELECTRONIC INDUSTRIES • October 1964

NEW PRODUCTS

CAPACITANCE BRIDGE

Selects range, achieves balance, and presents measured value in digital form.

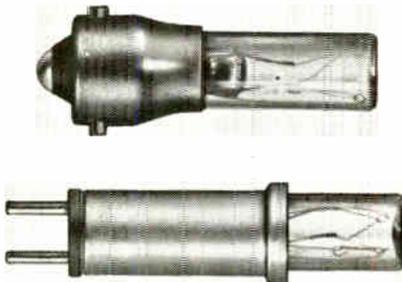


The Type 1680-A Automatic Capacitance Bridge measures parallel capacitance from 0.01pf to 100 μ f @ 400 and 1000cps, and from 100pf to 1000 μ f @ 120cps. Basic accuracy is $\pm 0.1\%$ of reading. The bridge also measures dissipation factor from 0.0001 to 1.0, and parallel conductance from 0.1nanomho to 1.0mho. Measurement results—capacitance and loss—are displayed, complete with decimal point and units, on an in-line digital readout. The same data is also supplied in binary-coded decimal form for use by printers. General Radio Co., West Concord, Mass.

Circle 230 on Inquiry Card

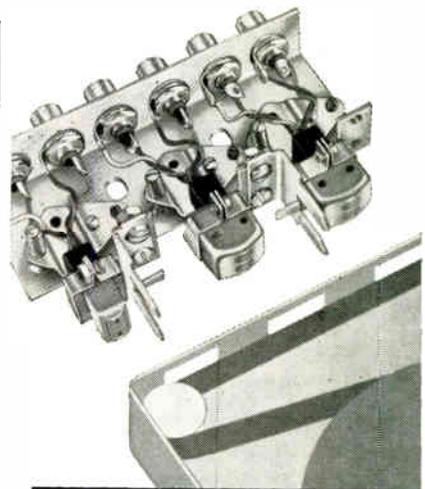
MINIATURE LAMPS

Eliminates transformers need for low-voltage lamps and the resistors for neons.



This incandescent lamp is $\frac{3}{4}$ -in. in dia. and is mounted in an anodized aluminum cartridge with stainless-steel bi-pin terminals. It is said to be the smallest standard 120v. incandescent lamp available today, and far brighter than neon lamps. The lamp offers compact size for space conservation, fast and easy connection to panel and circuit, long life expectancy and exceptional shock and vibration resistance. The same 120v. flat-end lamp can be mounted in a miniature bayonet base. These cartridge lamps are also available for a range of voltages from 6v. to 28v. and with a wide range of neon lamps. Colored filters are available. Chicago Miniature Lamp Works, 4433 Ravenswood Ave., Chicago, Ill.

Circle 231 on Inquiry Card



NEW!

Cartridge Mount*
reduces installation
and alignment
problems!

NORTRONICS HEAD MOUNT ACCOMMODATES UP TO THREE HEADS ON A SINGLE ASSEMBLY

This new Nortronics Cartridge Mount, eliminates the need for rear-mount heads! Designed for cartridge tape handlers using endless loop tape cartridges of the Fidelipac and Viking type, it permits fast, easy installation and alignment of up to three heads on one assembly! "Micrometer" adjustments permit setting of head height, azimuth and face perpendicularity—special lock screw on each head bracket "freezes" the adjustments. Heads are fastened to the bracket with a quick release screw clamp for fast installation.

Cartridge-Mount Kits, with all necessary hardware, are available for new equipment as well as for the conversion of existing cartridge players using rear-mount heads.

CARTRIDGE MOUNT COMPATIBLE WITH ALL NORTRONIC TAPE HEADS!

One record, one playback and one erase head may be mounted on a single assembly. Typically, two Nortronics Model P-B2H heads—one used for record, the other for playback—occupy the first two positions. These are Premium series half-track stereo heads with fine laminated precision-lapped, low loss core structures; deposited quartz gaps; and hyperbolic, all-metal faces. Any Nortronics erase head may be mounted in the third position. Cartridge Mounts, as well as the entire new line of tape heads, are available in production quantities.

For complete information about Nortronics Cartridge Mounts, write for our Form #7177.

*PATENT PENDING

Nortronics

8149 Tenth Ave. N., Minneapolis, Minn. 55427

Circle 105 on Inquiry Card

135



Judge us
by the
Companies
We
Serve

HOWCOR LAMINATIONS Are Standard Components of many of the World's Best Known Products

In the products of internationally famed manufacturers every component must contribute to product performance.

The number of world-known manufacturers who use HOWCOR Laminations (partial list on request) is your best reason for getting the latest facts on HOWCOR facilities, standards, engineering services and prices.

Write for Bulletin 100 and catalogs on HOWCOR Motor Laminations . . . Nickel Alloy Transformer Laminations . . . Silicon Steel Transformer Laminations.

HOWCOR
LAMINATIONS
A Division of Howard Industries, Inc.
3912 McLean Ave., Chicago, Illinois 60647

Circle 106 on Inquiry Card

NEW PRODUCTS

TEST SOCKETS

Dual-contact test sockets measure contact resistance of relays.

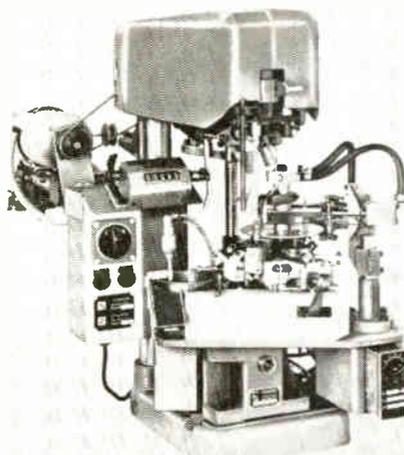


Plug-in testing of relays and measurement of contact resistance can be done quickly and reliably with custom test sockets. Dual-contact test sockets provide double contacts for each terminal. Test sockets are made to order to mate with relay headers, and will accept straight pin, hook, flattened and pierced and turret terminal leads. Automech Associates, Inc., 159 Washington Ave., North Haven, Conn.

Circle 232 on Inquiry Card

CORE WINDER

Delivers a complete coil—bonded, tinned, with terminals formed, ready for assembly.



The Kinomat BV3-G is capable of producing from 750 to 1400 coils/hr., depending on wire size, pitch and number of turns. The winder automatically winds a coil, then drops it down to the first of 6 stations on an indexing table where it is automatically sprayed for bonding, then carried to a patented solder pot where both terminals are dipped. Successive forming operations shape the terminals to specs., and the finished coil is automatically ejected from the mandrel. Associated American Winding Machinery, Inc., 750 St. Ann's Ave., Bronx, N. Y.

Circle 233 on Inquiry Card

Labac controls kilowatts with microwatts...



LABAC—A handy solid-state power supply for laboratory or shop use. Just plug it into a 60-cycle or 400-cycle outlet, and dial any power you want from zero to full line voltage . . . control it remotely with a 0-1 ma signal . . . or use it as a power relay for arclless ON-OFF switching. Output (either AC or DC) is proportional to input signal. Response time: 20 milliseconds.

NO VACUUM TUBES—NO MOVING PARTS

MANY USES—Test set-ups, equipment mock-ups, demonstrators, light dimming, electric furnace control, almost anywhere a variable transformer is used. Standard bench-type units can be easily panel mounted if desired.

MODEL CHOICES:

115-volt or convertible 115/230v. input.
10- or 20-a. capacity (convection cooled).
30-amp current capacity (blower cooled).

* Custom models available with capacities to 150 KVA.

Specialists in:
HIGH-PERFORMANCE PROGRAMMING AND CONTROL •
INFRARED HEATING • AC AND DC POWER CONTROLLERS



**CONTROLS
DIVISION**

RESEARCH, INCORPORATED

BOX 6164NK, MINNEAPOLIS, MINN. 55424

Circle 107 on Inquiry Card

ELECTRONIC INDUSTRIES • October 1964

NEW PRODUCTS

LINEAR VIDEO VOLTMETER

Freq. range of 10 cps to 6mc. Accuracy (f.s.d.) 1% from 40 cps to 1mc.

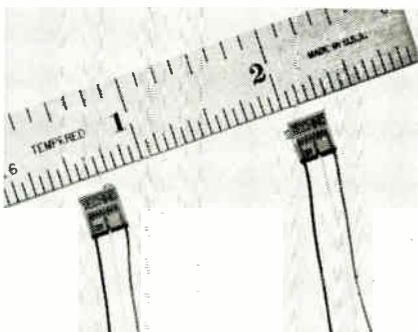


Model 311G has a voltage range of 1mv full scale to 300v. full scale in 12 ranges. It uses a linear scale with 2 voltage scales, 0 to 1.04 and 0 to 3.2; and a decibel scale, -10 to +2 in which 0db is the reference point equivalent to 1mw into 600Ω. Ballantine Laboratories, Boonton, N. J.

Circle 234 on Inquiry Card

WIREWOUND TRIMMER

Multi-turn unit has an adjustment ratio of 25:1; resistance values from 100 to 300KΩ.



The series 10 trimmers are available in 4 configurations: side and top adjust with weldable PC pins; side and top adjust with stranded Teflon leads. It is rated for ½w. at 50°C, derating to 0 @ 175°C. The temp. coefficient of the potentiometer is 50 PPM/°C; temp. coefficient of the resistance wire is 20 PPM/°C. The units meet or exceed all applicable requirements of Mil-STD-202 and Mil-E-5272. Techno-Components Corp., 18232 Parthenia St., Northridge, Calif.

Circle 235 on Inquiry Card

LIGHTWEIGHT CHAMPION OF THE T-R RELAYS



Actual Size

TYPE RJ1A
2KV PK (16 MC)
7 AMPS RMS (16 MC)
1³/₁₆" LONG
ONE OZ.

Once for ounce the RJ1A controls more power than any other relay in the world. It will handle 2 KW average power into a 50 ohm load at VSWR 1:1 at 2 to 32 megacycles. And since it was designed for high volume production it offers the utmost economy.

The high strength vacuum dielectric guarantees a tremendous internal overvoltage safety factor — more than double the rated peak test voltage. Resistance is low (.010 ohms) and remains low and stable for the life of the relay.

The RJ1A is ideally suited for such applications as airborne, mobile, or marine communications systems for switching between antennas, antenna couplers or transmitters, or between transmitters and receivers. In sonar equipment they are being used as long life relays to switch 25 amp, 100 milliseconds pulses to transducers.

For higher power applications Jennings offers a complete line of vacuum transfer relays not much larger than the RJ1A. These relays are available in peak test voltages up to 38 KV Peak and continuous current ratings up to 75 amps RMS.

Write for more detailed information on the RJ1A and Jennings complete line of vacuum transfer relays.

RELIABILITY MEANS VACUUM / VACUUM MEANS

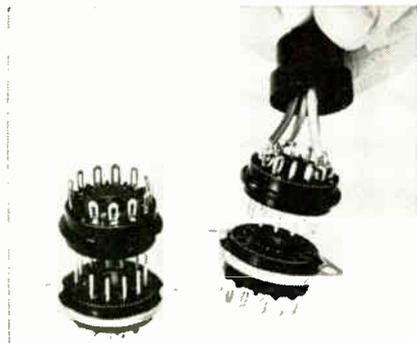
Jennings

JENNINGS RADIO MFG. CORP., 970 McLAUGHLIN AVE., SAN JOSE 8, CALIF., PHONE CYpress 2-4025

NEW PRODUCTS

CABLE CONNECTORS

Versatile 12-pin unit provides quick connect and disconnect for cable assemblies.

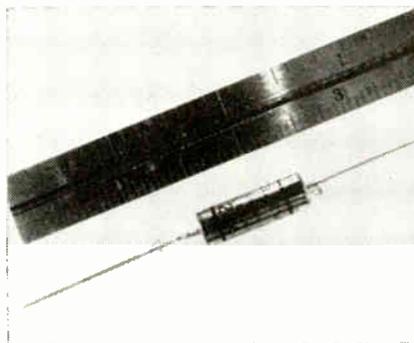


Series 712 Econo-Connector inserts and extracts easily, yet has reliable contact retention and resistance. The device consists of a male and female connector, either of which may be top or bottom chassis mounted; used as an unmounted cable connector; or used in PC applications. They are designed for audio use, commercial and industrial control circuits of all varieties, or as a multi-purpose electrical connector. Connector Corp., 6025 N. Keystone Ave., Chicago, Ill.

Circle 238 on Inquiry Card

CERAMIC LADDER FILTERS

Stop-band rejections of 50db and center freq. tolerances of $\pm 3\text{kc}$.

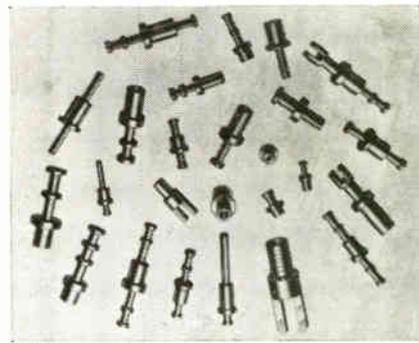


There are 5 standard models in this line with 6db bandwidths from 10kc to 40kc, which are available at 455kc and 500kc center freq. Input and output impedance is between 1K and 2K Ω . Shape factor is between 2.0:1 to 1.8:1, and insertion losses range between 4db and 5 db. Filters in the line have a peak-to-valley ripple of 1 to 3db max. (depending on bandwidth). Stability is $\pm 0.2\%$ for 5 yrs. Piezoelectric Div., Clevite Corp., 232 Forbes Rd., Bedford, Ohio.

Circle 239 on Inquiry Card

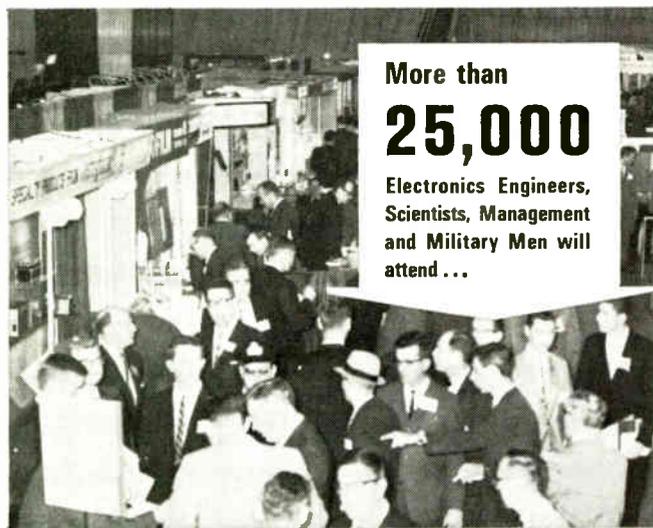
PC TERMINALS

Speed circuit-board assembly time and offer advanced fabrication facilities.



Terminals for multiple-lead terminations, and thru-hole terminals which permit leads to be fed from one side of the board to the other are in this new line. Also available are feed thru terminals which allow connection of leads at opposite sides of the PC board. Repairs and component replacements are greatly facilitated with much less chance of damage to the printed wiring or the components. Precision Metal Products Co., 41 Elm St., Stoneham, Mass.

Circle 240 on Inquiry Card



More than
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Electronics Engineers,
Scientists, Management
and Military Men will
attend...

20TH ANNIVERSARY

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Time Saving Shapes and Narrow Tape for
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"KWIKY-DOT" overlapping Donuts
and solid Discs for quick and easy
application.

Pressure-sensitive Teardrops,
Twin Pads, T's, and Corners.

Black non-stain, non-smudge narrow
tape in 15 or 60 yd. rolls from
1/32" wide. Also red translucent
and black on white.

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Same Day Shipment is Our Usual Service

Circle 110 on Inquiry Card

RECEIVER

Features continuous sweeping of 350Mc to 700Mc and 700Mc to 1400Mc octave band.



Model 1640-SW is a super-heterodyne receiver which operates in the 20Mc to 100Mc region. It features 0-1vdc output voltage proportional to freq. for external recording; AGC output proportional to the logarithm of a CW input signal (65db dynamic range); bandpass preselection providing 80db i-f rejection; 80db image rejection; and combined manual and motorized tuning control. Sensitivities are to -99dbm, 50/60cps FM cancellation. It has electronic and servo tracking AFC and direct reading tuning dial. Scientific-Atlanta, Inc., P. O. Box 13654, Atlanta, Ga.

Circle 241 on Inquiry Card

CIRCUIT COMPARATOR

Integrated circuit dc comparator converts analog signals to digital form.

This device compares the amplified signal level of a transducer with that of a fixed reference source, and provides an output voltage only if the signal voltage is greater than that of the reference. Voltage differences as small as 10mv can be detected, and will produce a min. comparator output voltage of 6v. The comparator handles input voltages of 0 to 5.5v. and has a bandwidth of 50Kc with a total power dissipation of 30mw. Motorola Semiconductor Products Inc., P. O. Box 955, Phoenix, Ariz.

Circle 242 on Inquiry Card

RIGHT-ANGLE CONNECTORS

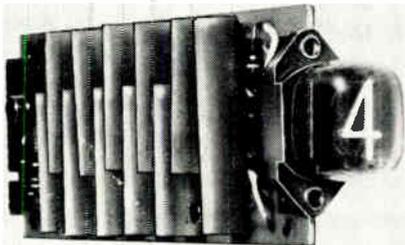
For PC uses where a soldered joint between connector and board is needed.

Series 6040 connectors allow the PC board to operate under the most rugged environmental conditions, including extreme shock, vibration and humidity. Available in units with 11, 15, 23 and 37 contacts, on 0.100 in. grid spacing for easy assembly and dip soldering. The connectors are made with either standard socket receptacles, or closed-entry type sockets which prevent test probe damage and insure positive spring action for contacts. Precision Connectors Div., Electronic Fittings Corp., 29 Sugar Hollow Rd., Danbury, Conn.

Circle 243 on Inquiry Card

DECADE COUNTER

Operates in forward and reverse directions at speeds to 110Kc.



The BIP 8954 is a reversible decade counter which uses silicon-controlled switches as the active element. It is expected to find wide uses in machine-tool control, X-Y plotting, etc. The unit has PC construction with an integrally mounted Nixie Tube. Versions are available for operating either standard size round or rectangular tube types. Both versions have 10 auxiliary high-current outputs for pre-set counting, or to operate auxiliary equipment such as printers, logic control circuitry or remote displays. Burroughs Corp., Electronic Components Div., Plainfield, N. J.

Circle 244 on Inquiry Card

THUMBWHEEL SWITCH

Mounted in multi-module assemblies for in-line readout of pre-set resistances.

Model 168 has a large PC terminal board to accommodate precision resistors. Each module uses 4 resistors in a 1-2-3-6 code to provide 10 incremental resistance values. Installation of the module is simple and fast: resistors are mounted by user or factory and switch is plugged into circuit. No wiring checkout is required. Model 168 saves considerable space over conventional rotary decade units. Available with standard PC connector or wire termination. Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif.

Circle 245 on Inquiry Card

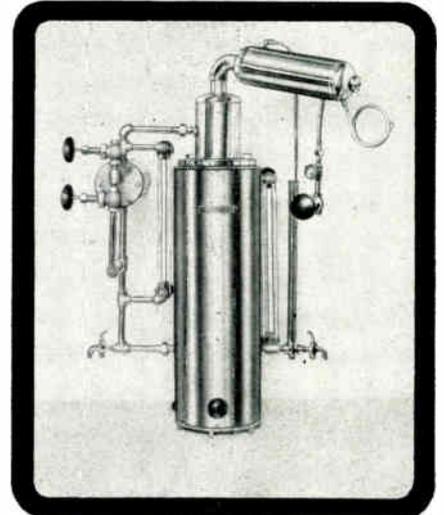
PERFORATOR TAPES

When perforated, the tapes can be read indefinitely. There is no deformation of holes.

These Mylar reinforced, opaque perforator tapes have thicknesses from 0.0043-in. down to 0.0015-in. (± 0.0003 -in.) and are suitable for both photoelectric and electro-mechanical readers. A laminating technique, Lamcote™ gives the tape exceptional strength and dimensional stability. Up to 33-1/3% longer footage is possible within standard reel size limitations. Changes in relative humidity will not cause them to swell, contract, expand or to be otherwise adversely affected. Arvey Corp., 3500 N. Kimball Ave., Chicago, Ill.

Circle 246 on Inquiry Card

SLASH "FREON" COSTS



WITH BARNSTEAD RECOVERY STILL

Important savings can now be made by recovering "Freon" TF used in your washing and rinsing operations . . . since the same solvent can be used over and over again.

With the NEW Barnstead "Freon" TF Recovery Still, the solvent is returned to its original purity in a single distillation. Operation is easy and inexpensive . . . "Freon" is fed into the evaporator of the Still . . . is condensed in a water cooled condenser . . . and is ready for reuse . . . thus reducing frequent "Freon" purchases and maintenance of inventory. Barnstead "Freon" Recovery Stills are available in two models: one is equipped with hot water heating coil for heating directly from plant hot water — and the other is equipped with its own electric heating unit and water jacket. Either can be supplied for both manual batch feed and for continuous operation. Bulletin #82 tells the complete money-saving story — write for your free copy today.

Barnstead
STILL AND STERILIZER CO.
51 Lanesville Terrace, Boston 31, Mass.

Circle 111 on Inquiry Card

LONG DISTANCE XEROGRAPHY

(Continued from page 70)

whereas the background areas reflect most of it. The reflected light is channeled into a photomultiplier and converted into an electrical signal. This signal is amplified and formed to produce a two-level video output signal, one level represents black areas and the other image background. This signal can be connected to the common-carrier transmission facility or for transmission over coaxial cable. Provision is made within the scanner to compensate for different copy background, enabling the scanner to accept wide ranges of colored paper background.

The two-level video signals received at the printer from the transmission facility are used to control the brightness of a CRT which is operating in a line scan mode. It does this by switching the CRT "on" and "off," depending upon which video level is being received. The scanner and printer CRT are scanned in perfect synchronism. The printer CRT is imaged onto the xerographic drum forming a horizontal line scan display, with the motion of the xerographic drum providing the vertical scan. The image is then transferred to plain paper using conventional xerographic methods. The standard equipment now available will use 190 and 135 lines/inch scanning rates.

How To Use Catalog 700 FOR ALL IT'S WORTH!



**EASY TO FIND
PART-MATED TOOLS
SPEED ASSEMBLY**

Wherever a job-proved CAMBION® tool will facilitate working with a CAMBION part, the tool is clearly called out — cataloged with dimensional drawings — annotated with hints on use. Swaging tools for connectors, tuning tools for coils, drills and spinning tools for terminals . . . all are detailed to end doubts on how to handle a part. Just one more design and production engineer-oriented feature of this 176-page full-line catalog of the more than 15,000 *guaranteed* CAMBION electronic components. Contact your Authorized CAMBION Distributors for local availability. For samples, sales engineering or additional free copies of Catalog 700, write or call Cambridge Thermionic Corporation, 410 Concord Ave., Cambridge, Massachusetts 02138. Phone (617) 876-2800.

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Standardize on CAMBION...The Guaranteed Electronic Components

Circle 114 on Inquiry Card

ELECTRONIC INDUSTRIES • October 1964

AC OR DC SMALLEST VANEAXIAL BLOWERS

Only 1 1/8" in diameter, these smallest blowers deliver 4 times as much air as other comparable size blowers, 15,000 times their own volume per hour. Use these rugged sub-miniature blowers for spot cooling of critical components where space is cramped and weight is important. Life is 1,000 hours, and most exceed 2,000 hours. Designed to meet MIL-E-5272. Globe makes larger blowers, too. Some units available for 24-hour delivery. Request Bulletin XAV. Globe Industries, Inc., 1784 Stanley Ave., Dayton, Ohio 45404.

VAX-1-AC 26 v.a.c. (115 v.a.c. w/1.2 MFD capacitor in series), 400 cps, 320 MA, 2.0 MFD phasing capacitor 1 1/2" dia. x 1 1/2" long. 1.5 oz.

VAX-1-DC 26 v.d.c., 250 MA, 1 1/2" dia. x 1 1/4" long. 1.4 oz.

Circle 112 on Inquiry Card



**eliminate
hand
plotting
of data**

Now you can afford the convenience and accuracy of automatic data plotting with an X-Y recorder. This new unit offers all the specifications and features necessary to insure the ease of operation usually found only in recorders twice the price.

- 8 1/2" x 11" or 11" x 17" chart size
- Zener reference voltages which eliminate periodic battery replacement
- Front panel switch allows easy chart paper insertion
- 100 K input impedance
- 0.25% accuracy
- Built-in electronic time base
- 1 mv/in. maximum sensitivity, switch selectable in 5 steps to 10 v/in.
- Electric pen lift
- Snap-on pen assembly
- Model HR-96T (8 1/2" x 11") \$995
- Model HR-98T (11" x 17") \$1095



houston instrument corporation

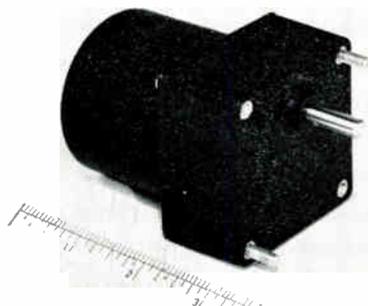
4950 Terminal Avenue / Bellire, Texas 77401 / MOhawk 7-7403
Cable: HOINCC / TWX 713-571-2063

Circle 113 on Inquiry Card

NEW PRODUCTS

AC GEARMOTOR

Offers output speeds dependent on motor speed and 13 geartrain ratios.



Rated at 10 lbs.-in. max., this unit measures $2\frac{3}{8}$ sq. x 3-1/16 in. long. Types UHS, UH, and UHL are available in 3 standard stack lengths, rated to 1/50 HP at 3600 RPM, and to 1/100 HP at 1800 RPM. Standard geartrain ratios range from 6:1 to 1800:1. Power input is 115-vac, 50-60cps, 1 phase. Globe Industries, Inc., 1784 Stanley Ave., Dayton, Ohio.

Circle 236 on Inquiry Card

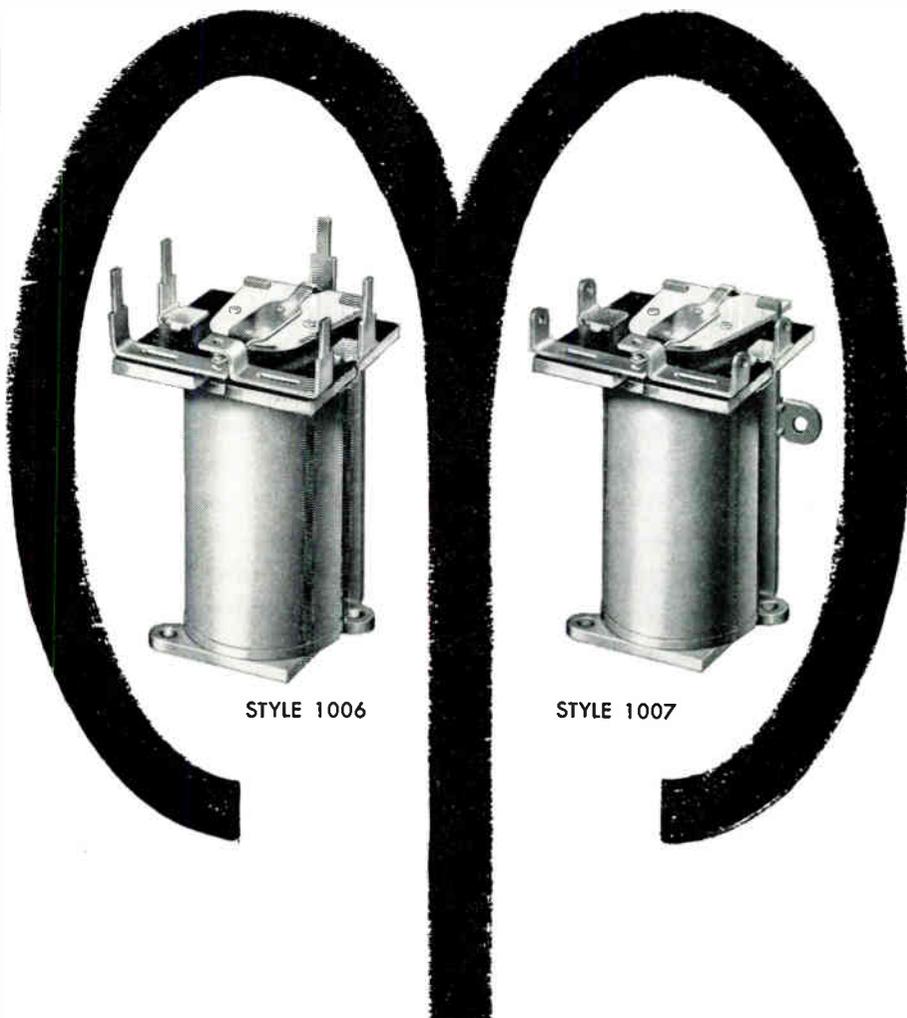
LOGIC SIMULATOR

Simulates a logic design by simply patching connections on a patchboard.



With the Logic Designer LDE 100, the systems engineer can easily verify his logic or add special auxiliary functions to the system on a temporary basis. He may also use the device to familiarize himself with NOR/NAND logic and the operating characteristics of the cards preparatory to systems design. Seventy-two logic cards are available. A representative 65-card mix contains 20 flip-flops, 16 NOR gates, 16 NAND gates, 4 decimal decoders, 2 Schmitt triggers, 2 solenoid drivers, 2 time delays, one 1-shot, 1 line driver, and 1 relay driver. Cards may be supplied to meet any need. Power supplies for the cards are built into the unit, permitting operation from 117vac. Consolidated Systems Corp., 600 E. Bonita Ave., Pomona, Calif.

Circle 237 on Inquiry Card



STYLE 1006

STYLE 1007

SENSITIVE RELAYS AT SENSIBLE PRICES

Price Electric Series 1000 Relays Now Feature . . .

- Sensitive Operation • Solder or Printed Circuit Terminals
- Open or Hermetically Sealed Styles • Low Cost

These versatile sensitive relays are designed for applications where available coil power is limited. They retain all the basic features, such as small size, light weight and low cost, that makes the Series 1000 General-Purpose Relays pace setters in their field.

TYPICAL APPLICATIONS

Remote TV tuning, control circuits for commercial appliances (including plate-circuit applications), auto headlight dimming, etc.

GENERAL CHARACTERISTICS

Standard Operating Current:

1 to 7 milliamps DC at 20 milliwatt sensitivity

Maximum Coil Resistance: 16,000 ohms

Sensitivity:

20 milliwatts at standard contact rating; 75 milliwatts at maximum contact rating. Maximum coil power dissipation 1.5 watts.

Contact Combination: SPDT

Contact Ratings:

Standard 1 amp; optional ratings, with special construction, to 3 amps. Ratings apply to resistive loads to 26.5 VDC or 115 VAC.

Mechanical Life Expectancy:

30,000,000 operations minimum.

Dielectric Strength: 500 VRMS minimum.

For additional information, contact:

PRICE ELECTRIC CORPORATION

323 Church St. • Frederick, Md. • Phone: 301/663-5141 • TWX 301/553-0462

JOINT U.S./INDUSTRY R&D HELD KEY TO NATIONAL SECURITY

Continued national strength and security insured by joint research and development efforts by industry and the government were underscored by Charles B. Thornton, board chairman of Litton Industries, before the National Security Industrial Association.

Mr. Thornton told the NSIA that no nation can be economically or militarily stronger than its industrial base. He also said that the U.S. has both the highest standard of living and the strongest military capability in history to prove its strength.

In his opinion, as we successfully extend the peace, we move the conflict into the arena of research and development. The important thing "about those engaged in defense industry is that the harder and faster they push present weapons and systems into obsolescence, the more likely we are to preserve the peace. Slowness could be our Achilles heel.

"We dare not risk the consequences of such a course," said Mr. Thornton. Our best chance to hold a war's outbreak in check lies in the R&D competition in the power blocs.

ASSEMBLER TIME-SAVER



P. L. Rotomator, produced by International Research and Development Corp., stores and delivers parts in a rotary parts cartridge under the work surface. Foot switch indexes the cartridge to the next part at convenient lap level position for shorter reaching distance, less fatigue and faster production.

CIRCUIT DEFINITION

The Electronic Industries Association defines *semiconductor integrated circuit* as—"The physical realization of a number of electrical elements inseparably associated on or within a continuous body of semiconductor material to perform the functions of a circuit."

MATH FORMULAS MAY SOLVE RANDOM DISTURBANCES

The machine or system immune to nature's random disturbances hasn't yet been built—and perhaps never will be. A Purdue University mathematician remarks, however, that he has new mathematical formulas to help automatic control systems cope effectively with the problems.

Rufus Oldenburger, School of Mechanical Engineering, said the formulas will in some cases make it possible for automatic control systems to predict disturbances.

Formulas can also be used to advise the system how to adjust itself while a disturbance is curbing performance. If the disturbance does cut performance, the formulas can be used to re-gain optimization.

Mr. Oldenburger said the formulas can be programmed in a system's controller. There are clues that precede disturbances. Formulas are applied to these clues to tell the system what off-setting action it should take.

Among major disturbances that upset system performance are sudden changes in temperature and in amount of power the system is getting.

Do You Need A **SLEEVING** that doesn't exist?

Most flexible insulating tubing or sleeving applications can be taken care of by the existing Varflex-manufactured lines. Occasionally something **special** comes along. Miniaturization in particular has produced a number of special needs.

However non-existent this sleeving may be today, it could be part of wired circuitry tomorrow. Varflex has cooperated with many engineers to develop specialized sleeveings. We welcome the opportunity to work with you; our diversified experience will be helpful.

Send for Free Folder of Actual Test Samples.

Varflex
CORPORATION
506 W. Court St.
Rome, New York



Circle 116 on Inquiry Card

low noise, *microvolt signal processing*

Instruments developed for infrared technology created this line—suitable wherever low noise characteristics are vital. Example: IRI's microvoltmeter indicates $2.2 \times 10^{-10} V$ (per cps^{1/2} @ 5KC).

Over 50 catalog units include:

amplifiers, pre-amps, calibrators, integrators, microvoltmeters

Get special combination tech bulletin.



INFRARED Industries Inc.

Santa Barbara, California
Phone 684-4181 (Area Code 805)

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Circle 117 on Inquiry Card

ELECTRONIC INDUSTRIES • October 1964

DOCTOR'S REPORT FAVORS EDP ANALYSIS OF MEDICAL DATA

Medical investigators at New York's Roosevelt Hospital have reported favorably on the value of advanced mathematical approaches to analysis of biomedical data.

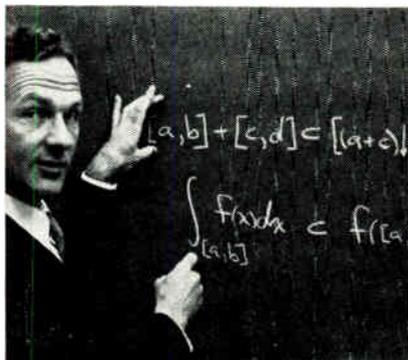
A paper by Drs. Arthur Lemlich and Herman Ziffer offered preliminary findings in current studies of the natural history, laboratory data, course and prognosis of patients with acute myocardial infarction (heart attack).

They used an IBM 7090 in advanced statistical analyses of data drawn from records of 368 patients admitted to the Hospital in 1958 and 1959 with the heart ailment. Data covered 69 separate clinical variables.

In addition to reporting use of classical statistical procedures as cross tabulation, regression analysis and factor analysis, both doctors told of using an experimental computer program to perform "cluster" analysis—a procedure which seeks to discover groups of closely related cases often hidden within a mass of data.

Computers separate patient clusters by repeatedly sifting many properties or clinical characteristics.

INTERVAL ARITHMETIC



Dr. Ramon Moore, Lockheed Missiles & Space Co. mathematician, points out basic formulas for interval arithmetic, source of a basic advance in computer operations. Two intervals can be contained in another interval, according to top formula. Similar operations are carried out on computers using the new formula and logic developed by Moore.

SUPERCONDUCTING WIRE

High-performance niobium-titanium superconducting wire (HI-120) is now available from Westinghouse Materials Manufacturing Division. The wire can generate extremely high magnetic fields at reduced power use.

Coils wound with HI-120 have as much as 33% higher current capacity than with niobium-zirconium.

NEW 'OVERLAY' TRANSISTOR HAS HIGH GAIN, BROAD USE

A new general purpose VHF/UHF "overlay" transistor with a typical 5-w output at 50 mc and 20db gain, was disclosed by RCA.

The new economy unit, the 2N3553, offers high gain in the 27-260mc range for rf uses as a driver or power output stage, reports Ben Jacoby, market planning manager for industrial semiconductors, RCA Industrial Tube and Semiconductor Div.

CALIF. COUNTY MAKES PITCH FOR NEW INDUSTRY PLANTS

Advantages of starting a new plant in Santa Clara County is the subject of a new colorful brochure just published by the Greater San Jose Chamber of Commerce, San Jose, Calif.

The brochure, entitled "a Forecast . . .," lists growing communities within the county, populations, financial and industrial aspects.

Copies of the brochure are available by writing to: Miss Doreen Jones, Industrial Dept., Greater San Jose Chamber of Commerce, Civic Auditorium Bldg., San Jose, Calif.

WHAT ARE YOUR SPECIFICATIONS?

WHATEVER THEY ARE, YOU WILL FIND THE ANSWER IN THE HOWARD LINE

MODEL 26 "A" FRAME INDUCTION MOTOR
J Mount. 1/80 to 1/10 HP

MODEL 33 "A" FRAME INDUCTION MOTOR
W Mount. 1/50 to 1/5 HP

MODEL 512 UNIVERSAL OR SHUNT GEAR MOTOR
A7 Gear Unit

MODEL 29-500 AC/DC GEAR MOTOR
A26 Gear Unit

POWERED BY HOWARD

Howard's 12 different gear units assure *universal and induction gear motors* exactly suited to your torque, speed and mounting requirements (also available in shunt or AC/DC units).

Howard's broad line of 26 and 33 frame induction motors, each with multiple mounting variations, assures exact adherence to your specifications.

Howard's control of the design and production of all important motor components, through its six manufacturing divisions, assures *total quality control* of the finished product.

HOWARD INDUSTRIES, Inc.

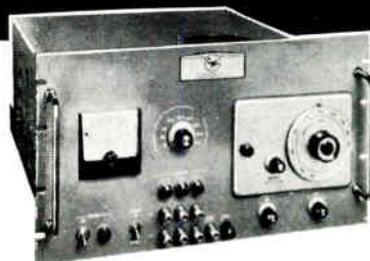
1760 STATE STREET, RACINE, WISCONSIN

Sales offices and representatives in principal cities.
Consult the Yellow Pages.

Circle 119 on Inquiry Card

ELECTRONIC INDUSTRIES • October 1964

Smallest 3-Phase Electronic Frequency Converters Ever Made!



Now, from CML, comes a series of the smallest 3-phase Electronic Frequency Converters ever made . . . featuring fixed or adjustable plug-in oscillators at frequencies ranging from 45 to 6,000 cycles. Write today for details on Models T500A through T2500A!

Model	3 ϕ Output VA	Dimensions (For standard 19" relay rack mounting)
T500A	500	8 $\frac{3}{4}$ " h x 21" d
T750A	750	14" h x 21" d
T1200A	1200	14" h x 21" d
T1750A	1750	14" h x 21" d
T2500A	2500	14" h x 21" d

CML, Inc.
A Subsidiary of Tenney Engineering, Inc.
350 Leland Avenue • Plainfield, New Jersey
Telephone (201) 754-5502 • TWX: 201-756-2064

Circle 38 on Inquiry Card

It stands alone



Hydrazine-Activated Flux[®] and Core Solder offers an exclusive combination of advantages:

- High wetting properties for good "bite."
- Non-corrosive connections.
- Residues removed by heating or water rinse.
- No change on aging.

No one flux is best for all purposes. TEST HYDRAZINE FLUX AND CORE SOLDER FOR YOURSELF. The liquid permits pre-fluxing, is useful for soft-soldering a wide range of copper and copper-based alloys. The core solder flows at an ideal rate, leaves a minimum of soldering residues. Write for samples of either, or technical literature.

Available only from Fairmount and its sales agents. *U.S. Patent No. 2,612,459 and others

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LAWYER OFFERS GUIDELINES TO PROTECT TRADE SECRETS

Guidelines to help firms protect secret data, plans, and know-how—much of it not patentable—are outlined by a leading corporation attorney.

R. G. Jeter, vice president, secretary and general counsel of The B. F. Goodrich Company, remarks that protection of a vast body of scientific knowledge and technology from competitors "has become a problem. The volume of litigation has increased substantially in recent years."

Mr. Jeter, who represented Goodrich in a case in which a former employee was permanently enjoined from giving BFG trade secrets to his new employer, a competitor, suggests the following as a guide for corporations:

Identify secrets and make them unavailable to the public and to employees who do not work around them. Check character of prospective employees who will work with such data. Advise present and future employees of the nature of the work and of their obligation.

Include in employment contract a clause that the employee will not disclose secret information. Compensate adequately employees who will work with confidential information. When an employee resigns to take a job with a competitor, (a) conduct an exit interview and inform him of his obligation respecting secret data, and (b) talk it over with competitor, if it seems advisable.

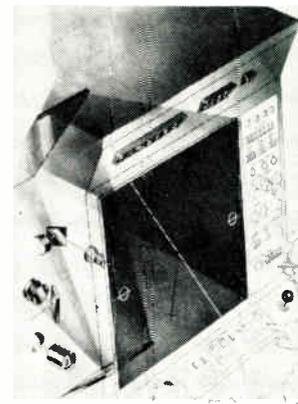
When hiring an employee from a competitor, (a) advise the employee that he is not being hired to obtain confidential information, (b) assign him to work he did not do for competitor, and (c) review, if appropriate, problem areas with former employer before putting new employee to work.

With the help of lawyers, set up a system for receipt of ideas from third persons. Advise everyone in the organization to whom ideas may be sent, including corporate officers, of such procedure.

100TH YEAR FOR THE ITU

The World's oldest inter-governmental organization celebrates its 100th anniversary next year. May 17, 1965, marks the centennial of the International Telecommunication Union (ITU) which was founded in Paris in 1865. Celebrations are scheduled for Washington, D. C., and New York. The ITU is now a specialized agency of the United Nations.

"V" ANGLE READER



Artist's view of Semi-automatic "V" Angle Reader with part of interior optical system, control panel and viewing screen on which a film frame is projected and automatically positioned. Operator makes precise measurement of missile pitch angle using image rotation technique. Device being produced by Link Group, General Precision, Inc., for White Sands Missile Range, N. M.

WESTINGHOUSE GEAR TO HELP BOEING CIRCUIT RESEARCH

Research studies on semiconductors and integrated circuits will be conducted for the aero-space division of The Boeing Co. with a pilot line to be installed by Westinghouse Electric Corp.

The pilot line will be installed at Boeing's \$5,800,000 space center to be built near Seattle. Nine similar integrated circuit facilities have been installed at various Westinghouse locations. The Boeing facility will be the first, outside of Westinghouse, which will furnish know-how and supply equipment needed for the installation.

RCA'S 16-FT. SPEAKER IN FAIR'S WATER DISPLAY

The most powerful loudspeaker ever built, a 7,000-lb superlative of sound reproduction with an output equal to 1,000 console phonographs at full volume, plays a nightly role at the New York World's Fair. It is 16 feet in diameter.

Designed by RCA in conjunction with Commercial Radio-Sound Corp., its New York Distributor of sound products, the giant speaker pours forth music in high fidelity as part of a synchronized display of water patterns, color, sound, and fireworks.

From its location in the center of the Fair's "Fountain of Planets," the speaker rises on a hydraulic lift behind a swelling water curtain that signals the start of the display.

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Fall Computer Conference Opens in Frisco Oct. 26th

The 1964 Fall Joint Computer Conference will be held in San Francisco during the week of October 26. Upwards of 4000 persons are expected to attend.

The Conference will occupy most of the facilities of the San Francisco Civic Auditorium and adjacent Brooks Hall—the latter to house a trade exhibition featuring 200 booth displays. The headquarters hotel will be the Jack Tar, on Van Ness Avenue, where reg-

istration will commence Monday, October 26, between 6 and 10 P.M. Registration will continue at the Jack Tar Tuesday, October 27, between 7:30 and 10:30 A.M. Similar hours will be in force at the Civic Auditorium during the following two days.

Evening Sessions

Two special evening panel sessions have been planned, both at the Jack Tar at 8 P.M. Tuesday's session on *Training for the Computer Field* will be led by Ned Chapin of Menlo Park,

Calif., a data-processing consultant. The Wednesday evening session on *Input and Output Graphics* will be moderated by Donn B. Parker of Control Data Corp., Palo Alto, Calif.

Special Presentations

This year an experimental offering on *Very High-Speed Computer Systems* will be presented by leading manufacturers. Teams of technical, management and sales people will make the presentations at half-day sessions, running the full three days of the conference. Also, as part of the technical program, there will be workshops on technical items of special interest. Discussion groups will meet during the evening to recap and extend the material presented during the regular sessions, meeting with session chairmen and authors.

Technical Program

Papers covering a broad range of topics will be given at 17 technical sessions. Here, briefly, is a rundown of a few of these sessions.

Sessions 1, 4, 8, 11: Very-High-Speed Computers 1964—The Manufacturers' Point of View; session 2: Programming Techniques and Systems; session 3: Expansion of Functional Memories; session 5: New Computer Organizations; session 6: Management Applications of Simulation; session 7: Digital Software for Analog Computation; session 9: Input and Output of Graphics; session 10: Mass Memory.

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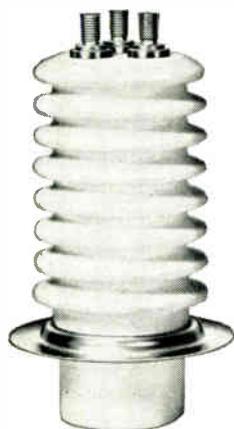
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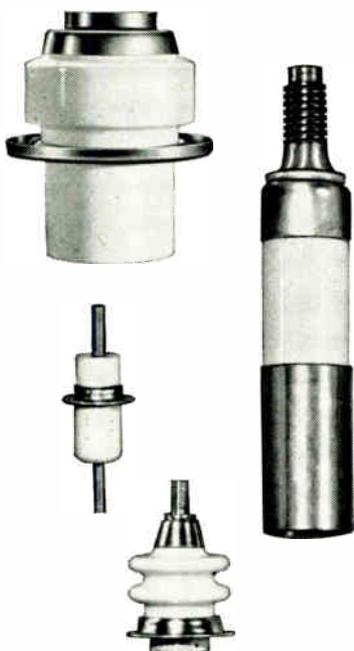
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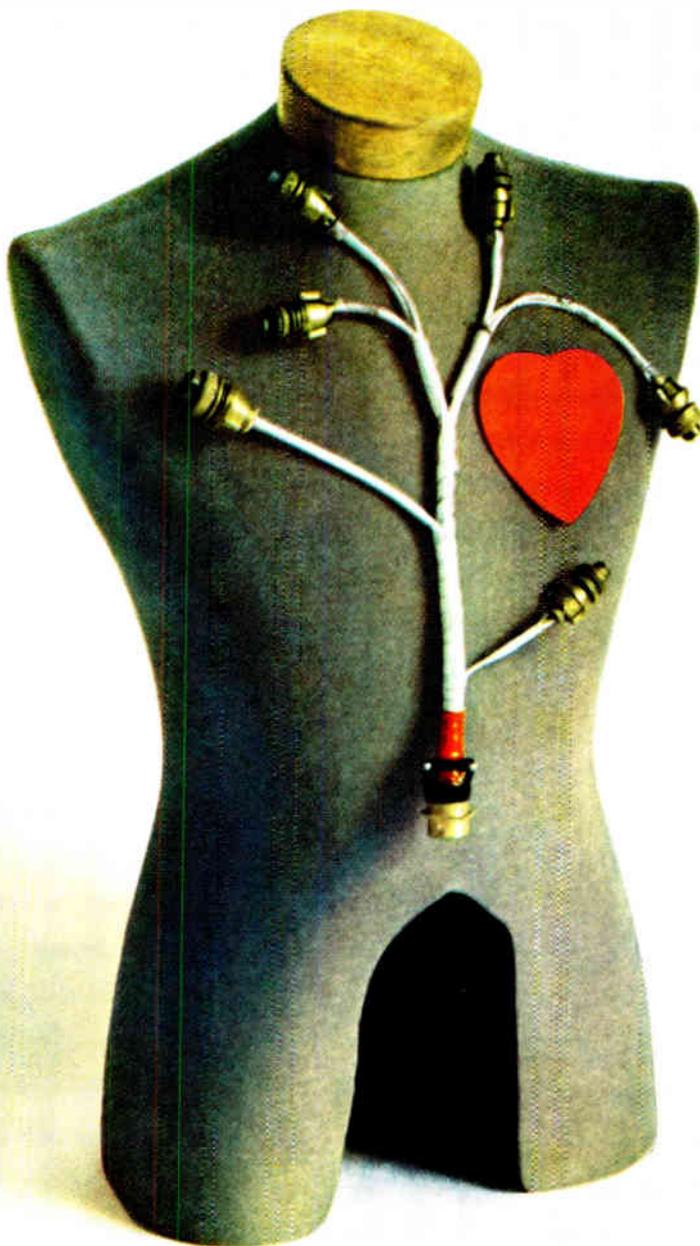
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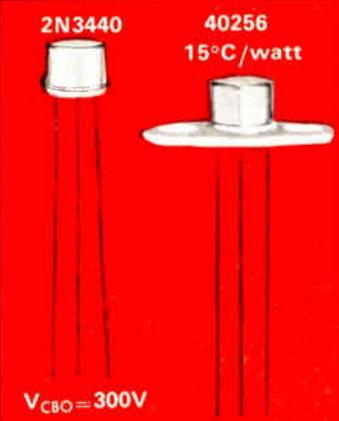
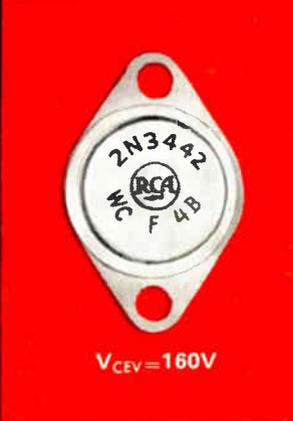
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		2N3441	2N3442
V _{CEO} (sus)	@ I _C = 200 ma @ I _C = 100 ma	140V Min	140V Min
V _{CEV}	@ I _C = 100 ma @ I _C = 50 ma	160V Min	160V Min
I _C Max		3A	10A
h _{FE}	@ I _C = 3A dc @ I _C = 0.5A dc	20-80	20-70
f _T		0.8 Mc	0.4 Mc
P _T		25W	117W
θ _{j-c}		7° c/w	1.5° c/w

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2N3439	450V Max	0.5V	40-160	30 min	30° c/w
40255 (Flange Version of 2N3439)					15° c/w
2N3440	300V Max	0.5V	40-160		30° c/w
40256 (Flange Version of 2N3440)					15° c/w

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