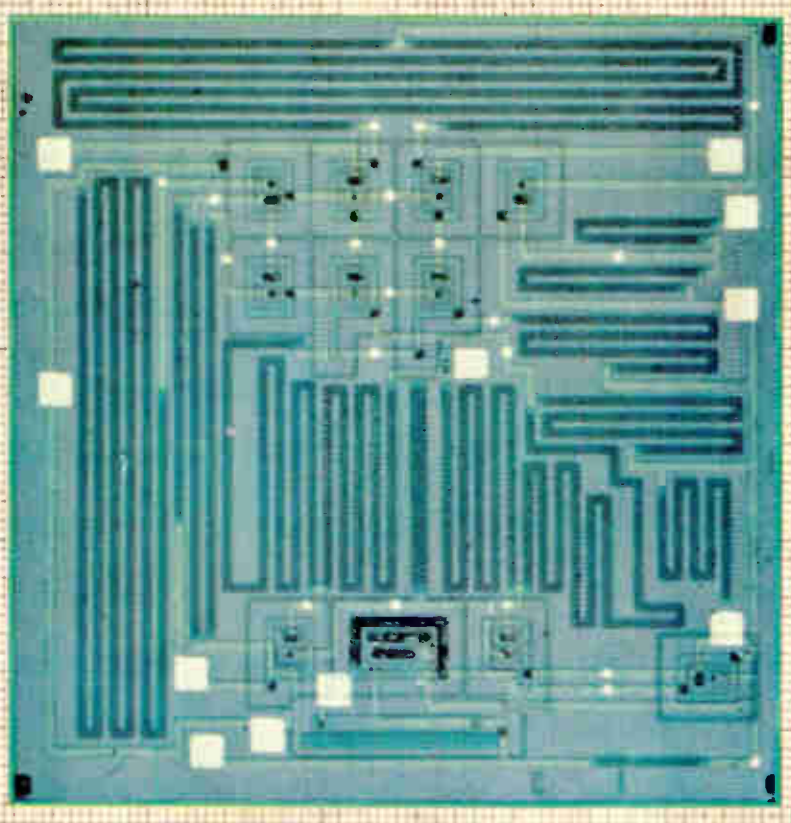
ELECTRONIC INDUSTRIES

THE STATE-OF-THE-ART MAGAZINE



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The reliability of a measurement

Transients generated by relays

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Oper. Temp. Range	−65 C to +175 C			
Adjustment Turns	15 ±2	25 ± 2	22 ± 3	23 ± 2
Mounting Centers	.750	1.000	1.000	.520
Standard Tolerance	± 5%	±5%	± 5%	± 5%
Standard Resistance Values	10 ohms 20 ohms 50 ohms 100 ohms 500 ohms 1K ohms	2K ohms 5K ohms 10K ohms 15K ohms 20K ohms	25K ohms 30K ohms 50K ohms (Max. Models 691, 697, 5091 & 5050) 100K ohms	

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ELECTRONIC INDUSTRIES
The STATE-OF-THE-ART Magazine

Growing Pains in Integrated Circuits

WILL INTEGRATED CIRCUITS (IC) bring large dollar volume and more engineering jobs in the future?

Advances in IC technology have come about at a fast pace but many problems remain to be resolved. Even with sizeable government spending in recent years to develop IC technology, sales in 1964 were less than $30 million.

What will the sales be over the next five years? No one is really sure. It appears certain that government orders for IC's will not be substantial enough in the foreseeable future to utilize present manufacturing capability. Volume business must come from other sources. The computer market is presently the major user of IC devices. Other markets for high volume identical digital circuits are needed.

First of all are *engineering* considerations:

1. There are no standards for manufacturing techniques or processes.

2. Test procedures for ICs are in a state of flux. There is no concurrence among users and between users and suppliers as to what parameters should be tested. Circuit testing is responsible for 25-50% of the IC's cost. Thus, better ways (based on better specs) can cut costs. More adequate test procedures are needed.

The pulse generator is the most important test instrument. Also important is the oscilloscope. Test jigs and fixtures challenge the imagination. Today's problem in testing is how to get in and out of the IC.

The trend appears toward more functional testing as opposed to single component testing. In testing, one must be careful in everything he does—dress of test leads, grounding of equipment, etc.

3. Growing use of ICs will push future designs toward a completely modular concept. They may offer a challenge in the design of compatible input-output devices, impedance matching and interconnections. The latter is a major problem.

4. Field design changes can only be done by replacing the entire IC package.

5. Hybrid and monolithic ICs both have a place in circuit design. Hybrids are in an advanced state of development; monolithic still holds promise of great improvements in function and reduced costs.

6. Linear IC development will be slower than digital with the possible exception of the microwave area.

7. Existing solid state problems have carried over into the IC area. Included are intermetallics, isolation and parasitic capacitance. New and improved materials development will be needed for IC progress.

Here are some *marketing* considerations:

1. The present outlook for high volume ICs is in the computer market.

2. The government appears to be a relatively poor volume market for IC's at present.

3. IC's for consumer applications are not on the immediate horizon.

4. Most component companies and large systems producers have in-house IC capability, but these companies will probably need second sources of supply.

5. IC costs must be competitive with conventional circuits to gain new volume markets. Costs are often not readily ascertained in the current state-of-the-art. Some vendors may underprice to make a sale. This creates a false image and can lead to trouble as it did in the transistor industry.

6. Costs will influence decisions between hybrids and monolithic devices.

7. IC users need more cooperation from vendors—performance guarantees, disclosure of materials used, disclosure of manufacturing specifications, etc.

How will ICs affect your future as an engineer?

1. The engineer will need to learn IC technology because all large companies are interested in IC developments.

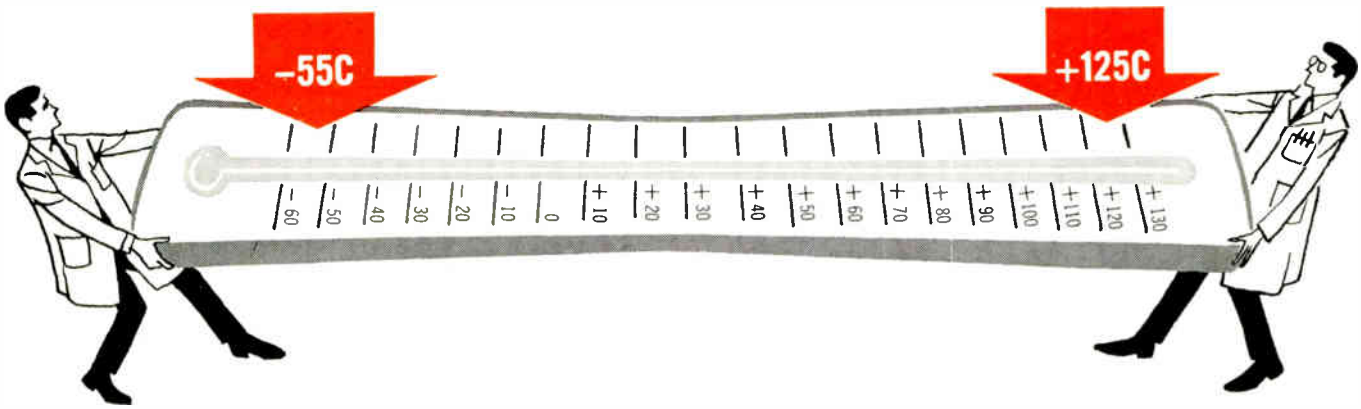
2. He must learn to communicate with manufacturers of ICs. The engineer must become familiar with processes, materials, interconnections, layout and geometrics. He must also be able to understand the problems between the manufacturers and systems users. To the creative man who understands these inter-disciplinary techniques, good jobs will be available.

3. The present-day circuit designer appears to be losing some of the control he had over circuits with the advent of IC technology. The number of such designers will become less and the number of systems designers greater with acceptance of IC's.

4. The future circuit designer will be a sophisticate in IC technology. He will probably work for the IC manufacturer rather than for equipment and systems manufacturers.

Bernard F. Osbahr

New from Sprague!



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ELECTRONIC INDUSTRIES

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COVER: CBS Labs' new high-impedance, high-gain, three-stage operational amplifier measures 100 mils by 102 mils. 50 units fit on a wafer. The chip contains 11 transistors and 18 resistors. Article begins on page 62.

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

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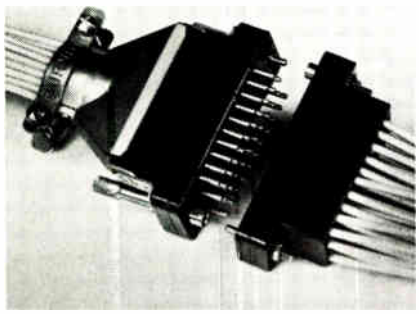
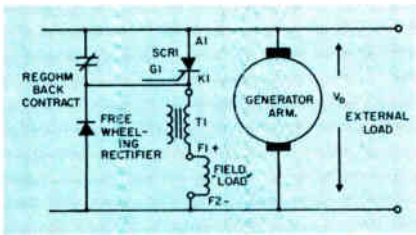
HIGHLIGHTS



Multi-Pin Connectors



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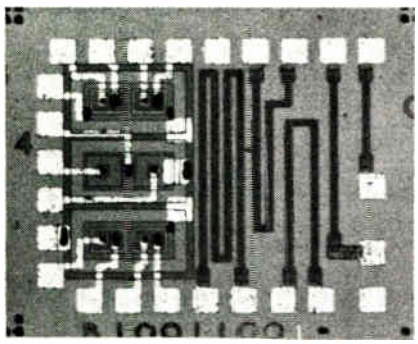
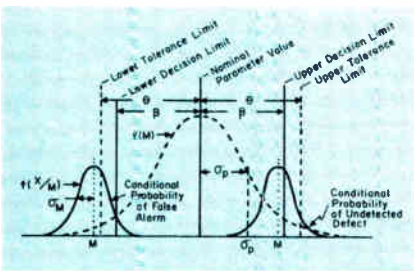
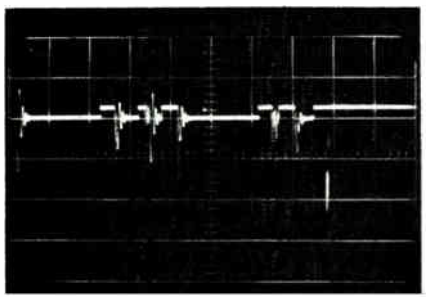


Thin Film and Semiconductors



Reliability of a Measurement

Suppressing Relay Transients



MULTI-PIN CONNECTORS 40
In this Part 3 of the connector survey, ELECTRONIC INDUSTRIES tabulates the multi-pin connector products of suppliers in the electronic connector industry.

THE IMPACT OF INTEGRATED CIRCUITS ON INDUSTRY ROLES 53
The development of integrated circuitry in its various forms is forcing major technical and economic changes in the industry. This article discusses the courses open to integrated circuit and equipment manufacturers.

MATING THE THIN FILM AND SEMICONDUCTOR TECHNOLOGIES 62
There are different approaches to combining metal film resistors with oxide passivated semiconductor devices. One such approach is discussed here. It is a case history of the design and construction of a high-gain, three-stage operational amplifier with a Darlington output, in I/C form.

MEASURING DC RELAY COIL TRANSIENTS 68
It is no surprise that relays generate transients. But most engineers do not realize the magnitude and duration of these transients that create RFI and can burnout parts. Here are the results of some tests, along with suggestions for reducing transients.

SUPPRESSING RELAY COIL TRANSIENTS 73
Relay coils generate inductive "kicks" which create high level transients. Several methods of transient suppression are described here. Selection of suppression must be done with care to minimize the effect on relay release time.

A SEMICONDUCTOR SERVO FOR DC CONTROL 76
Many areas of automatic control would not be possible or practical today without semiconductors. In others, great improvement has been made. The all SCR servo system described here is designed to give better performance capability and reliability than previous schemes. And, it costs less.

THE PROBABLE RELIABILITY OF A MEASUREMENT 102
A means is described for accurately determining the confidence of reliability for a system. Given is the relationship of measurement accuracies and decision tolerances to the probabilities of undetected defects and false alarms.

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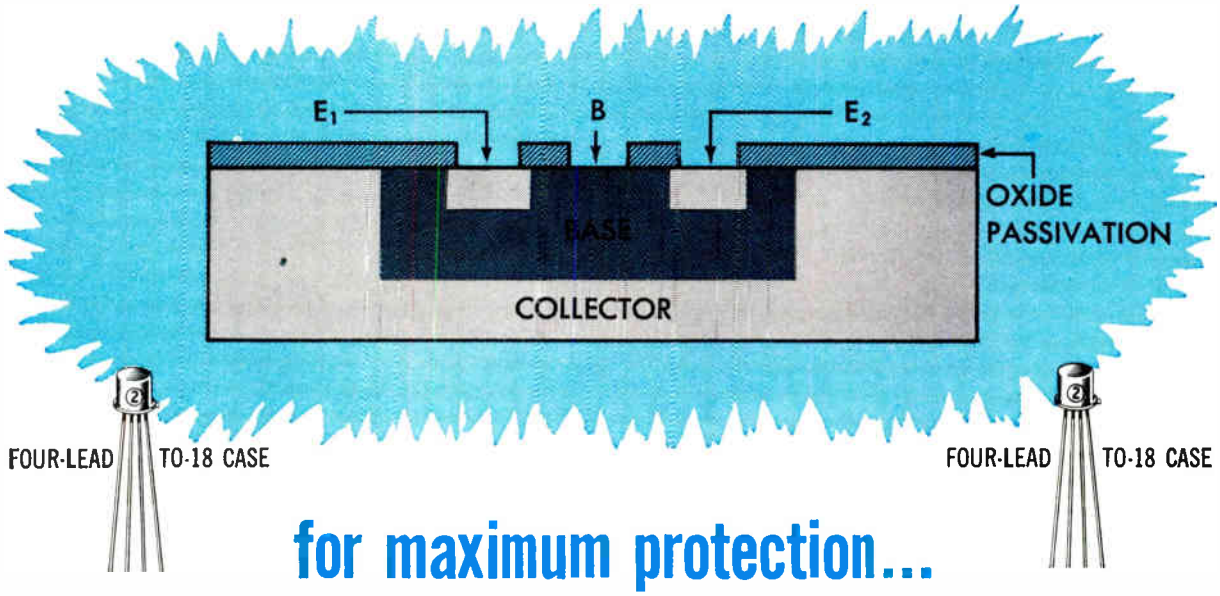

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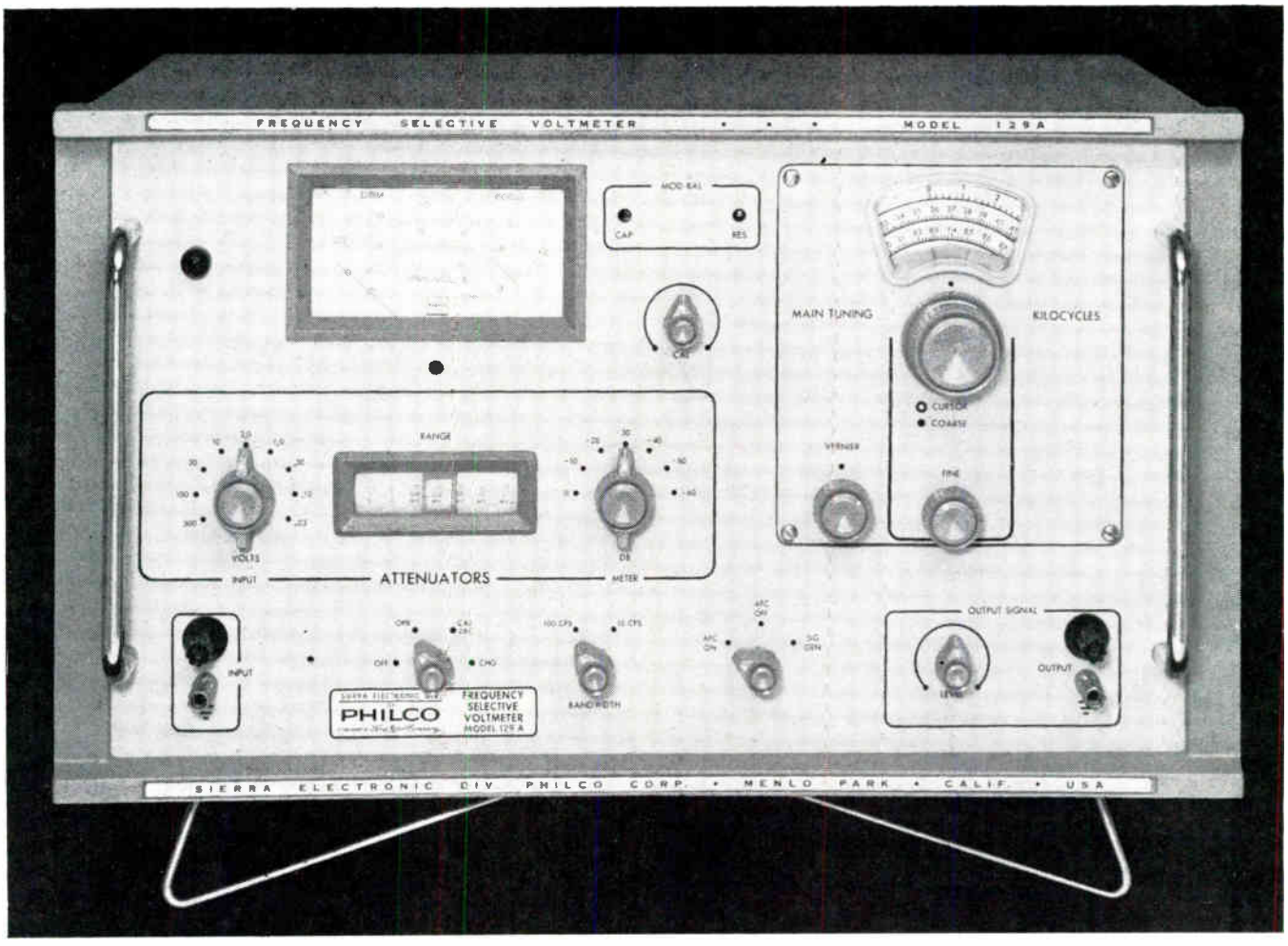
Sierra's 129A



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ELECTRONIC INDUSTRIES RADARSCOPE

Developments and trends affecting the State-of-the-Art of technologies throughout the electronic industries

OPERATES AT ROOM TEMPERATURE

Continuous operation of a ruby laser at room temperature is demonstrated by George F. Smith, Assoc. Dir. of Hughes Aircraft Co.'s Research Laboratories, where the laser was developed. Laser consists of an ordinary ruby rod, pumped to threshold by a single mercury lamp operating at 1000 w. in a special elliptical cavity.

AN ELECTRON MICROSCOPE with a resolution of 2 Å, which could focus on particles only eight billionths of an inch in size is the aim of a group from Cornell University. Work will be done under a grant made to the University by the National Institute of General Medical Sciences of the National Institutes of Health, and the National Science Foundation. The whole field of biomedical research would benefit from such an advance. The project should make possible direct observation of atoms within enzymes, proteins, viruses, and other molecules of importance.

A FUEL CELL POWERPLANT designed and built by Pratt & Whitney Aircraft has successfully generated electrical power for over 1,000 hours. This is enough time for more than two lunar missions. The fuel cell system is to supply electrical power for life support, guidance and communications equipment for the command and service modules of the manned Apollo spacecraft. The unit was tested in a sealed vacuum chamber simulating the conditions of space. It was operated at times under maximum emergency power conditions.

WAVE PROPERTIES OF PLASMAS are being probed by engineers at the Denver Research Institute (DRI), University of Denver. They are trying to learn how electromagnetic waves interact with ionized plasmas, and the influence of these waves on the physical properties of the plasma. Understanding these interactions can lead to the use of plasma for diagnostics, plasma heating, high energy transmitters in a plasma environment, astrophysics, and propagation of electromagnetic waves through the ionosphere.

FLYING ANTENNAS, as long as 1,500 feet from tip to tip, will be orbited on NASA satellites to pinpoint sources of celestial radio signals. Two "Radio Astronomy Explorer" satellites will be designed to investigate 1-f emissions from our galaxy, its planets and the stars. They are to provide the first mapping of our galaxy at frequencies below ionospheric cutoff. There are to be two 750 foot V-shaped antennas mounted opposite each other, forming an X.

OPTICAL TRACKER sensitive enough to find and follow a light bulb 30 miles in the sky has been developed by ITT's Astrionics Center in San Fernando, Calif. The tracker, part of a complete antennas calibration system, consists of a telescope, an electro-optical sensing system, an X-Y gimballed mount, and associated electronics. Portable Automatic Calibration Tracker (PACT) was developed for NASA.

TELEVISION CAMERA announced by RCA can view scenes in light ranging from daylight to starlight. Designed primarily for military field use, it employs a new intensifier vidicon pickup tube instead of an image orthicon. It uses all solid state components for compactness and light-weight.

SOLAR CELLS have undergone impact tests using simulated micrometeoroid particles. Tests made use of an electrical discharge light gas gun ("Hotshot") to send the 10^{-7} gram range particles at a speed of 100,000 ft/sec. Findings indicate, contrary to general opinion, that cells would not normally suffer complete failure. They would have only normal reduction of efficiency. Tests were conducted by the Astronautics division of General Dynamics Corp. at the Rhodes and Bloxsom Labs in Canoga Park, Calif.

SIGN OF THE TIMES is being reflected in products of Hewlett-Packard's Frequency and Time Div. They have dropped prices for solid-state instruments and raised them for vacuum-tube instruments. Reductions in solid-state component prices have permitted the decrease. Vacuum-tube products were priced at a time when their cost was lower, making adjustments necessary now.

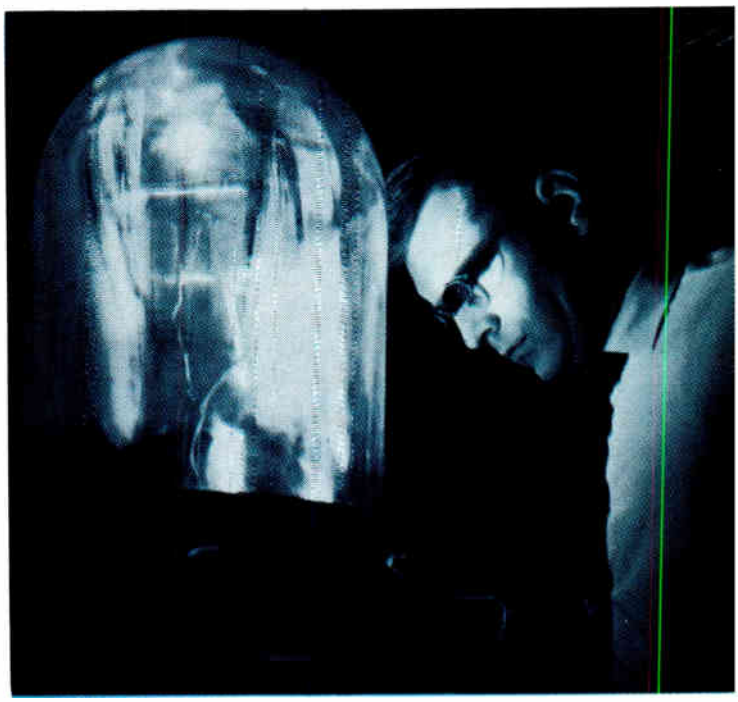
COHERENT LIGHT will be studied by Hughes Aircraft Co. under a contract awarded by the U.S.A.F Office of Scientific Research. More specifically, Hughes will conduct a theoretical study of propagation of coherent light through the atmosphere. The company hopes to find means of circumventing the harmful effects of a turbulent atmosphere on an earth-bound laser beam. Also studied will be the generation and properties of microwave phonons in solids by a giant-pulse laser beam. This is important because optical components can be damaged by the production of such phonons.

RARE EARTH glass laser uses erbium and ytterbium as the active components in the same glass matrix. Developed by American Optical Co., the glass body is a cylinder about 22 in. long and 0.04 in. in diameter. Ytterbium ions within the glass absorb the activating light and the excitation is then transferred to the erbium which emits laser radiation is in the infrared region at 1.54 microns. Device operates at room temperature.

PENETROMETER is an instrumented package that can assess the hardness, penetrability and bearing strength of a surface upon which it falls. A contract for research, development and preliminary design is being negotiated with Aeronutronic Div. of Philco by NASA. The probe will be part of the Apollo program for lunar surface information. It will transmit the data to an orbiting Apollo spacecraft.

RADIO LINK OPERATES AT 90 GC

For over a year General Telephone & Electronics Laboratories Inc., has been operating this experimental radio system across Long Island Sound. System is one of the few in the world which operates at a frequency of 90 GC. The millimeter-wave antenna for the system is adjusted by Herman O. Dressel of GT&E, who is in charge of the link.



INTEGRATED MICROWAVE AMPLIFIER

Engineers at Bell Telephone Laboratories have developed an integrated circuit amplifier that operates from 0.5 to 3 GC with bandwidths of 1000 MC. Vacuum deposition is one method used to make the amplifiers. Here, K. M. Eisele evaporates aluminum oxide onto the ceramic substrate which forms the basic amplifier circuit.

MICROELECTRONICS

AUTOMATIC MACHINE simplifies the production of masks for microcircuits. Paper tape control unit supplies coded instructions to maskmaking unit, which is essentially an optical column with a stepping X-Y stage. The mask is formed on same-size photo plate with a controlled light beam. Stage positioning is controlled to within 2.5 microns. The machine has produced a complete set of masks for an emitter-coupled logic gate in less than 1 hour. It was developed by NCR under Air Force sponsorship.

DISPLAY CONSOLE has been developed that will work with radar, sonar, or computers. The display uses plug-in microcircuits to change operations. For computers it can display line by line messages at a rate of over 250,000 characters per second. For radar it can handle 100 targets with range scales from four to 512 miles. It uses a one gun tube for best registration.

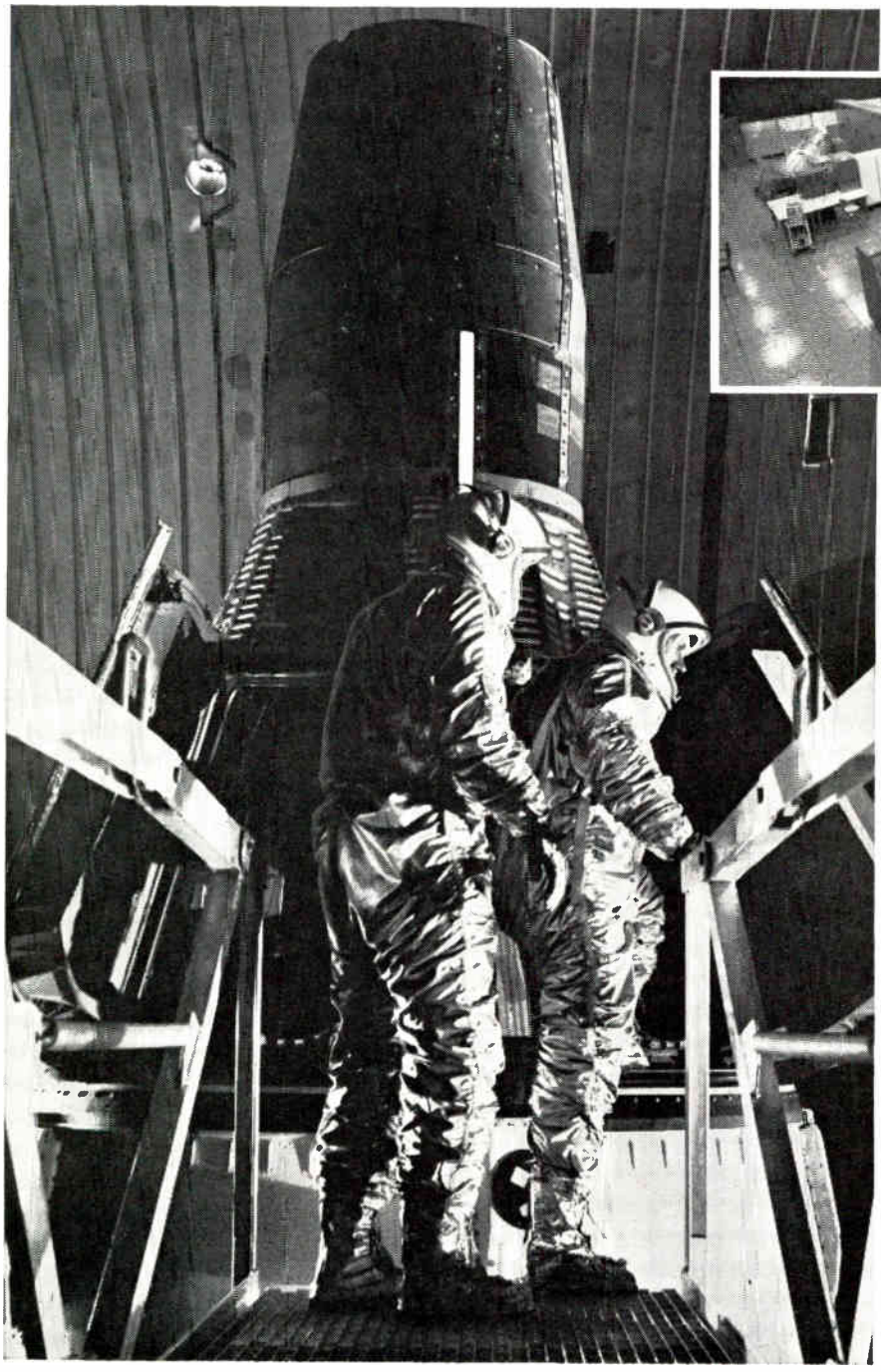
MICROCIRCUITS will be used in instrumentation radars to be produced by Sperry Rand Corp. (Sperry Gyroscope Co. Div.) for the Pacific Missile Range. The monopulse radars, designated AN/FPQ-10, will be designed to acquire and track missiles and aircraft. Except for the transmitter they will use solid state circuits throughout. About 35% of the circuits will be microcircuited. The transmitter will provide multiple pulses with variable spacings and pulse widths at a peak power of over 1 megawatt.

DEEP SPACE AT "GROUND ZERO"

When NASA's astronauts board their Gemini spacecraft it will be with the feeling of old hands at familiar jobs. Even ground crews will operate with the facility of seasoned experts. This is the way it must be, even though it will be a first for both men and machines—each person, each system functioning in unison.

McDonnell engineers designed and built the trainers and simulators for Gemini's orbital rendezvous missions as well as launch, orbital flight and reentry.

The Gemini Mission Simulator is one example of how the skills and facilities of McDonnell Electronics Division are applied to mirror desired situations through true simulation.



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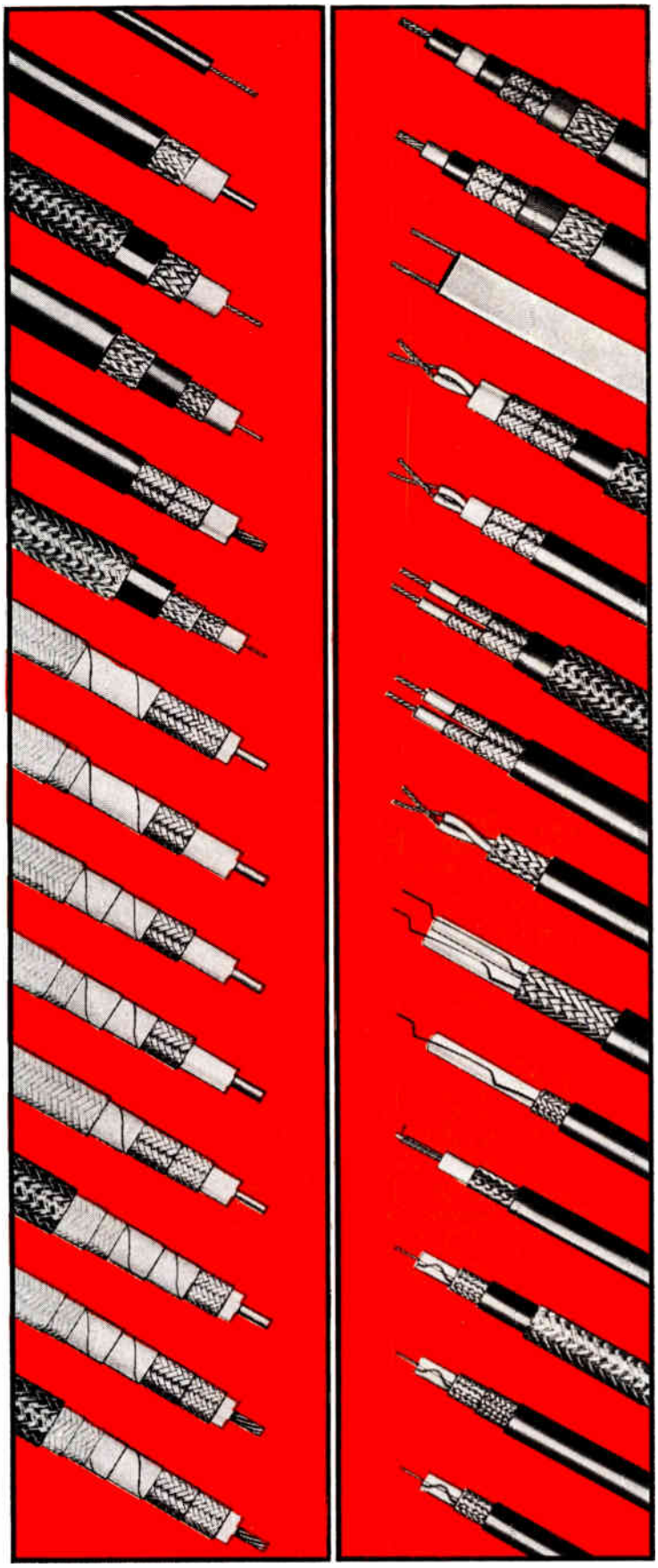

The COAX you need is made by ITT

ITT makes nearly every standard type of coaxial cable currently being manufactured . . . and is the *only* source for many of them. So chances are you can't need a cable that we don't already have on the shelf or on-line.

We make them with solid and semisolid TFE; with foam FEP; with solid, semisolid, and foam polyethylene; irradiated and unirradiated; with silicone rubber; and with polypropylene. We make them to military specifications, industrial specifications, customer requirements. In standard, miniature, and subminiature sizes—in general-purpose, high-temperature, and special-characteristics types—for usual, unusual, and special applications. We make them for every environment, from ocean bottom to outer space, from —100° to +500° F.

ITT also manufactures an unlimited variety of specially designed, one-of-a-kind coaxials. So if your requirements are unique, we'll gladly get out the slide-rule and drawing board.

For ITT coax see your local electrical or electronic distributor or your ITT sales representative—for engineering assistance or technical data write: Dept. EI, ITT Wire and Cable Division, International Telephone and Telegraph Corporation, Clinton, Mass. In Canada, write or call ITT Royal Electric Company (Quebec) Limited, Pointe Claire.

wire and cable division ITT

We can't reduce the price of gold. But we can show you how to lower your gold plating costs.

Alautronex™ 18 and Autronex® W are low gold content processes. Each produces a deposit that is approximately 75% gold by weight and 60% gold by volume. Alautronex 18, an alkaline bath, deposits a gold alloy more than twice as hard as hot cyanide gold plate with no sacrifice in electrical conductivity. Autronex W, an acid process, produces a gold deposit with superior corrosion and wear resistance due to its unique hardness of 400-450 Knoop.

Either of these low-gold-content processes will materially reduce gold plating costs wherever the purity of the gold deposit is not a functional requirement. Even if your present specifications call for a high purity gold, the unique characteristics and potential savings inherent in these processes make it worth your while to evaluate them now. We'll be happy to arrange for sample plating of your product. For further information write:

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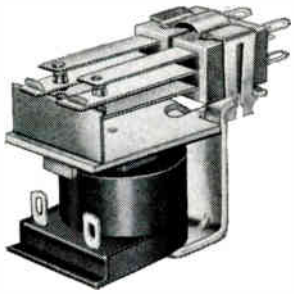
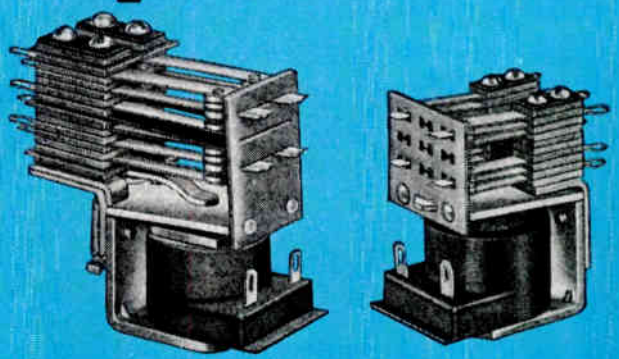
Sel-Rex®

Regional Offices and Laboratories in Los Angeles, Chicago and Providence.
Subsidiaries and Affiliated Companies in Canada, Switzerland, England, West Germany.
In Canada: SEL-REX OF CANADA LTD., 1770 Woodward Drive, Ottawa 5, Ontario



If this 98c relay is so good..

..why do we build these more expensive ones?



Our mass-produced series 900 relay *is* good. It sells for only 98-cents in quantity and is available in DPDT 10-ampere capacity for its full rated life and you have your choice of six voltages . . . 6, 24, and 115VAC; 6, 12 and 24VDC. It's UL-approved for 115V. And chances are it will handle a good percentage of your relay applications. ☐ But not all. ☐ That's why we make the series 640 and 240 custom-built standard relays. They're available in combinations up to 8 poles with voltages to your specs. You can have both with molded switches if you want. ☐ Want an unusually compact relay with 10 amp. capacity? That's the UL-approved series 640. ☐ Need a relay that will carry 15 amp. continuously? The UL constructed 240 will. ☐ Bulletin B-1 describes these relays fully. Write today for your copy. Guardian Electric Mfg. Co., 1550 W. Carroll Avenue, Chicago 7, Illinois. Dept. EI54

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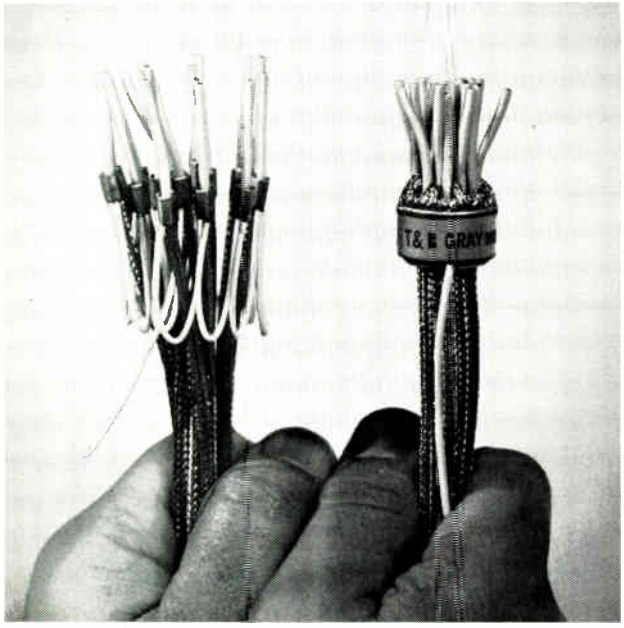
PRODUCTS FOR EVALUATION

T&B ENGINEERED

CONNECTION SYSTEMS AND CABLING TECHNIQUES

Samples available on letterhead request

MULTIPLE SHIELDED CABLES OR OVERALL SHIELDED CABLE GROUNDED WITH ONE COMPRESSION —



OLD WAY *NEW WAY*

The design advantages are: 1. Positive selection of inner and outer sleeves and installing die by a complete color-coded system; 2. A more reliable grounding termination because only one ground wire connection is made —conventional daisy chain jumper method is eliminated; 3. Smaller, more compact bundle is easy to inspect; 4. Only one ground wire is required, however additional ground wires may be used if needed; 5. With one stroke of the tool, the interlace die will produce a 360° compression uniformly securing all individual shields around the connector; 6. Noise-free connection.

- Easier and quicker to install — one compression grounds all conductors simultaneously
- Improved reliability — multiple connector errors eliminated
- Smaller, less bulky bundle diameter — eliminates individual connectors and daisy chained jumpers
- Reduce installed cost — fewer parts, less installation and inspection time

Circle 9 on Inquiry Card

MIL TYPE SPLICES AND MULTI-SPLICES

NEW TECHNIQUE SAVES SPACE . . . ELIMINATES TERMINAL STRIPS

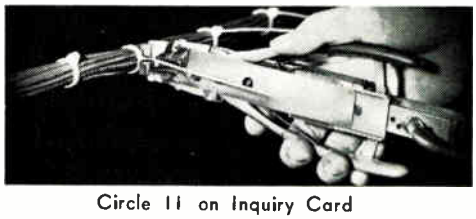
This line meets MIL-T-7928. It has found wide acceptance in the electronic and aerospace industries. Permits splicing of multiconductors anywhere in the wire bundle. It is a compact, self-contained junction, completely insulated, provides extended flex protection. Inspection window gives reliability check. These connectors operate over a wide temperature range. The insulation material is nylon (Zytel®). When compared to other methods the multi-splice system offers weight and space savings, reduced installation costs, less noise interference and elimination of moisture and fungus traps. The line accommodates wire sizes from No. 10 to No. 26. All sizes can be installed with only one tool — WT-145A. SEE STA-KON solderless terminals for tool features.

Write for complete technical information.

Circle 10 on Inquiry Card

TOOLS FOR HIGH SPEED TYING

Greatest savings and efficiencies can be obtained with the TY-RAP Method by using the manual or semi-automatic tools. Speed in tying wire bundles ranging from 1/16″ to 4″ is accomplished in only two operations. One operation positions the ties. Speed tying with the aid of a tool completes the job. Because the tool has a tension control for tying and semi-automatically completes the other functions necessary for a neat tie, an operator with only a few minutes training can achieve complete tying uniformity.



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COMING EVENTS

April

Apr. 12-15: SAE Nat'l Aeronautic Meeting & Production Forum, SAE; Sheraton Park Hotel, Washington, D. C.
Apr. 13-15: Nat'l Telemetering Conf., IEEE, AIAA—ISA; Shamrock Hilton, Houston, Tex.
Apr. 14-15: Electronics & Instrumentation Conf. & Exhib., IEEE & ISA; Cincinnati Garden, Cincinnati, Ohio.
Apr. 19-21: 3rd Nat'l ISA Biomedical Sciences Inst. Symp., ISA; Statler-Hilton Hotel, Dallas, Tex.
Apr. 20-22: Symp. on System Theory, IEEE, USDRA, SIAM; Polytechnic Inst. of Brooklyn, N. Y.
Apr. 20-22: 19th Annual Freq. Control Symp., Army Electronics Labs.; Atlantic City, N. J.
Apr. 21-23: Inst. of Environmental Sciences Mtg. & Expos., IES; Sherman House, Dallas, Tex.
Apr. 21-23: Int'l Nonlinear Magnetics Conf., IEEE; Sheraton Park Hotel, Washington, D. C.
Apr. 21-23: Southwestern IEEE Conf. & Elec. Show, IEEE; Dallas Memorial Audit., Dallas, Tex.
Apr. 27-29: American Power Conf., IEEE; Sherman Hotel, Chicago, Ill.
Apr. 27-30: Spring Conv. Audio Eng'g Soc., AES; Los Angeles, Calif.

'65-'66 Highlights

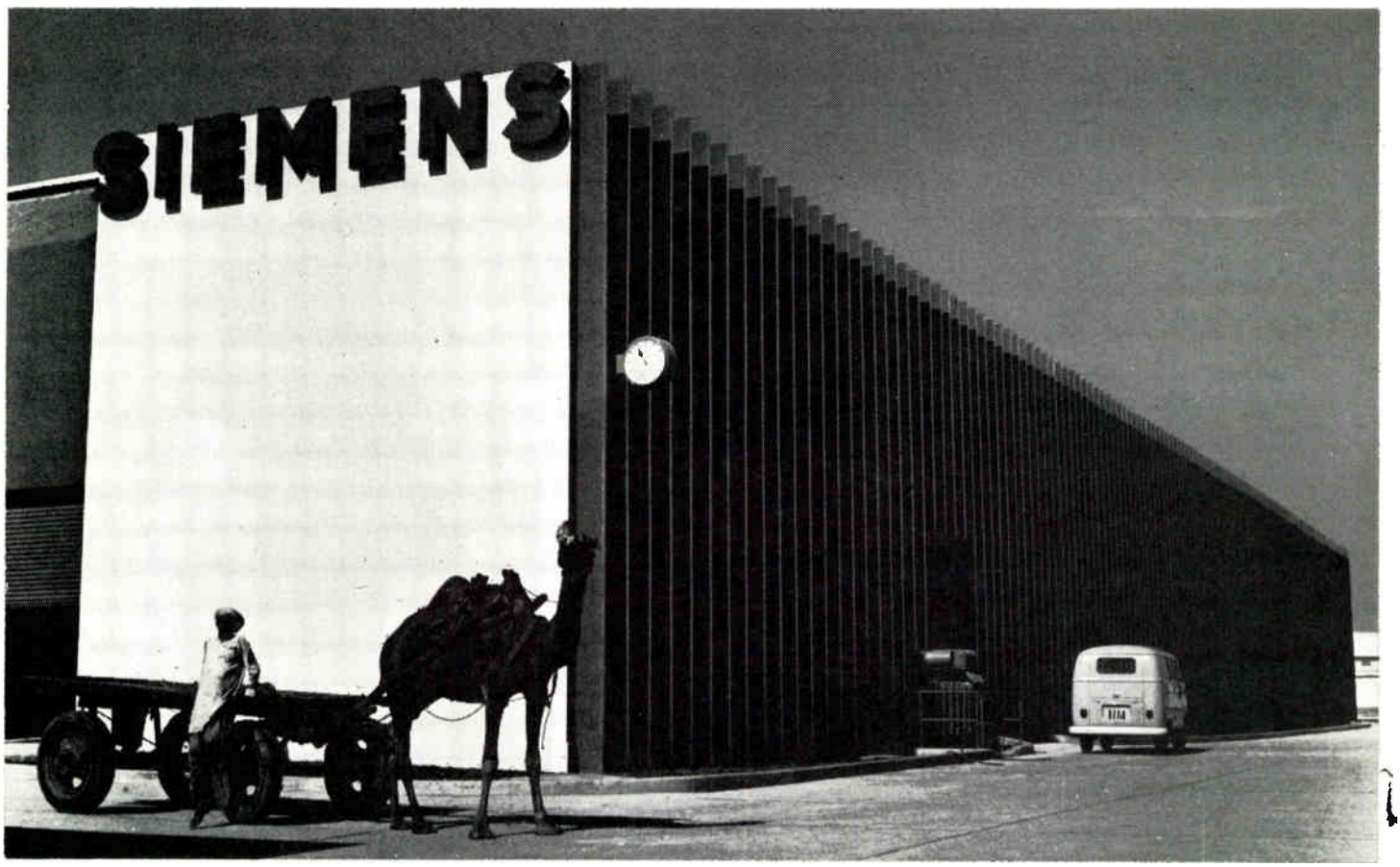
WESCON, Western Electronic Show & Conv., Aug. 24-27, IEEE, WEMA; Cow Palace, San Francisco, Calif.
Nat'l Electronics Conf., Oct. 25-27; McCormick Place, Chicago, Ill.
NEREM, Northeast Research & Eng. Mtg., Nov. 3-5, IEEE; Boston, Mass.
IEEE Int'l Conv., Mar. 21-24, 1966; Coliseum, New York Hilton, New York, N. Y.

May

May 3-5: 19th Annual Tech. Conf., ASQC; Biltmore Hotel, Los Angeles, Calif.
May 4-6: Post Apollo Missions, AAS; Conrad Hilton Hotel, Chicago, Ill.
May 4-6: 5th Annual Packaging Ind. Conf., IEEE; Milwaukee Inn, Milwaukee, Wisc.
May 5-7: Microwave Theory & Tech. Symp., IEEE; Americana Motor Hotel, Atlanta, Ga.
May 5-7: Electronics Components Conf., IEEE; Marriott Twin Bridges Motel, Washington, D. C.
May 6-8: Nat'l Symp. on Human Factors in Electronics, IEEE; Sheraton Hotel, Boston, Mass.
May 10-12: Nat'l Aerospace Electronics Conf., AIAA, IEEE; Dayton, Ohio.
May 13-14: Symp. on Signal Transmission & Processing, IEEE; Columbia Univ., New York, N. Y.
May 17-20: Design Eng. Conf., ASME; Coliseum & Americana Hotel, New York, N. Y.

This is Siemens

...making motors and transformers in Pakistan, in the modern factory shown below. We also make cables in India, generators in Spain, telephones in Argentina. We manufacture in 28 countries and erect, service and repair our installations in almost every country in the world. Of the 240,000 in the Siemens family, 40,000 are employed abroad. Everywhere, they provide imaginative planning, high-quality equipment, skilled and rapid construction and reliable service.



SIEMENS

Siemens MKH

metallized film capacitors

Small size and high reliability are new standards set by Siemens capacitors. Twenty years' experience in making metallized capacitors has resulted in advanced precision techniques which closely control every capacitor property, making them 100% "foolproof" in service. "Self-healing" is an automatic reaction, eliminating the possibility of any voltage breakdown.

Two-way self-healing gives double protection. Internal voltage breakdown very rarely occurs. If it does, the thin metal coatings at the breakthrough point, act as a fuse and immediately vaporize, eliminating the breakthrough point within microseconds.

Electrochemical self-healing is the second protective process. It starts whenever and wherever insulation resistance decreases in the dielectric material. This process operates at any voltage, even as low as 10 mV, changing the metal coating at the point of lowest insulation resistance to a non-conductive oxide—thus eliminating the point electrically.

Less than one breakdown (self-healing) per year and per mF—that is the consistent average shown by tests at nominal voltage. This value, which is for the first year, is even less for succeeding years.

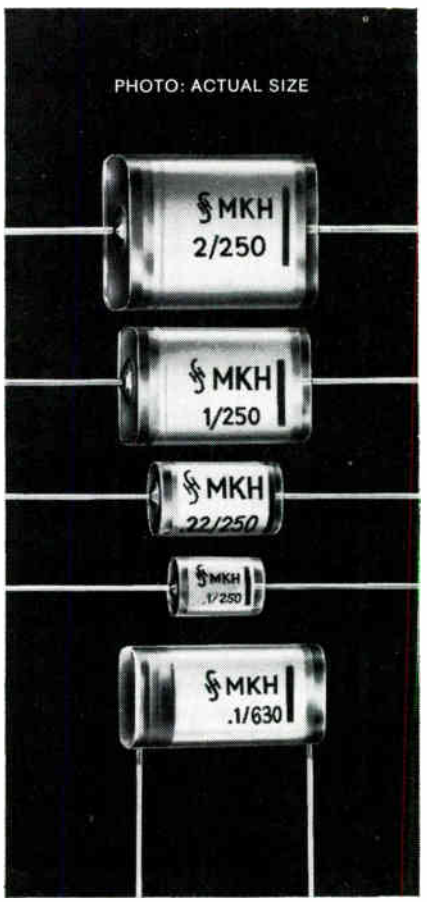
Highly stable capacitance. Overload tests (at 2.2 nominal voltage and at 85°C) show that decrease in capacitance as a result of self-healing is negligible, even after several years.

Small size—low cost. Intricate manufacturing techniques enable MKH (metallized polyester) capacitors to be produced to unvarying standards. They are available with axial or radial leads, in flat compact form. Leads soldered to metallized ends ensure reliable contact. The dielectric is polyester film, widely used for capacitors.

MKH properties. Operating temperatures: −40° to +125°C. Insulation resistance: minimum 20,000 megohms for normal capacitance up to .022mF at +20°C. For higher capacitance values: 10,000 megohms X mF (typical values). Temperature coefficient: approx. .04%/C° between 0° and 70°C. Dissipation factors: 0.5% at 1 kc; 1.5% at 10 kc (typical values).

Immediate shipment. Substantial stocks are held in White Plains, N. Y.

Write now for full information on Metallized Film Capacitors.



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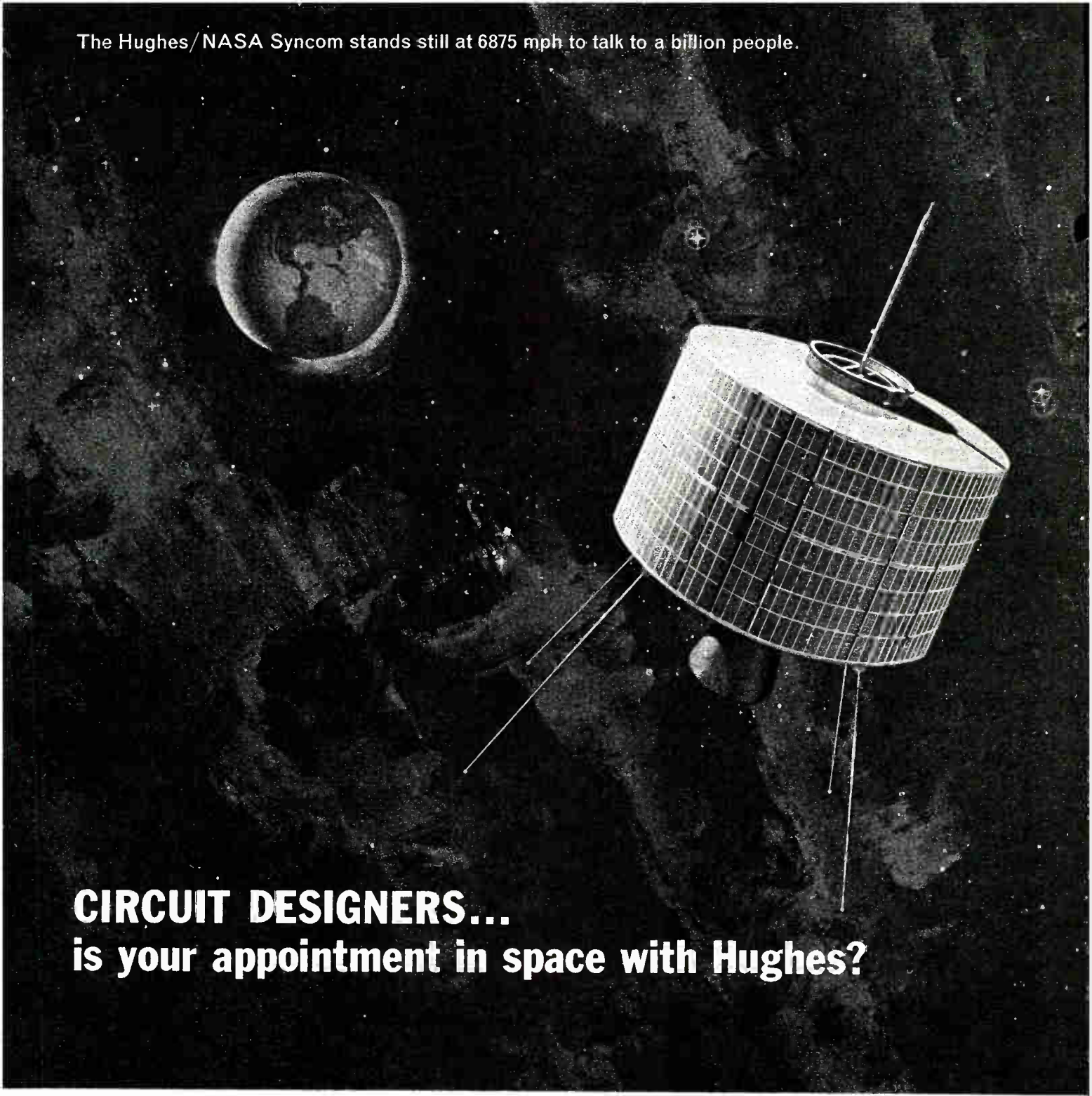

CIRCUIT DESIGNERS...
is your appointment in space with Hughes?

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

This vigor will assist the qualified engineers and scientists towards more and better opportunities for both professional and personal growth.

Many immediate openings exist. The engineers selected for these positions will be assigned to the following design tasks: the development of high power airborne radar transmitters, the design of which involves use of the most advanced components; the design of low noise radar receivers using parametric amplifiers; solid state masers and other advanced microwave components; radar data processing circuit design, including range and speed trackers, crystal filter circuitry and a variety of display circuits; high efficiency power supplies for airborne and space electronic systems; telemetering and command circuits for space vehicles, timing, control and display circuits for the Hughes COLIDAR (Coherent Light Detection and Ranging).

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

For immediate consideration, please airmail your resume to:

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Head of Employment
Hughes Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City 54, California

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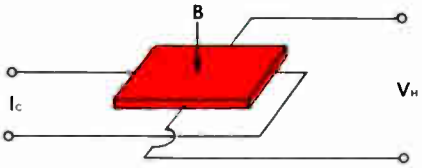
THE HALL EFFECT and its applications*

The Hall effect is the generation of a voltage across opposite edges of an electrical conductor which is carrying current and is placed in a magnetic field.



The Hall phenomenon may be expressed by the equation:

$V_H = K_{HOC} (I_C \times B)$

V_H is the Hall voltage,
K_{HOC} is the open circuit sensitivity constant,
I_C is the control current,
B is the component of the magnetic flux density perpendicular to the device

K_{HOC} is a constant determined by the Hall element material and geometry. I_C and B may be d-c or time-varying. If I_C is held constant, the output, V_H, is proportional to B. The Hall effect can be applied to a gaussmeter, linear transducer, non-contact switch, d-c and a-c non-contact current measurements, angular transducer and many other applications. Placing the Hall device in the air gap of a magnetic circuit results in a Hall Multiplier which opens up an entirely different area of applications. In the air gap of a magnetic structure, the magnetic flux density, B, is a function of the field current, I_F. Therefore, the Hall voltage output is proportional to the instantaneous product of the field current, I_F, and the control current, I_C. I_F and I_C may be d-c or time-varying. The Hall Multiplier may be used as a modulator, chopper, power transducer, analog multiplier, and in many other applications where an output voltage, V_H, is desired as a function of the instantaneous product of two independent inputs I_F and I_C.

*Send for complete booklet.

Model BH-700 "Hall Pak" (actual size) one of 12 off-the-shelf devices

Now an Invaluable Laboratory Instrument

F. W. Bell's Model 240

INCREMENTAL GAUSSMETER

ABSOLUTE MEASUREMENTS: 12 ranges from .1 gauss (1/5 of earth's field) to 30,000 gauss full scale.

STRAY FIELD MEASUREMENTS: Down to 100 gammas (.001 gauss) full scale.

INCREMENTAL MEASUREMENTS: Resolution of 1 part in 10,000. See a .01 gauss variation in a 100 gauss field.

DIFFERENTIAL MEASUREMENTS: A difference of 1% between two points produces a full scale reading.

HALL DEVICE PROBES: Measure flux density in gaps only .006" long and solenoid fields down to .065" in diameter. Active areas can be as small as .0002 square inches for high resolution.

If the Model 240 doesn't meet your requirements, send for information on the other 5 Bell Gaussmeters. Also complete instrumentation for production testing and inspection of magnets.

When you think of magnetic field measurement — think of Bell

F W BELL INC.

Representatives in principal cities
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1356 Norton Ave, Columbus, Ohio, 43212
Phone 614-294-4906
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Circle 40 on Inquiry Card

Circle 41 on Inquiry Card

MILITARY PROCUREMENT RISING — Defense procurement plans for communications and electronic equipment in the coming fiscal year show an uptrend. Pentagon budget asks for $240 million for the year beginning July 1, compared to $206 million for current year. For the first time, the military will be buying single-sideband equipment to provide "greater frequency coverage and range capability."

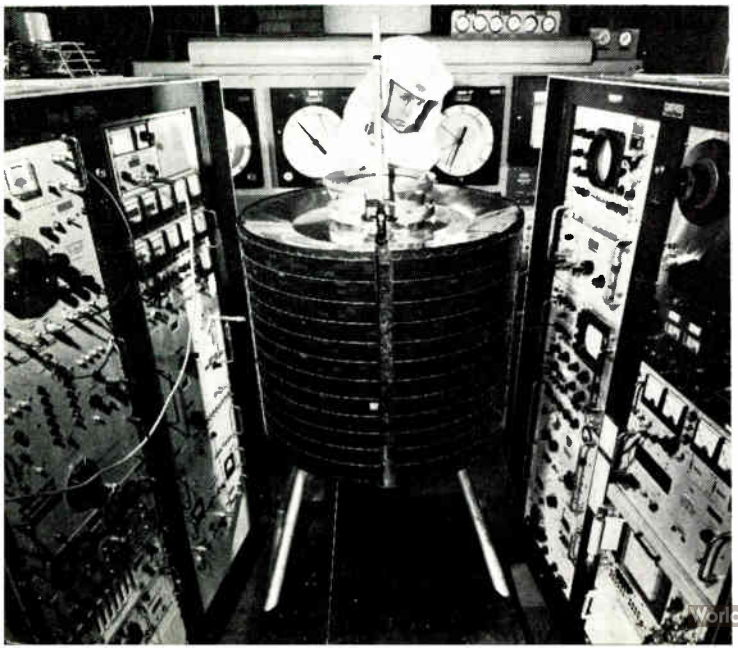
COMSAT SEEKS AT&T CONTRACT — Communications Satellite Corp. is seeking FCC approval for a contract for $300,000 for research data and consultive services for COMSAT ground stations. Under the plan, AT&T would work with COMSAT's own technical researchers to design the ground stations and the equipment for the system.

EASIER LOANS PROPOSED—Long-term, low-interest government loans would be available to firms hurt by defense cuts, or by closing of bases, under a bill now in the Senate. The plan, sponsored by Sen. John Sparkman (D.-Ala.) also would apply to companies hurt by urban renewal projects. Loans could run for 20 years at 4% or less.

COST-CUTTING PUSHED — Pres. Johnson is making it clear that he intends to press his cost-cutting drive. He says that he will not be satisfied to achieve economies only in DOD. He intends to demand from every federal department and agency a report on dollar savings in fact, and those anticipated. The President demands "maximum value per dollar spent" through "increased productivity and greater efficiency."

EARLY BIRD IN FINAL TESTS

Soon to be launched as "Public Satellite No. 1" is Early Bird, the world's first commercial communications satellite now undergoing check-out for electronic equipment and vacuum chamber tests at Hughes Aircraft Co. The craft will provide 240 telephone channels.



PROCUREMENT RATE UNCHANGED—Government procurement for defense will hold steady at $13.22 billion in the fiscal year beginning July 1, if Pres. Johnson has his way. This figure is only slightly less than the $13.27 procurement rate of the current fiscal. New obligational authority is down more sharply, however—from $13.4 billion to $11.4 billion. As for research and development by DOD, spending in the new fiscal year will be at the rate of $15.4 billion, up about $100 million from this year's rate. At NASA, expenditures in the new year are estimated to be $5.1 billion—up from this year's $4.9 billion. Congress probably will vote just about what Mr. Johnson wants, and may even add funds he has not requested.

MOL DESIGN STUDIES—Department of Defense is asking industry for design studies for the proposed manned orbiting laboratory (MOL). Three contractors will be selected, each of whom must have capability to carry out the MOL program. Eventually, one will be selected. Under a 1962 pact, DOD and NASA joined to develop the MOL.

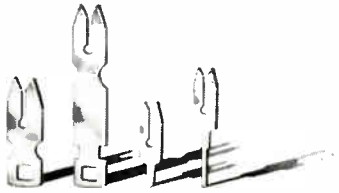
HOW RESEARCH PAYS OFF — Manufacturers that spend big money on research earn more (in net sales per employee) than firms of similar size that spend little. This is one item of interest reported in "Industrial R&D Funds in Relation to other Economic variables," just published by the National Science Foundation. Other points: Individual salaries are higher in large research firms, and investment in new equipment is higher. For a copy, ($.65), write Superintendent of Documents, Washington, D.C., 20402.

CHECK PARTS NUMBERS—Defense Supply Agency (DSA) is asking defense contractors to review parts numbers cross-referenced with federal numbers. Objective is to validate, correct, and add or withdraw obsolete manufacturers' numbers, and eliminate "no user" and duplicate federal stock numbers from the federal catalog system. DSA predicts that manufacturers will benefit from the check.

METRIC SYSTEM STUDY—Congressmen are taking another look at the possible adoption of the metric system in the U.S. Sen. Claiborne Pell (D.-R.I.) and Rep. George P. Miller (D.-Calif.) have begun a drive for a comprehensive study. They contend that this country suffers economic loss in international trade and also wastes many man hours and effort because of the need in many industries to convert to the metric system.

*TRADE-MARK
†PAT. PENDING

"You mean to say you can do practically everything we can?"



"...and in a fraction of the space!"

YES!

THE ELCO BI/CON†† CONTACTS AND SERIES 8300 CONNECTORS ARE THE ASTOUNDING NEW MINISCULE GIANTS OF THE INDUSTRY!

Here is the first ultraminiature, completely hermaphroditic contact useable on a .050" grid! Measuring only .035" across its widest dimension, it still provides the proven reliability of the fork-design ELCO VARICON* contact nose, with 4 beveled mating surfaces; and its strength and electrical characteristics in no way reflect its size reduction compared with its larger counterparts. Designed for countless applications including memory planes, insulator blocks, circuit modules with potting shells, printed circuit and rack-and-panel connectors, and curved connectors for non-flat surfaces, this new miniscule "giant" offers packaging engineers previously unknown freedom in design and construction of ultraminiature assemblies. Series 8300 printed circuit connectors, created for use with ELCO BI/CON contacts are also of hermaphroditic design; will accept up to 40 contacts on .050" increments, yet measure only 2.020" long x .100" high x .075" wide. Contacts are secured by twisting the tails. Insulators may be used as plugs or receptacles; singly or in multiple stacks, for maximum density in parallel, perpendicular or tandem card applications. Contacts may also be mounted directly to laminates by press fit, dip soldering or staking; and terminating contact tails by welding is another possibility. Further applications include soldering to glass or ceramic substrates, and welding to flexible flat cables. Want complete data and sample ELCO BI/CON contact? Write, call, wire or TWX us at once!

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

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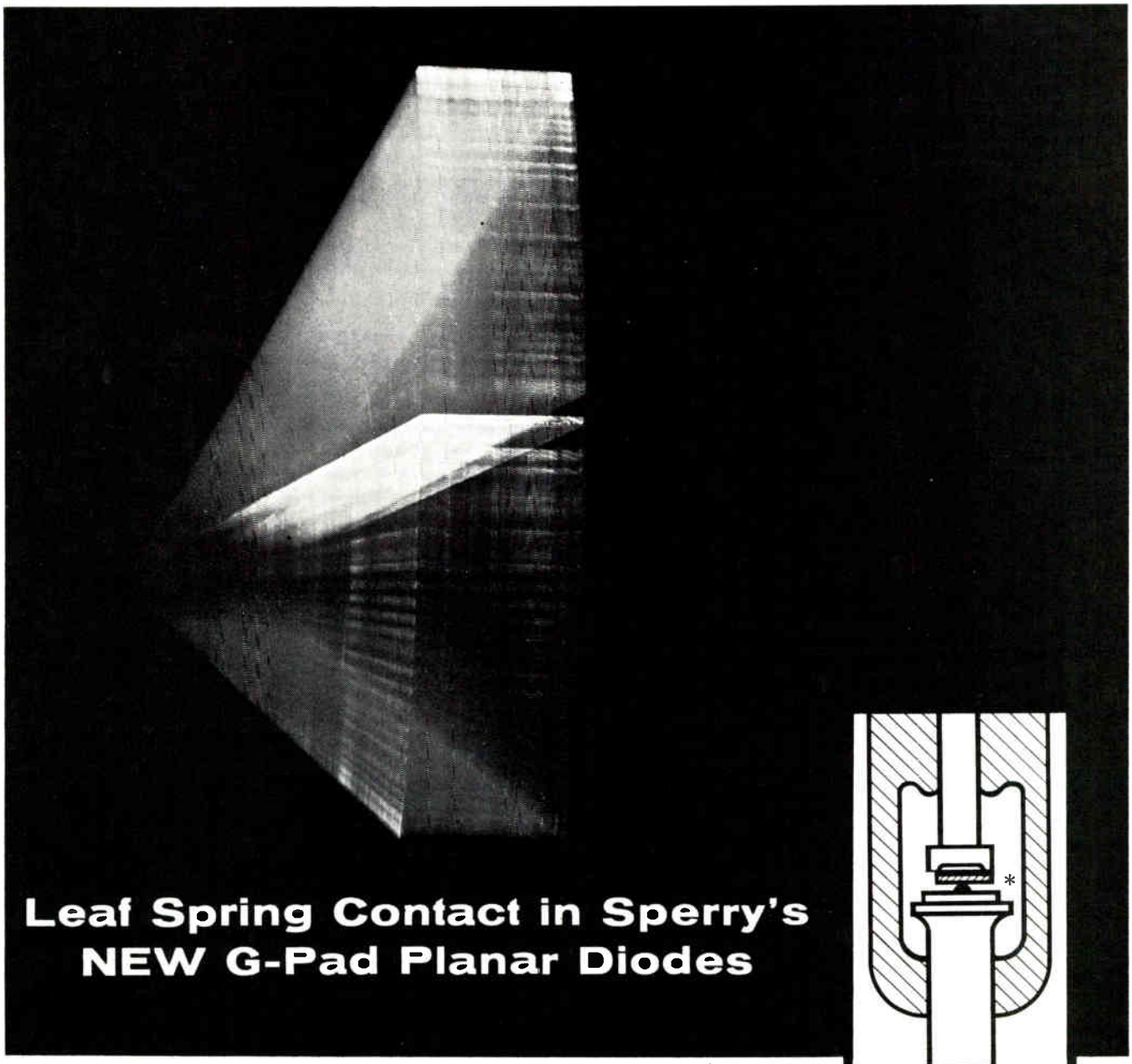
Main Plant and Offices: Willow Grove, Pa. 19090; 215-659-7000; TWX 510-665-5573. ELCO Pacific: W. Los Angeles, Cal. 90064. ELCO Midwest: Chicago, Ill. 60645. Representatives, Branches, Subsidiaries, Joint Ventures and Licensees Throughout the World



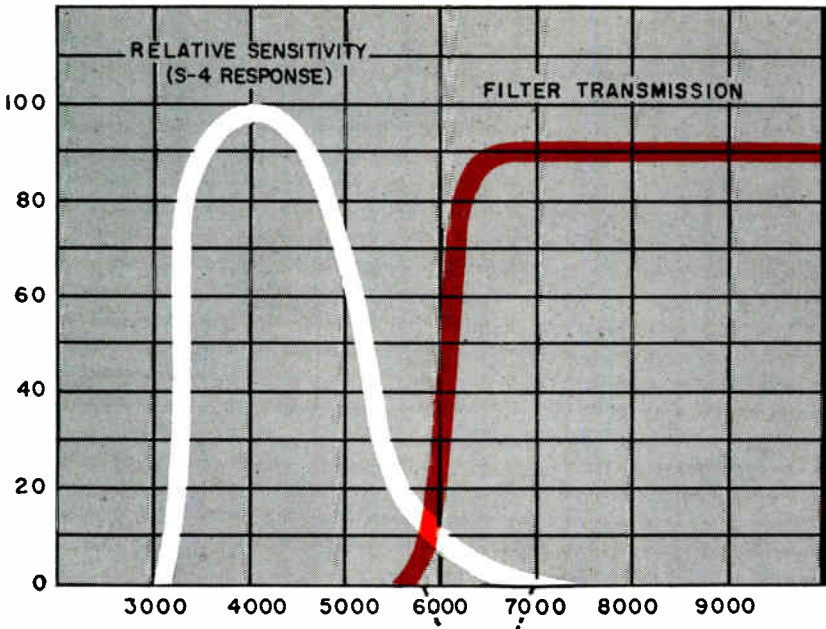
Leaf Spring Contact in Sperry's NEW G-Pad Planar Diodes

* Patent Applied For

Pull as many G's as you like on Sperry's new silicon planar diodes. Leaf spring construction* *absorbs* the shock and stress at the forward contact. Whether you use high conductance, or high speed milliwatt types, G-Pad diodes provide a new standard in component reliability. ☐ Sperry extended the standard 1,500-G shock test to 10,000 G's . . . the variable frequency vibration test at 55 to 2,000 cps from 20 G's to 40 G's . . . the standard centrifuge test from 20,000 G's to 40,000 . . . and the standard vibration fatigue test was raised three times to 60 G's at 60 cps. *And, G-Pad diodes have withstood all accelerated tests.* ☐ In fact, about the only things standard in the new construction are the DO-7 package and the low cost. G-Pad diodes are compatible with automatic equipments for handling, inspection, loading, and insertion. ☐ These new units retain the proven hermeticity of the DO-7 . . . while adding the new mechanical stability of smaller packages. ☐ Whether your computer is going to be mounted on an open hearth charging machine, or in the research wing of a hospital, choose this important advance in semiconductor construction . . . Sperry's new G-Pad silicon diodes. They don't *have* to have rough treatment . . . they're just impervious to it. **SPERRY SEMICONDUCTOR, Dept. D1, Norwalk, Connecticut 06852.**

SPERRY

DIVISION OF SPERRY RAND CORPORATION



*The anode current comprising the "white" portion of this ratio is measured with a tungsten light source operated at a color temperature of 2870°K. The anode current comprising the "red" portion of this ratio is measured under conditions identical with the "white" measurement except that the light input is transmitted through a specially selected red filter as shown above.

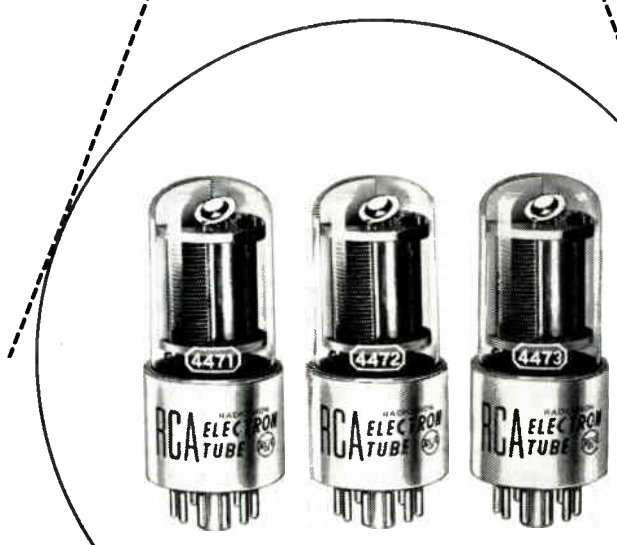
"Red-to-White" Ratio* Controlled Above 5800 Angstroms

Now! RCA introduces three new photomultipliers with sensitivity ratings controlled above 5800 angstroms. A particularly desirable characteristic for radiation detection and measurement in the red region of the spectrum, this specified "red-to-white" ratio* is 5% or greater for RCA-4471; and 7% or greater for RCA-4472 and 4473. The 4471 and 4472 have all the desirable features and characteristics of the 931A as well as a higher luminous sensitivity rating, while the 4473 has all the desirable features and characteristics of the 1P21 as well as a higher luminous sensitivity rating. The 4471 and 4472 are unilaterally interchangeable with the 931A and the 4473 is unilaterally interchangeable with the 1P21.

Recommended for critical applications for detecting and measuring extremely low levels of light, these three RCA photomultipliers are excellent for use in such applications as flame, spark, and arc spectroscopy; in color printing processes; and in flying spot scanners.

Complete data are available from your RCA representative. See him about these and other RCA light-sensitive devices. Or, for information on specific types, write: RCA, Commercial Engineering, Section D50Q, Harrison, N. J.

ALSO AVAILABLE THROUGH YOUR RCA INDUSTRIAL TUBE DISTRIBUTOR



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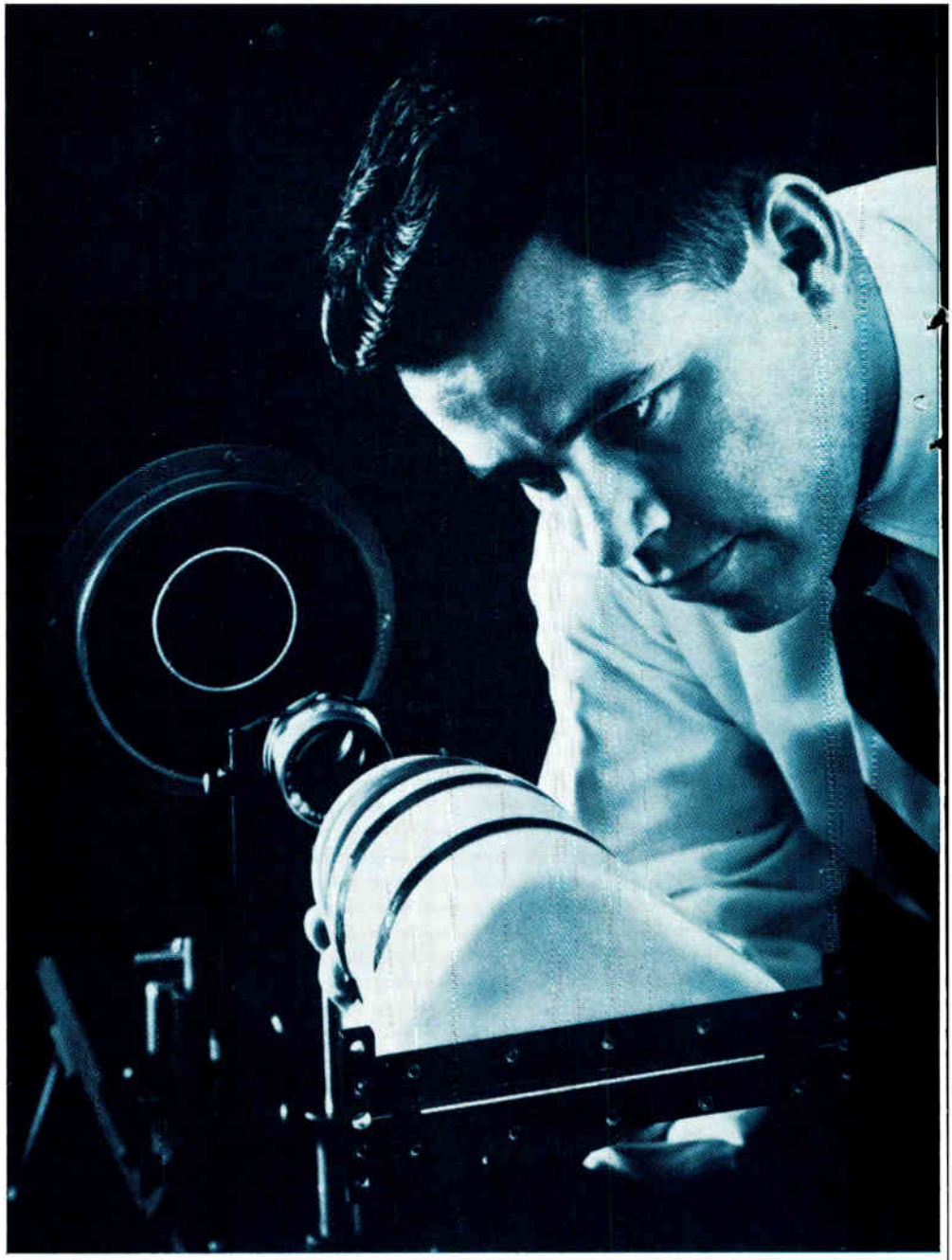
ELECTRONIC SNAPSHOTS

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

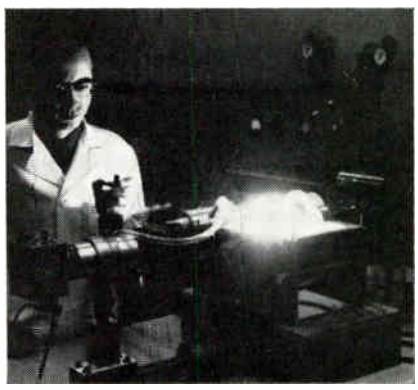


SHAPE CONVERTER ▶

New developments in fiber optics include Du Mont Laboratories' shape converter. Circle of light on CRT has been converted and is presented on rear of shape converter as a straight line. Technique may produce TV pictures of up to 50,000 horizontal lines.

PULSE AT NORMAL 68 ▶

Described as first liquid laser to produce light pulses at room temperatures, GT&E Labs engineers report that the device can put out pulses at 68°F. Previous liquid lasers need —150°F. Above, device emits light burst as activated by Dr. Charles Brecher, a developer.



◀ SNAP GENERATORS

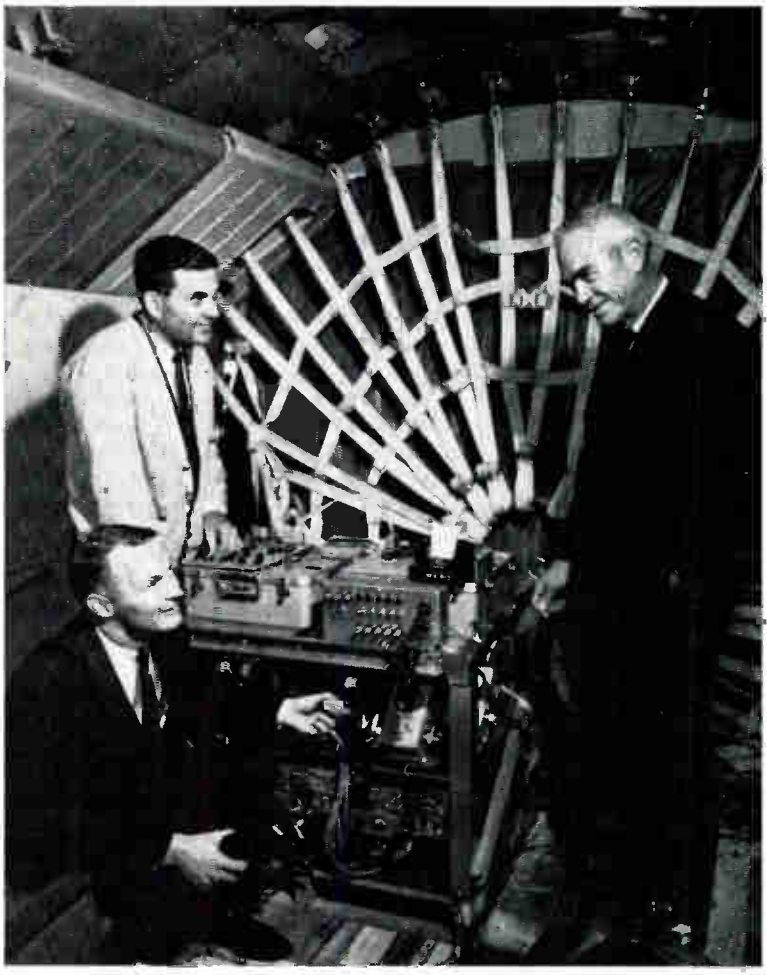
Martin Company technician James Peters adjusts wiring on two SNAP-19 nuclear generators for 12-day test in thermal vacuum chamber. Data convinced engineers that generators would perform well in space. Test was held before shipment to NASA Goddard Space Flight Center.

▲ **ORBITAL LABORATORY SIMULATOR**

What an astronaut might see through window ports as spacecraft rendezvous to link and transfer men and gear. Windows actually are TV screens that show computer-driven "space views"—a part of advanced Integrated Manned Space Systems Simulator by General Dynamics.

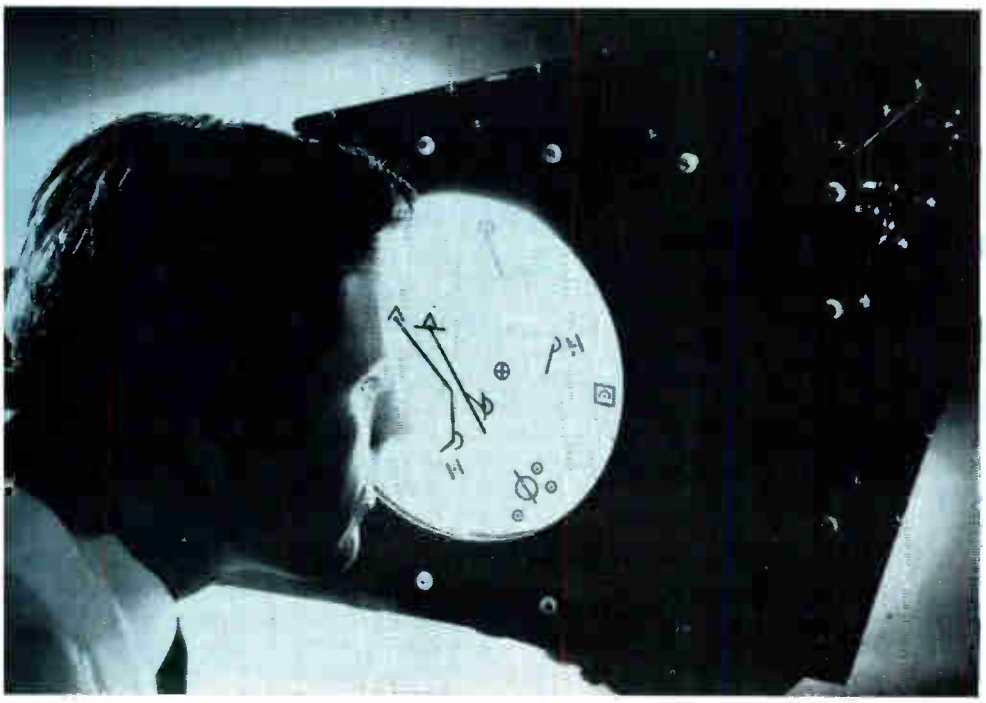
AIR EDP ▶

Mach module of Honeywell's new air data computer adjusted by engineer Laurel Tengren before shipment to American Airlines. Systems will be used in 727 transport Jets.



▲ **MESSAGE RELAY VIA SATELLITE**

Final check on Bendix communications equipment used to relay radio messages from in-flight Jet Clipper over Pacific via Syncom III. Kneeling, Robert Bohannon, Pan Am Airways engineer; left, standing, William Pulford, Bendix radio engineer; right, is Waldo Lynch, Pan Am vice president. Messages were transmitted up to 7,000 miles away.



◀ **CRT FULL COLOR DISPLAY**

Cathode ray tube system with full color display capability developed by Litton Industries. Litton says system can withstand military environments and shocks, resist color degradation from changing magnetic fields. Full-range color can be used in display of sensor-computer data in military activity.

A Statement by Lionel Corporation concerning Telerad Manufacturing and Lionel Electronic Laboratories

The Lionel Corporation, anticipating the needs of the electronics industry, has embarked on a new program to strengthen its position in the components field.

Step number one has been the establishment of *an entirely new* management team, dedicated to satisfying *customer* requirements. This new management group is pledged to attain the following goals . . . FAST!

> Improved manufacturing techniques . . . realistic scheduling . . . rigid quality control . . . finished products meeting the highest standards of the industry.
>
> New design concepts and new products . . . an expanded and strengthened design department aiming for the absolute in reliability and performance.

In addition, Lionel has consolidated its four electronic divisions at its headquarters plant in Hillside, New Jersey. This will afford the concentration of effort . . . management, sales, engineering and production . . . to put Lionel abreast of the state-of-the-art in *each* product line.

Quotations and deliveries will be *as promised* . . . Lionel will make no delivery promise that it does not honestly expect to meet . . . even if it means *losing an order!*

OUR REPUTATION FOR QUALITY HAS ALWAYS BEEN EXCELLENT.
WE INTEND TO KEEP IT SO.

LIONEL ANTON CONNECTORS

- MICRO-MINIATURE
- ENVIRONMENTAL
- UMBILICAL

- Rack and Panel
- Printed Circuit
- Test Points
- Relay Sockets

Customized Designs to Customer Requirements

TELERAD MANUFACTURING

MICRO-WAVE COMPONENTS

- Co-Axial Lines
- Test Equipment
- Transponders
- Cavities
- Couplers

LIONEL ELECTRONIC LABORATORIES

RADIATION DETECTORS AND COUNTERS

- Alpha
- Beta
- Gamma
- Neutron
- X-Ray
- Neutron Proportional
- BF-3 Counters
- Ionization Chambers
- Geiger Counters

Specialized Developments for Aero-Space Requirements

SPECIAL PRODUCTS

- Sequential Relays
- Miniature Motors
- Motorized Potentiometers
- Switches

PROTOTYPES TO PRODUCTION

Facilities Available for Mass Production,
Assembly and Inspection of Metal or Plastic Components

TELERAD MANUFACTURING CORP. ■ LIONEL ELECTRONICS LABORATORIES

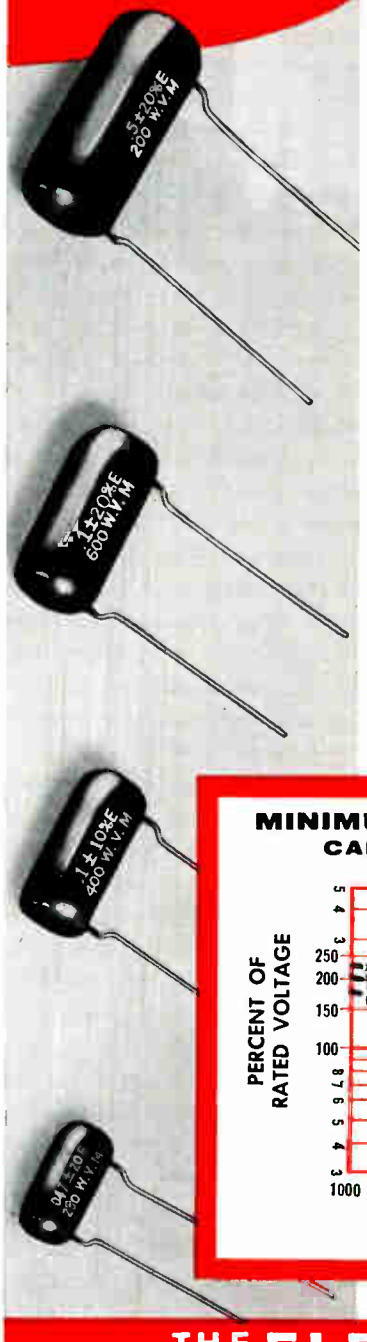
HOFFMAN PLACE, HILLSIDE, NEW JERSEY

Another New High Order of Reliability!

El-Menco

*MYLAR-PAPER DIPPED CAPACITORS

TYPE MPD



ASSURE A LOW FAILURE RATE OF

Only 1 Failure in ~~7,168,000~~ 14,336,000 Unit-Hours for 0.1 MFD Capacitors★

Setting A New High Standard Of Performance!

★ Life tests have proved that El-Menco Mylar-Paper Dipped Capacitors — tested at 105°C with rated voltage applied — have yielded a failure rate of only 1 per 1,433,600 unit-hours for 1.0 MFD. Since the number of unit-hours of these capacitors is inversely proportional to the capacitance, 0.1 MFD El-Menco Mylar-Paper Dipped Capacitors will yield ONLY 1 FAILURE IN 14,336,000 UNIT-HOURS.

CAPACITANCE AND VOLTAGE CHART

• *Five case sizes in working voltages and ranges:*

200 WVDC —	.018 to .5 MFD
400 WVDC —	.0082 to .33 MFD
600 WVDC —	.0018 to .25 MFD
1000 WVDC —	.001 to .1 MFD
1600 WVDC —	.001 to .05 MFD

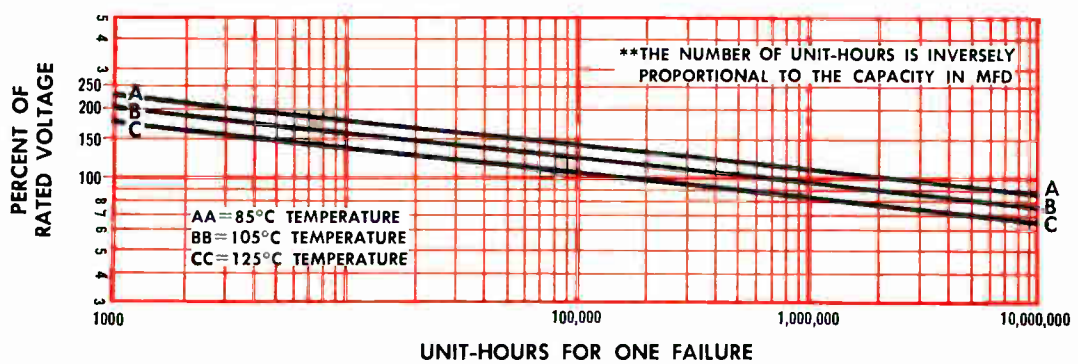
SPECIFICATIONS

- **TOLERANCES:** 10% and 20%. Closer toleronces available on request.
- **INSULATION:** Durex phenolic epoxy vacuum impregnated.
- **LEADS:** No. 20 B & S (.032") onnealed copper clod steel wire crimped leads for printed circuit application.
- **DIELECTRIC STRENGTH:** 2 or 2½ times rated voltage, depending upon working voltoge.
- **INSULATION RESISTANCE AT 25°C:** For .05MFD or less, 100,000 megohms minimum. Greater than .05MFD, 5000 megohm-microfarads.
- **INSULATION RESISTANCE AT 105°C:** For .05MFD or less, 1400 megohms minimum. Greater than .05MFD, 70 megohm-microforods.
- **POWER FACTOR AT 25°C:** 1.0% maximum at 1 KC

These capacitors will exceed all the electricol requirements of E. I. A. specification RS-164 and Military specifications MIL-C-91B and MIL-C-25C.

Write for Technical Brochure

MINIMUM LIFE EXPECTANCY FOR **1.0 MFD *MYLAR-PAPER DIPPED CAPACITORS AS A FUNCTION OF VOLTAGE & TEMPERATURE



*Registered Trade Mark of DuPont Co.

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Exclusive Exporter to Jobbers and Distributors in the U. S. and Canada

West Coast Manufacturers Contact: COLLINS & HYDE CO., 1020 Corporation Way, Palo Alto, California; 5360 Whittier Boulevard, Los Angeles, California

NONDEFENSE SALES MAY RISE 80% BY 1970, REPORT SAYS

Electronic industries in the U. S. are expected to increase sales of nondefense products by about 80% by 1970, according to a report on "Conversion Prospects of the Defense Electronics Industry," just released by the Hofstra University Division of Business. Even this great increase, however, will be equivalent to only about one-half of the 1962 defense market, the report claims.

The 487-page book was prepared by 16 graduate students of business administration, directed by Dr. John E. Ullman, Chairman, Department of Management, Marketing, and Business Statistics.

Foreseeing an increase in the nondefense market of $4.2 billion a year by 1970, the report predicts that this total will include: $1.4 billion in consumer electronics, $2 billion in industrial products (mostly automation systems and computers), and $800 million in a variety of markets which would need government funds to be fully realized.

INDUSTRY TO GET DATA ON ARMY'S BUYING NEEDS

Designed to broaden competition for the Army dollar, and reduce acquisition costs, a pilot test is underway at nine regional Army/Industry Materiel Information Liason Offices. The Army wants to find whether this type of marketing data will help in decisions of management to bid on more kinds of Army materiel.

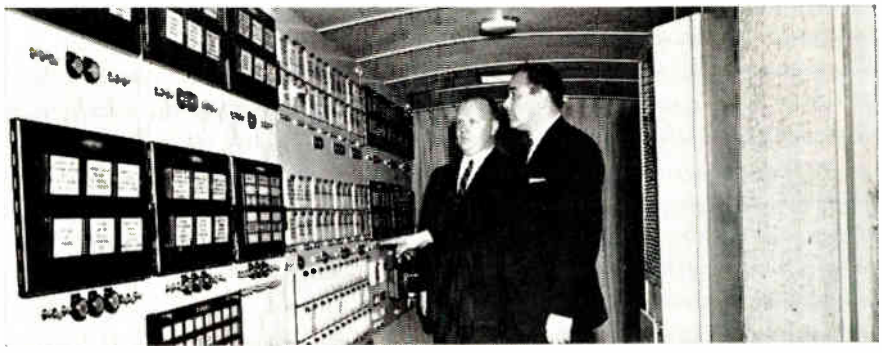
The program is based on an Advanced Planning Procurement Information (APPI) form to be prepared for each end item to be procured. The forms will be released to current bidders and sources cleared to receive them.

DISTRIBUTOR'S SEMINARS OFFERED TO CUSTOMERS

To help project and design engineers and purchasers acquaint themselves with the fundamentals and latest advances in integrated circuits, Semiconductor Specialists, Inc., Chicago distributor, is introducing in-plant technical seminars to the electronic industries.

This is the first time that a distributor has taken the initiative in originating technical sessions in the product user's plant, according to Richard K. Dahlem, vice president. Distributors have had to rely on their suppliers to support such technical functions for customers.

PRODUCT DEMONSTRATION BUS TOURS NATION



Fourteen-foot panel holding more than 20 different annunciators inspected by George Daniels, Jr., left, sales demonstrator, and George Mitchell, sales manager for the Scam Instrument Corp. Panel is mounted in a 26-foot bus now touring the U. S. for SCAM.

SALES IN TV-RADIO NEAR ACROSS-BOARD RISE IN 1964

Distributor sales of Monochrome TV sets and radio sets in December 1964 were up from the previous month (November), from the corresponding month of December 1963 and for the entire year of 1964 over 1963, the Electronic Industries Association's Marketing Services Department reports.

Production of black-and-white sets also was up over the previous month, over the corresponding month in 1963 and for the year 1964 over 1963, it was reported. Color TV production dropped in December 1964 from the previous month. Total TV production (monochrome and color) was up in December over the previous month.

Distributor sales of monochrome TV sets totaled 811,466 units for December 1964, and were 6.8% above 759,521 units sold in December 1963. Total for the entire year was 7,684,960, a rise of 12.5% from 6,828,383 for 1963.

Radio distributor sales, excluding auto, totaled 1,482,883 for December 1964, up 7.5% from 1,379,021 for December 1963. Sales for the entire year of 1964 totaled 10,771,276, a rise of 8% from 9,975,209 in 1963.

Total TV production (monochrome and color) for December 1964 was 931,573 units. Sales for the entire year totaled 9,570,385 units.

AEROSPACE AT $20 BILLION, LOOKS FOR FURTHER GROWTH

The U. S. aerospace industry, whose sales continued at a $20 billion pace in 1964, looks for continued activity on this level in government and commercial business during 1965, reports Karl G. Harr, Jr., President of the Aerospace Industries Association.

Noting factors supporting estimates of a bright outlook, Mr. Harr cited many "technical accomplishments" which are bringing new weapon systems, space hardware, and advanced commercial aircraft (all with electronic systems and hardware) into operational inventories.

The industry spokesman also pointed out that many aerospace firms are turning to other fields to augment sales and contribute to national growth.

ELECTRONIC/ELECTRICAL MANUFACTURING INDUSTRY

(Total Value of Shipments Including Exports and Interplant Transfers)

	1963	Estimate 1964	Forecast 1965	Percent Change
	(In Millions of Dollars)			1965–1964
Consumer Products	$ 6,750	$ 7,425	$ 7,685	+3.5%
Lighting Equipment	1,930	2,025	2,165	+6.9%
Industrial Electronic & Communication Equipment	8,500	9,010	9,460	+5.0%
Industrial Equipment	4,120	4,530	4,755	+5.0%
Building Equipment	910	1,000	1,030	+3.0%
Insulating Materials	465	500	525	+5.0%
Insulated Wire & Cable	1,590	1,830	1,965	+7.4%
Generation, Transmission & Distribution Equipment	2,215	2,390	2,510	+5.0%
Total Industry Shipments	$26,480	$28,710	$30,095	+4.8%

Source: National Electrical Manufacturers Association

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INDUSTRIAL PLASTICS

CHECKING MICROMINIATURE INTEGRATED CIRCUITS . . .

FORMICA® FR-45 GLASS-EPOXY LAMINATE IS SO RELIABLE IT'S USED TO HELP TEST RELIABILITY.

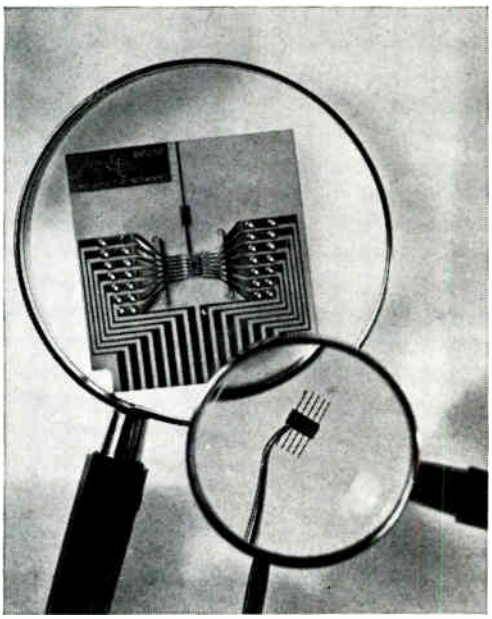

Photo courtesy Texas Instruments, Inc.

To check this 1/4" microminiature integrated circuit (shown held by tweezers), it is fastened to test board of FORMICA® FR-45 laminate.

It stands to reason: test equipment must be more reliable than whatever is being tested.

That's why equipment used to test microminiature integrated circuits employ circuit carriers of FORMICA® FR-45 glass-epoxy laminate.

Precision molded, the circuit carriers hold up under the prolonged 200°C. temperatures required for high-speed testing of these tiny circuits which are the brain cells of aircraft, missile, and satellite computers or their ground-support systems.

For your electronic circuit applications requiring the very finest flame retardant copper clad, specify FORMICA® FR-45. It has high mechanical strength, high strength retention at elevated temperatures, good electrical properties. Holds flatness even in extreme process environments. Color: off-white to light tan. Finish: semi-gloss. Meets military specification MIL-P-18177 for types GEE & GEB and MIL-P-13949C for types GE, GB, GF, & GH. Write for a complete technical data sheet.

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Astrodata's New Astrolock-loop FM Subcarrier Discriminator*

Stability

Within ±0.01% of center frequency for 24-hours after a 5-minute warm-up.

Linearity

Better than ±0.02% of full bandwith, best straight line.

The Astrodata Model 402-201, all solid-state FM subcarrier discriminator utilizes the new Astrolock phase-frequency detector, crystal-referenced, FET chopper-stabilized VCO, and current mode loop filter, which are proprietary developments of Astrodata, Inc.

This completely new and different type of locked-loop discriminator gives performance exceeding that of both conventional phase-locked-loop and pulse-averaging types of discriminators.

The new crystal-referenced, FET chopper-stabilized VCO provides state-of-the-art performance in stability and linearity, without a temperature controlled oven.

The Astrolock detector, with its composite phase-frequency characteristic, assures positive lock-in at any signal level within the 66 db dynamic range. True locked-loop performance is provided for deviations up to ±40%, with specified linearity. A quadrature detector mode of operation, selected by a switch on the front panel, provides correlation detection for extremely low S/N signals.

The Model 402-201 introduces a new method of tape-speed compensation in which the reference frequency is processed in the frequency domain. As a result, tape speed compensation is perfect at any fixed frequency from lower bandedge to upper bandedge, and is better than 30 db for intelligence frequencies up to a modulation index of 4. Deviations of more than ±3% anywhere in the band can be accommodated. No adjustments are necessary.

With this new Astrodata Tape Speed Compensation system, the over-all stability for a given data channel is that of the data discriminator alone, whereas in a conventional system the over-all stability is the sum of the stabilities of both the data discriminator and the reference discriminator.

A complete line of accessories is available for use with the Model 402-201. Channel Selectors and Low Pass Filters are provided for all standard IRIG and Constant Bandwidth center frequencies up to 300 kc. Six discriminators and one common power supply mount in a rack adapter which occupies a panel space of 7-in. x 19-in.

For complete technical information on Astrodata's unique Astrolock - loop FM Subcarrier discriminator and full line of telemetry components, call your local Astrodata engineering sales representative or write to us directly.

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LETTERS

to the Editor

Direct Conversion

Editor, ELECTRONIC INDUSTRIES:

Paul Rappaport's article on direct conversion in your February 1965 issue was an excellent summary of the state-of-the-art. However, the conversion of nuclear fission or fusion energy into heat and then into power by an intermediate process can hardly be called "direct." This same comment would apply to the utilization of the radioactivity from radioisotope sources, as discussed in the text but omitted from Figure 1.

In your editorial you challenge electronic engineers to apply some "foresight and ingenuity" to the problem of direct conversion. This challenge might well be directed toward the problem of direct conversion of the energy possessed by fundamental particles originating in nuclear processes. Some significant starts have been made in this field by Safonov and others in the direct conversion of fission fragment energy to electrical energy and by still others in the conversion of the energy associated in radioactive decay directly to electrical or propulsive power.

Within the nuclear context of the problem, actual "direct" conversion presents the real challenges and, if successfully mastered, promises unique payoffs.

Arnold Kramish
Physics Department
The Rand Corp.
1700 Main St.
Santa Monica, Calif.

Missing Zeros

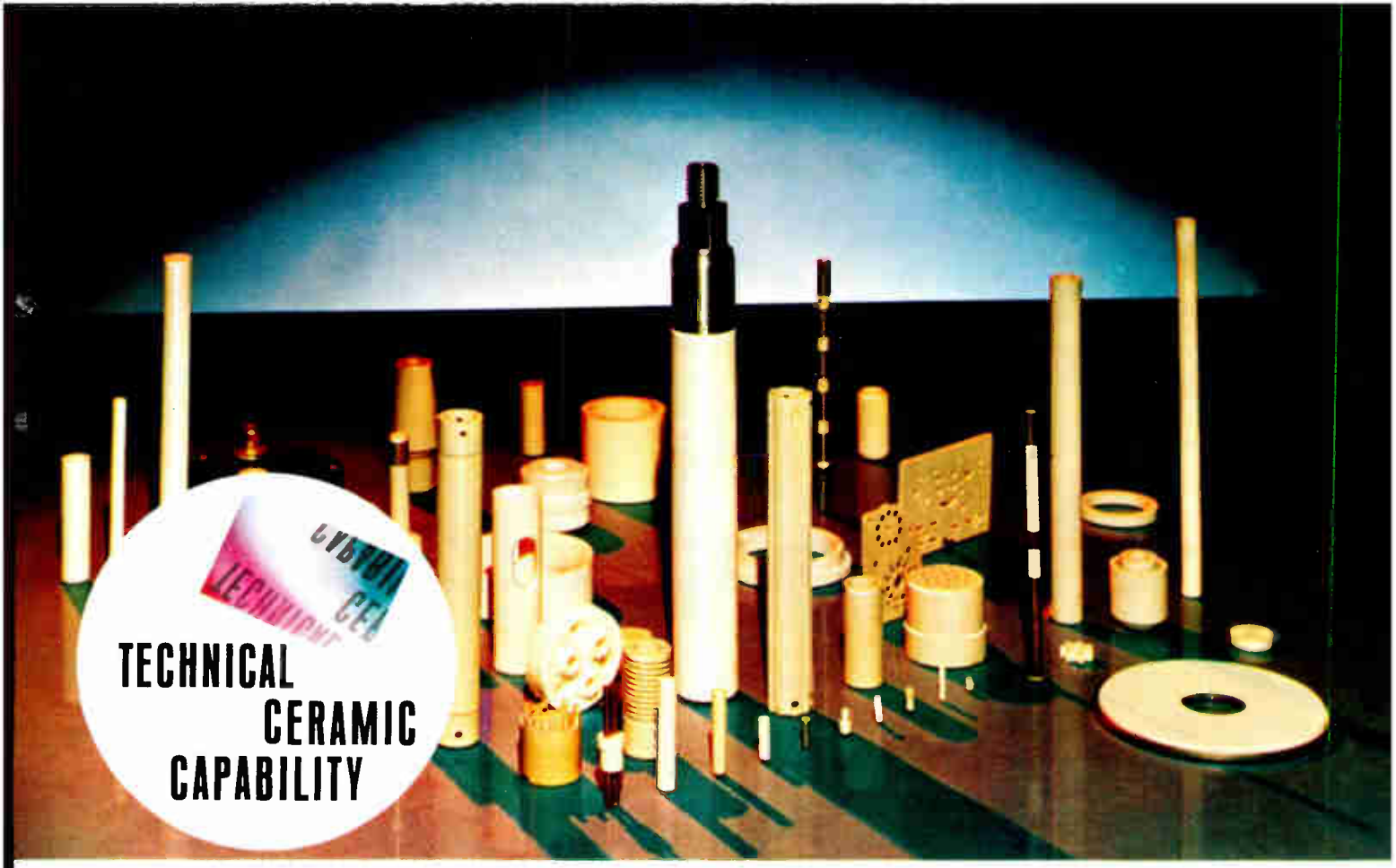
Editor, ELECTRONIC INDUSTRIES:

You probably dropped a few zeros in recording 30,095,000 (page 8, Feb. issue) as sales forecast by NEMA.

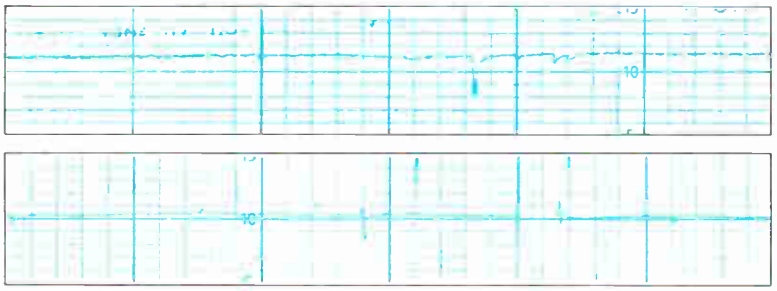
Julian Loebenstein

General Instrument Corp.
Rectifier Division
65 Gouverneur St.
Newark 4, N. J.

Ed. Note: Mr. Loebenstein was correct, three zeros were left out of that figure and also the $9,460,000 figure.



Centralab Ceramic Substrates for thin-film deposition and microelectronics with surface finish of less than one micro-inch!



50,000X vertical magnification. Each small Division = 2 microinches
100X horizontal magnification. Each small Division = .002"

The surfaces of these Centralab high alumina ceramic substrates are so incomparably smooth that your equipment probably can't measure the surface finish*. The Centralab research and development organization has combined new ceramic formulations with new firing and polishing techniques to achieve these unique substrates. A full range of them is now available to meet any requirements for surface smoothness.

For additional information write to the Technical Ceramics Department, Centralab, the Electronics Division of Globe-Union Inc., P. O. Box 591, Milwaukee, Wisconsin 53201.

**Unless you happen to have the Model 3 or 4 Talysurf which shows maximum average variation of 0.7 microinch, with .030" cutoff and .0001" radius stylus.*

For additional information circle number 205 on the publication inquiry service card.

TYPE OF FINISH	MICROINCHES (Arithmetical Average) .030" cutoff wavelength
Glazed and Polished	0.7
Glazed	12 and 3**
Diamond Polished, no glaze	12
As fired	40

**.003" cutoff utilized to eliminate the factor of waviness.

Other specifications are in keeping with these achievements

Minimum Fired thickness—.020"	Thermal Expansion Coefficient (10^{-6})
Minimum Diamond Polished thickness—.010"	20°-200°C = 5.5 in./in./°C
Camber—.006"/inch (or less)	20°-400°C = 6.58 in./in./°C
Thickness Tolerance to ±.001"	20°-600°C = 7.24 in./in./°C

Centralab®

DIVISION OF GLOBE-UNION INC.

Quality in Depth

Through Centralab Research and Development the products illustrated on these pages have been made available to the electronic industry.

For Immediate Delivery . . .

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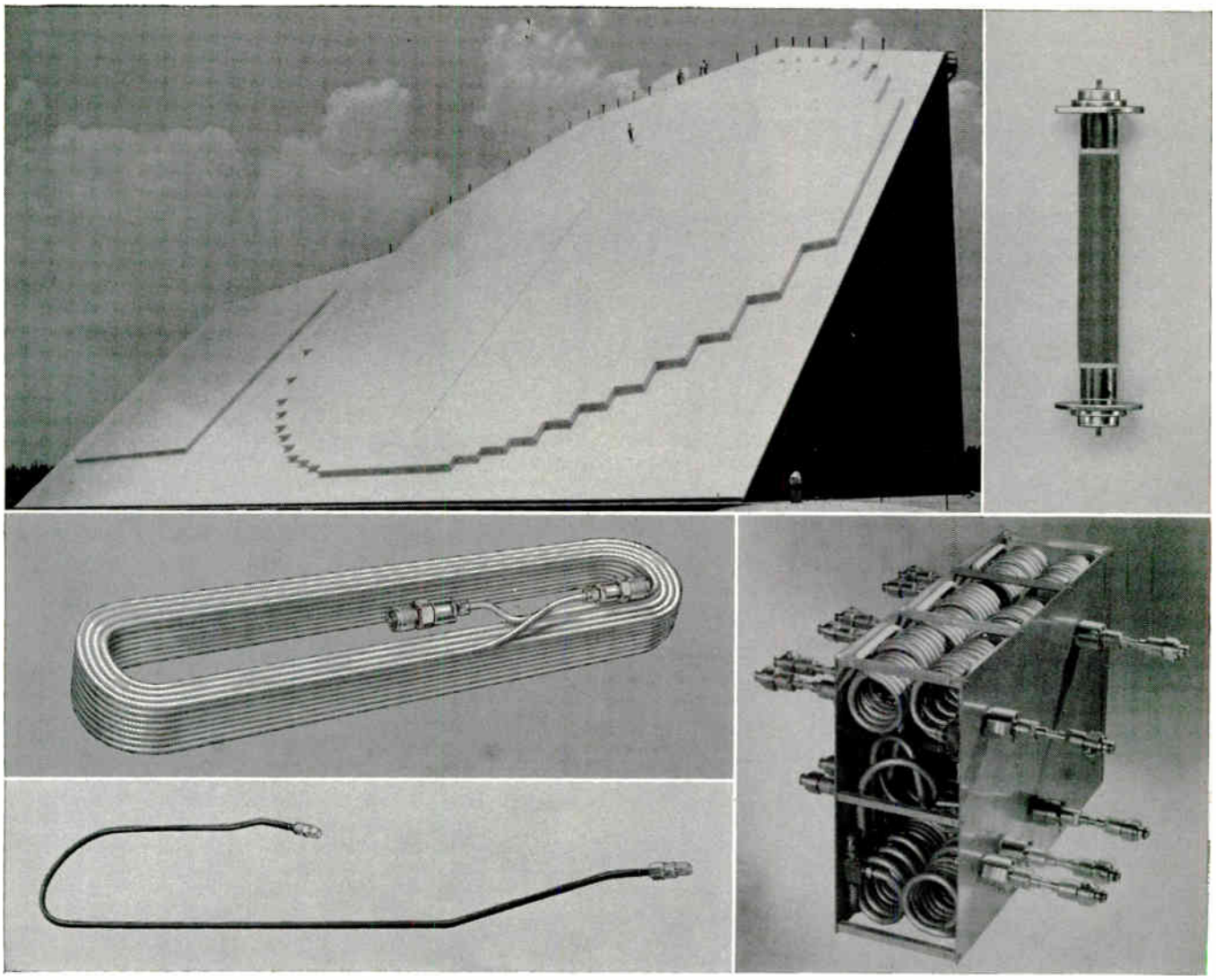

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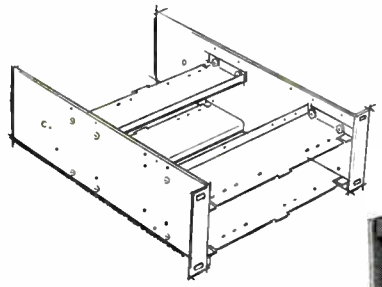
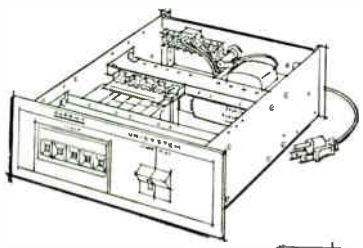
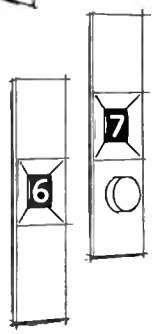
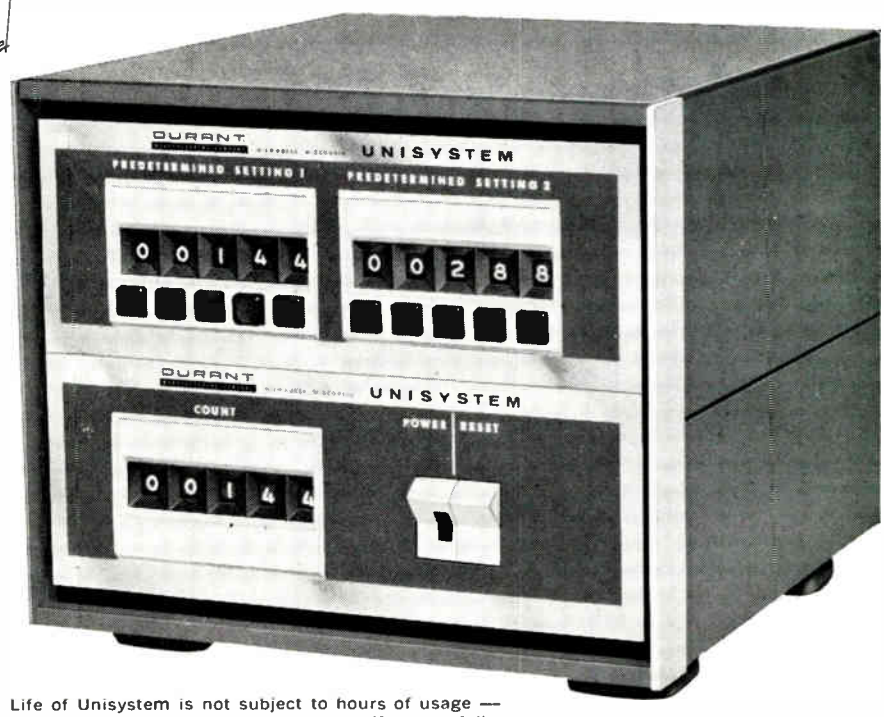
A new, low cost way to design in high accuracy in electrical, electronic recording and controlling

DURANT UNISYSTEM









Life of Unisystem is not subject to hours of usage — and it retains accumulated data even if power fails.

It's modular—you can match your exact application

What's the price you're paying for speed and accuracy in counting control up to 40 cps? Here's how you can cut costs with advanced design and modular flexibility.

Durant Unisystem is a new, but thoroughly proven sequential counting control. It employs the use of our unique Unipulser®, a single decade, high speed electromechanical counter — and our Uniset 10-step selector switch, for fast push-button settings and greater current carrying capacity.

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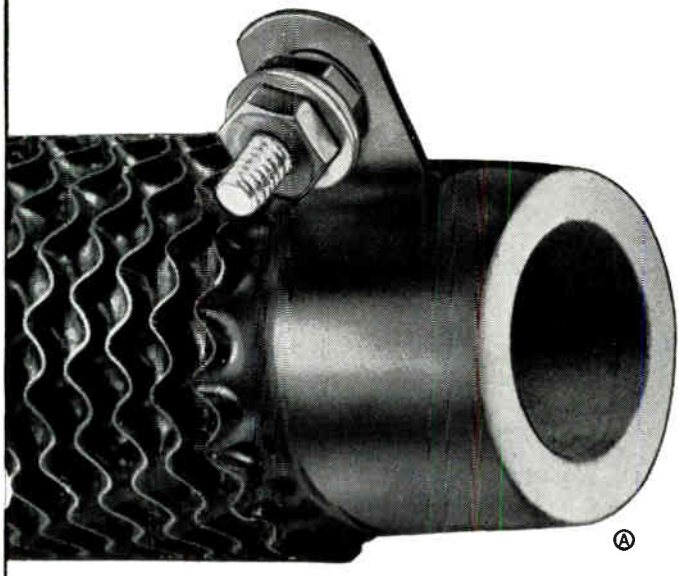
Unisystem can provide single and multiple level predetermining, repeat cycle predetermining, remote readout, data storage and more. Functions you can design in for metering, processing, converting, scaling, printing — and manufacturing of all types. To find out more about the advantages of Unisystem, write for Catalog 90. Durant Manufacturing Company, 685 North Cass Street, Milwaukee, Wisconsin 53201.

DURANT®
MANUFACTURING COMPANY
MILWAUKEE, WISCONSIN

what power rating do you need in a resistor?



Ⓐ

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Ⓑ Ⓒ Ⓓ Ⓔ Ⓖ

Here are seven standard types that take you from 1 to 1500 watts

Ⓐ **Up to 1500 watts**—Corrib®: high current, low resistance. Fixed or adjustable. Stocked in 300-watt size, 24 resistance values.

Ⓑ **220-1200 watts**—Powr-Rib®: high current, low resistance. Fixed or adjustable. Stocked in 29 resistance values from 700 to 1000 watts.

Ⓒ **Up to 1000 watts**—Lug-type: wire-wound, vitreous enameled. Fixed, adjustable, and noninductive types. Stocked in several hundred values, types, and sizes. MIL-R-26C types available.

Ⓓ **Up to 95 watts**—Thin-type: wire-wound. Fixed or adjustable. Stocked in almost 200 sizes and values. MIL-R-26C types available.

Ⓔ **Up to 20 watts**—Brown Devil®: wire-wound, vitreous enameled. Fixed only. Stocked in approximately 100 sizes and values.

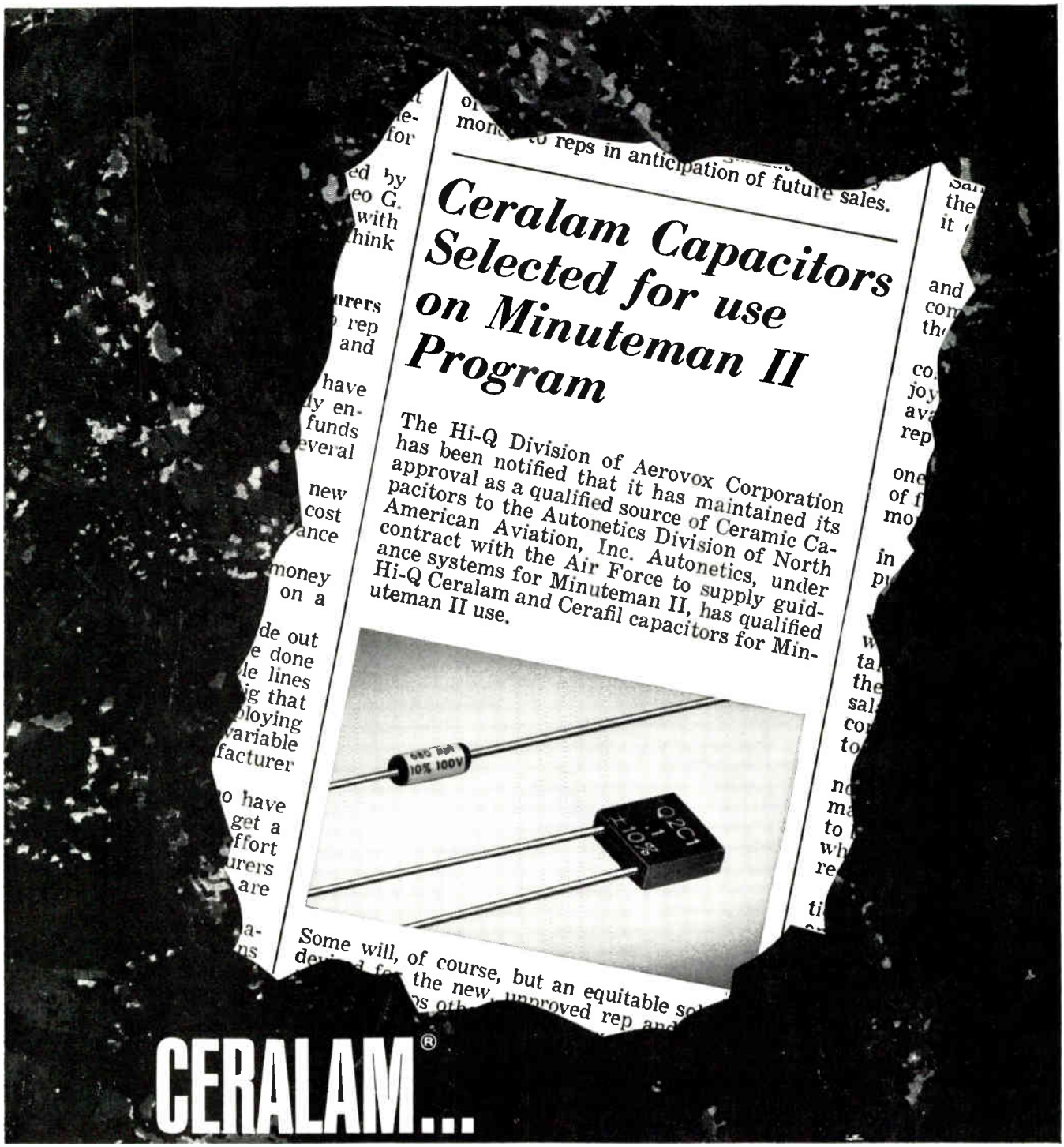
Ⓕ **Up to 11 watts**—Axial-lead (insulated): *molded* vitreous enamel coating, Series 99. Wire-wound. MIL-R-26C types.

Ⓖ **Up to 11 watts**—Axial-lead (precision, insulated): *molded* silicone-ceramic coating, Series 88. Wire-wound. Stocked in over 500 values and sizes with 1% tolerances. MIL-R-26C types available.

Close tolerances to 0.05% and low temperature coefficients to 0±20 ppm plus high stability, noninductive, and tapped units are available in most types above. Also a wide selection of terminal configurations including the quick-connect type. For fast, authoritative information on resistance products, come to Ohmite. Write for Catalog 30.

OHMITE
MANUFACTURING COMPANY
3662 Howard Street, Skokie, Illinois 60076
Phone (312) ORchard 5-2600

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



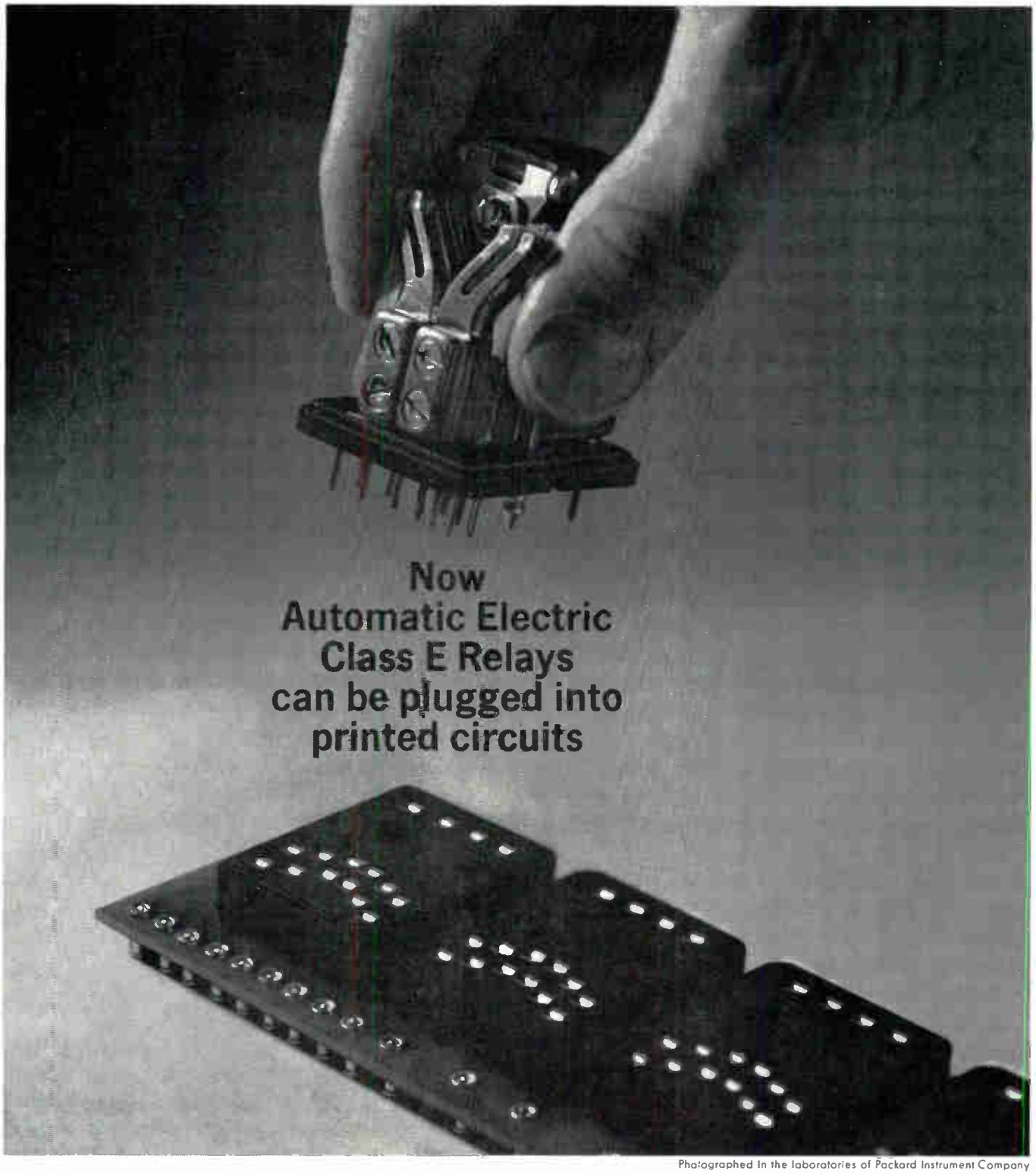
the proven approach to reliability

Hi-Q's CERALAM capacitors satisfy fully the challenges of critical electronic developments and applications through the unusual versatility inherent in their design and the unparalleled reliability resulting from their monolithic structure. Manufactured in the industry's most advanced "clean room" facilities and under a stringent quality control program. Write today for complete information on Ceralam capacitors to . . .

AEROVOX CORPORATION

OLEAN, N. Y. • MYRTLE BEACH, SO. CAR.

Hi-Q® DIVISION



Photographed in the laboratories of Packard Instrument Company

See the special socket? It's a handy new convenience. You can attach the socket to the circuit—and insert a Class E taper-tab relay later on.

This new method can simplify packaging, shipping and inventory. You don't have to ship a printed-circuit board with the relay in place. Ship them separately—with all the resultant benefits.

At the receiving end, it's easy to insert the complete series ETA assembly with its plastic dust cover. Remove it anytime, quickly. The socket stays in place.

Want some helpful details? Just drop us a line, and ask for AE's Product News on the ETA socket.

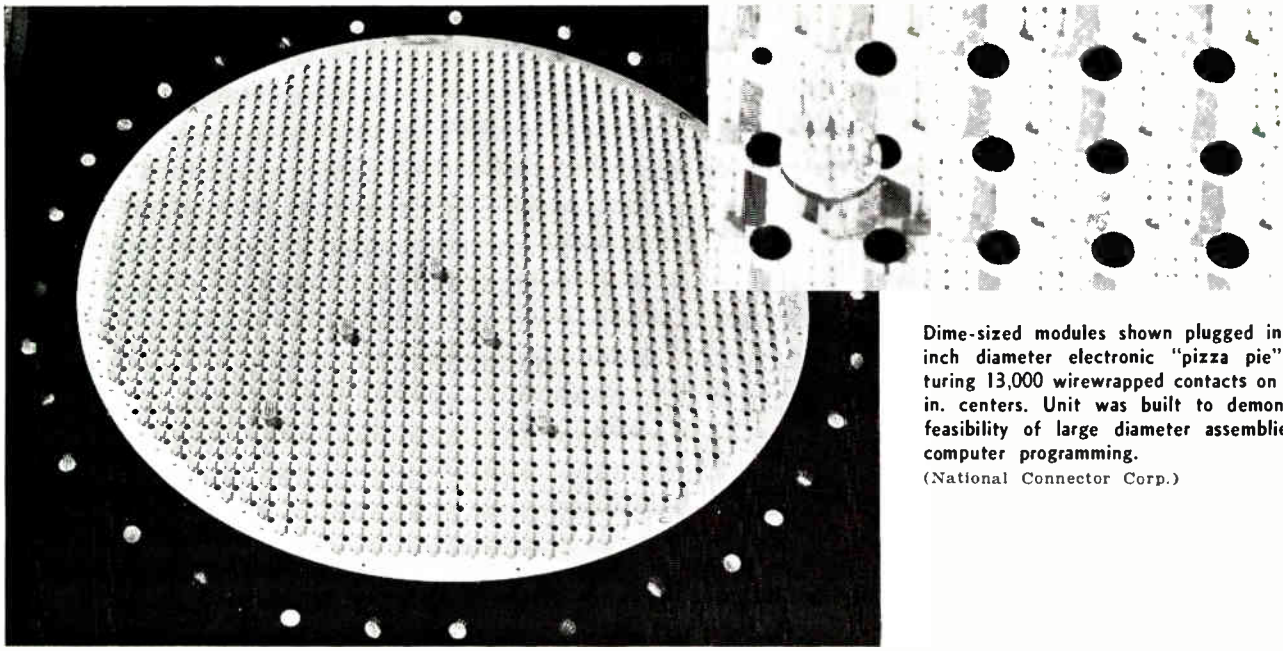
Widest Mounting Choice

In addition to this new ETA socket with printed-circuit terminals, other Class E relay sockets are available with dual taper-pin and taper-tab terminals. And the relays themselves can have conventional solder, taper-tabs, or wrapped-wire terminals, or pins for plug mounting.

This amounts to the industry's widest selection of Class E relay connections—another good reason to check Automatic Electric for *all* your relay needs. Write the Director, Relay Control Equipment Sales, Automatic Electric, Northlake, Illinois 60164.

AUTOMATIC ELECTRIC

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS GT&E



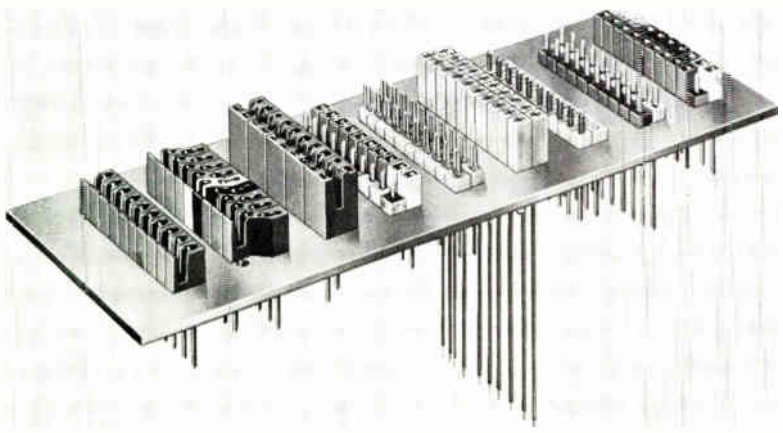
Dime-sized modules shown plugged into 30 inch diameter electronic "pizza pie" featuring 13,000 wirewrapped contacts on 0.125 in. centers. Unit was built to demonstrate feasibility of large diameter assemblies for computer programming. (National Connector Corp.)

1965 Connector Specifications Guide

Part 3: Multi-pin Connectors

In this part 3 of the connector survey, ELECTRONIC INDUSTRIES tabulates the multi-pin connector products of 94 suppliers in the electronic connector industry.

Modular connector systems illustrating basic contact and insulator designs which can be combined to form a 0.200 in. grid of almost limitless size. (Elco Corp.)



"MULTI-PIN" COULD MEAN ANY CONNECTOR ever made that has two or more contacts. But industry uses the term to refer to two general classes of multiconductor connectors, one known as "cylindrical" types and the other as "rack and panel." Cylindricals include the standard and miniature size round types ("AN" and "MS" types defined by military specifications) which may be wall, box or cable mounting plugs and receptacles, umbilical connectors, power and audio connectors. The rack and panel types also may be cable mounting, or supplied with special hardware for recessed mounting on chassis or panels, or for mounting directly to plug-in components. The so-called rack and panel connectors are generally considered to be rectangular,

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STATE-OF-THE-ART
FEATURE

although, of course, round connectors are also used in rack and panel applications. Though they are not strictly connectors, transistor, tube and relay sockets are products of several multi-pin connector manufacturers and are therefore included in this part of the connector survey.

Evolution of Cylindricals

The chart lists the manufacturers of the miniature round connectors meeting the military specifications MIL-C-26500, MIL-C-26482 and the National Aerospace standard specification NAS-1599. These are miniaturized designs of the standard MIL-C-5015 specification. Though not shown in the charts, an upgraded version of MIL-C-26500 with reliability requirements for power connectors is available in the MIL-C-38300 connector, and a rack and panel version of MIL-C-26500 is available as MIL-C-26518.

Modular Designs for High Density Connections

Off-the-shelf modular connectors are available from several manufacturers to be used for large area, high contact density distribution centers or computer programming boards.

The connectors are built on a simple modular basis: Contacts are inserted into colorful nylon bushings, and the bushings which serve both as a dielectric and contact retaining device, are snapped into holes in a base plate of aluminum or other material. Many different types of male and female contacts are available for manual wiring, programmed wiring or dip soldering connections. Contacts can be supplied spaced on .050- to .200-inch centers. Insulators can be color coded and also supplied with a metallic coating for efficient grounding to conductive base plates.

New Miniature Sockets

An ever-present problem with miniature sockets has been the ease of pulling the pins from the socket during installation or service. A newly designed contact is now available that consistently withstands a 7-pound pull test. Also available is a 12-pin fluorocarbon plastic transistor socket with unusually low pin-to-pin and pin-to-chassis capacitance.

Today's Obstacles to Reliability

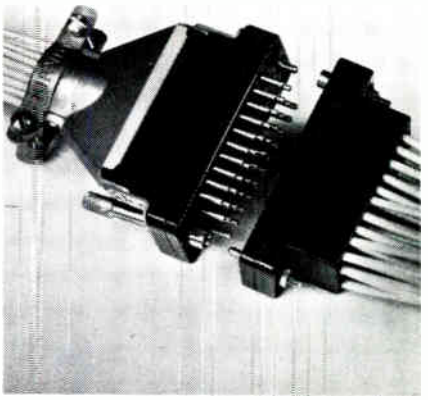
Reliability might be expected to be high among the

Third in a Series of Reports
Industry's Most Complete
ELECTRONIC CONNECTOR SURVEY
Watch Future Issues For:

PART 4: PLUGS, JACKS CORDS AND TERMINALS

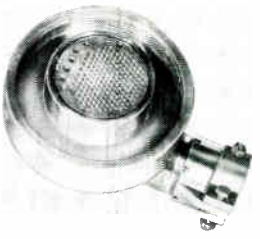
PART 1: PRINTED CIRCUIT CONNECTORS appeared in the January issue of E. I.

PART 2: COAXIAL CONNECTORS appeared in the February issue of E. I.

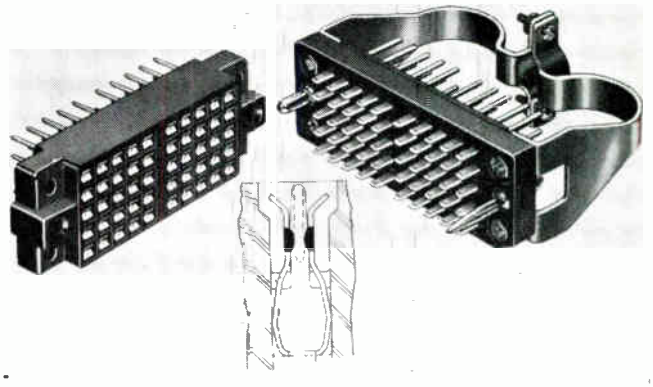


Rack and panel connector with up to 152 contacts. (Burndy)

Special submersion Polaris Header Assembly. (Bendix)

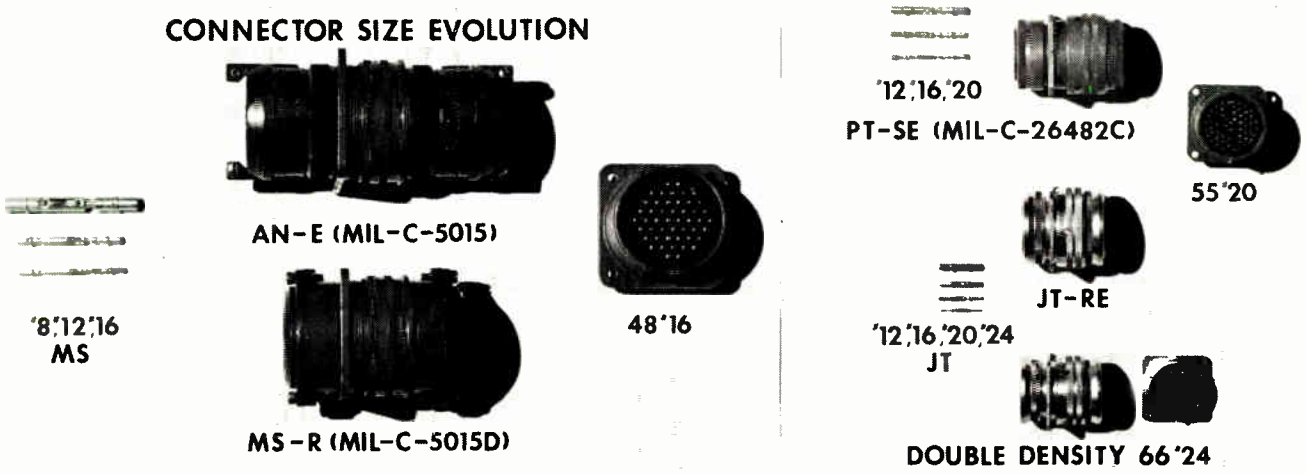


Hermetically sealed plate containing 1,218 contacts for vacuum chamber/space applications. (Deutsch)



Blade type rack and panel connector designed for frequent insertion and removal cycles. Black area shown in drawing is 75% gold precious metal alloy. (Cinch)

Miniature circular environmental connector mates with Mil-C-26500 connectors and is designed to NAS 1599 specifications. (ITT Cannon Electric)



more exotic cylindrical and rectangular connectors designed for frequent uncoupling for regular maintenance inspection, circuit checkout or repair in military and aerospace service.

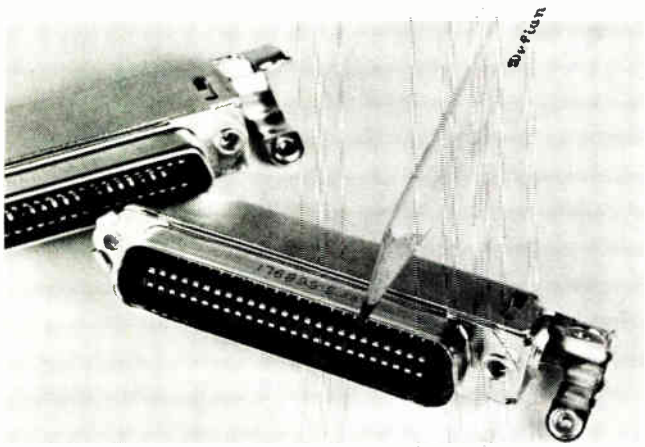
Analysis of failure rates shows the inherent reliability of connectors to be very high compared to other components. This conclusion, however, depends upon how the failures are evaluated. One obstacle to connector reliability is the need for statistical design limits for the connector as other component manufacturers have established, rather than the "go-no-go" capability expressed in connector specifications. Another obstacle to reliability is connector mishandling which still accounts for about half of all connector failures. The third is misapplication of a connector design. This last obstacle, however, would probably be lessened if the specification problem was solved. Rightly or wrongly, the connector industry is presently blamed for time consuming and frustrating delays in missile and space vehicle launches when pre-flight checkouts show up faulty connectors.

Reliability Programs

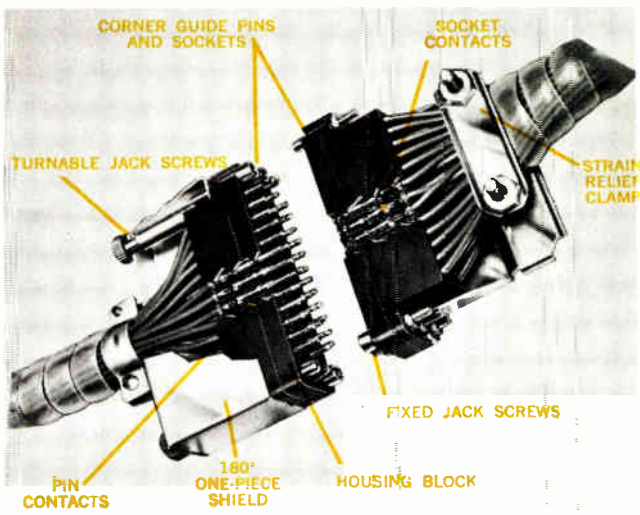
In the quest for total reliability, connector manufacturers have begun test and quality control programs that are conceived to let the electronic design engineer know exactly what he is getting in the way of proven reliability with a given connector design. These programs are not easy to set up, or to live with, and the methods of statistical analysis differ. They also require usually some participation on the part of the customer. But the belief is that these steps must be taken by the connector industry to gain the same reliability posture that other component industries enjoy.

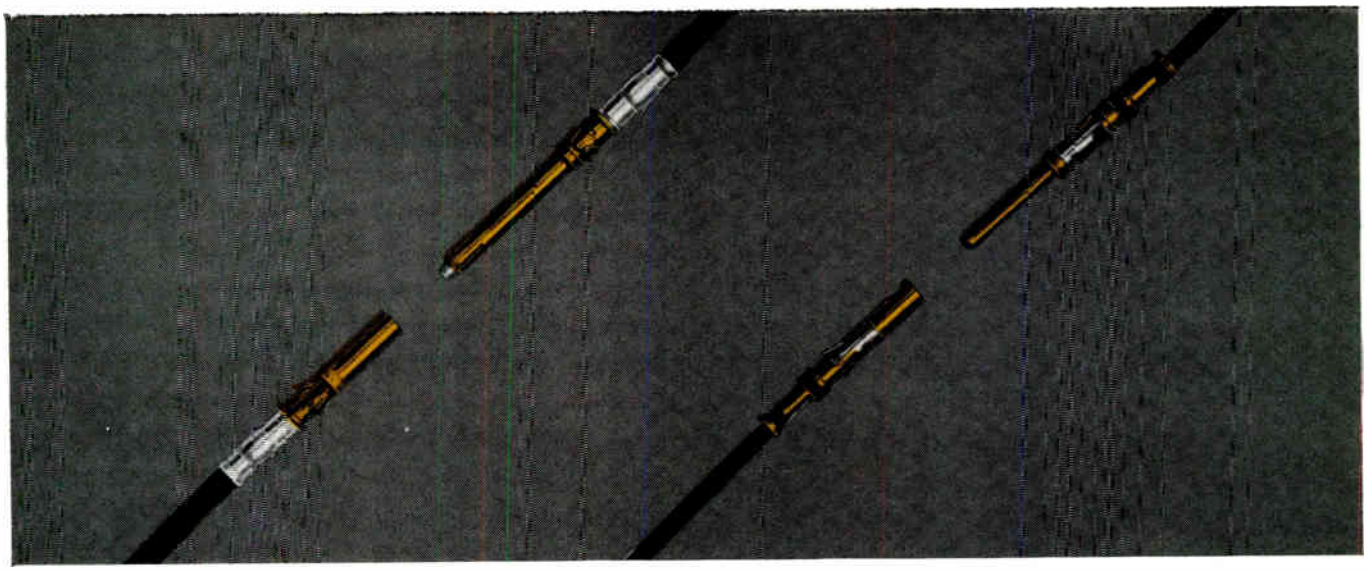
Amphenol's quality control program instituted last year is aimed at new reliability in space flights and is built around "total traceability" of all parts and materials. Connectors are coded so that every part and all the materials that go into the units can be traced and checked at any phase from supply to production. The new coding is expected to simplify locating potentially troublesome connectors throughout the missile program. A reliability test cycle operation, as part of the program, will enable the company to present the engineer with a connector and documented data showing the actual reliability expectation based upon the tests. When connectors are made idiot-proof and indestructible, reliability will have been drastically improved. But, as systems get larger and components get smaller, new and greater demands are placed on the connector.

Fifty-Contact rack and panel "Blue Ribbon" connector used extensively in telephones, radios and other communications equipment. (Amphenol)

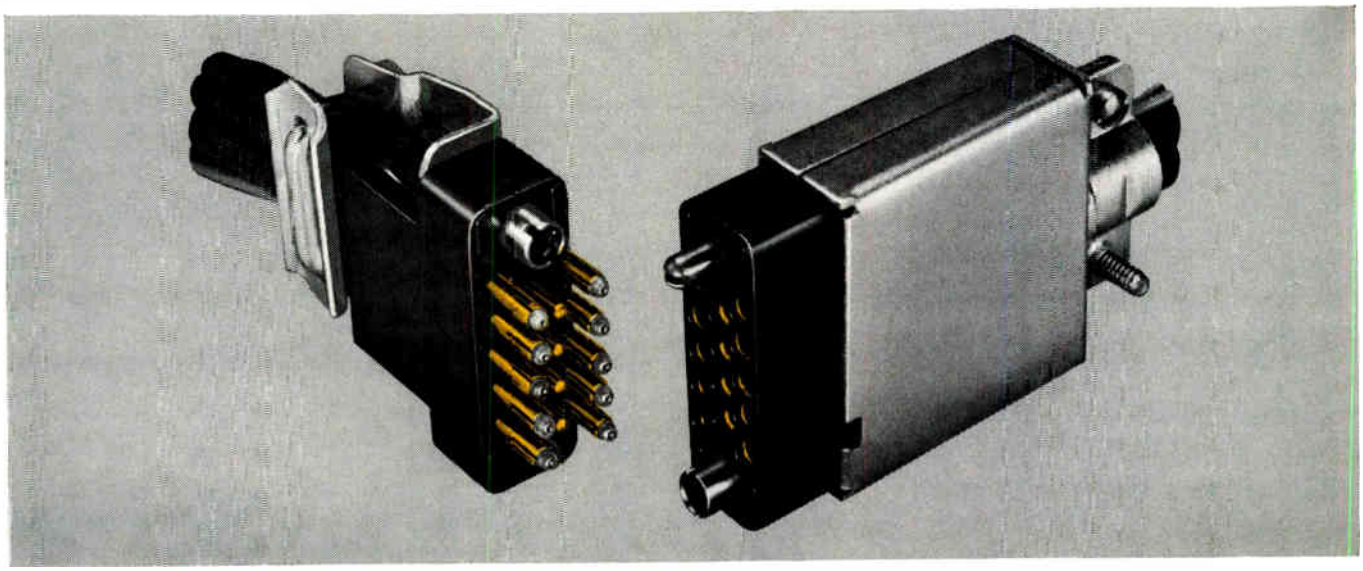


Typical rectangular cable-mounted connector. (AMP, Inc.)





Coaxial Pin and Socket



Mix 'em

Now you can bring power and shielded signal circuits through the same connector . . . in any combination! AMP's new subminiature coaxial contacts match any size 16 pin and socket, snap into the same housings wherever your application calls for them.

Both contact styles feature long-life closed-entry design and gold plating. Since they both fit the same diameter cavities, you are not limited to special configurations. And you can select from a variety of connector configurations ranging from 14 to 104 positions in diallyl phthalate or phenolic blocks; as well as types with pre-assembled die-cast aluminum shells. Versatility like this will reduce your inventory problems.

And think of the savings per installed connector! Coaxial contacts are applied with a single stroke of the A-MP★ tool which simultaneously crimps center conductor, braid and cable support—a technique originated and championed by AMP. Their two-piece design includes complete contact assembly and a separate ferrule. Pin and socket contacts, of course, are available in strip form for high-speed automachine application. So . . . whether you mix or match contacts, you get not only quick, easy assembly, but the kind of uniform reliability that eliminates rejects.

Here's the gist of our mix/match story:

1) Choose any A-MP Series "M", "D", or "W" Connector housing that accepts #16 contacts
2) Choose Type II, III, or III(+) pin and socket and/or Subminiature COAXICON★ Contacts
3) Terminate your leads with AMP's matched hand or machine crimping tool
4) Snap the crimped contacts into the housing in any configuration

For all the details, write today.

★Trademark of AMP INCORPORATED

AMP INCORPORATED
Harrisburg, Pennsylvania

INDUSTRIAL SALES DIVISION

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

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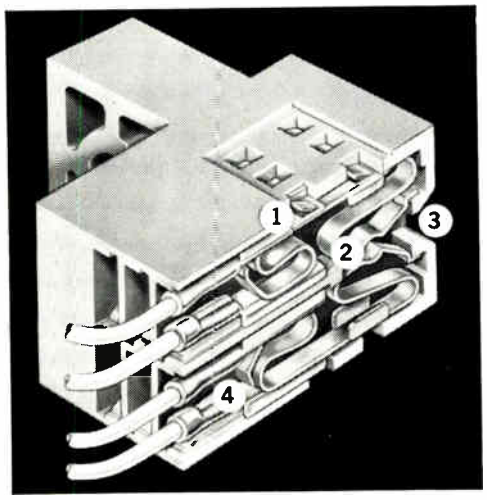
MANUFACTURERS OF MULTI-PIN CYLINDRICAL and RACK & PANEL CONNECTORS

	CYLINDRICAL CONNECTORS																			RACK & PANEL CONNECTORS CHASSIS CONNECTORS									
	RACK & PANEL CONNECTORS	CABLE MOUNTING CONNECTORS	COMB. WIRE & COAX CONNECTORS	RECEPTACLES, PANEL MTG.	RECEPTACLES, CABLE MTG.	RECEPTACLES, BOX MTG.	MIL-C-26482 TYPES	MIL-C-26500 TYPES	NAS 1599 TYPES	HEADERS, TERMINAL STRIPS	POWER CONNECTORS	MINIATURE	SUBMINIATURE	MICROMINIATURE	HERMETIC SEAL	SOLDER TYPES	SOLDERLESS TYPES	RIBBON CABLE CONNECTORS	TOOLS	RACK & PANEL CONNECTORS	PLUGS & SOCKETS	TUBE & TRANSISTOR SOCKETS	RELAY SOCKETS	LINE CONNECTORS	TERMINAL STRIPS	MINIATURE	SUBMINIATURE	HERMETIC SEAL
ACCURATE ELECTRONICS CORP., P.O. Box 935, Elyria, O.										X	X	X	X								X	X		X	X	X	X	
ACI DIV. OF KENT, 206 Center, Princeton, N. J.																		X										
AIRBORN, INC., P.O. Box 20232, Dallas, Tex.	X	X		X	X	X				X	X	X			X	X	X		X	X	X		X		X	X		X
ALDEN PROD. CO., 117 N. Main St., Brockton, Mass.		X		X	X						X	X						X			X		X	X	X	X		
AMP INC., Harrisburg, Pa.	X	X	X	X	X	X		X		X	X	X	X	X	X		X	X	X	X	X			X		X	X	X	X
AMPHENOL CONNECTOR DIV., 1830 S. 54 Ave., Chicago, Ill.	X	X		X	X	X	X	X		X	X	X	[1]X	[1]X	X	X	X	X	X	X	X	X	X	X	X	X	[1]X	X
ARCO ELECTRONICS, Deutsch Distr., Community Dr., Great Neck, N. Y.	X	X	X	X	X	X	X		X			X	X		X	X	X		X	X						X	X	X
ARMEL ELECTRONICS, INC., 1601 75th St., N. Bergen, N. J.	X											X	X		X			X		X	X		X		X	X	X	
BARNES DEVELOPMENT, 213 W. Baltimore, Lansdowne, Pa.										X											X	X	X					X
BEAUCHAINE & SONS, Laconia, N. H.	X	X		X	X						X									X	X							
BENDIX CORP., SCINTILLA DIV., Sidney, N. Y.	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X		X	X						X		
BILL JACK INDUSTRIES, 143 S. Cedros Ave., Solana Beach, Calif.		X		X	X	X								X	X	X	X											
BIRNBACH RADIO CO., INC., 145 Hudson St., New York, N. Y.	X	X	X	X	X	X					X	X	X	X	X					X	X			X	X	X	X	
BURNDY CORP., Norwalk, Conn.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CAMBLOCK DIV., WALTHAM PREC. INSTR. CO., Waltham, Mass.	X									X	X	X	X				X		X	X				X	X	X	X	
CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge, Mass.																X	X								X	X		
CARLOMA CORP., 4610 N. Lindbergh Blvd., Bridgeton, Mo.			X														X				X							
CICOIL CORP., 13833 Saticoy St., Van Nuys, Calif.												X	X	X		X		X										
CINCH MFG. CO., 1026 S. Homan Ave., Chicago, Ill.	X	X		X	X						X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X
CLARE CERAMICS, INC., Cary, Ill.				X		X				X	X				X													
COLE ELECTRIC CO., 8439 Stellar Dr., Culver City, Calif.	X	X		X	X	X				X	X	X			X	X	X			X	X			X		X		X
CONTINENTAL CONNECTOR CORP., 34-63 56th St., Woodside, N. Y.	X	X	X	X	X		X				X	X	X	X	X	X	X		X	X	X		X		X	X	X	X
DAGE ELECTRIC CO., INC., Hurricane Rd., Franklin, Ind.	X	X		X	X	X	X			X					X	X	X						X					
D-CEMCO, INC., 1024 W. 9th St., P. O. Box 8, Upland, Calif.																									X	X	X	
DIGITAL SENSORS, 4127 N. Figueroa St., Los Angeles, Calif.	X	X									X					X		X		[2]X	[2]X			[2]X				
ELCO CORP., Willow Grove, Pa.	X	X		X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	
ELECTRONIC CONNECTORS, INC., Kew Gardens, N. Y.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
ELECTRONIC FITTINGS, CORP., 29 Sugar Hollow Rd., Danbury, Conn.	X	X		X	X		X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X	X	X
ELECTRONIC MOLDING CORP., 40 Church St., Pawtucket, R. I.										X											X	X			X	X		
ERCONA CORP., 432 Park Ave., New York, N. Y.	X	X	X	X	X					X	X	X			X	X	X	X		X	X	X	X	X	X	X		X
ETC, INC., 990 E. 67th St., Cleveland, O.																	X		X									

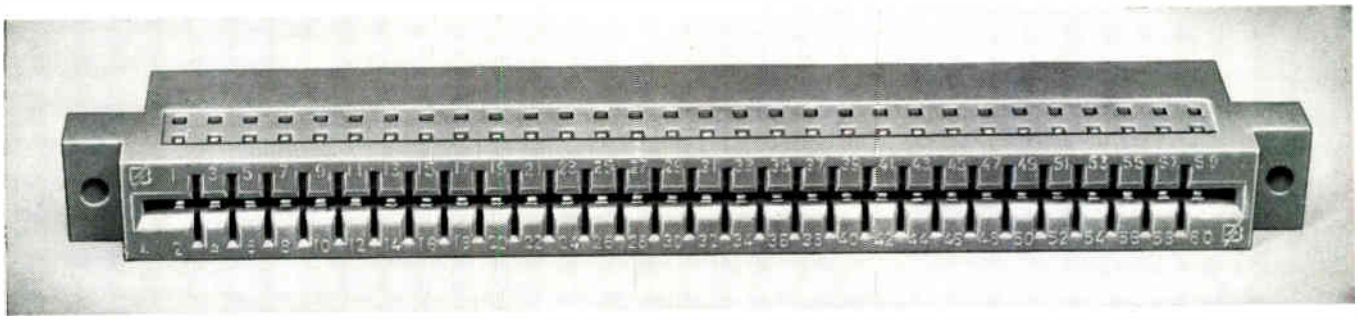
1 – Made by Microelectronics Facility, Broadview, Ill.

2 – Flat, Flexible, Multiconductor Interconnecting Cable



Adept:

our .100 spaced PC connector is a proven success



Adapt:

we built another just like it...on .156 centers

The features built in to our .100 spaced PC connector brought enthusiastic engineering acceptance. Now we've put those features into a more widely applicable .156 spaced connector in the latest addition to our PC line. We **repeat** . . . all features are common to both the .100 and the .156. For instance, the new .156 (like the .100) has crimp-type, removable terminations automatically installed by the Burndy HYFEMATIC.™ Tooled for quick delivery in 15, 22, 30 and 43 positions. More? Read on.

1. **Wire Terminal Lock**—holds contacts securely in place. Simple, rear-inserted extraction tool releases terminal.
2. **Spring Contact**—accordion type, gold plated beryllium copper. Permanently installed in connector body for maximum protection.
3. **Closed Entry**—on board side protects springs against probe damage and self aligns warped boards. Accepts square-cut boards.
4. **Wire Terminal**—gold plated, installed with HYFEMATIC, also hand tools. For double sided boards, double read-out per contact on each side.

Connector body is ruggedly constructed of high impact thermo-plastic. Board contact springs are pre-loaded to avoid damage during handling. For additional information on new .156 spaced PC Connector (and the .100 as well), contact Burndy OMATON Division.

BURNDY
MAKES ALL TYPES OF ELECTRICAL
CONNECTORS
Norwalk, Connecticut

Circle 29 on Inquiry Card

MANUFACTURERS OF MULTI-PIN CYLINDRICAL and RACK & PANEL CONNECTORS (Continued)

	CYLINDRICAL CONNECTORS																				RACK & PANEL CONNECTORS CHASSIS CONNECTORS									
	RACK & PANEL CONNECTORS	CABLE MOUNTING CONNECTORS	COMB. WIRE & COAX CONNECTORS	RECEPTACLES, PANEL MTG.	RECEPTACLES, CABLE MTG.	RECEPTACLES, BOX MTG.	MIL-C-26482 TYPES	MIL-C-26500 TYPES	NAS 1599 TYPES	HEADERS, TERMINAL STRIPS	POWER CONNECTORS	MINIATURE	SUBMINIATURE	MICROMINIATURE	HERMETIC SEAL	SOLDER TYPES	SOLDERLESS TYPES	RIBBON CABLE CONNECTORS	TOOLS	RACK & PANEL CONNECTORS	PLUGS & SOCKETS	TUBE & TRANSISTOR SOCKETS	RELAY SOCKETS	LINE CONNECTORS	TERMINAL STRIPS	MINIATURE	SUBMINIATURE	HERMETIC SEAL
FRANK W. MORSE CO., 354 Congress St., Boston, Mass				X																									
GARLOCK, INC., 602 N. 10th St., Camden, N. J.																						X	X			X			
GC ELECTRONICS CO., 400 S. Wyman St., Rockford, Ill.																										X			
GENERAL PROD. CORP., 107 Salem St., Union Springs, N. Y.																					X					X			
GENERAL RADIO CO., West Concord, Mass.																						X				X			
GEOPHYSICS CORP. OF AMERICA, Burlington Rd., Bedford, Mass.		X		X	X	X					X	X				X	X											
GLASSEAL PRODS. CO., INC., 725 Commerce Rd., Linden, N. J.	X	X		X	X	X				X		X	X	X	X	X	X			X	X				X	X	X	X
GLENAIRE, INC., 1211 Air Way, Glendale, Calif.	X	X	X	X	X	X	X	X			X				X	X	X							X		X	X		
HOLUB INDUSTRIES, INC., 468 Elm St., Sycamore, Ill.																	X								X				
HUGHES CONNECTING DEVICES, P. O. Box H, Newport Beach, Calif.	X	X	X	X	X	X	X				X	X	X	X	X	X	X			X	X		X			X	X	X	
IBM CORP., INDUSTRIAL PRODS. DIV., White Plains, N. Y.	X	X									X																		
INDUSTRIAL ELECTRONIC HARDWARE, 109 Prince St., New York, N. Y.				X	X															X		X	X		X				
ISOLATION PRODS. INC., 2286 Mora Dr., Mountain View, Calif.																								X					X
ITT CANNON ELEC., INC., 3208 Humboldt St., Los Angeles, Calif.	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X
JAVEX ELECTRONICS, 9509 Oak Glen Rd., Cherry Valley, Calif.				X	X	X					X					X												
JETTRON PRODS., INC., 57 Rte. 10, Hanover, N. J.																							X						
KINGS ELECTRONICS CO., 40 Marble Dale Rd., Tuckahoe, N. Y.																										X			
LAB-TRONICS, INC., 3656 N. Lincoln Ave., Chicago, Ill.	X	X	X	X	X	X					X	X	X	X	X					X	X								
LEVITON MFG. CO., 236 Greenpoint Ave., Brooklyn, N. Y.				X	X	X					X																		
LIVINGSTON ELECTRON CORP., 320 Runnymede Rd., Essex Fells, N. J.				X											X	X							X						X
MALCO MFG. CO., 4023 W. Lake St., Chicago, Ill.	X	X		X						X	X	X	X						X	X						X	X		
MATRIX SCIENCE CORP., 3311 Winona Ave., Burbank, Calif.	X	X	X	X	X	X	X			X	X		X		X		X		X	X	X								
METHODE ELECTRONICS, INC., 7447 W. Wilson Ave., Chicago, Ill.	X	X		X	X	X	X			X	X	X			X	X	X		X										
MICRODOT, INC., 220 Pasadena Ave., S. Pasadena, Calif.	X	X	X	X	X	X	X	X			X	X			X		X									X			
MICRO-LECTRIC INC., 19 Debevoise Ave., Roosevelt, N. Y.	X			X		X		X							X														
JAMES MILLEN MFG. CO., INC., 150 Exchange St., Malden, Mass.																				X	X	X	X		X	X			
MINNESOTA MINING & MFG. CO., 2501 Hudson St., St. Paul Minn.	X	X															X	X											
MOLEX PRODS., 9515 Southview Ave., Brookfield, Ill.				X	X	X						X					X												
NAT'L. CONNECTOR CORP., SCIENCE-INDUSTRY CTR., Minneapolis, Minn.	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X								
NAT'L. TEL-TRONICS CORP., 52 St. Casmir Ave., Yonkers, N. Y.																					X				X	X	X		
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NEWAL, INC., 80 Pickett District Rd., New Milford, Conn.	X	X		X	X	X				X	X	X	X		X	X	X			X	X				X	X		X
NORTH ELECTRIC CO., Galion, Ohio	X	X		X	X											X	X			X								
NUGENT ELECTRONICS CO., INC., 802 E. 8th St., New Albany, Ind.		X	X	X	X					X	X	X	X	X	X	X	X			X		X	X	X	X	X	X	X
NU-LINE INDUSTRIES, INC., 1015 S. 6th St., Minneapolis, Minn.	X	X											X			X										X		
OMNI SPECTRA, INC., 8844 Puritan Ave., Detroit, Mich.																				X						X		
PACKARD ELECTRIC DIV., GMC, P. O. Box 431, Warren, Ohio																				X				X		X		X
PENN-UNION ELECTRIC CORP., P. O. Box 209, Erie, Pa.							X	X			X					X	X											
PERMONITE MFG. CO., 910 W. Jackson Blvd., Chicago, Ill.										X											X				X	X		
PHYSICAL SCIENCES CORP., 314 E. Live Oak Ave., Arcadia, Calif.	X	X	X	X	X	X	X	X		X		X	X	X	X	X	X											
PROGRESS WEBSTER CORP., 5 Bridge St., Watertown, Mass.	X	X		X	X	X	X			X	X	X			X	X												
PYLE-NATIONAL CO., 1334 N. Kostner Ave., Chicago, Ill.	X	X	X	X	X	X		X	X		X	X			X	X	X		X	X	X			X		X		
PYLON CO., INC., Attleboro, Mass.																				X								
RAYTHEON CO., IND. COMPS. DIV., 55 Chapel St., Newton, Mass.			X	X	X			X				X				X			X									
RYE SOUND CORP., 145 Elm St., Mamaroneck, N. Y.		X									X		X															
SEALECTRO CORP., 139 Hoyt St., Mamaroneck, N. Y.	X	X	X							X		X	X	X						X					X	X	X	
SEALTRON CORP., P. O. Box 15073, Cincinnati, Ohio	X						X	X	X	X					X													X
SPECIALTY SOCKET CO., 305 Fort Lee Rd., Leonia, N.J.												X	X	X							X	X				X	X	
STANDARD CONNECTOR CORP., 57 State St., North Haven, Conn.	X	X		X	X	X						X				X	X		X	X						X		
STATHUM INSTRUMENTS, INC., 2211 Stathum Blvd., Oxnard, Calif.	X	X		X	X	X				X	X					X												
TECHNICAL MATERIAL CORP., 700 Fenmore Rd., Mamaroneck, N. Y.	X	X	X	X	X	X	X		X			X	X	X		X	X	X		X	X		X			X	X	
TELEPHONE DYNAMICS CORP., 32 Sunrise Hwy., Baldwin, L.I., N. Y.		X										X									X					X		
TELERAD MFG. CORP., LIONEL ANTON DIV., Hoffman Pl., Hillside, N. J.	X	X	X	X	X	X				X	X	X		X	X	X	X			X	X		X			X		
THOMAS & BETTS CO., 36 Butler St., Elizabeth, N. J.																	X											
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TWIN LOCK, INC., 13115 Washington Blvd., Los Angeles, Calif.																	X											
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VACUUM CERAMICS, INC., Cary, Ill.	X									X	X	X	X	X	X					X								X
VARITRON WEST, INC., 20245 Sunburst St., Chatsworth, Calif.	X			X	X	X	X	X		X	X	X	X	X	X								X	X	X	X	X	X
VIKING INDUSTRIES, INC., 21343 Roscoe Blvd., Canoga Park, Calif.	X	X		X	X							X		X	X	X			X	X	X		X	X		X	X	X
E. B. WIGGINS, INC., 3424 E. Olympic Blvd., Los Angeles, Calif.	X	X		X	X	X	X			X	X	X			X		X											
WINCHESTER ELECTRONICS INC., Main St. & Hillside Ave., Oakville, Conn.	X	X	X	X	X	X				X		X	X	X		X	X		X	X	X	X	X	X	X	X		

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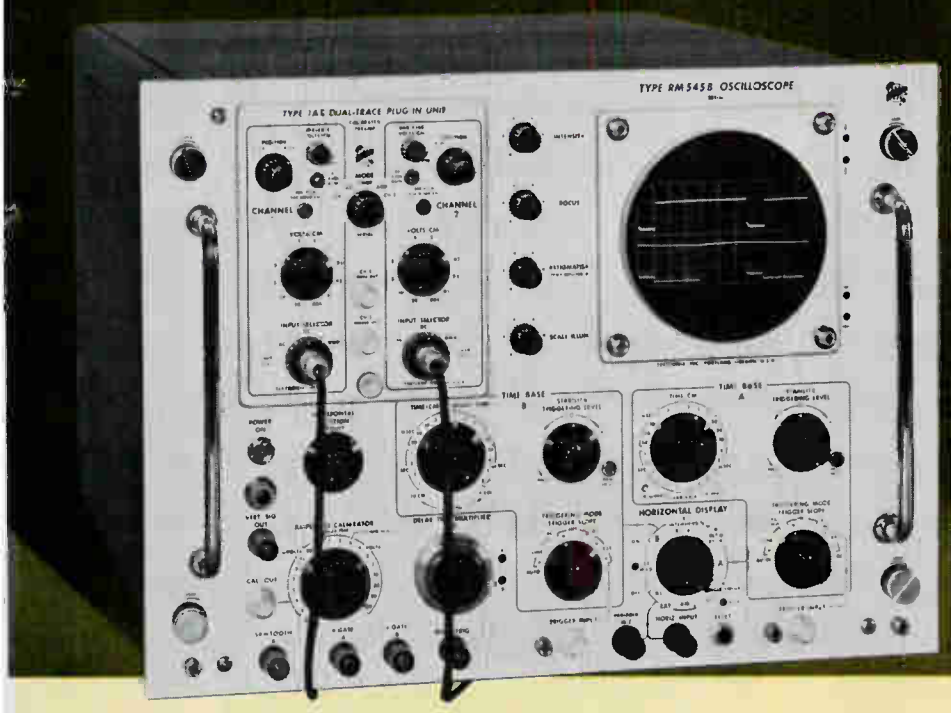

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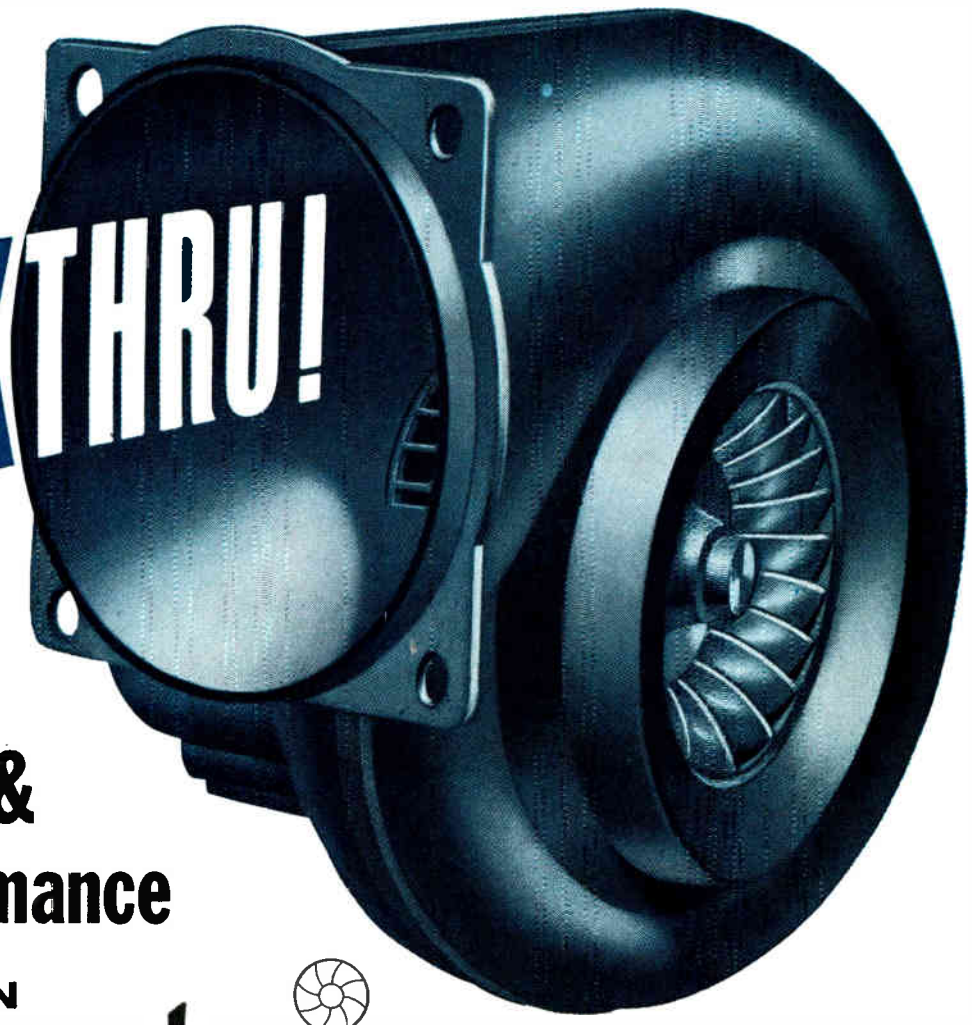

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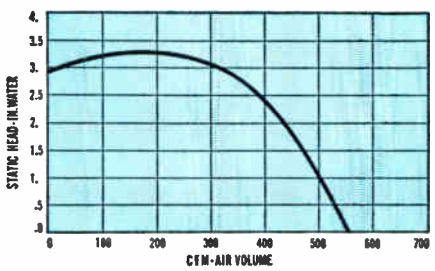

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By HERBERT M. ISAACSON
Defense Electronics Div.
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831 Broad St.
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The Impact of Integrated Circuits on Industry Roles

The development of integrated circuitry in its various forms is forcing major technical and economic changes in the industry. This article discusses the courses open to integrated circuit and equipment manufacturers.

CONVENTIONAL CIRCUITRY, composed of discrete components that are assembled and interconnected, has permitted the equipment manufacturer to retain design and manufacturing capability completely in his own hands. By the same token, component manufacturers have been able to provide the components needed by the equipment manufacturer at far less cost than he could make them for himself. The two segments of the industry, the equipment and the component, have been able to operate for many years to their mutual benefit without encroaching on each other's province. (It was not so in the early days of the radio industry, with many receiver manufacturers also making their own components.)

The main difference between conventional and integrated circuitry (I/C) is that the circuit elements and their interconnections are an integrated whole, as the name suggests. This fact upsets the traditional structure of the industry.

Limited Control


H. M. Isaacson

It means that the equipment manufacturer will no longer be able to dip into his box of components and evolve a new circuit, sub system, or system. Instead, he will have to deal with integrated circuit "black boxes," of stipulated input and output characteristics, within which he is restricted and over which he has but limited control. Several ways of obtaining a desired circuit function might be conceived, but the choice is determined not solely by the equipment manufacturer's capabilities, but also by the "black box" I/C manufacturer's facilities, process capabilities, and design ingenuity. The consequences are many.

For the manufacturer of components that are replaced by I/C elements it will mean a decrease in his market—perhaps a catastrophic decrease. He will be under pressure to convert—perhaps to become an I/C manufacturer, or an equipment manufacturer.

The transistor manufacturer will be faced with a declining market as transistors are superseded by I/C's. But, since the manufacturing technology for I/C's is but an extension of transistor manufacturing, almost all transistor manufacturers are making I/C's. Therefore transistor and I/C manufacturers can be considered one and the same. The loss of one market will be compensated for by the other.

Must Work Closely

Because of the interdependence of I/C design with I/C manufacturing process capability, the I/C and the equipment manufacturers must work closely to evolve optimum equipments. This interdependence imposes restriction on the equipment manufacturer in the areas of flexibility, contributed value, minimization of lead time, and retention of proprietary information. It requires a close and intimate relationship between the two, much more than required between traditional equipment and component manufacturers. One effect of this is to create a strong stimulus for the equipment manufacturer to attain I/C manufacturing capability. And, conversely for the I/C manufacturer to increase his contributed value still further and attain equipment manufacturing capability. There are large obstacles to either endeavor.

The I/C manufacturer who might want to enter the equipment field would have the task of creating a highly specialized equipment design and development engineering organization. He would also have to establish a fabrication facility and an effective marketing organization. He would learn that the relationship between equipment manufacturers and their customers, built up over a period of years, is not easily overcome. Also, having entered the equipment business and become a competitor of those in it, he would no longer have them as customers.

The equipment manufacturer who contemplates making his own I/C's would find some high hurdles in his

(*Continued on following page*)

A compromise for equipment manufacturers would be to buy master units and complete the etching, cutting and packaging.

INTEGRATED CIRCUIT IMPACT (Concluded)

path. The technology is very sophisticated, with some parts of it of trade secret or proprietary nature. Acquisition of it would be time consuming and expensive. The fabrication equipment and the highly refined controls needed are very costly—into multi-millions for a production facility. Tooling for a specific circuit is costly and the hazard of rapid technological obsolescence is high. Improvements or breakthroughs in manufacturing have repercussions on circuit designs, making feasible designs that were blocked by process limitations, thereby obsoleting existing designs.

All of this says that the volume of usage of I/C's must be high and the required life span before obsolescence short, to make amortization of design, tooling, and manufacturing facility costs economically acceptable. Volume of this sort does not exist in the military or aerospace fields. Application of I/C to industrial, commercial, and household equipments in the future might have requirement large enough to justify captive I/C facilities.

Compromise Arrangement

Certain compromise arrangements toward accommodation of the equipment manufacturer's desire to engage in I/C manufacture without the prohibitive costs are being explored. This may evolve as industry practice. The equipment manufacturer may enter only partially into I/C manufacture.

A large portion, perhaps half, of the cost of I/C manufacturing is in the mounting, connecting, and packaging operations after the making of the diffused wafer. The technology required is not too much different from that to which the equipment manufacturer is accustomed, modified of course for the changed form and size factor of I/C vs. conventional circuitry. Also, the process equipment cost for these operations is modest compared to that for making the diffused wafer. These are factors to induce an equipment manufacturer to attain this limited kind of I/C capability.

Some I/C manufacturers are looking for business in that market by offering circuits in wafer or chip form. These might be their standard circuits, custom designed circuits, or "uncommitted" or "master" wafers. The latter are wafers containing repeated arrays of transistors, diodes, and diffused passive elements, with an all over deposited aluminum film. Then by a photo resist and etching step performed by the equipment manufacturer, the aluminum film is etched to an interconnection pattern to the desired circuit formation. Various circuits can be formed using the same standard "master" wafer, by changing only the interconnection photo resist pattern. This is analagous to what the equipment manufacturer was able to do with discrete components.

Should he be willing to sacrifice a measure of flexibility, the equipment manufacturer could purchase his photo resist masks from specialized vendors. This would eliminate the need for mask making facilities.

While the use of "master" wafers has advantages of flexibility, minimization of lead time, and possibly retention of proprietary information, a portion of the wafer area is wasted since only selected elements in it are used. Hence, beyond a moderate quantity it is cheaper to use custom made I/C wafers.

By having his own I/C packaging capability, an equipment manufacturer could more readily use multichip designs wherein several circuit chips are mounted and contained within a single hermetic housing. Because the housing itself is an appreciable portion of the manufacturing cost of conventional I/C flatpaks, reduction in the number of housings used reduces its cost. Also, reliability is increased because the number of housing seals reduces the hazard from seal failure.

Reliability

A complicating factor for the manufacturer who buys circuits in wafer or chip form is reliability. When he buys a complete packaged I/C he also obtains the benefits of whatever reliability assurance programs the I/C manufacturer has established. While he still might have such benefits to the extent that failure modes were pertinent to the wafer itself, he would have to generate his own reliability information for the fabrication processes he performed himself. However, by using fabrication processes and equipment that coincided with those used by the I/C manufacturer, he would have reason to expect comparable reliability.

Because of the technical and economic benefits, alert equipment manufacturers are taking a hard look at the partial entry into I/C manufacture outlined here. Those who do so successfully will have an important advantage over the others.

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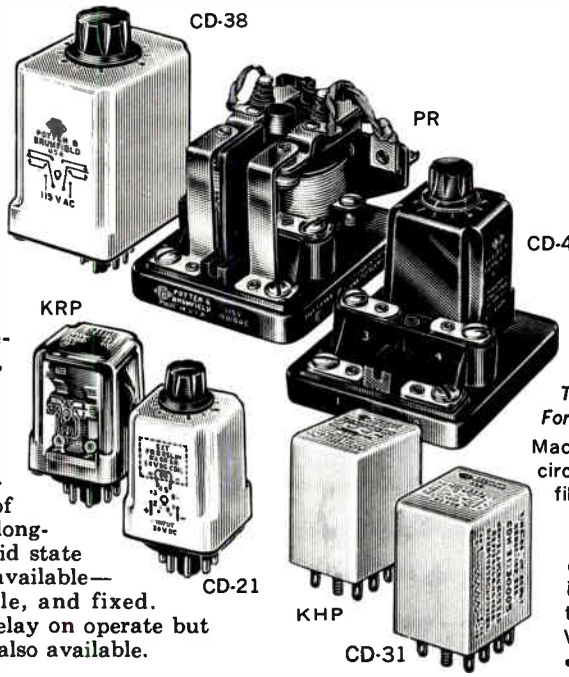

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CDB-38-70012	0.6 to 60	115V AC	1 & 7	52.45
CDD-38-30012	0.6 to 60	24V DC	1 & 7	49.50

NOTES

1. Has internal relay with DPDT contacts rated at 10 amperes, 115V AC. **2.** Use with Potter & Brumfield relay KRP5AG—115V AC, KRP11AG—115V AC or KRP14AG—115V AC. **3.** Use with Potter & Brumfield KRP5DG—24V DC, KRP11DG—24V DC or KRP14DG—24V DC relay. **4.** Use with Potter & Brumfield KHP17D11—24V DC relay. **5.** Resistor-adjustable. **6.** Use with Potter & Brumfield PR11AY—115V AC relay. **7.** Provides delay on release; all others have delay on operate.

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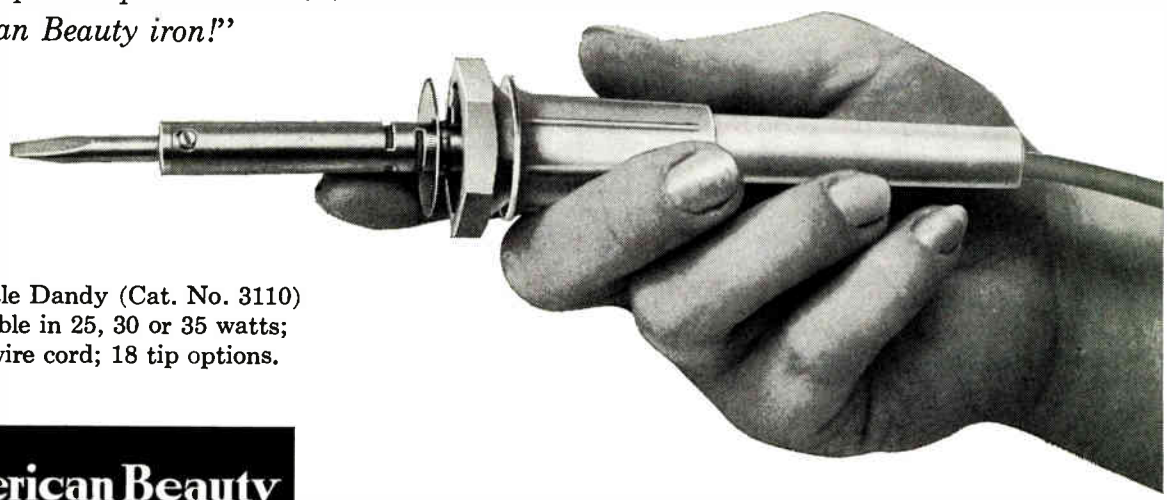

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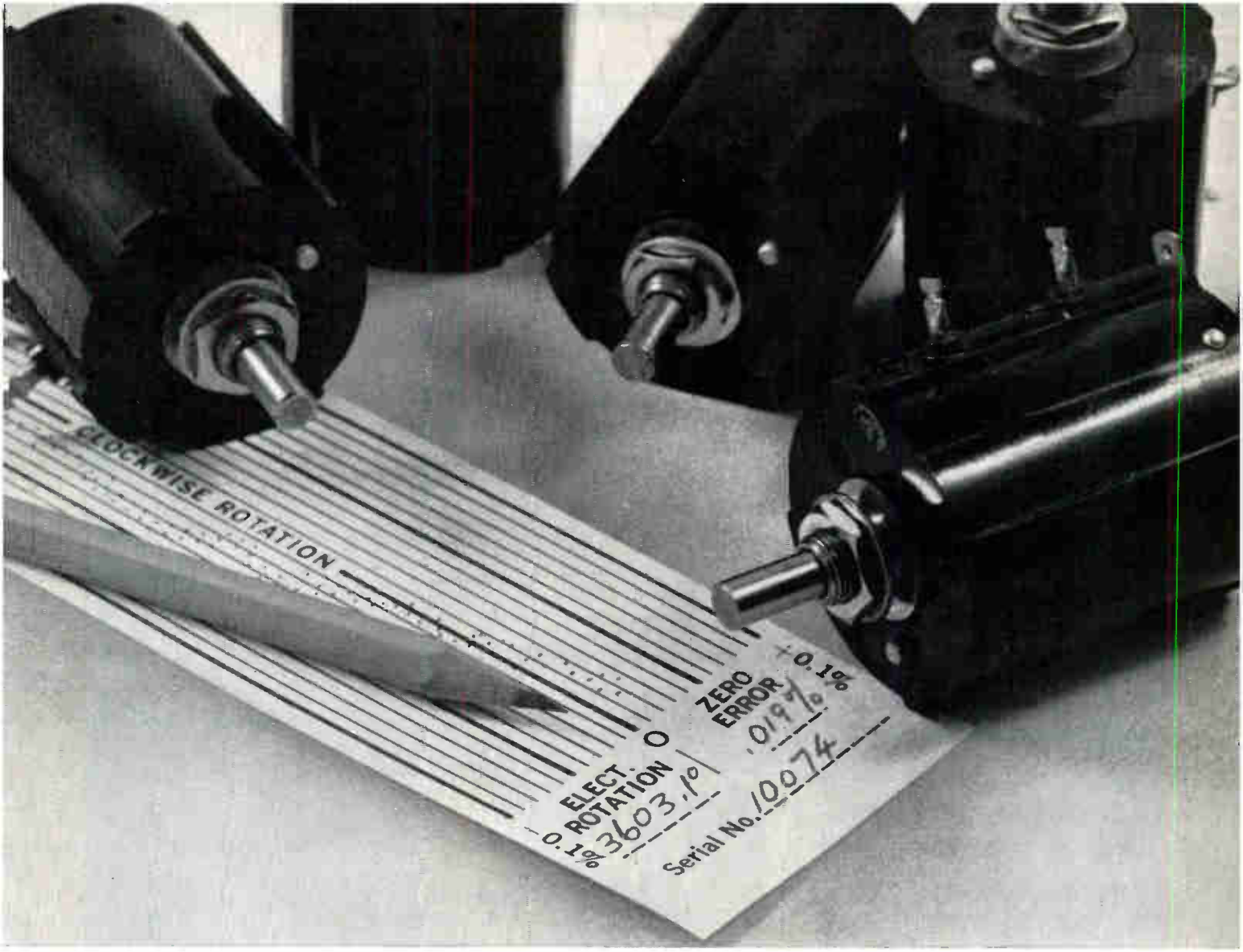

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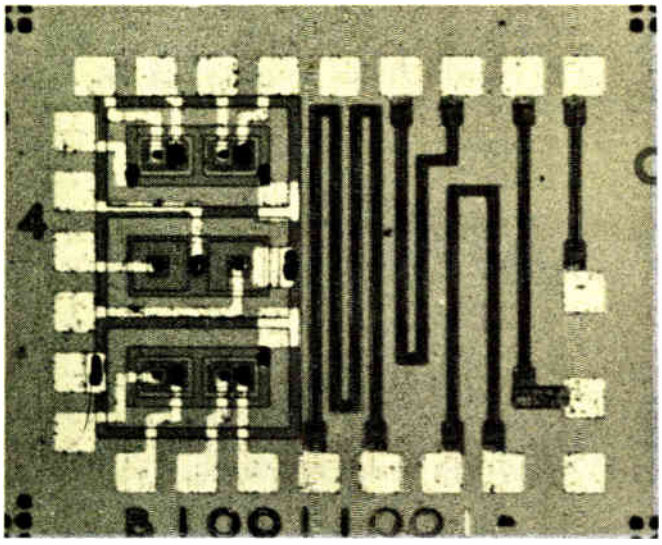

Fig. 1: Microphotograph of experimental chip.

There are different approaches to combining metal film resistors with oxide passivated semiconductor devices. One such approach is discussed here. It is a case history of the design and construction of a high-gain, three-stage operational amplifier with a Darlington output in I/C form.

Mating The Thin Film and Semiconductor

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FEATURE

When the first monolithic microcircuits were built, their performance was much poorer than that of circuits made from normal discrete components. This was because performance of individual components used in the monolithic circuits was limited.

This gap between monolithic microcircuit components and standard components has since narrowed. As a result, performance and complexity of I/C's has improved greatly.

Performance was improved by the successful marriage of thin film technology and oxide passivated semiconductor technology. Basic limitations of diffused resistors are greatly reduced by using metal film resistors on top of silicon dioxide.

At present, there are different ways of combining metal film resistors with oxide passivated semiconductor devices. Here we will deal with the approach used at CBS Laboratories. Capability of this technology is shown by a case history analysis. The analysis is made of the building of a high impedance, high gain, three stage operational amplifier with a Darlington output in I/C form.

* * *

Before attempting to design and build a microcircuit two things must be known. These two are the capability of the technology and the electrical characteristics of the microcomponents to be used.

To establish the data necessary for evaluation a test vehicle was designed. It contained six resistors, four transistors and two semiconductor capacitances, Fig. 1. Line-width of the metal-film resistors is one mil. The transistors have a 2 x 2 mil emitter area with the collector 3.5 x 4 mil.

Transistor Technology

The transistor fabrication process is fairly standard. When the transistors are built a smooth pin-hole free oxide must be left. This serves as substrate for the deposition of the thin metal films used for resistors. Design of the high-gain high impedance amplifier with low output impedance requires transistors tailored to show high gain at low current levels. The higher the bulk resistivity of the wafer, the easier it is to get high gain transistors. But, high resistivity means high-collector series resistance. Thus, NN+P epitaxial material is used.

Transistor Characteristics

With normal circuits, the designer has freedom in selecting transistors. In designing microcircuits he loses this freedom. It is still not possible to build every type of transistor available as an individual component. And the circuit designer has to live, in a microcircuit, with one specific transistor type. Also, this one type will most likely show a bigger spread in electrical characteristics than individual components. Remember that transistors sold as individual units are usually screened into different categories.

It is now obvious what one has to do to specify microelectronic transistors—Electrical characteristics of the device must be specified. The natural spread of characteristics on a wafer achieved by the specific fabrication process must also be specified. Only if both are taken into account will a microcircuit work.

By MAX J. SCHULLER
Manager,
Microelectronic Technology Branch,
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High Ridge Road,
Stamford, Conn.

Technologies

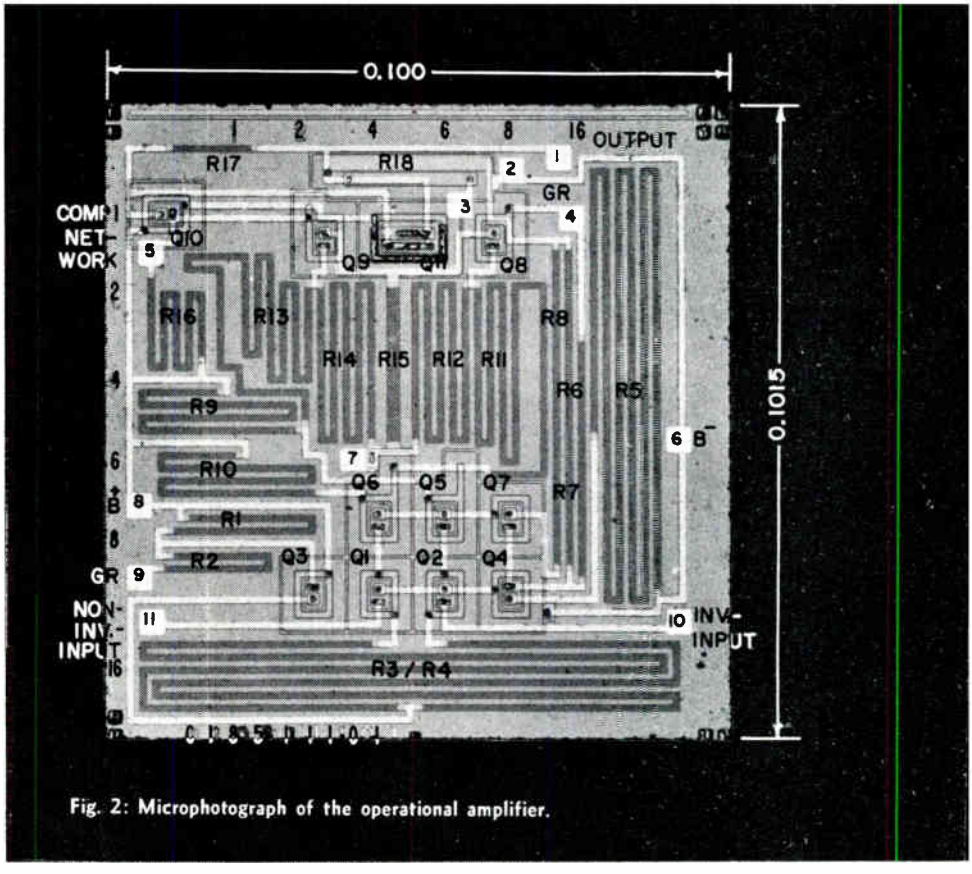


Fig. 2: Microphotograph of the operational amplifier.

The most important parameters for the circuit to be designed are h_{FE} and V_{BE}. In both cases not only is the average value important but so is the spread and the temperature dependence. For some parameters (leakage current, breakdown voltages, junction capacitances, etc.) it is enough to know that the specific parameter does not exceed a certain value at a specific temperature.

Fig. 3 shows the typical h_{FE} vs. I_C relationship for the developed lowpower transistor. Fig. 4 shows the typical distribution over a wafer.

A typical distribution of the difference of V_{BE} for a fixed collector voltage and current for transistors located right next to each other is shown in Fig. 5.

Other importnat electrical parameters are summarized in Table 1.

This data shows that the developed transistor is equal to the best available low signal transistors. Its V_{BE} tracking capability is almost as good as the best available matched pairs.

Resistor Technology

The resistors are built by vacuum deposition. Standard vacuum deposition methods had to be modified to make them compatible with the oxide passivated semiconductor technology. To make the thin-film technology compatible with semiconductor technology, resistor dimensions must be in the same range as the semiconductor devices. Present day transistors are in the mil range, thus, the resistors must be in the mil range. One mil line widths were used as the lower limit for resistors. Presently only photographic methods using glass emulsion masks and photo sensitive emulsions can satisfy the above needs economically.

There are two standard ways of depositing metal films on dielectric substrates: evaporation and sputtering. Only the problems concerning the evaporation method are considered here, though some are common to both methods.

To produce stable and reproducible metal films on any type of substrate, the substrate must be cleaned in a special way. Some cleaning methods include chemicals, electron and ion bombardment, heating of the substrate to high temperatures, etc.

Applying the standard methods of fabricating metal films to substrates having p-n junction devices destroys the transistors and diodes. Common effects are decreasing of h_{FE} by a factor of 10 and more, increase of leakage currents by three or four magnitudes and instability of electrical characteristics under life tests. Other common effects are formation of channels and generating pin holes in the silicon dioxide.

Only by closely controlling all thin-film processes is it possible to avoid destroying or changing the semiconductor devices in making reliable metal films.

Material Used

Various materials are available for making metal film resistors. Two types of metal films are needed to build microcircuits. One is the high-resistance film which forms the actual resistor. The second is a low resistance film used to interconnect the resistance films and semiconductor devices.

If films of different materials are used for the two functions they must not react with each other at the

(Continued on following page)

evaporation temperatures or over the circuit's normal operating temperature range.

In these circuits, gold is used for interconnections and NiCr (80%, 20%) as resistance film. Gold is inert to chemicals, gases and NiCr. NiCr was used because of its ease of evaporation and proven record as resistance film.

Additional Problems

In the same way the thin-film process had to be modified to account for effect on p-n junction components, the standard processes used in making semiconductor devices must be modified. After a wafer with semiconductors is processed, it is scribed into chips using a diamond needle. It is then mounted on a substrate and lead connections are made from the chip to the package. Some of these processes can affect or destroy the metal films.

Because these films are only in the 50 - 100 Å range, silicon dust generated during scribing can scratch and open the metal film. Exposure to high temperature ambients during packaging operations (chip mounting, lead attachment) can change or destroy the thin metal-film. Minute amounts of chemicals can eat the resistance film away.

An effective way out of these problems is to coat the film with a relatively thick dielectric layer. Evaporated silicon monoxide is effective in this regard. It protects against mechanical, chemical and heat damage.

Resistor Characteristics

An engineer designing with standard resistors is interested in resistance, tolerance, temperature coefficient, power rating and long life stability. In designing microelectronic circuits, these parameters are still important, but each shows a certain spread due to the limits of the technology. Resistors cannot be selected as done on a production line. Even adjusting of resistors is often impractical because it's difficult to measure the resistors in a completely interconnected network.

In making the resistors, 400ohms/square sheet resistance and one mil line widths were used. Test data shows that ± 20% is well within the state of the art.

Relative Tolerance

By going from 1 mil to 5 mil resistors, an improvement of a factor of five can be achieved in respect to relative tolerance (from 3% to 0.5%).

Long-Life Stability

A process capable of producing resistors with tight absolute and relative tolerance is worthless unless the

Table 1 IMPORTANT ELECTRICAL PARAMETERS

PARAMETER	SYMBOL	CONDITION	TYPICAL VALUE
Dc Current Gain	h_{FE}	I_c = 10 μa, V_{CE} = 3 v, T = 25°C	100
Emitter to Base Voltage Matching	ΔV_{BE}	I_c = 10 μa, V_{CE} = 3 v, T = 25°C	4.7 mv
Emitter to Base Voltage Tracking	$\frac{\Delta V_{BE}}{\Delta T}$	I_c = 10 μa, V_{CE} = 3 v, T = +25°C to (− 55°C)	3.7 μv/°C
Emitter to Base Voltage Tracking	$\frac{\Delta V_{BE}}{\Delta T}$	I_c = 10 μa, V_{CE} = 3 v, T = 125°C to 25°C	22 μv/°C
Collector cut-off Current	I_{CBO}	V_{CB} = 10 v, T = 125°C	15 na
Separation Junction Leakage	I_{CSO}	V_{CB} = 10 v, T = 125°C	25 na
Emitter cut-off Current	I_{EBO}	V_{EB} = 5 v, T = 125°C	10 na
Output Capacitance	C_{ob}	V_{CB} = 0 v, f = 1 MC	1.76 pf
Input Capacitance	C_{ib}	V_{EB} = 0 v, f = 1 MC	2.35 pf
Isolation Capacitance	C_{cs}	V_{CS} = 0 v, f = 1 MC	14.1 pf

resistors are stable under operating conditions. The resistors described here are designed for continuous operation at 125°C, and 150°C storage. Fig. 6 indicates the drift of values for the microresistors when operating at different power levels. It shows that at up to about 300 μa/mil line width, the change after 1000 hrs. of life test is negligible compared to zero power dissipation.

Fig. 7 is the distribution of the change of resistor values which were on life-test for a total of 1000 hrs. at 150°C. Average change of resistor value is 0.3%.

Fig. 8 shows the change of resistor value under step stress conditions. Only beyond 350°C does this types of resistor fail catastrophically. Table 2 summarizes these characteristics.

Operational Amplifier Design

After component characteristics are determined actual circuit design can proceed. The design is first tested by building a breadboard using separate microcomponents.

Fig. 9 is the circuit diagram of the amplifier. It contains a total of 11 transistors and 18 resistors. Total resistor value in the circuit adds up to about 750 K ohms. Resistor values range from 150 K ohms to 1 K ohm.

Main goal of the design was to get high ac and dc

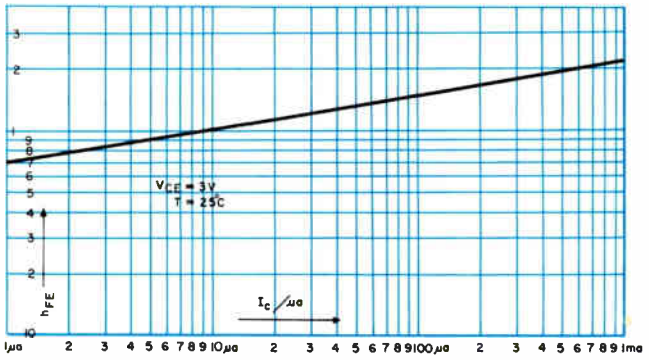


Fig. 3: Typical h_{FE} versus collector current relationship for the developed low-power microcircuit transistor.

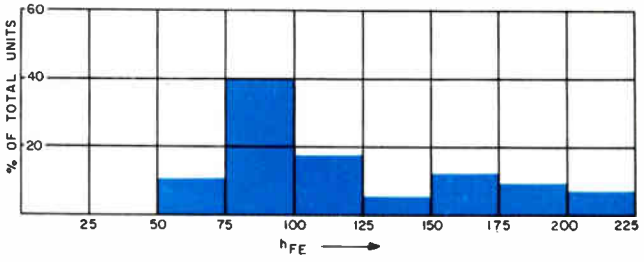


Fig. 4: Typical distribution of h_{FE} over a wafer.

Fig. 5: Typical distribution (right) of V_{BE} for adjacent transistors over wafer. (I_c=10 ua, V_{CE} =3 v).

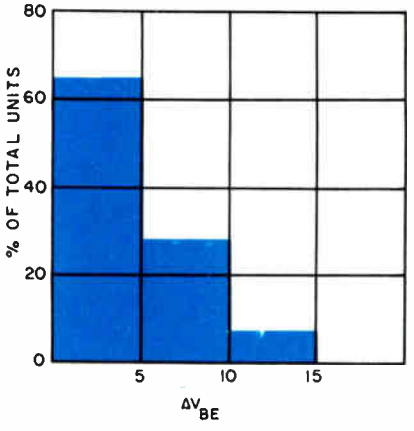


Fig. 6: Change of resistor value (below) with load conditions (T=125°C, t=1000 hours).

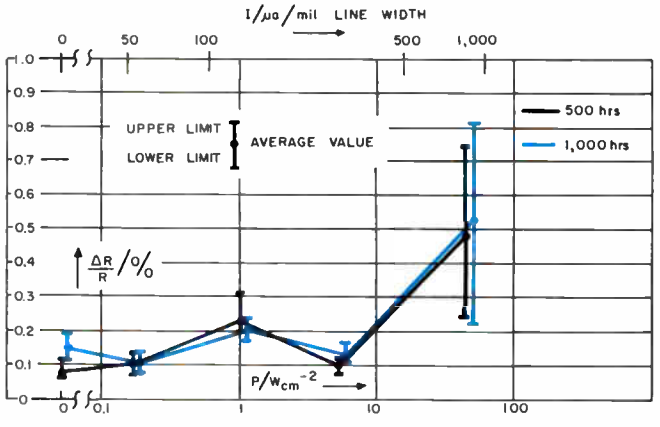


Table 2 RESISTOR CHARACTERISTICS

Absolute tolerance ± 20%.
Relative tolerance 1 mil ± 3%, 5 mil ± 0.5%.
Power Rating 300 μa/mil line width $\frac{\Delta R}{R} < 0.5\%$ **125°C 1000 hrs.**

High temp. storage (150°C) $\frac{\Delta R}{R} < 0.5\%$ **1000 hrs.**

Temp. coefficient ± 150 ppm from −55°C to 125°C.
Matching of Temp. coefficient ± 20 ppm from −55°C to 125°C.

Table 3

Wafer No.	β (I_B = 1 μa, V_{CE} = 30)	A
1	50	2600
2	85	5180
3	180	6560
4	60	2870

input impedance without sacrificing gain, and to get good common mode rejection and low output impedance. This was achieved by operating the transistor of the first stage at low current levels and using three amplifying stages and a Darlington emitter follower output stage.

Operational Amplifier Fabrication

Amplifier fabrication can be broken down into three phases: (1) building of microcircuit masks, (2) diffusion and evaporation of components and (3) packaging of microcircuits.

Fig. 2 is a microphotograph of the amplifier. All transistors are the same size except Q_{11}. This one's size has been increased by a factor of five because of the high current in the output stage. Distance between oxide windows is 0.5 mil on all transistors.

Q_{11} and R_{18} are the heat generating elements in the circuit. Thus, transistors in the first two stages have been moved as far as possible from Q_{11} and R_{18}.

The transistors which must be matched to assure good performance of the circuit have exactly the same electrical lay-out. Also, they are positioned symmetrical to the heat generating area of the circuit (Q_{11} and R_{18}).

Power dissipation per resistor can range from 100 mw to 100 μw.

One basic design rule for CBS's metal film resistors is that power rating of a 400 ohms/square film is 300 μa/mil line width (5.75 w cm^{-2}). Using this figure, all resistors except R_{18}, R_{15}, can be laid out for one mil line-width and 400 ohms/square. The current through R_{15} is about 500 μa. Thus, the line-width of this resistor is increased to two mils.

Resistor R_{18} has the highest power dissipation. A maximum of 10 ma can flow through it. Thus, no attempt was made to use 400 ohms/square for this resistor. Two versions of this resistor are included in the lay-out. One is a semiconductor resistor using the base diffusion and the other a metal film resistor using 100 ohms/square. The metal film resistor is permanently connected into the circuit. The diffused resistor is used as back-up for the thin-film one.

Resistors which have to be matched in the circuit to achieve good performance require geometries as identical as possible. These are: $R_3=R_4$, $R_9=R_{10}$, $R_{11}=R_{13}$, $R_{12}=R_{14}$.

Because of circuit complexity, it was difficult to avoid cross overs. In two instances the N+ diffusion of the collector contact (Q_3 and Q_4) was used as cross over. In one case, the p-type separation diffusion was used for carrying the B^- supply voltage. Chip size of the operational amplifier is 100 mil by 102 mil. About 50 good units fit on a wafer.

Fig. 7: Graph at the left shows the distribution of the change of resistor values which were on life-test for 1000 hours at 150°C.

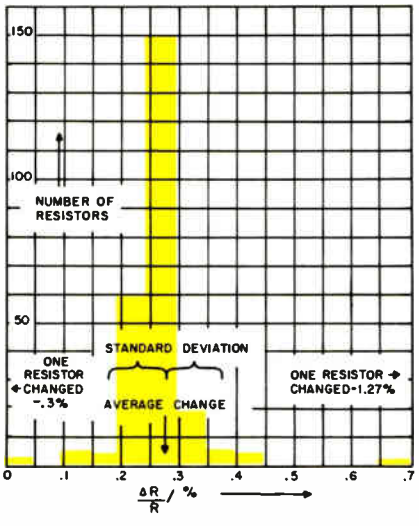
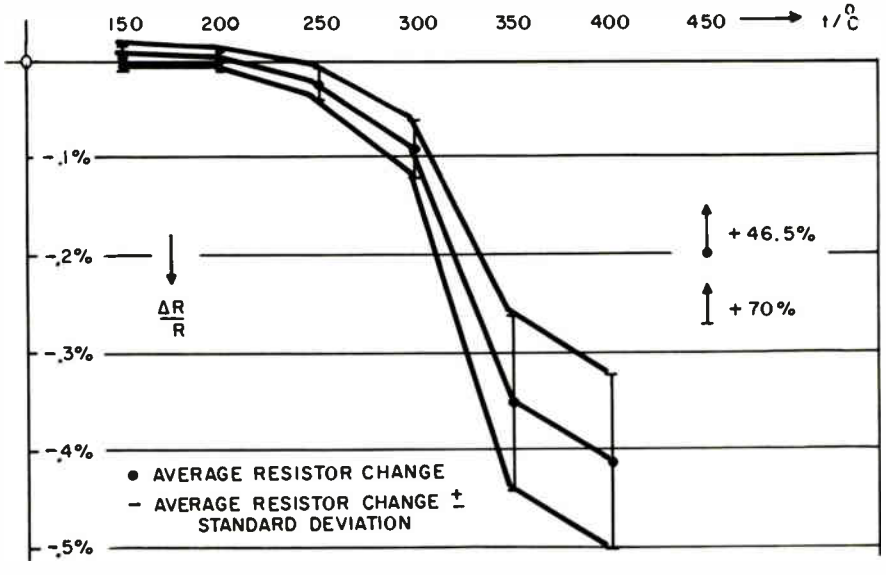


Fig. 8 (below): Step-stress test on thin-film resistors. (Resistors were stored for twenty-four hours at each temperature.)



Components Fabrication

As expected, a certain spread of transistor characteristics showed up from wafer to wafer. Their most critical parameter is their gain. If they do not show enough gain the amplifier would either not bias itself or not show enough gain. Wafers with different average transistor gain, even below the specified value, were processed to find how the amplifier characteristics changed. The results are discussed later.

To make sure that the resistors in the symmetrical path were well matched, a test run was made to check the geometrical layout. Most of the resistors were well within ±1%.

A standard flat pack or TO-5 can be used in mounting the amplifier. The leads are attached using standard thermo compression bonding methods.

Electrical Evaluation

The microelectronic version of the amplifier was compared against the breadboard using microcomponents. Table 4 shows a full list of characteristics on the first production lot. Whenever available the data measured on the breadboard were included.

In every respect the monolithic version of the differential amplifier is better than the breadboard with one exception. Open loop voltage gain is somewhat lower in the integrated version. This is because in the first production lot a couple of wafers were included which did not have the needed high gain transistors. This was done intentionally to find out what gain was actually needed to satisfy the circuit.

Table 3 shows how the average gain of this amplifier changes with the average gain of the transistors.

The monolithic thin-film/semiconductor technology at CBS Laboratories was developed with the cooperation of E. Littau and J. Kostelec.

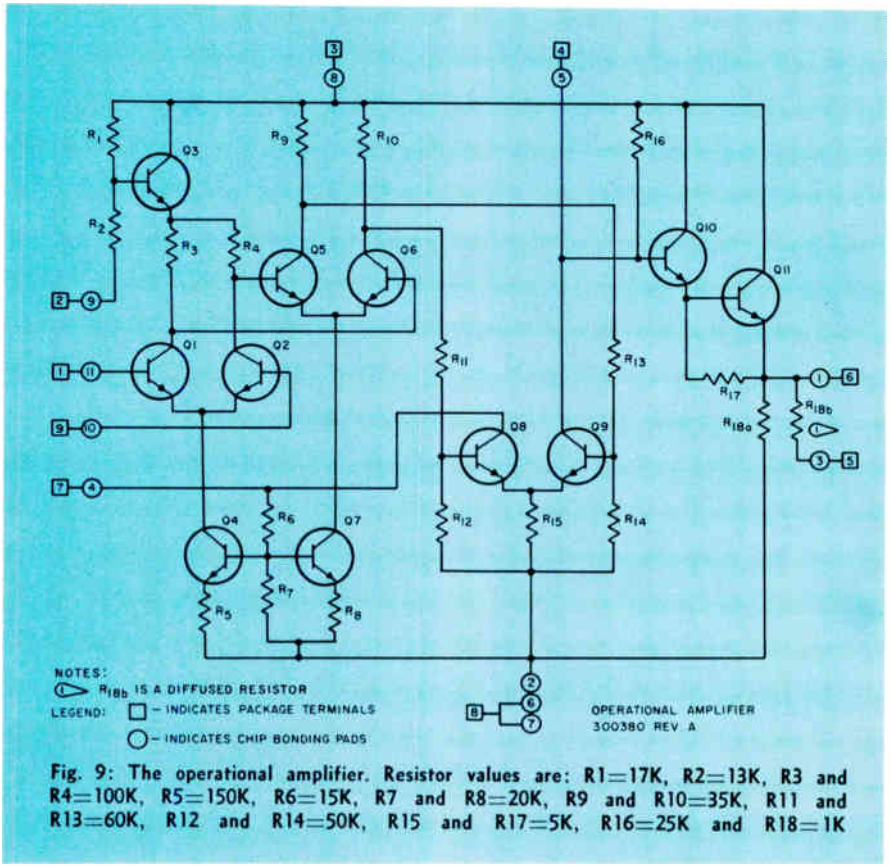
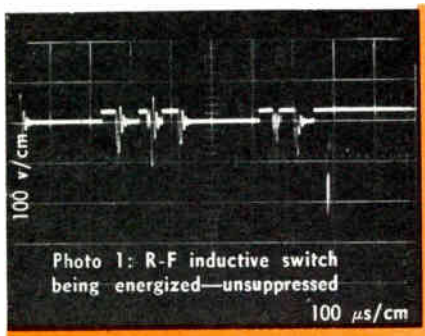


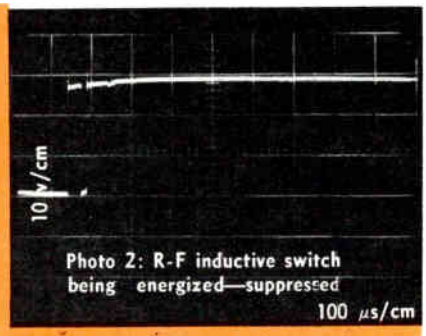
Fig. 9: The operational amplifier. Resistor values are: R1=17K, R2=13K, R3 and R4=100K, R5=150K, R6=15K, R7 and R8=20K, R9 and R10=35K, R11 and R13=60K, R12 and R14=50K, R15 and R17=5K, R16=25K and R18=1K

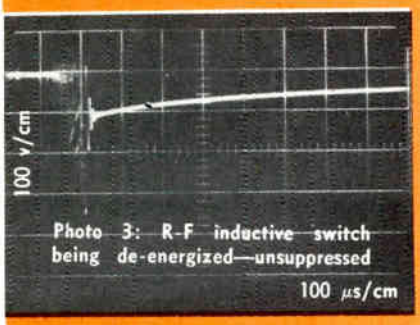
Table 4

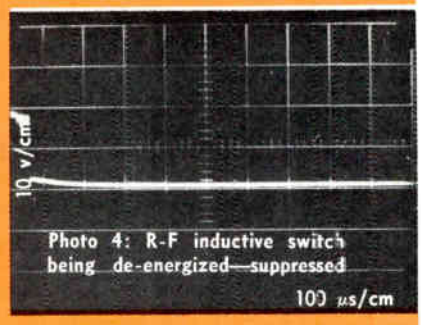
Comparison of Monolithic Version of Operational Amplifier and Breadboard Using Microcomponents

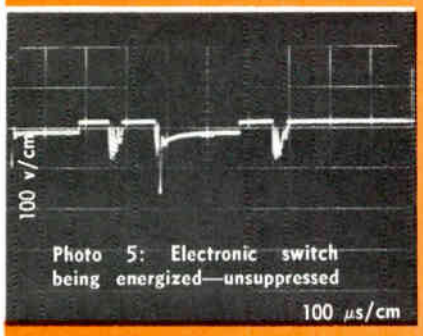
Parameter	Units	Condition	Monolithic $V^+ = 6v$, $V^- = -6v$ Typical	Breadboard $V^+ = 6v$, $V^- = -6v$
T = 25°C				
Input Offset Voltage (ΔV_{in})	mv	—	2.23	3
Input Offset Current (ΔI_{in})	μa	—	0.048	0.3
Input Impedance (R_{in})	KΩ	1 KC	400	—
Input Bias Current (I_{in})	μa	—	0.25	—
Common Mode Rejection Ratio (CM_{RR})	db	1 KC	87	65.5
Open Loop Voltage Gain (A_{vo})	—	1 KC	4400	6775
Open Loop Band Width (B_o)	MC	—	0.091	0.033
Output Impedance (R_o)	Ω	—	26	—
Output Voltage Swing	v	—	+3.2	—
		—	−3.9	—
Noise Referred to Input	μv	—	20	25
Pos. Supply Voltage Sensitivity	μv/v	—	190	—
Neg. Supply Voltage Sensitivity	—	—	135	—
Dc Supply Power (P)	mw	—	87	93
T = −55°C				
Input Offset Voltage	mv	—	2.4	—
Input Offset Current	μa	—	0.15	—
Open Loop Voltage Gain	—	—	1626	—
Input Bias Current	μa	—	0.792	—
T = 125°C				
Input Offset Voltage	mv	—	2.0	—
Input Offset Current	μa	—	0.0124	—
Open Loop Voltage Gain	—	—	6000	—
Input Bias Current	μa	—	0.12	—
Avg. Temp. Coeff. of Input Offset Voltage				
−55°C — T — 25°C	μv/°C	—	25	—
25°C — T — 125°C	μv/°C	—	5	—

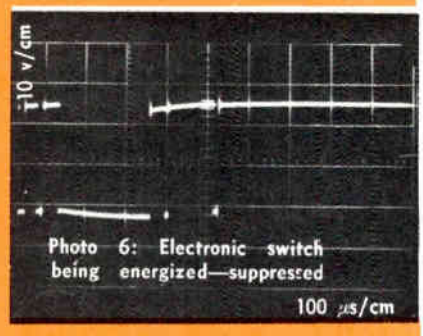


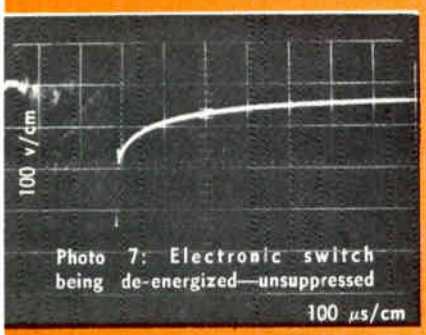


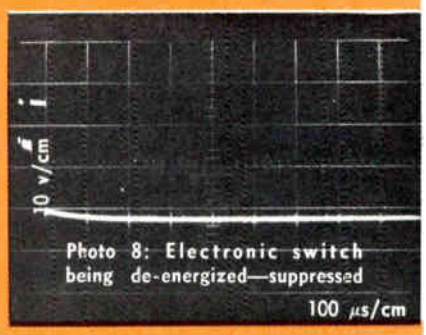


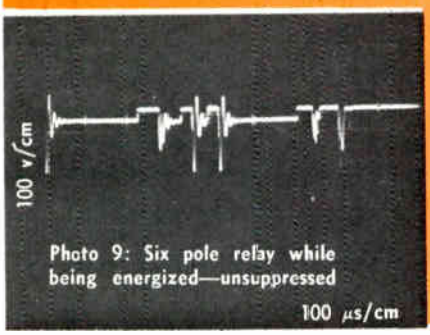


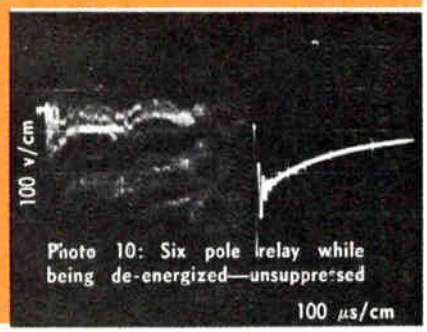












Measuring

IT IS ALMOST COMMON KNOWLEDGE among engineers that dc relays, inductive switches, and similar devices are generators of transients. However, what is not realized is the extend of magnitude and duration in which these transients occur. Since these devices operate mostly from a 28vdc supply source, they imagine transients occuring up to 3 or 4 times the voltage rating, or 100 v, and for a short undefined duration. Actually, transients from these devices can exceed 600 v and last for durations measured in tenths of a millisecond.[1] It is for this reason that the following tests were performed.

* * *

Four items were selected at random from a system presently being designed by AEL. These items consist of

Item	Type	Current Rating
A.	R-F Inductive Switch	240 ma
B.	Electronic Switch	200 ma
C.	Relay - 6 pole	140 ma
D.	Relay - 4 pole	115 ma

These were standard unsuppressed inductive devices which were used throughout the system. They are typical units which may be used in any given system. Each was a product of a different well known

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DC Relay Coil Transients

It is no surprise that relays generate transients. But most engineers do not realize the magnitude and duration of these transients that create RFI and can burnout parts. Here are the results of some tests, along with suggestions for reducing transients.

manufacturer. They were designed to operate from a 26.5 vdc source, but to draw a different current.

Measuring Procedure

The test setup used in transient measurements is simple and straight forward. The only measuring device used was a Polaroid camera and an oscilloscope, Fairchild Model No. 766H with a model 76-02A Amplifier head and 74-03A time base generator. A 10:1 probe was used as a pickup device due to the magnitudes of transient voltage. A sketch of this test setup is shown in Fig. 1.

Each item was tested individually. The ramp resulting from switching the toggle switch was used to trigger the oscilloscope and photographs were made of the resulting transients. After the transients were recorded, suppression components such as capacitors, R-C networks, diodes, etc., were placed across the inductor windings. The results were again photographed.

Further tests were made into the cause of the h-f hash associated with the transients by placing capacitors across the toggle switch.

Switch 1 had two inductors. For this test, the inductors were connected in parallel. This resulted in the evaluation of two identical switches connected in parallel, as they often are in equipment.

Test Results

The scope was calibrated at 100 v/cm on the vertical scale and 100 μsec/cm on the horizontal scale for all photographs. For the suppressed transient case, the time base was the same, but the vertical scale was calibrated at 10 v/cm.

The results of testing the r-f inductive switch will be discussed in detail. The results occuring from the other items will be discussed more briefly since they are similar. Table 1 is a tabulation of the results.

R-F Inductive Switch

Photo 1 is the result of energizing the two inductors associated with the switch, which were connected in parallel. The toggle switch contacts bounced six times before steady state dc was reached. It took about 750 μsec for this to take place. The ringing, which occurred with each bounce, was the result of the momentary de-energizing of the inductive load and is estimated to occur at about 150 KC. The peak-to-peak transient is shown as 200 v. The other hash noted between the bounce and transient is due to arcing across the toggle swith contacts (this was later proven).

Photo 2 is the result of suppressing the inductive switch by placing a 1N538 diode across the inductor terminals. The toggle switch bounced only twice and it took about 0.19ms to achieve a steady dc potential. Note the absence of ringing or arcing. The only transients shown are about 4 v overshoots when the voltage reaches +28 v.

Photo 3 is the result of de-energizing the unsuppressed switch. A transient of over 400 v peak-to-peak is shown with 150 KC ringing. The other noise or hash with the transient is the result of arcing across the toggle switch as the contacts are broken. The transient occurs for 300μsec and there is a delay of more than 250μsec before zero volts is smoothly approached. It takes over 700μsec to reach a steady zero potential.

Photo 4 is the result of de-energizing the switch with a 1N538 diode across its terminals. A small amount of arcing is noted during

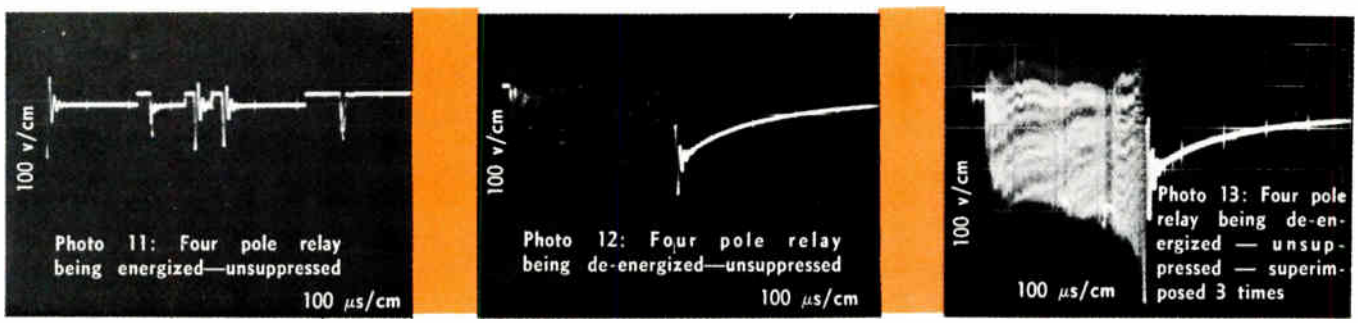

Photo 11: Four pole relay being energized—unsuppressed

Photo 12: Four pole relay being de-energized—unsuppressed

Photo 13: Four pole relay being de-energized — unsuppressed — superimposed 3 times

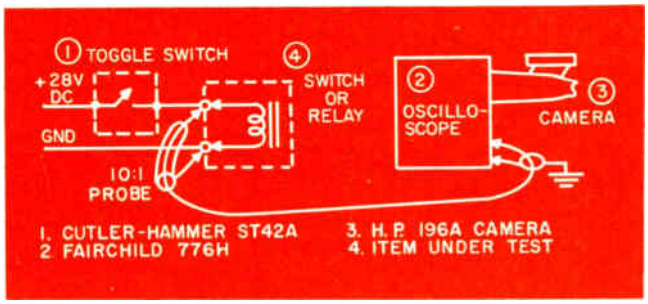

Fig. 1: Test set-up used to measure coil transients.

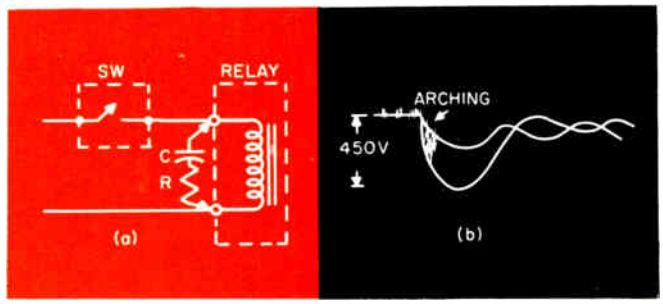

Fig. 2a: Connection of R and C across coil and (b) its effect.

the 70μsec delay before the voltage drops to zero. The voltage appears to drop in steps. The photograph shows a step to 18 v in about 20μsec and then to zero volts in 50μsec. The cause of this stepping phenomenon is believed to be due to the mechanical properties in the switch, although this has not been proven. A slight notch in the spring tension of the switch could be felt as it is slowly opened.

Electronic Switch

Photo 5 is the result of energizing the Electronic switch. The transient and bounce are similar to that of the r-f inductive switch, which is compared in Table 1.

Photo 6 is the result of energizing the Electronic switch with a 1N538 diode across the inductor terminals. There is much more contact bounce than that for the suppressed r-f inductive switch. Also, the overshoot reaches a peak of about 8 v.

Photo 7 is the result of de-energizing the Electronic switch. The duration of the arcing is about twice that of the r-f inductive switch and less than half of that of the relays. The duration of the arcing and transient appears to be inherent.

Photo 8 is the result of de-energizing the switch with a 1N538 diode across the inductor terminals. The transient is suppressed and the 18 v step is still evident, even though the voltage goes back to 28 v before ending at zero.

Six Pole Relay

Photo 9 is the result of energizing the relay. It is similar to the results of the other items tested since most of the noise is due to contact bounce. This was suppressed by placing a 1N538 diode across the relay terminals. Since the results are similar to that for the switches, photographs of this were not taken.

Photo 10 is the result of de-energizing the relay. Note the long duration of the arcing and transient. It takes almost 1 ms for the reaction to stabilize and the potential to reach zero. This appeared to be completely eliminated by placing a 1N538 diode across the relay terminals.

Four Pole Relay

Photo 11 is the result of energizing the relay. Note that the first transient exceeds 200 v. Transients were eliminated and the bounce reduced by placing a 1N538 diode across the relay terminals.

Photo 12 is the result of de-energizing the relay. Photo 13 is the same as Photo 12 except that the switch was de - energized three times with the results superimposed. The difference between the six pole and four pole relay results seem to be in the duration of the arcing and transient. The six pole relay, which draws more current, has the longer transient duration.

Other Tests

Although the placement of a diode across the inductive switch or relay coil appeared to suppress the transient and arcing, other components were also tried. The four pole relay was used in the following test. The de-energizing cycle was used since it generated the largest transient.

A capacitor and resistor series network, R=110Ω and C=0.1μf, were placed across the relay terminals as shown in Fig. 2a. The transient generated as shown in photo 12 was reduced to that shown in Fig. 2b. It appears that the R-C network in parallel with the inductor forms a tuned circuit. The transient is shaped into two damped sine waves with a peak amplitude of 450 v. Note also that the arcing noise was reduced.

A capacitor, C=0.1μf was placed across the toggle switch as shown in Fig. 3a. The arcing was almost eliminated, although the transient was still present as shown in Fig. 3b. It took almost 1 ms for the voltage to reach a steady zero potential. Also notice the presence of two transients, probably due to the charging action of the capacitor and/or the imperfect switching action of the toggle switch. The value of capacitance was changed to .0022μf. The results are shown in Fig. 3c. The arcing across the switch was quite evident and the transient reached a peak of 400 v.

The .1μf capacitor was placed across the terminals of the relay as shown in Fig. 4a. The results were the same as in Fig. 3b. If we consider the 28vdc power source to be a low impedance, the capacitor is effectively still across the switch. However, the capacitance was changed to .0022μf with results as shown in Fig. 4b. Note that the transient reached a peak to peak value of 700 v. Also, much arcing was present.

Conclusions

Results indicate that standard inductive devices, such as relays and switches, operating from a 26.5 vdc source can generate transients exceeding 600 v. in amplitude. Furthermore, it can take up to 900μsec. for the transition from the energized

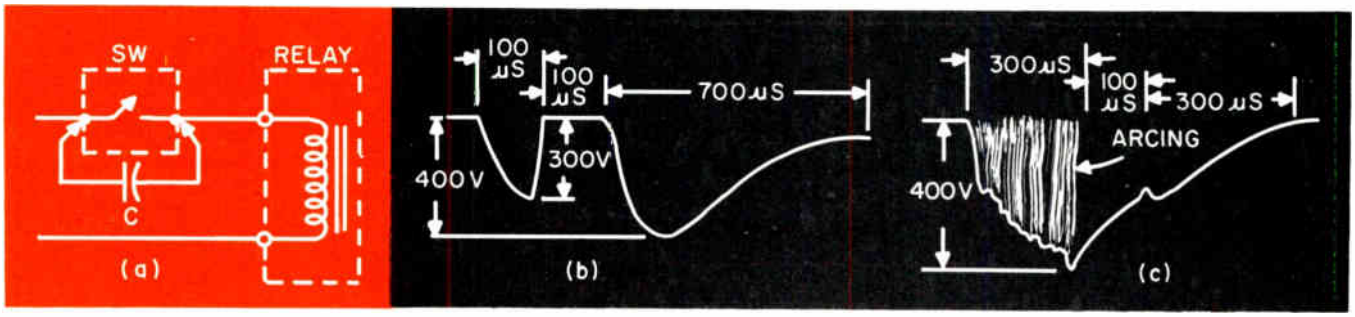

Fig. 3: C=0.1μf in (a) above. Arcing was almost eliminated (b) with transient still present. Capacitor was changed to .0022 μf in (c) above.

to the de-energized state to occur. These transients can exceed RFI specifications and be harmful to circuitry.

There is nothing mysterious as to why the transients occur. Consider a steady state dc current flowing through the coil. At the instant the switch is opened, the current very rapidly decreases to zero, i.e., a large negative di/dt is created. Thus, since the voltage across an ideal inductor is equal to,

$$e = L \frac{di}{dt}$$

L = inductance of device in henries

a large negative voltage transient is generated. The magnitude of di/dt is a function of the speed at which circuit is broken and the current flow is stopped. The induced voltage initiated an arc across the contacts that are breaking the circuit.

By placing the diodes across the terminals of the relay or switch, the following was observed:

1. The toggle switch bounce was reduced.
2. The overall switching time was reduced.
3. The arcing across the toggle switch contacts was reduced or eliminated.
4. The transients were reduced or eliminated.

Two diodes were used consistently as suppressors in the tests and therefore can be recommended. They are the 1N645 and 1N538. However, care must be exerted when selecting diodes. The current ratings must be adequate or the I^2T rating for fusing of the diode should never be exceeded. A safe way of selecting diodes is to have the current rating at least equal to that of the device to be suppressed.

Another consideration is the switching time of the diode. If it is too slow, a transient may start to build before the diode turns on. It is interesting to note that about six different diodes were tried, some of which were power diodes, and none failed to suppress the transients.

In system design, the conducted noise can be reduced by isolating the relay circuits from the rest of the system. To maintain this isolation and prevent the relay system from floating, and possibly reaching a high potential above ground, it should preferably be grounded at a single point. The ground connection should be made at the source.[3]

The author would like to acknowledge the cooperation and helpful assistance rendered by Messrs. D. Shapiro and C. Haubrich of AEL in performing the transient tests.

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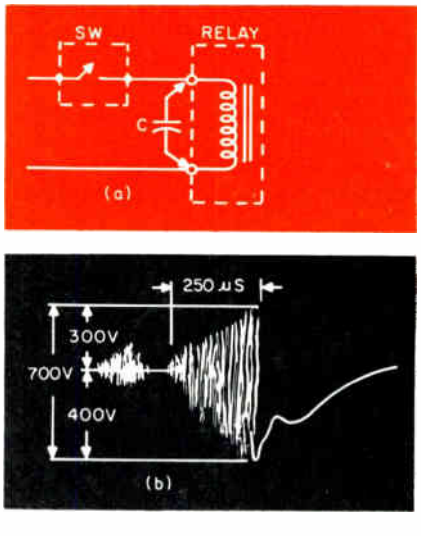
2. "Design Techniques for Interference — Free Operation of Airborne Electronic Equipment" Air Force Document ATI 159699: Prepared by Frederick Research Corp. 1952.
3. Rocco F. Ficcki "The Grounding of Electronic Equipment" Eighth Tri-Service Conference On Electromagnetic Compatibility, Oct. 1962.

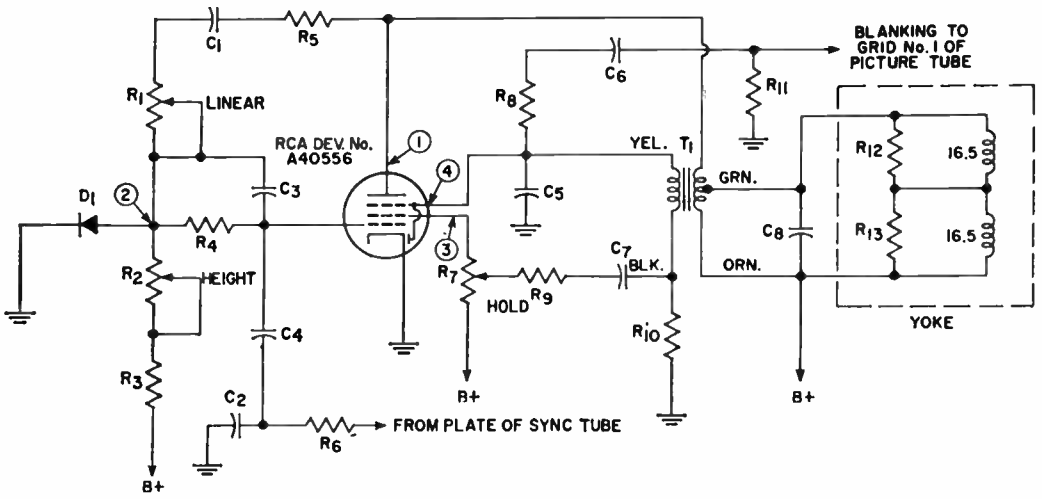
TABLE 1

	RF Inductive Switch 240 ma	Electronic Switch 200 ma	Six Pole Relay 140 ma	Four Pole Relay 115 ma
ENERGIZE CYCLE				
Max Pk-Pk Transient	200v	200v	200v	200v
Frequency of Ringing	150KC	150KC	87KC	87KC
Switch Bounces	6	4	6	5
Time to Steady State	750μs	700μs	700μs	725μs
DE-ENERGIZE CYCLE				
Max Pk-Pk Transient	400v	450v	550v	600v
Frequency of Ringing	150KC	150KC	87KC	150KC
Duration of Transient	300μs	350μs	900μs	700μs
Time to Steady State	700μs	700μs	1000μs	850μs

Fig. 4: A 0.1μf was placed across coil with results similar to Fig. 3b. With .0022μf across coil results were as seen in sketch (b).



A VERTICAL OUTPUT CIRCUIT

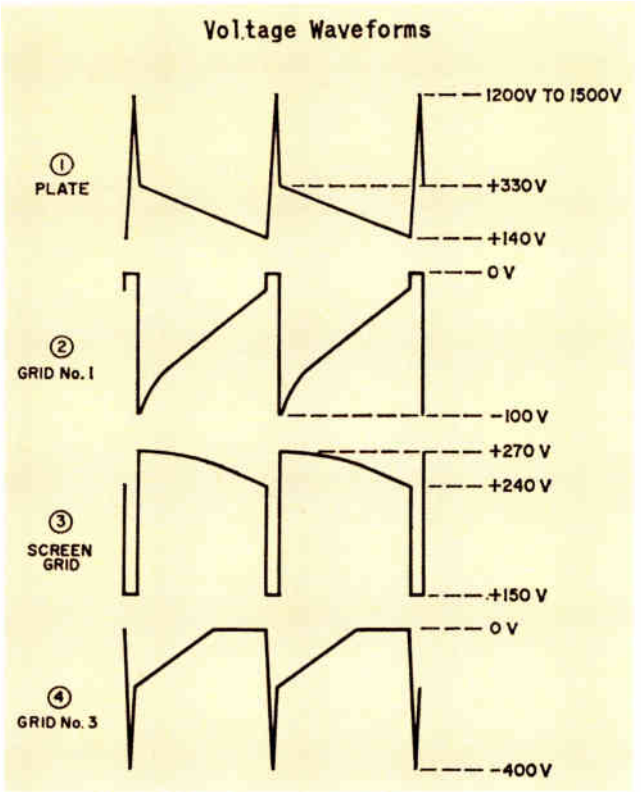


HERE IS A SHORT DESCRIPTION of a blocking-oscillator type of self-oscillating vertical-output circuit. It uses a new dual control power pentode, RCA developmental No. A40556, that has special features for use in this application. This tube overcomes certain disadvantages previously associated with such circuits and makes possible simpler and less costly circuits. Performance is also improved over conventional type circuits currently in use.

Abstracted from ST-2721 issued by RCA, Commercial Receiving-Tube and Semiconductor Div., Harrison, N. J.

Typical Component Values

C_1—0.015 μf, 1000 v.
C_2, C_3—0.001 μf, 200 v.
C_4—0.01 μf, 300 v.
C_5—0.001 μf, 450 v.
C_6—0.022 μf, 150 v.
C_7, C_8—0.1 μf, 300 v.
D_1—diode; peak—inverse—voltage rating, 150 v.
R_1—potentiometer, 25,000 ohms, ½ watt
R_2—potentiometer, 0.5 megohm, ½ watt
R_3—1.5 megohms, ½ watt
R_4, R_9—39,000 ohms, ½ watt
R_5—68,000 ohms, ½ watt
R_6—82,000 ohms, ½ watt
R_7—potentiometer, 10,000 ohms, ½ watt
R_8—0.22 megohm, ½ watt
R_{10}—0.39 megohm, ½ watt
R_{11}—56,000 ohms, ½ watt
R_{12}, R_{13}—220 ohms, ½ watt
T_1—transformer, CP Electronics No. X9235, or equivalent
Yoke—center—tapped toroid, 16.5 ohms per section (33 ohms total)

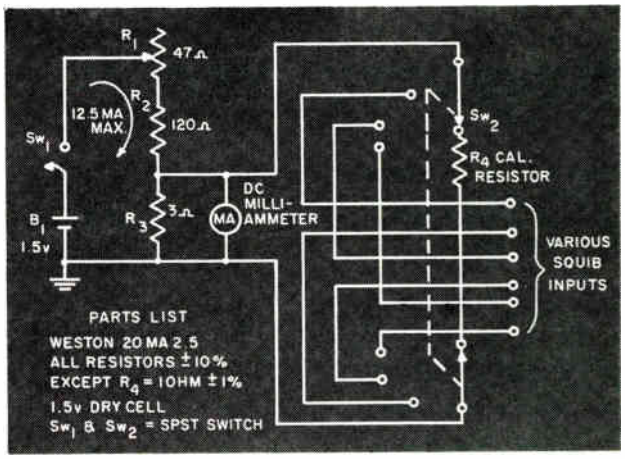


PORTABLE SQUIB TESTER

HERE IS A SIMPLIFIED DIAGRAM of a piece of test equipment for portable field use in checking squib or explosive valve instrumentation on board satellites and other rocket vehicles.

Since many low-level squib devices are designed to be checked for go-no-go continuity at a current rating of 10 ma, this portable test circuit is conveniently utilized.

Operation is straight-forward, first close switch SW1 and adjust R1 (47 ohms) for full-scale deflection. Next check and verify this current level by closing switch SW2 before inserting various explosive devices for continuity indication.



Submitted by EDWIN G. FONDA, 1690 Nilda Ave., Mountain View, Calif.

By JOHN S. JORDAN
Asst. Chief Engineer
Struthers-Dunn, Inc.
Pitman, N. J. 08071

Suppressing Relay Coil Transients

Relay coils generate inductive "kicks" which create high level transients. Several methods of transient suppression are described here. Selection of suppression must be done with care to minimize the effect on relay release time.

THE PROBLEM OF COIL TRANSIENTS generated when relay coils are de-energizing has been covered in an article, "Measuring DC Relay Transients," authored by Mr. Robert Goldblum, of American Electronic Laboratories. Since some of the relays in the article were made by Struthers-Dunn, Inc., we feel it is worthwhile to present some methods of suppressing these transients and show the effects of each on the release time of a relay, as well as the suppression of the inductive 'kick.'

Our intent is to show only relative effects of a few of the more common methods of suppression. These are based on measurements made on the type FC-6 relay only. The transient voltages generated during the release of the relay, as well as the release time, will vary with relay types, as well as the types of diodes used. However, we feel that the results will be similar.

* * *

Types of Suppression Evaluated

Three types of suppression were evaluated. These are shown in Figs. 1, 2, and 3. Fig. 1 shows two PSI type 726 zener diodes connected back-to-back across the coil; Fig. 2 shows one PSI type 460 diode; Fig. 3 shows resistance connected across the coil. The suppressed and unsuppressed transients are plotted in Fig. 4, as is the release time of the relay.

Looking at Fig. 4, you will note that resistance is shown across the bottom from zero to infinity. Zero being that of the diode resistance path and infinity being that of no suppression at all. On the left hand side of the curve, we show the release time of the relay in milliseconds. The right hand side shows the transient generated when the relay coil is deenergized. The zero resistance, which would be that of the diode connection in Fig. 2, gives the best suppression in that no transient voltage was noticed. Note that with the zero resistance across the coil, the release time is the longest. In the case of the relay used, the release time went from 3 ms with no suppression to 15 ms with the diode across the coil. The inductive kick went from 400 v with no suppression to zero volts with full suppression.

Using the circuit in Fig. 3 with different values of resistance across the coil, we learned the shape of the release time and the transient curves between zero resistance and infinity. Measurements were made using 100, 200, 300, and 400% of the relay coil resistance and then the curve was extrapolated to the no suppression or infinity resistance points on the curve. From these curves, as an example, using a parallel resistor equal to the coil resistance, the release time changed from 3 ms to 9.5 ms and the inductive kick went from 400 v unsuppressed to 25 v.

Measurements were also made using back-to-back zener diodes across the coil, as in Fig. 1, and the suppressed voltage and release time points are shown as an 'X' on the respective curves in Fig. 4. The suppression in Fig. 1 raises the release time from 3 ms to 5 ms and lowers the peak transient from 400 v to about 32 v. Referring to Fig. 4 again, note that the zener diode circuit affects the release time about the same as the parallel resistance of 600% and affects the peak transient voltage about equal to a parallel resistance of 125%.

Depending upon circuit needs, one can determine from these curves the type of suppression that best fits the use. A discussion of the advantages and disadvantages of each type of suppression evaluated follows.

Advantages and Disadvantages

Back-to-back zener diodes, Fig. 1.

A. The use of this circuit does not make the relay polarity sensitive and the applied coil voltage can be in either direction. Also, this method can be used for ac operated relays providing the zener voltage is in keeping with the peak ac voltage.

B. The suppressor circuit consumes no power when the relay is energized.

C. There is relatively good suppressing effect.

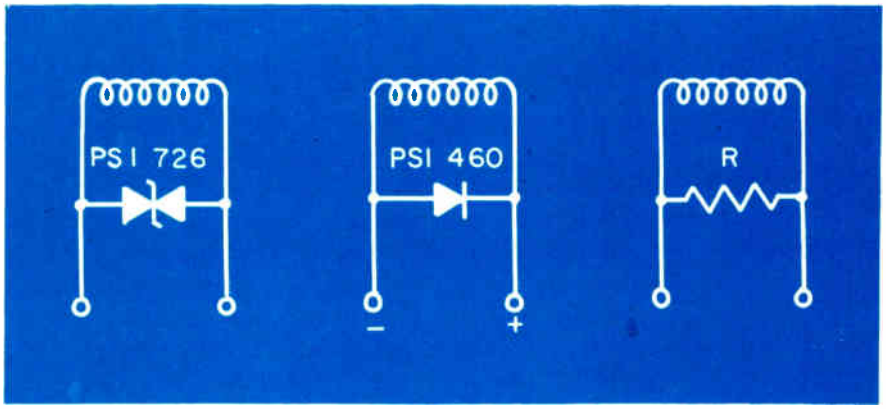
D. There is relatively little effect on the release time.

E. This is the most expensive of the three methods evaluated.

Silicon Diode, Fig. 2.

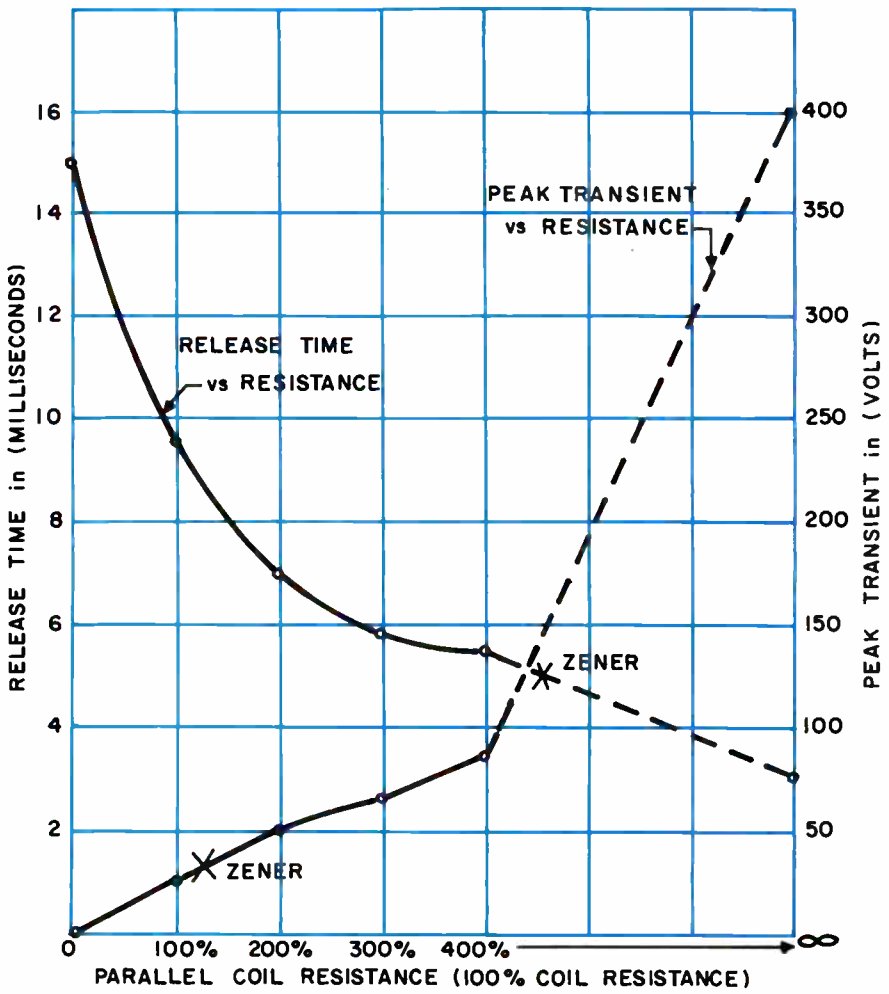
A. Use of single silicon diode in parallel with the coil makes the relay polarity sensitive. Application of

SUPPRESSING TRANSIENTS (Concluded)



Figures 1, 2, and 3, respectively, depict methods of suppressing relay coil transients.

Fig. 4: Suppressed and unsuppressed transients are plotted with relay release time.



coil voltage in the wrong direction can result in blowing the diode.

B. This circuit is not power consuming when the relay coil is energized.

C. Of the three methods evaluated, this connection has the best suppressing effect in that the transient is reduced to zero.

D. There is a substantial increase in the release time. In the case of the relay measured, it was about five times slower than with no suppression.

E. The cost of this method is between that of the back to back zener diodes and the resistance system.

Parallel Resistance, Fig. 3.

A. This circuit is not polarity sensitive.

B. The use of parallel resistance may be a disadvantage because it consumes power continuously when the coil is energized. The amount of power consumed of course, is proportioned to the value of resistance used.

C. There is relatively good suppressing effect depending on the value of resistance used.

D. The effect on release time is also a function of the value of resistance used.

E. This method is the least expensive of all of the methods evaluated.

Conclusions

It is now obvious that there are any number of methods that can be used to suppress the inductive kick generated by a relay coil when de-energized, but it must be realized that the release time of the relay will be affected. An Applications Engineer must know what his circuit needs are, as well as consider the costs and then decide what is the best means of suppression for the circuit.

#77 Converting Gray Code to Decimals

By B. C. KENNY Fellow Engineer
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HERE ARE TWO METHODS for the direct evaluation in the decimal system, of integers expressed in cyclic binary form (reflected binary, Gray code). Although these methods could be mechanized, they are given for the benefit of the engineer who must interpret counts shown in Gray code. Both methods rely on the same principle.

First Method

1. Regarding the cyclic binary number as a conventional binary number, write down, in descending order, the powers of two associated with the bit positions where 1's occur.

2. Keeping the first term positive, connect the terms of this sequence with alternating minus and plus signs.

3. Sum the series so formed and double the result.

4. If the final sign of step (2) was a "plus," subtract one.

Example

In cyclic binary the number 13 is written 1011. Following the given method, one computes thus:

Steps (1, 2, 3)

$$(8 - 2 + 1) \times 2 = 14$$

Step (4) Subtract one, getting 13.

Second Method

The second method, which is well suited for mental arithmetic, is more difficult to describe than to perform. A few definitions will be helpful.

Pointer: A pencil point, finger, or other convenient place marker.

Lower level: A horizontal line just below the cyclic binary bits.

Upper level: A horizontal line just above these bits.

Current bit: A bit above or below which the pointer is currently placed.

Count: The result of evaluation up to the present point. The count is finally the answer sought.

The step-by-step procedure follows.

(1) Start the count at zero.

(2) Place the pointer at the lower level beneath the leftmost bit.

(3) If the current bit is a zero, go on to step (5).

(4) (The current bit is a one). Reverse the level of the pointer; and add one to or subtract one from the count, accordingly as the motion of the pointer is upward (+) or downward (—).

(5) Move the pointer one bit position to the right at its present level and double the count.

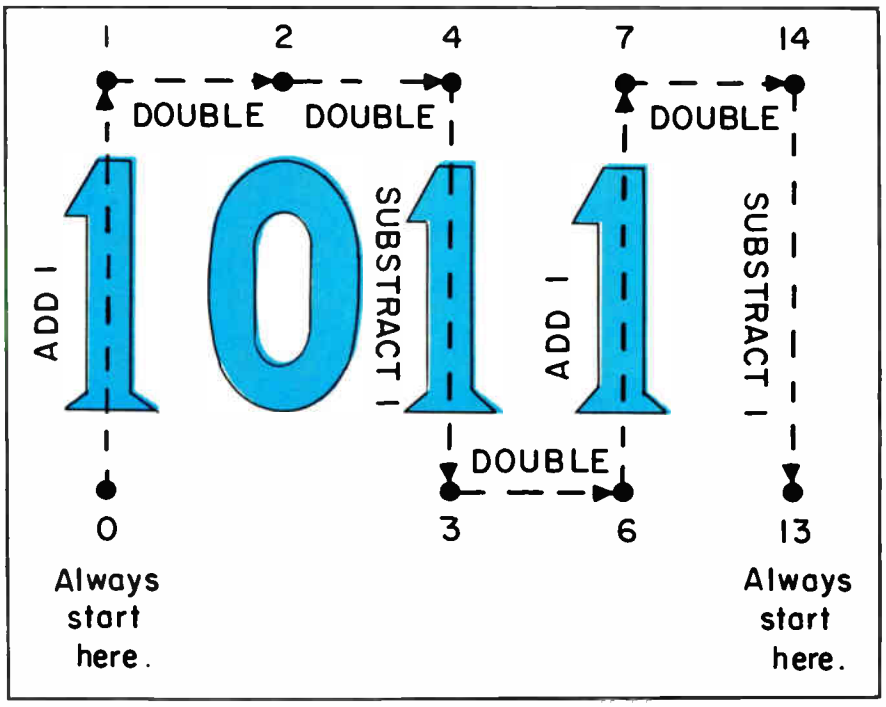
(6) If there is still a current bit, return to step (3).

(7) (The pointer is beyond the last bit.) If the pointer is at the upper level, lower it and subtract one from the count.

(8) (The pointer is at the lower level, past the final bit.) The count is the desired result.

One may regard the 0's as obstacles and the 1's as paths by which the pointer can move between levels. The technique resembles the so-called "double and dibble" method of evaluating ordinary binary numbers.

Fig. 1 shows how to convert the cyclic binary representation 1011. The path of the pointer is traced and labeled with both the required arithmetic operations and the resulting values of the count.



A Semiconductor Servo for DC Control

The all SCR servo system described here is designed to give better performance capability and reliability than previous schemes. And, it costs less.

By **BARUCH BERMAN** Mgr. & Chief Eng., Industrial Control Engineering, Electric Regulator Corp., Pearl Street, Norwalk, Conn.

THERE IS A CONSTANT DEMAND for an accurate system which will allow continuously proportional static control of equipment where only dc is available. And, this is without using complicated inverter transformers and circuitry.

In older approaches transistors were used. But, these had low efficiency, limited power and added complexity for equal gain.

Uses for this type equipment are usually found for battery charging generators, dc generators, power sources and power pulse generation.

We will describe a time ratio control device and analyze its circuitry, principle of performance and salient features. We will also attempt to show the unique use of a semiconductor circuit and a *REGOHM.

* * *

The overall circuit is shown in Fig. 1 and the block diagram in Fig. 6.

For ease of explanation the unit will be separated into its major building blocks.

The Power SCR Network

In the circuit described (Fig. 2) the servo is used to control the field of a dc generator. It does this in such a way as to maintain the average generator output voltage constant within ½%.

The generator may be driven by any prime mover such as an induction motor, diesel engine, etc. DC voltage may also be obtained from stand-by batteries or other unregulated power sources.

When the generator speed is raised, the voltage across terminals A1+ and A2− increases in proportion to speed and excitation. This voltage is impressed across the power SCR network, Fig. 2. This net is comprised of the power SCR1 (rating depends on 'load' current RMS), free wheeling rectifier, load (in this case generator shunt field) F1+-F2− and primary of loop shaping transformer T1.

To insure proper voltage build-up the back contacts of a *REGOHM unit are used to shunt out the power SCR and provide a low current path. Thus, a self-excited mode is established. When an existing steady state dc source is available, and no build-up conditions are needed, the back contact may be used for sequencing.

Sampling SCR Network

The power SCR1 (see Fig. 3) is an "on" device, as are all standard SCR's (excluding the gate turn off SCR), which has not reached an industrial status yet. An "on" device is one which can be turned on by a gate signal, but can't be turned off efficiently by a reverse gate signal. A rough analog is a gas thyration. A transistor, for instance, is an "on-off" device; i.e., without a signal it will revert to the "off" state.

The only way an SCR can be turned off is by back biasing it; i.e., making the cathode, K1, more positive than the anode, A1, or reducing the current through the SCR to zero.

Conditions affecting SCR turn off may be found in major manufacturers' SCR boundbooks.

Thus, we see that for control to be imposed on the network, a turn-off signal is needed. This signal is furnished by the sampling SCR.

The sampling SCR network (Fig. 3) is comprised of the sampling SCR2 (rating depends on design goal), gate blocking rectifier REC2, sampling resistor R8, ratio resistors (R6, R7) and commutating capacitor C1.

As long as finger No. 4 of the *REGOHM sequencer is shorting gate G2 to cathode K2, the sampling SCR2 can't conduct. Under these quiescent conditions SCR2 is open circuited. Voltage on the sampling resistor R8 is then determined by ratio resistors R6 and R7. R7 is essentially in parallel with R8 because gate diode REC2 is forward biased. Thus, the voltage on R8 ($V1$) is essentially

$$V_o \frac{R8}{R8 + R6} = V1,$$

while contact No. 4 is closed. Note that R7 » R8. When contact 4 opens, the voltage on resistor R8 begins to drop. This establishes a potential difference across G2 to K2, and causes SCR2 to conduct, clamping R8 to A+. The voltage on R8 changes by

$$dV1,\ dV1 = V_o - V_o \left(\frac{R8}{R8 + R6}\right).$$

V_o is the output voltage across A+ to A−.

The voltage on C1 cannot change instantly and thus $dV1$ appears added to the voltage existing on the load (generator field), which is about V_o. Thus, cathode

K1 becomes more positive by $dV1$ than anode A1, causing SCR1 to turn off.

Note that the voltage on R8 need drop only enough to cause enough current to flow to fire SCR2 through G2; this is about 2 v (if C12 is used).

On the following oscillations $dV1$ will be determined by about the ratio of

$$\frac{R7}{R6 + R7}, \text{ or } dV1 \text{ will be } V_o - V_o\left(\frac{R7}{R6 + R7}\right) = dV1.$$

The above described how the sampling network supplies the turn off signal for SCR1, the power SCR1. In our case steady state $dV1 \cong V_o/2$. SCR1 in turn commutates SCR2 with the full voltage $dV2 = V_o$.

Firing SCS Network

The SCS (silicon controlled switch) turns on the power SCR1.

The SCS is a four terminal SCR, i.e., it has, in addition to the cathode gate G_K3, an anode gate, G_{A3}. Control can be established by passing a signal current from anode A3 to anode gate G_{A3}, A3 being positive.

The network consists of the SCS1 and blocking rectifier REC1, Fig. 1.

The signal that turns the SCS1 on is supplied by the error bridge. But, a reverse bias is needed to block and make the SCS revert to the off state, as with a standard SCR.

The off signal is obtained automatically by the SCR1 firing. When SCR1 goes on, the voltage at point A, Fig. 1, is clamped to the A+ line. This voltage is higher than the anode voltage of A3, thus SCS1 becomes reverse biased and turns off. For comparison it may be stated that A3 is at the zener REC3 plus REC4 potential point B, which is at 20v, while V_o is at least three times that. REC1 reduces the inverse voltage on SCS1, and improves reliability. By shorting K3 and GK3, the forward holding off voltage "VBo" of SCS1 is materially improved. Spurious firing conditions are greatly minimized. On some SCS's, when the anode current is below a prescribed level, it is possible to turn off by introducing a reverse gate signal. But, the gain is not much better than one.

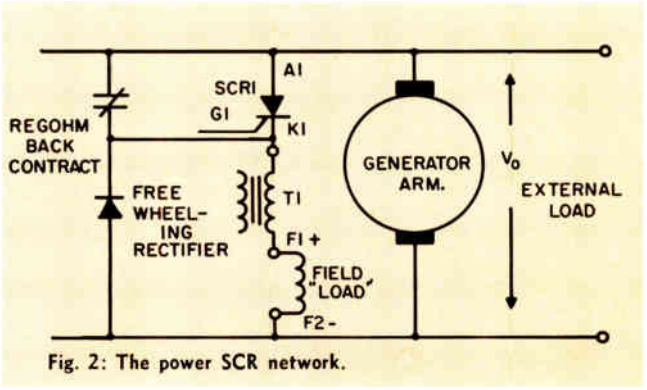


Fig. 2: The power SCR network.

Semiconductor Error Bridge

The error bridge (Fig. 4) is comprised of the limiting resistor R3, zener reference diodes REC3 and REC4, sensing leg resistors (R2, R4, R5) and pot RH1.

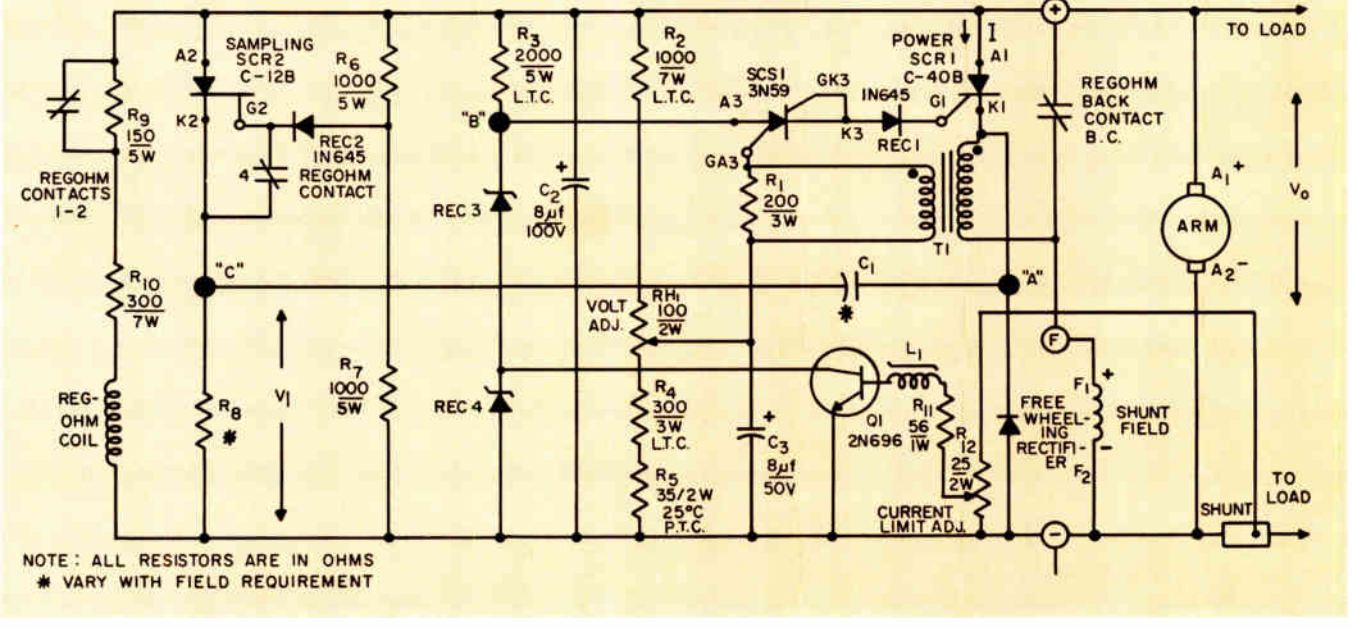
The first two are defined as the reference leg, and the third as the sensing leg.

The error bridge signals the SCS when to fire or trigger the power SCR1 on.

The SCS cannot turn the SCR1 off, only on. The SCS1 losses are low as compared with a transistor because it is either full on or full off, without any appreciable drop.

Zener diodes REC3 and REC4 provide the reference voltage. They are acting as solid state "reference cells" which never need replacing. They are insensitive to frequency changes within the power frequency range

Fig. 1: Schematic diagram of the over-all circuit is shown at the right.



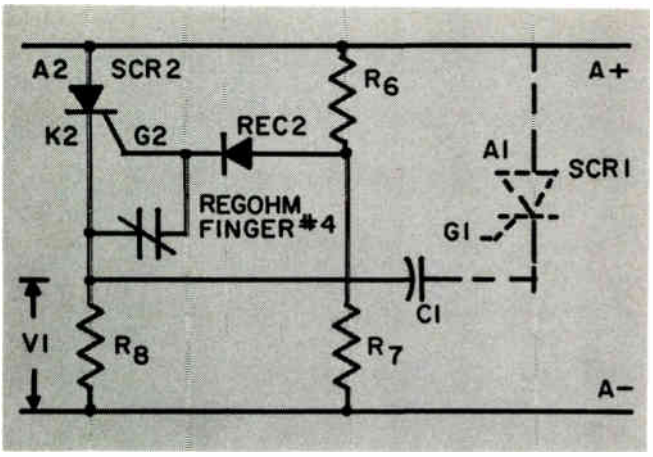


Fig. 3: The sampling SCR network.

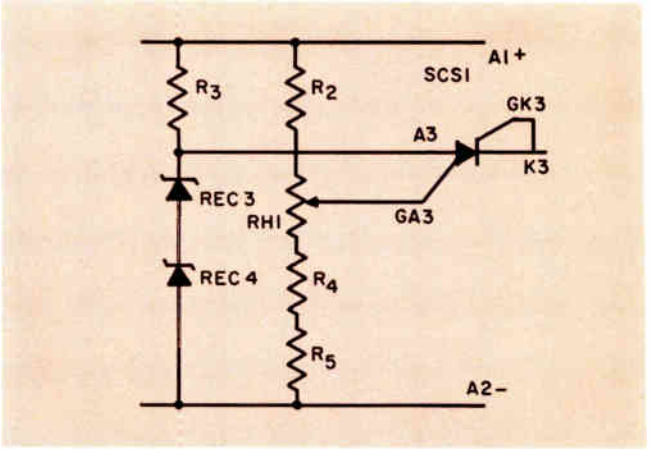


Fig. 4: The semiconductor error bridge.

SEMICONDUCTOR SERVO (Continued)

and possess a low internal impedance. This makes them largely insensitive to line voltage changes also.

Special zeners are picked out to insure low temperature co-efficient $dV/°C$. But, where wide temperature variations are encountered, more sophistication is needed to insure bridge temperature stability. This is done by making R5 have a slightly positive temperature co-efficient. This compensates for changes in zener and SCS characteristics.

Now, if V_o is low, the voltage across REC3 and REC4 to ground is higher than from the arm of RH1 to ground. A current will flow from A3 to G_{A3}, turning SCS1 on. SCS1 in turn will turn SCR1 on. The rise of voltage at A will switch SCS1 back to its off position, getting it ready for its next move.

Stabilizing and Shaping Network

A major advantage of this system is its mode of accepting an analog signal coming from the bridge and converting it into a digital signal through the SCS and SCRs. This in turn is averaged out by the time constant of the field or load, converting back to analog output.

To insure proper control to the SCS and assist it in turn off, T1 is inserted in series with SCR1 and the field with its polarities as indicated by the dots, Fig. 1.

When the SCS fires SCR1, a slug of voltage appears across T1. This induces a voltage in the secondary of T1 in such a direction as to oppose and reverse any current flowing in the SCS anode gate. We know that once SCR1 is turned on we don't need SCS1 firing. In fact, we want it off. This slug causes SCS to immediately turn off, even though there may be noise coming to the error bridge from the line. R1 modifies the impedance and signal level.

When SCR2 turns SCR1 off the opposite effect takes over, trying to turn SCS1 on. But, the voltage from the commutating capacitor, reverse biasing SCR1 and the SCS1, negates this effect.

C3 serves as a hash filter, removing the sampling SCR2 h-f noise from the bridge. This noise also appears on the line if a battery or a filter C2 is not connected. C2 makes a system such as this independent of the nature of the external load, whether resistive or capacitive (battery). This system works just as well then, with a battery connected load or resistive load.

Solid State Protection Circuit

It is often desirable to insure against overload, whether transient or permanent. It is also advantageous to have the system automatically recover as soon as the fault is removed.

The limiting circuit (Fig. 5) is comprised of the transistor Q1, choke L1, resistor R11, pot R12 and shunt.

If overload occurs, the signal across the shunt increases, as does the signal across R12. This causes a current to flow through R11, and L1 into the base of Q1, decreasing the impedance of Q1. The voltage across the zener diodes begins to be dragged down. This causes the output voltage to decrease and thus remove V_o and limit the fault current to a safe value. R12 allows adjustment of limit level. L1 insures proper averaging, otherwise the transistor will regulate peaks of short duration which are not the real source of overload.

Operation

Refer to Fig. 1. On start up the power plant builds up speed. Residual or external flashing causes V_o to also increase. Resistor R10 determines the current flowing into the REGOHM coil, and thus the point at which the back contact will open. This contact is quite rugged and heavy. It will carry a heavy current without deteriorating, even after many operations. When the contact opens, the field current of the machine attempts to keep itself constant, per Faraday law.

At this point SCR1 may still be off because SCS1 receives its voltage from the zener level. And, if the zener is already regulating, although there is current in the SCS gate, it is reverse biased because point A is clamped by the back contact to V_o+. But, Faraday's law will cause the voltage at point A to go to about -1 or -2v as soon as B.C. opens and allows the SCS to fire SCR1 immediately, re-establishing self excitation

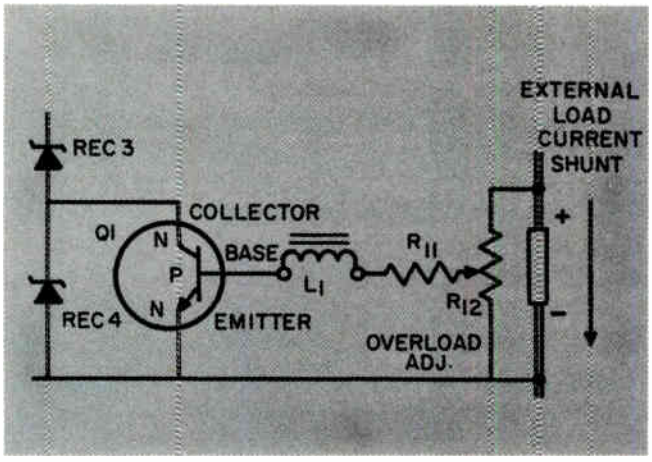


Fig. 5: The limiting circuit.

through SCR1. The SCS will be turned off again due to the reverse bias from A. But, because the voltage of the zeners is higher than on the arm of RH1, current will continue flowing in the anode gate of the SCS.

The REGOHM sequence is such that only now can fingers 1 and 2 open, limiting REGOHM coil dissipation and approaching the position on the armature where finger No. 4 may open.

As finger 4 opens, SCR2, as explained before, will fire clamping point C to V_o+ and send a voltage pulse through C1 which will back bias SCR1 and turn it off. But, if the final V_o, as preset by RH1, has not been reached yet, the SCS will refire SCR1 immediately back. This will be understood if we observe that as soon as SCR1 cuts off, the voltage on K1, or point A falls to −1v which allows the SCS to trigger SCR1 again instantly.

The recovery of point A from −1 to $+V_o$, sends a commutating pulse back to SCR2. The dV voltage, which reverse biases SCR2, is equal to V_o. Thus if K2 was at A+ voltage of V_o it will be reverse biased by the full V_o. Total voltage, at this point, on R8, is $2V_o$.

When the preset output voltage V_o is reached, SCR1, the power SCR, will stay off until the error triggers the SCS and (in turn) SCR1 on. Thus we see that time on and off of SCR1 is determined by the error bridge. The sampling network only determines the interval at which a check will be made to find if SCR1 is in its proper state.

Sampling time is determined by the time constant R8 x C1 network, and $dV1$. This method of control is commonly referred to as time ratio control as opposed to pulse width modulation.

Sampling time in this particular case was based on $R8 \times C1 = 250 \times 5 \times 10^{-6} = 1.25 \times 10^{-3} = 1.25$ms, and $dV1$.

$C1$ was chosen to handle at least 10a total at 20ms SCR switching off time.

$$C1 = \frac{Idt}{v} = \frac{10 \times 20 \times 10^{-6}}{40} = \mu f$$

Where $V_o = 74$v and R6, R7 set at about half voltage. If the SCR's were guaranteed to turn off at 12ms, less than 5μf would be enough.

The sampling frequency may be found as follows: the sampling resistor starts decaying from voltage equal to $2V_o$. When it reaches the voltage divider ratio

$$V1 = V_o \frac{R6}{R6 + R7}$$

it will refire and sample. If $V1$ in this case is $V_o/2$, then $V_o/2 = 2V_o\, e^{-t}/RC$. t = sampling time.

$$e^{-t}/RC = 1/4$$

$$-t = RC \ln 1/4 = RC \times 1.38 =$$

$$t = 1.25 \times 1.38 \times 10^{-3} = 1.72 \text{ ms}$$

$$\text{Sampling frequency } \frac{1}{t} = \frac{1}{1.72} = 580 \text{ CPS}$$

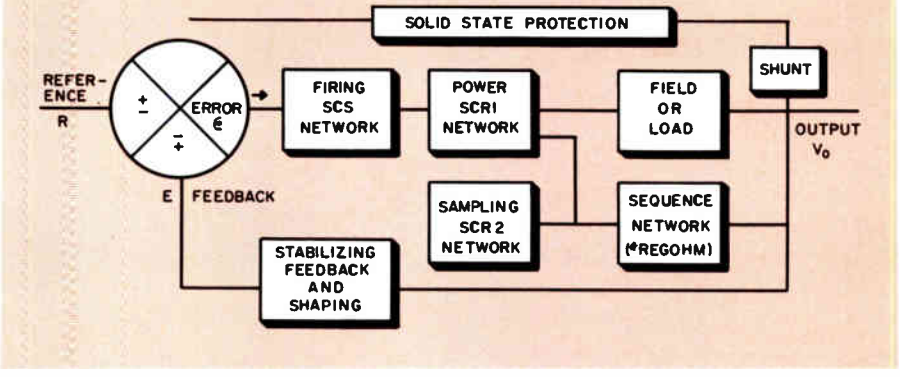
In practice, $V1$ is slightly lower than $V_o/2$ and the frequency approaches 500 CPS. This is due to component tolerances, and the non linearity of the sampling network.

Conclusions

This static servo system is designed to give better performance capability and reliability with attendant lower cost than previous schemes.

Since on-off operation is used, dissipation is minimal. The inductance on the output acts as a fly wheel to insure smoothness and uniformness of current output, making a unique marriage of digital accuracy and analog usefulness.

Fig. 6: The block diagram embodies the device functionally.



By ZVI MISHORY, Development Engineer,
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Solid State Relay for Data Communication

SCR's can replace electromechanical relays in many h-v applications. The problem is to develop a reliable switching method.

THE OPERATION OF TELETYPE machines and other data equipment requires standard keying sources. In telegraph communications, for example, sources of 60v-60ma, or 120v-60ma are used both in neutral and polar operations.

Up to now, normal electromagnetic (EM) relays were used for line keying. Recent developments of faster machines, and the need for distortionless signals and service free devices, eliminated EM relays for many uses. Also, solid state relays are becoming standard items in modern communication systems. We will discuss a method of using a solid state relay in high voltage applications.

* * *

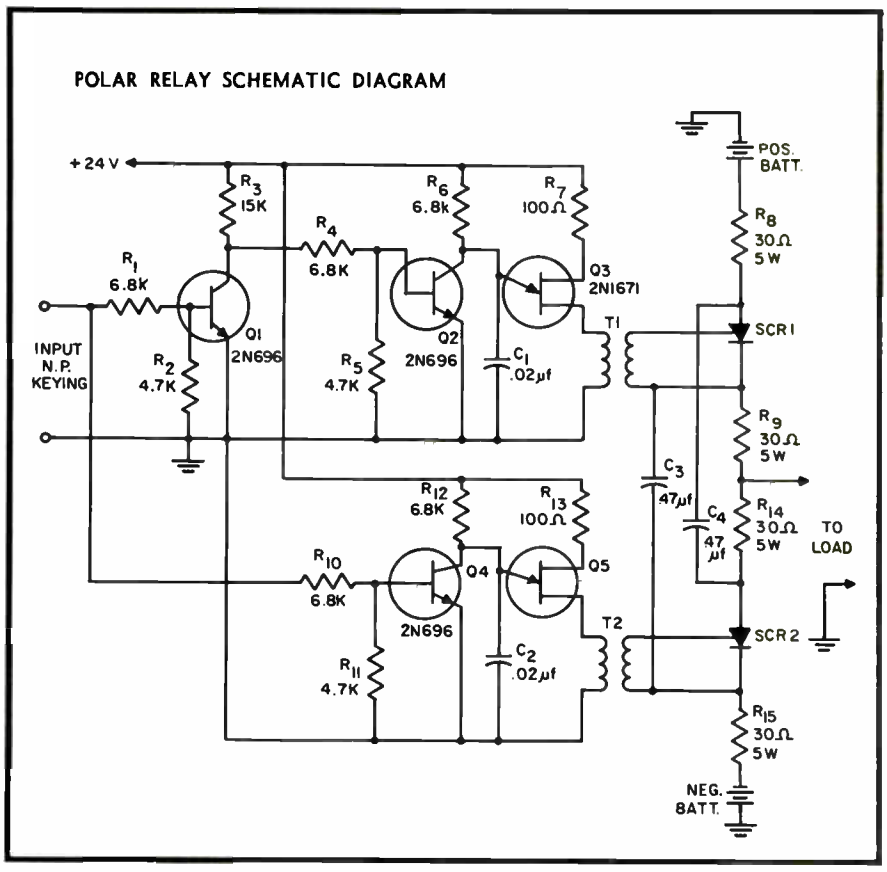
To create a solid state device that will replace an EM relay in every phase of operation is almost impossible. And, it certainly isn't economical. The reason is mainly the low contact resistance of the EM relay. Obviously the solid state relay doesn't have to possess all the properties of the normal one. Only the end purpose will determine what features the solid state relay must possess.

Uses SCR's

Our particular relay is designed for teletype and general data use. High voltage requirements in teletype circuits lead to the use of silicon controlled rectifiers (SCR's). Even high voltage transistors today break down during transients of 300v and above. And when high - voltage breakdowns occur, they are not as fatal in SCR's as they are in transistors. By their natural behavior SCR's are either in "on" or "off" position, and the switching period is too small to allow large power dissipation. SCR's can conduct several amps without exceeding their power specs. In many cases R-C filters are used to avoid high voltage transients, but they cause large current transients. SCR's can stand these transients better than transistors and even relay contacts. The only disadvantage in using SCR's is the high turn-off power. In many dc switching circuits additional SCR'S are used to perform turn-off operations. This is done, e.g., in a similar relay made by a major manufacturer. To obtain a polar operation this company uses 4 SCR's. We will obtain the same operation with two. Each SCR will be serving a double purpose: (1) Switching the load to the battery associated with the SCR. (2) Switching the complementary SCR off.

In neutral operation the current is switched on and off upon the

POLAR RELAY SCHEMATIC DIAGRAM



load as we pass from mark to space conditions and vice versa. But, in polar operation the load current reverses each time we pass from one condition to the other.

Our circuit will be flexible to various loads, and will provide damping for load transients. Although SCR's are comparatively slow for computer operations, they are fast for teletype and high speed data communication systems. My feelings are that SCR's can replace many other mechanical, electromechanical, and transistorized switching circuits to provide better accuracy, higher speeds, and more power.

Caution

Theory on the design of SCR circuits is still in its early stages. Thus, knowledge of basic SCR properties along with common sense are the best tools for the SCR circuit designer. Being bistable devices, extra caution should be taken when placing SCR's in linear circuits. They break linear transients whenever they switch on or off. Thus, calculations must be broken to parts with the proper matching of currents and voltages on the boundaries.

Operation

SCR1 and SCR2 switch the load either to the positive or the negative battery. The triggering circuit can pulse only one SCR at a time. Assuming SCR1 is switched on, it will switch SCR2 off via C1 and C2. The condition of both SCR's switched on cannot be reached in this operation, but, it is a "Stalemate" condition. To release the SCR's from that condition sensors can be inserted in the battery wires. They will operate on the currents caused by both SCR's being switched on, and will disconnect the battery either momentarily or permanently.

Pulse transformers provide complete isolation of the high voltage circuitry from the triggering circuits. Placement of the secondary between the gate and the cathode of each SCR prevents the following from happening: (1) Reflections from the output circuit back to the unijunction transistors Q3 and Q4. (2) Undesirable SCR switching that could occur due to load pickups and transients.

The unijunction transistors provide pulse trains to the corresponding SCR's. The reason for a pulse train instead of one pulse is to assure that information is not lost when the load battery fails or is switched off momentarily. The pulse trains are controlled by Q2 and Q4 that are switched alternately by Q1 and the input signal. We observe therefore that Q1 serves as a "phase inverter" so that Q2 and Q4 deliver inverted information and either Q3 or Q5 can send pulse trains at any particular time.

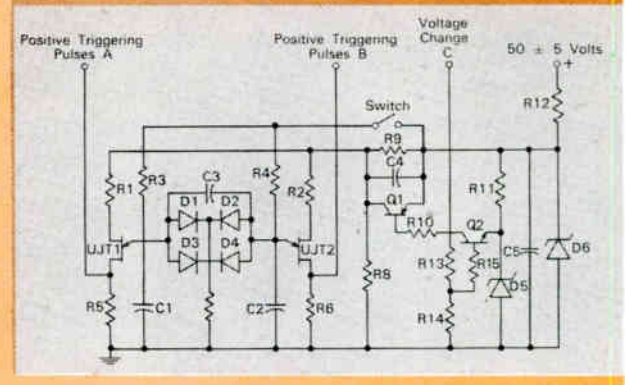
CIRCUIT-WISE

Transistorized Trigger Circuit

VARIABLE ELECTRICAL CONTROL of the frequency of a trigger circuit used to provide alternate gating pulses to two controlled rectifiers was needed. Two synchronized unijunction transistor oscillators, whose frequency is controlled by variation of their base-to-base voltage were used.

Two unijunction transistor (UJT) oscillators are synchronized by connecting diodes D1, D2, D3, and D4 and capacitor C3 as shown. Positive triggering pulses appear alternately at points A and B.

The frequency of these pulses is varied by changing the base-to-base voltages of UJT1 and UJT2. Resistors R9 and R8 serve as a voltage dividing network. Voltage appearing across R1, R2, and ground is the voltage appearing across R8. The voltage across R8 increases as progressively higher base current flows in transistor Q1, causing it to appear as a progressively lower impedance in parallel with R9. An increase in voltage at point C beyond a predetermined value will cause a base current flow in Q2, which in turn causes a base current to flow in Q1. The result of this increased voltage at point C is an increased base-to-base voltage in the UJT oscillators and a resultant decrease in trigger frequency.



When it is necessary to direct the first of a series of pulses to a particular controlled rectifier, a slight asymmetry can be incorporated in the oscillator circuits to insure this condition.

For further information contact: Technology Utilization Officer, Goddard Space Flight Center, Greenbelt, Md. 20771. Ref. B63-10553

DESIGN GUIDE-LINES FOR SPACE THERMAL ENVIRONMENTS

By EDWARD W. JONES, Consulting Engineer, 199-15 120th Ave., Jamaica, N. Y.

THIS ARTICLE FORMS SOME BASIC DESIGN GUIDE-LINES FOR VEHICLES which must survive space thermal stresses. It is intended to increase the probability for vehicle survival and to save time for the design engineer. It saves the design engineer's time by providing him with a convenient data sheet with pertinent engineering parameters relative to both the material and the thermal environment in which the material will be used.

* * *

Shown below are maxima and minima for ambiency applicable to specified regions in space. Temperature maxima and minima shown define operational environmental limits (except where modified thru design) for both Space Vehicle and functional black boxes. Thus defined to a first approximation are environmental design needs for the engineer facing the task of using semiconductor devices for space applications.

Distance above surface of Earth towards Sun	Maximum Ambient Temperature, °K	Minimum Ambient Temperature, °K
< 500 miles	395	245 (Earth shine)
240,000 miles	420	125 (Black space)
10,000,000 miles	431	125 (Black space)
25,000,000 miles	467	125 (Black space)

Materials and Their Characteristics

Material classifications based on relative sensitivities to high temperature are:

Class	Group Designation and Example	Maximum Melting Point, °K
1.	The Carbides (T_aC; HfC; T_aC·ZrC)	4150
2.	Graphite	Sublimes, 4050
3.	The Metals (W)	3680
4.	Nitrides and Borides (H_fN; H_fB)	3600
5.	Oxides (THO_2)	3450
6.	Metallic Combinations (Re_3W_2)	3325
7.	Mixed Oxides ($SrO{\cdot}ZrO_2$)	3150
8.	Organics (TFE Fluorocarbon; carbonized resins; phenolics; modified epoxies)	Sublimation, 1100

Characteristics as Functions of Temperature

In Table 1 are presented the following material engineering characteristics as functions of temperature: (1) Tensile strengths and changes in same; (2) Coefficients of thermal conductivity and changes in same; (3) Specific heats and changes in same. Also shown is the magnitude of proportionality constant "K." This constant has the dimensions of dynes × Sec./cm⁴. It is related to Eq. 1 as indicated below.

$$(TS) \cong \frac{(K_1)\ (K_2)}{\text{Thermal Capacity}} \qquad (1)$$

$$\text{whence: } d(TS) \cong \frac{(TS)^2\ (\rho dC) - (K_1)\ (TS)\ (dK_2)}{(-K_1)\ (K_2)}$$

In Eq. 1 TS = tensile strength; K_2 = coefficient of thermal conductivity; $\rho(dC)$ = density times change in specific heat.

Eq. 1 predicts tensile strength shifts for cryogenic regions where predictions are in agreement with observations. Predictions for high temperature (1500°K) TS changes are not as good as are those for low temperature shifts. But, deletion of the subtrahend in the numerator of Eq. 1 provides a good basis for comparative high temperature predictions.

Graphic Studies of Characteristics

Fig. 1 shows TS in dynes/cm²/gram weight. Of interest to the designer is the following: Where TS and weight are of prime concern, materials of low atomic weight with concomitant high TS are obviously indicated. Be, Ti, Ni, Mo, Fe, Cu, Ag, W, are so indicated and ranked as apropos in the order listed. But, final choice should be judged in terms of Figs. 3 and 4, and Eq. 1.

Fig. 2 shows TS as a function of thermal diffusivity. Of interest to the designer are the following: (1) Where both TS and thermal diffusivity are high, probable use of heat sinks and/or alternatives is indicated as needed for high temperature service; (2) Where TS is high while thermal diffusivity is low, the probability of successful high temperature service is enhanced, provided the melting point sufficiently exceeds the pertinent level of thermal stress.

Fig. 3 describes the empirical relationship between melting point and thermal diffusivity. With melting point high enough in terms of use requirements, the lower the thermal diffusivity, the greater the probability of survival. This is especially true under conditions of thermal shock and/or temperature cycling.

Fig. 4 shows the relationship between coefficient of thermal conductivity and specific heat. Of importance to the design engineer are: (1) Metals with NTP coefficients of thermal conductivity > 0.25 cal-

Article provides the design engineer with pertinent engineering data relative to materials and the space thermal environments in which they will be used.

ories/cm²/sec. should not produce abrupt changes in toughness as functions of shifts in environmental temperature; (2) Metals with NTP coefficients of thermal conductivity < 0.25 calories/cm²/sec, and, showing large deviations in this value as a function of temperature could possibly be subject to abrupt changes in toughness for the thermal range of interest, with consequent catastrophic failure hazards; (3) To obviate considerations of structural failure due to thermal stress, the ideal material for use in Space is one with minimal changes in both coefficient of thermal conductivity and specific heat over the ranges of thermal stress pertinent to the use (note behaviour of Nb, Ni, Mo, Ti, etc., in Fig. 4).

Fig. 4 describes the futility of attempting statistical predictions of material rupture-fracture over the thermal range of interest to space design-engineers.

Fig. 5 shows the relationship between thermal capacity and temperature. Transition temperatures (region where low impact, brittle fractures replace high impact ductile fractures) occur in the regions of greatest changes of slope. Enhanced survival probability indicates: (1) Material selection should be based on least values for slope changes; (2) The advisability of selecting operating temperature ranges beyond points for maximum slope change.

THERMAL CONTROL SUMMARY

Cryogenic Environment	500° K to 1200° K	Temp. > 1200° K
1. Control thru thermal insulation; Design geometry based on "Waffle" weave or honeycomb type structures plus high vacuum.	1. Control thru thermal insulation using pyrolytic graphite, tantalum carbide, zirconium carbide, thorium oxide; Coat with Asbestos Phenolics, epoxies.	1. Control thru thermal isolation using programmed sublimation (ALN; Si_3N_4; NH_4F; Mg_3N_2)
2. Heaters plus thermal paths of high "K" (Ref. Table 1).	2. Forming high emissivity surfaces thru heat treatment or ceramic coatings.	2. Programmed ablation using polyamides, foamed resins, carbonized resins, fused silica; ceramic filled honeycombs, inorganic particle-filled refractories.
Fix-generation for thermal cycling consists in obtaining and maintaining radiative surfaces of high emissivity (the greater the surface emissivity the less that value of thermal gradient extending thru the 'medium and the less the strain produced by temperature shock).		
	3. Use of heat sinks; See Tables 1 & 2.	3. (1) and (2) above plus thermal insulation plus refrigeration outlined in preceding column.
	4. Refrigeration (a) Thermo-electric (b) Solid cryogenic (c) Fluid flow	

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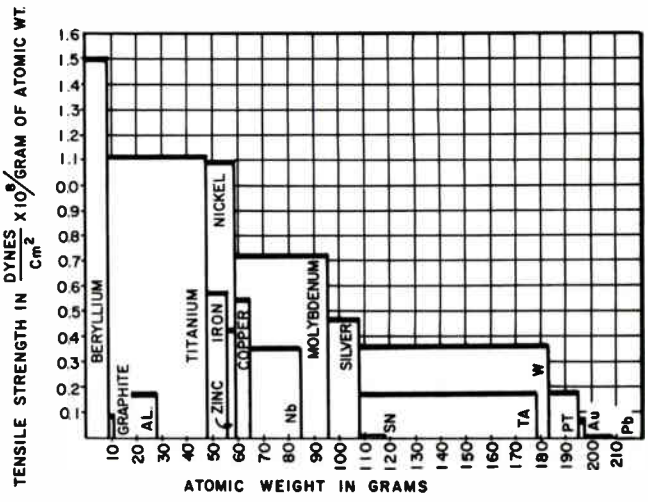

Fig. 1: Relative rankings in tensile strength for pure metals.

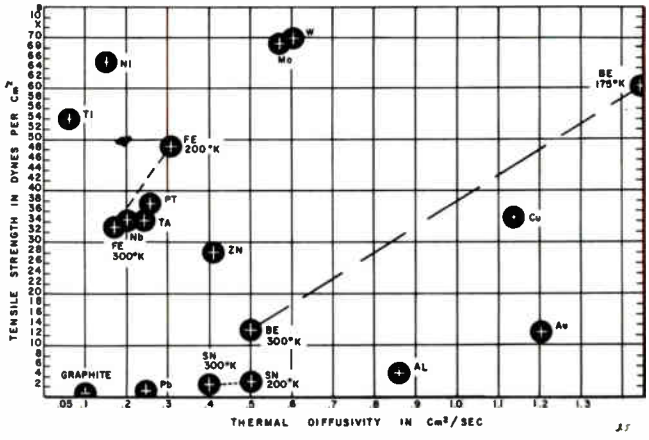

Fig. 2: Relationships between TS and thermal diffusivities.

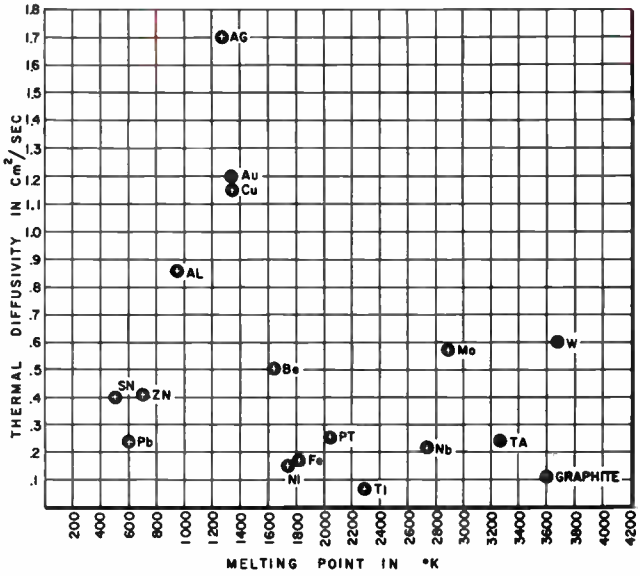

Fig. 3: Relationship between NTP diffusivities and melting point.

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Table 1

ENGINEERING CHARACTERISTICS AS FUNCTIONS OF TEMPERATURE

	300° K						200° K					
Element*	TS	C	K_2	K_1	D	MP	C	− dC	− ρ dC	K_2	dK_2	dTS
Be	13.55	0.42	0.39	27.1	0.5	1623	0.264	0.156	0.2917	0.33	0.06	48.6 x 10^8
Graphite	<1	0.146	0.037	9.9	0.11	3600	0.046	0.100	0.22	0.70	0.663	—
Al	5	0.213	0.497	5.6	0.86	933	0.206	0.007	0.0188	0.597	0.100	—
Fe	32.8	0.103	0.161	190	0.173	1812	0.0918	0.0112	0.0881	0.22	0.059	15.1 x 10^8
Ni	65	0.106	0.142	41.9	0.155	1725	0.0914	0.0146	0.1299	0.19	0.1274	—
Cu	35	0.091	0.918	30.7	1.14	1356	0.0854	0.0056	0.0501	1.07	0.152	—
Zn	28	0.095	0.28	67.9	0.413	692	0.0871	0.0079	0.0563	0.35	0.07	—
Nb	34	0.064	0.125	154	0.22	2741	—	—	—	—	—	—
Mo	69	0.058	0.34	121	0.57	2883	0.053	0.0053	0.0541	0.345	0.005	—
Ag	50	0.065	0.998	29.4	1.7	1233	0.0537	0.0113	0.1186	1.05	0.07	—
Sn	2.1	0.056	0.167	5.1	0.407	505	0.0512	0.0048	0.0349	0.18	0.008	0.28 x 10^8
Ta	34	0.033	0.134	141.6	0.24	3269	0.0319	0.0015	0.0249	—	—	—
Wo	69	0.034	0.397	114	0.605	3683	0.0299	0.0041	0.0791	0.445	0.048	—
Au	12.4	0.031	0.715	10.2	1.209	1336	0.0296	0.0014	0.02704	0.78	0.065	—
Pb	1.7	0.030	0.083	6.9	0.245	600	0.0298	0.0008	0.00907	0.099	0.016	—
Pt	37.6	0.032	0.173	148	0.254	2042	0.0304	0.0013	0.0344	0.175	0.002	—
Ti	54	0.125	0.037	900	0.065	2093	0.111	0.014	0.0635	0.0855	0.0818	125 x 10^8

*TS = Tensile Strength in $\frac{\text{dynes.}}{\text{cm}^2} \times 10^8$

K_1 = Proportionality Constant in $\frac{\text{dynes. Secs.}}{\text{cm}^4}$

C = Specific heat in Cal. per $\frac{\text{gram}}{°\text{C}}$

D = Thermal Diffusivity in $\frac{\text{cm}^2}{\text{Sec.}}$

K_2 = Thermal Conductivity in $\frac{\text{Cal.} - \text{cm}}{\text{cm}^2 \cdot \text{Sec.} \cdot °\text{C}}$

MP = Melting Point in °K

Specified Environment for a Given Vehicle

Summarized are results from analyses of thermal models applicable to a specified environment for a given earth-orbital space vehicle.

Max. Thermal Input from ambiency = 443 BTU/ft² hr.
Max. Ambient Temp. = 122° C.
Min. Ambient Temp. = −28° C.
Avg. thermal gradient thru vehicle = *7.2° C.

*Assumes average coefficient of thermal conductivity of 0.497 cal—cm/cm²/sec when vehicle is oriented for maximum specified input from solar radiation with maximum Earth shine, aft. Emissivity is assumed ,unity.

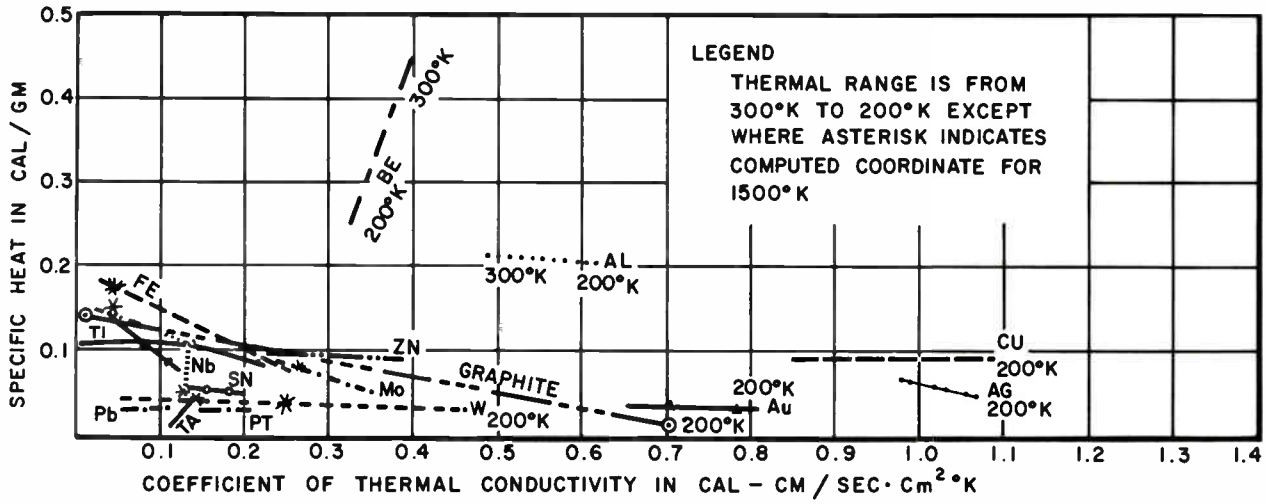
The conclusion is reached that due to possible thermal isolation for some segments of the space-vehicle's skin and/or black-boxes, environmental "hot-spots" approximating 122°C from environmental considerations alone can be present. Design guidelines aimed at this contingency are formed in Table 3.

A detailed procedure for derating electro-mechanical piece parts for the specified thermal environment.
Example: Item—one high level pulse transformer (Group 3, MIL Hdbk 217) of hermetic seal and class "S" insulation (MIL-T-27A). This piece part is used in a black-box affixed to outer skin surface of missile.

1. "Hot-Spot" Temperature Determination
   "Hot-Spot" Temp. = ambient temp. + functional temp. rise (specified or computed) = 122°C + 5°C = 127°C.
2. From Table 43-A (MIL Hdbk 217), for this class item with "hot-spot" temp. of 130°C, Failure Rate (generic) is 16.5 x 10^{-6} hrs.
3. Using Table XV, MIL Hdbk 217, application factor is listed as 0.8.

(*Continued on page* 86)

Fig. 4: Relationships between coefficients of thermal conductivity and specific heats for some metals.



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Reliable snap-action and Licon® dependability built into a full line of Licon precision single-break switches. All are UL listed, CSA approved. Whatever your requirements, Licon has the switch you need.

LOWEST MOVEMENT DIFFERENTIAL

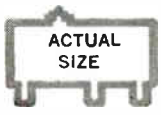
- **LONGEST LIFE**
- **HIGHEST AMBIENT TEMPERATURE RANGE**

TYPE 19 SUBMINIATURE CRICKET® SWITCH

Here's a highly sensitive subminiature switch offering movement differentials down to .0003 inch maximum. Unique Cricket® switch blade mechanism includes only two moving parts, provides mechanical life rated at over 10 million cycles compared to competition's 50,000 cycles minimum or premium priced 1 million cycle switch. Electrical life at full rated load is 100,000 cycles—at one half rated load, 250,000 cycles, nominal. Available with solder and single or double turret terminals. Standard case material allows operation from —65°F to 275°F ambient compared to other premium priced hi temp (250°F) models. Available in a full line of level, pushbutton and toggle actuators.

ELECTRICAL RATING

125/250 v AC: 5 amps
115 v AC: 400 cps—5 amps
28 v DC: Res. (Sea Level)—4.0 amps
Ind. (Sea Level)—2.5 amps
Ind. (50,000 ft.)—2.5 amps



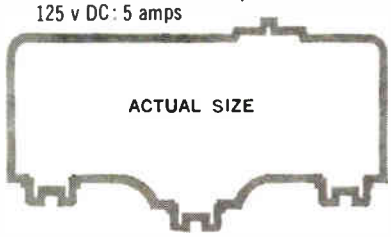
LONGEST LIFE

TYPE 10 GENERAL PURPOSE SWITCH

Exceeds standard requirements for precision and repeatability. Handles most switching applications. Serpentine snap-action mechanism assures positive electrical control with high vibration resistance. Movement differentials down to .001 inches maximum. Precision molded and protected against corrosion. Rated at 15 amps with contact gap of .040 or .070. Full line of pin, sealed, roller plungers and straight or roller lever models, screw and quick connect terminals in wide choice. Basic switch is also available with rating of 22½ to 30 amps as type 08 and 09 series.

ELECTRICAL RATING

125/250/480 v AC: 15 amps (U. L. Listed)
125 v AC: ½ h.p. (U. L. Listed)
250 v AC: 1 h.p. (U. L. Listed)
30 v DC: Res. —15 amps
Ind. — 5 amps
Motor— 5 amps
125 v DC: 5 amps



U. S. PAT. NOS. 2,840,656 AND 3,013,131
OTHER U. S. PATENTS APPLIED FOR OR PENDING

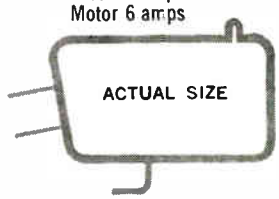
MOST RELIABLE

TYPE 23 HIGH CAPACITY MINIATURE SWITCH

A precision switch in miniature that offers extra long mechanical and electrical life. Provides over 20 million cycles mechanical life—over twenty times the life of competitive switches. Electrical ratings based on 50,000 cycles as full rated load, 15 million at pilot duty. At one half rated load, expected life increases to 200,000 cycles, nominal. Unique "heat dam" slot eliminates flow of solder and flux on models having solder terminals. Also with screw or quick connect terminals. Molded plastic case. Operational at ambient temperatures over 180°F.

ELECTRICAL RATING

125/250 v AC: 8 amps (U. L. listed)
250 v AC: ⅓ h.p. (U. L. listed)
125 v DC: ½ amps
250 v DC: ¼ amps
30 v DC: Res. 10 amps
Ind. 6 amps
Motor 6 amps



For a complete description of the full line of Licon precision electrical switches, write for your copy of the Licon General Switch Catalog.

"Remember, you're never more than a few feet away from a product of ITW" ™

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6615 W. IRVING PARK ROAD • CHICAGO, ILLINOIS 60634
IN CANADA: CANADA ILLINOIS TOOLS, LTD.—67 SCARSDALE ROAD—DON MILLS, ONTARIO, CANADA

Table 2

SOME HIGH TEMP. HEAT SINK MATERIALS & THEIR ENGINEERING PROPERTIES

Material	Melting Point, °K	*Coeff. of Thermal Conductivity	**C	***ρ
Graphite (Sublimes)	4050	0.16	0.49	1.76
Titanium Carbide	3539	0.02	0.24	5.14
Boron Nitride	3290	0.03	0.26	2.32
Titanium Nitride	3240	0.025	0.25	5.69
Magnesium Oxide	3191	0.025	0.36	3.63
Silicon Carbide	2991	0.125	0.35	3.33
Beryllium Oxide	2839	0.10	0.50	2.79

* Coefficient in cal-cm/cm²/°K, avg. value over total range.
** Specific heat in cal/gram/°K, avg. value over total range.
*** Density in grams/cm³, avg. value over total range.

Table 3

THERMAL CONTROL AND DESIGN GUIDE LINES FOR SPECIFIED STRESS LEVELS

Structures and Materials Cryogenic Operations	400° K	Electro-Mech. Components Cryogenic Operations	400° K
Exercise right choice of materials. See Fig. 1, 2, 3 and 4.	"Hot-Spot fix" generation— 1. Coat skin uniformly with ceramic suspensions.	1. Where operational environment requires such, apply heat of local generation/radiation and/or conduction.	Derate transformers and rotating E-M. devices in accordance with the example detailed in the text.
	2. Pre-heat-treat skin material so as to form surface oxides of enhanced emissivities.	2. Choose material (See Table 1) where super-conductivity is either absent over the range of thermal stress encountered, or where super-conductivity is used as a design parameter, per se.	
	3. Construct high "K" paths between fore and aft portions of vehicle (thermal struts).		

DESIGN GUIDE-LINES (Continued)

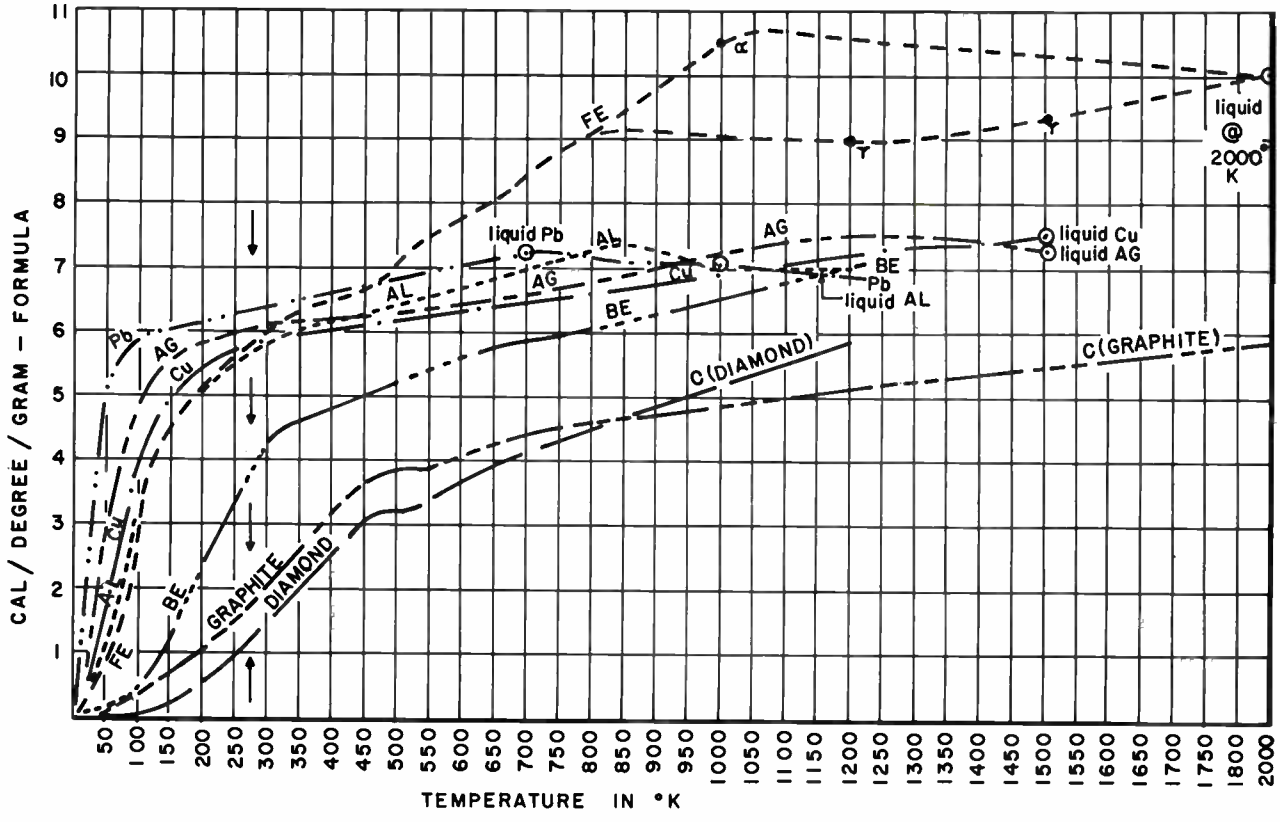
4. Assuming that proper functioning of this piece part is solely contingent on surviving those environmental stresses unique for satellites, K_e, or environmental modifier, developed as a function of inter-acting temp., shock, and vibration environments, is 1.075. Under the assumptions stated, this modifier is unique for the specified stress levels (note: normal, or operating mode failure—rate factor, for satellites in general is assumed unity).
5. Effectual Failure Rate:
   = (λ generic) (Application Factor) (Environmental Modifier)
   = $16.5 \times 10^{-6} \times 0.8 \times 1.075 = 14.19$
   parts failing for each 10^{-6} hrs of service in the specified environment.

Detailed procedure in using "Design Guide-Lines" in connection with the designing of a high speed electronic computer with about 400 parts.

1. Specification Requirements
   (a) Weight: Min. Compatible with function
   (b) Size: Min. Compatible with function
   (c) Input: Digital pulses > Johnson Noise + 100 μv.
   (d) Code: Binary with min. bits consistent with representation of five digit parameters with accuracy of ±0.1% and max. response time of 10 μsec.

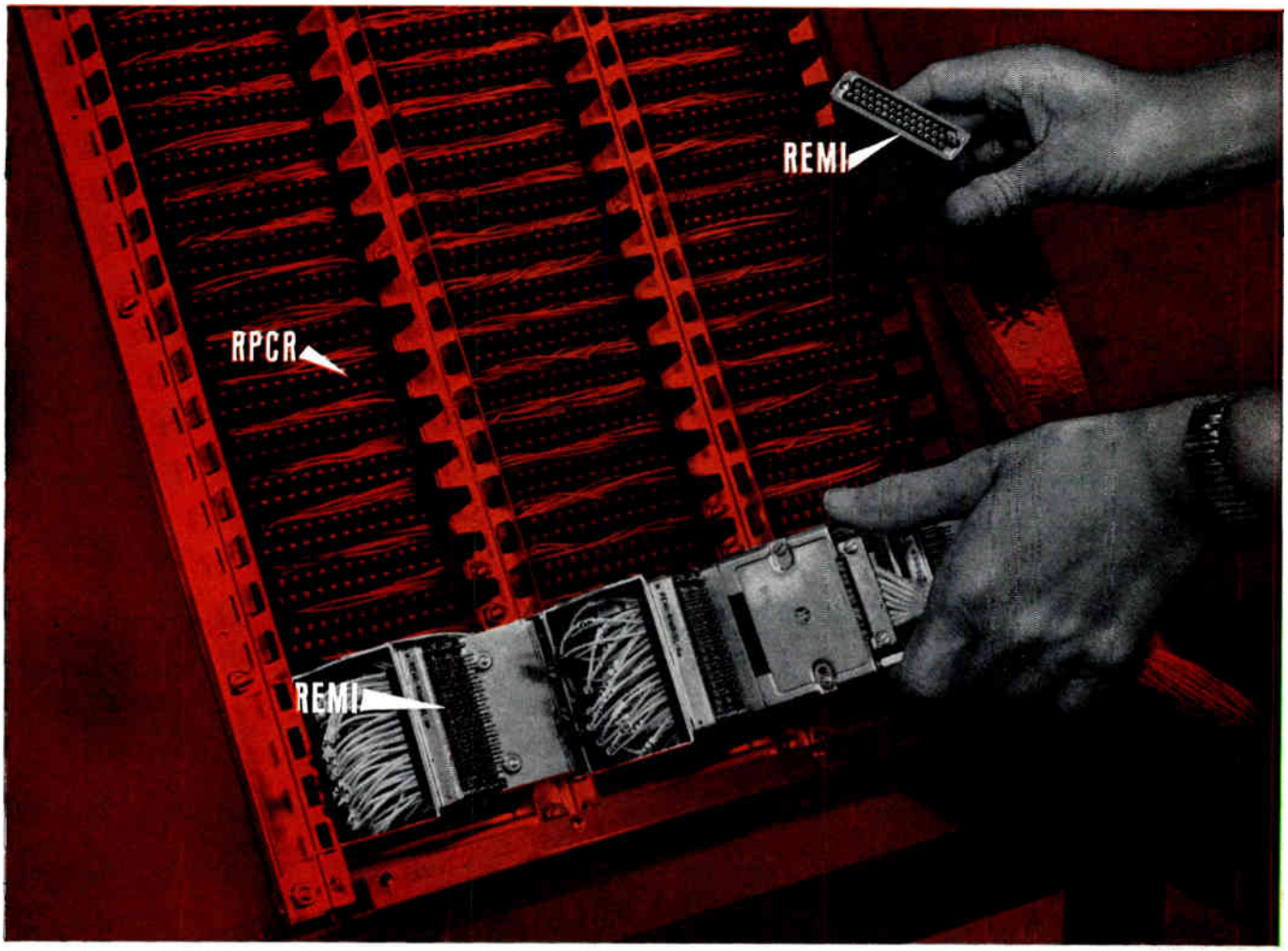
(*Continued on page* 131)

Fig. 5: Relationship between thermal capacity and temperature.



No. 4 of A Series of U.S.C. Connectors At Work

RCA 3301 REALCOM COMPUTER RELIES ON



U. S. C. REMI® and RPCR CONNECTORS

■ The RCA 3301 Realcom derives its name from the real-time and communications capabilities which it adds to conventional data processing. It brings users functional modularity—a new computer concept which enhances function, as well as capacity and speed. RCA called on U. S. C. REMI sleeve-fitted, closed-entry, crimp type contact plug and receptacle connectors and U. S. C. RPCR printed circuit receptacles for its 3301 Processor and Control Module. REMI male and female spring phosphor bronze contacts snap into same special heat-treated beryllium copper sleeves at 7 lbs. max.—do not ride in bare plastic. Permanently assembled sleeves in strong plastic body mean outstanding retention repeatability. High-reliability U. S. C. RPCRs, in tough polycarbonate plastic body, use with (1/8" or 1/10") special heat-treated beryllium contacts and take wide tolerance (1/16" nominal) printed boards.

■ REMI® connectors are available in 7, 14, 18, 20, 21, 26, 34, 41, 42, 50, 75, 104, 123, 150, 225 contacts; meet applicable MIL-C 8384B provisions. Wire sizes A. W. G. #14 to #30 and MIL-W-16878A #16 to #32. Crimping by MIL-T-22520A (WEP) Class I or II tools.

■ RPCR's are available in 26 contact (13 on a row) and 52 contact (26 on a row) sizes with either wire wrap, solder eyelet or half eyelet terminations. Plating both series as desired. WRITE NOW FOR DETAILS ON BOTH SERIES.

U.S.C. REMI Connectors

U.S.C. RPCR Connectors

U. S. COMPONENTS, INC.

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or use TWX: 212-824-6990: TEL: 212-TA 4-1600

TELEX: 01-2411: or Cable: COMPONENTS NYK.

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IC Analyzer

Data is available on an analyzer for measuring integrated circuit parameters. Model IC 101 analyzer provides random access programming of 4 internal power supplies, 2 external functions, and readout points for integrated circuits with up to 16 active leads. Voltage (current readout optional) can be read with an external DVM to 0.1% accuracy. The instrument includes a 1% mirror-backed meter movement for parameter display. Optimized Devices, Inc., 220 Marble Ave., Pleasantville, N. Y.

Circle 130 on Inquiry Card

RF Connectors Wall Chart

This wall chart cross-reference covers Mil-C-22557 subminiature r-f connectors. It includes dimensional drawings and electrical specs. Sealectro Corp., ConheX Div., 225 Hoyt St., Mamaroneck, N. Y.

Circle 131 on Inquiry Card

Miniature Connectors

Data is available on a series of subminiature connectors which withstand extreme environmental conditions. Designated the WSE series, they have crimp removable contacts. They operate while energized without degradation under salt fog conditions and exposure to 100% oxygen and relative humidity. They will withstand vacuum conditions of 10^{-4}mm mercury or better, temps. over 200°C, thermal shock of −30°C to +65°C, and mechanical sawtooth shock of 78 G's. Hughes Connecting Devices, P. O. Box H, Newport Beach, Calif.

Circle 132 on Inquiry Card

Lighted Pushbutton

Data sheet #429 describes the TIB Series transistor - controlled Button - Lite with replaceable incandescent lamp and integral switch. The unit combines a transistor - controlled incandescent lamp and a momentary contact swith within a 9/16 in. dia. body. Designed for use in computers, data processing, guidance, industrial control, instruments and other solid-state systems. Transistor Electronics Corp., P. O. Box 6191, Minneapolis, Minn.

Circle 133 on Inquiry Card

Disc File Article

A 24-page, illustrated technical article entitled, "Characteristics of the Bryant Series 4000 Disc File" is available. Included are notes relating to the philosophy used in developing the disc file; a description of the elements used; statistics on the ability of the file's digital actuator to enable precise repeatability in gaining access to data that is stored in the file; and the reliability concept used during design. Bryant Computer Products, 850 Ladd Rd., Walled Lake, Mich.

Circle 134 on Inquiry Card

Design Manual

Engineering and design data on constant-voltage transformers have been published in 12-page manual CV-225. The manual points out how a CV transformer protects circuit components and reduces circuit costs. It presents well-illustrated data on how to design the transformer into an electrical or electronic circuit, and lists the particular type and rating to be selected for a specific job. Sola Electric Co., Basic Products Corp., 1717 Busse Rd., Elk Grove Village, Ill.

Circle 135 on Inquiry Card

Power Resistor Catalog

Catalog D-130, 12 pages, 2 colors, describes a complete line of stock Vitrohm vitreous enamel wire-wound power type resistors. Stock resistance values, prices and dimensions are given for resistors ranging from 1 to 200w. Mounting hardware data is also included. Ward Leonard Electric Co., Electronic Distributor Div., Mt. Vernon, N. Y.

Circle 136 on Inquiry Card

Connector Catalog

This 25-page catalog describes UL-approved Series 01 Varicon™ connectors. Introduction distinguishes between connectors as hardware and connectors as sophisticated interconnection components. Catalog also describes technique whereby the same 4 basic parts may be built up to any practical given number of contacts. Elco Corp., Willow Grove, Pa.

Circle 137 on Inquiry Card

IC Circuit Tester

Data is available on a digitally controlled power system for integrated circuit testing. It is capable of 2½ billion combinations of voltage and current in steps of 1μa or 10mv. This power system is all silicon, solid-state and programmable. Electronic Measurements, div. of The Rowan Controller Co., Eatontown, N. J.

Circle 138 on Inquiry Card

Microwave Catalog

Bulletin 10-1 is a short form catalog describing an entire line of microwave products. Included is data on amplifiers, antennas, detector mounts, varactor and video diodes, filters, freq. multipliers, instruments, semiconductor testers, and solid state switches. American Electronic Laboratories, Inc., P. O. Box 552, Lansdale, Pa.

Circle 139 on Inquiry Card

NAND/NOR Gate

This data sheet describes the 264D4 dual 4-input NAND/NOR high fan-out gate. The DTL unit has a fan-out of 15 and noise immunity of 1v. It comes in a 14-lead flat package. Schematic is provided. General Micro-electronics, Inc., 2920 San Ysidro Way, Santa Clara, Calif.

Circle 140 on Inquiry Card

Instrument Guide

This 122-page instrument specifying guide does more than just list instruments available. It is loaded with tutorial data. A section entitled, "Introduction to Freq. and Time-Interval Measurement" offers a good review or introduction to this subject. The instruments listed are accompanied by photos and complete specs. In addition, an Instrument Selection Chart is provided. Beckman Instruments, Berkeley Div., Richmond, Calif.

Circle 141 on Inquiry Card

Metallography Short Course

Handbook E-260, "Applications of Metallurgical Microscopy," is, in effect, a short course in metallography. The 28-page publication is filled with photomicrographs which illustrate the important principles of metallography. The photomicrographs are supported by a text that covers all the ground between basic definitions to unconventional uses of the metallograph. Bausch & Lomb Inc., Rochester, N. Y.

Circle 142 on Inquiry Card

Connector Wall Chart

A comprehensive illustrated wall chart, T91, showing a full line of compression connectors for use with shielded and coaxial conductors to terminate or ground the shielding is available. The chart, which is printed in color, gives catalog and ordering data. Connector cable dia. is from 0.034 in. to 0.185 in. The Thomas & Betts Co., 36 Butler St., Elizabeth 1, N. J.

Circle 143 on Inquiry Card

Tiny TWT

This illustrated data sheet describes the Beacotron matched-gain TWT. It is designed for use between the antenna and crystal in any video receiver and eliminates crystal burnout. The 1½ x 1½ x 4¾ in. unit is available for use in L, S, C, and X-band, and has a 3:1 bandwidth and a 10-20db signal gain characteristic. Electronic Specialty Co., 4561 Colorado Blvd., Los Angeles, Calif.

Circle 144 on Inquiry Card

Silicon Photo Cells

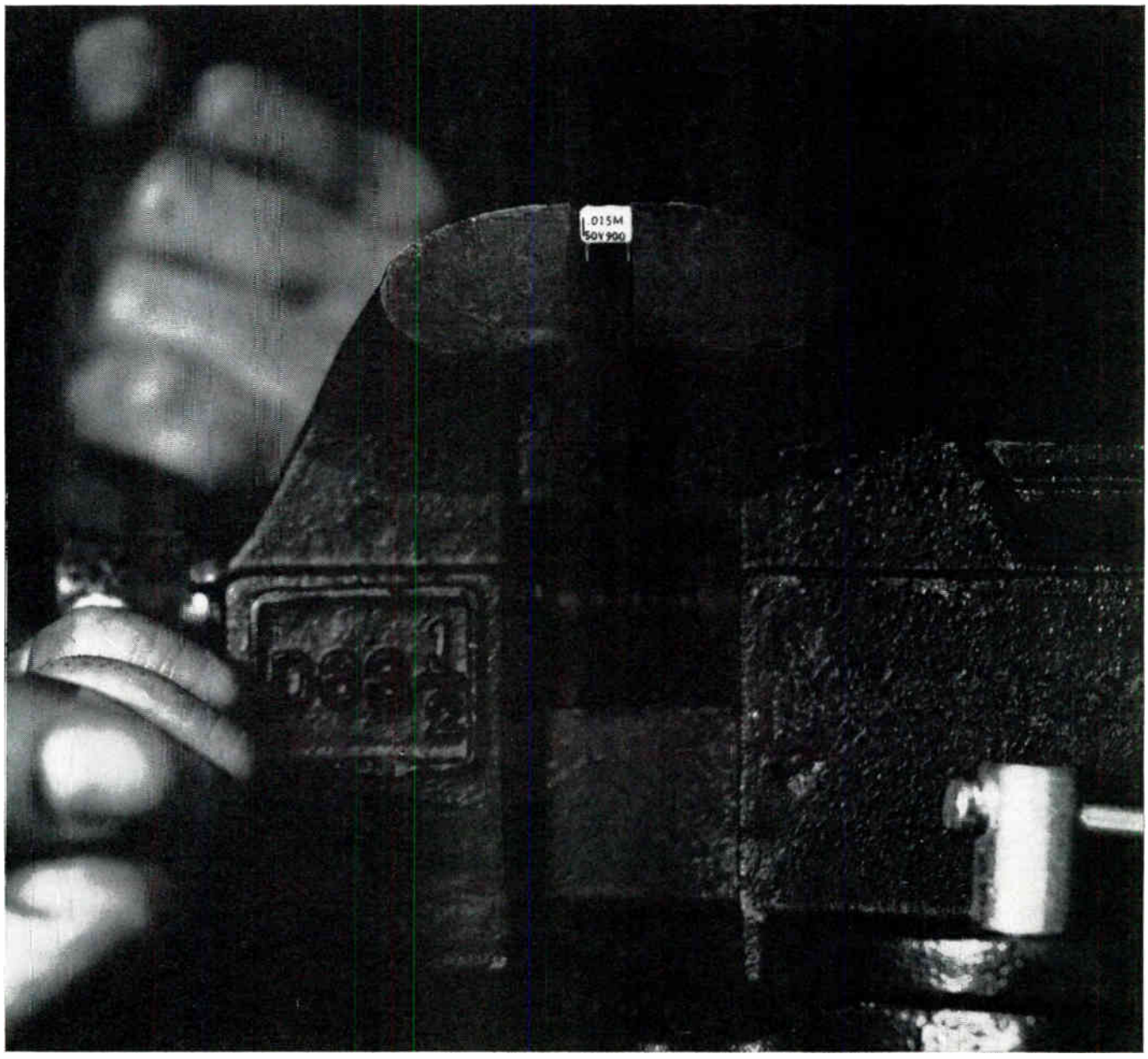
Data is available on cells that can be used as energy converters, paper tape readers, card readers, and photo-electric controls. Output is amplified by a transistor. Data contains characteristic curves and design information. Datasensors Inc., 318 Interstate Rd., Addison, Ill.

Circle 145 on Inquiry Card

Lamp Filters & Lenses

Catalog No. 200 lists a line of filters, lenses, and embedded lamps. Each list shows the colors available within the series. Master Dynamics, 165 San Lazaro, Sunnyvale, Calif.

Circle 146 on Inquiry Card



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NEW TECH DATA

Recorder/Reproducer

The MTR-3200 is a lightweight portable recorder which records analog, FM and digital data. Tape capacity varies from 1250 to 2400 ft. Number of tracks: 14 direct, FM record/reproduce; 16 or 32 digital record/reproduce. More data available from Leach Corp., Controls Div., 1123 Wilshire Blvd., Los Angeles, Calif.

Circle 147 on Inquiry Card

Fans Catalog

This catalog provides complete technical description, performance data and electrical specs. on the complete line of fans and blowers. They are provided for a wide range of airflow capacities and for use with various power sources. Rotron Mfg. Co., Inc., Woodstock, N. Y.

Circle 148 on Inquiry Card

Articles Bibliography

An annotated bibliography of articles dealing with microwave equipment design concepts and the use of microwave energy for industrial purposes is available. It contains reference material valuable to many areas outside the electronics industry; especially fields of plastics, chemicals, pharmaceuticals, fabrics, and food processing. Request should be made on company letterhead to Industrial Applications Laboratory, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, Calif.

Serial Memory

Bulletin 500 describes a high data rate serial memory packaged on a 7½ x 4¼ in. PC card. Plug-in connection is accomplished through a 35-pin connector. Max. bit rate is 10MC RZ or NRZ with total capacity up to 20,000 bits, depending on bit rate and delay. Delay lines up to 1000μsec. are board-mounted. Andersen Laboratories, Inc., 501 New Park Ave., W. Hartford, Conn.

Circle 149 on Inquiry Card

Crystal Case Relays

Data is available on 2 crystal case relays designed for 2a. 2PDT switching uses. Relays are available with operating voltages from 6 to 48vdc. The series 951 full size relays are 0.875 in. high and 0.800 in. long. The series 952 half-size relays are only 0.400 in. high and 0.800 long. Cook Electric Co., Wirecom Div., 2700 Southport Ave., Chicago, Ill.

Circle 150 on Inquiry Card

Semiconductor Guide

An illustrated 2-color catalog, "Entertainment Semiconductors Replacement Guide and Catalog," is available. Included in the guide are sections devoted to a full line of transistors, rectifiers, dual diodes, crystal diodes, and color TV rectifiers. Typical data covers uses, ratings and prices. Send requests on company letterhead to General Electric, Electronic Components Div., Owensboro, Ky.

Miniature Pushbuttons

The miniature Tiny-T® T-Bar® momentary pushbutton switches mount on ¾ in. centers. They may be used for operating 10 x 10 relay switching matrices. P/N 803-5-1 has a 1 to 3 oz. feel. P/N 803-5-2 has a 5 to 7 oz. feel. These switches are rated at 3a. 110vac resistive. Additional information is available. Electronic Controls, Inc., T-Bar Switch/Relay Div., Danbury Rd., Wilton, Conn.

Circle 152 on Inquiry Card

Backup Power System

This brochure describes a battery-backup power system that provides continuous 117vac power regardless of interruptions or fluctuations of the incoming ac. The EECO 746 is a fully automatic system. Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif.

Circle 153 on Inquiry Card

Ultrasonic Instruments

Bulletin PS-900 illustrates and describes new series of pulse ultrasonic testing instruments for detecting internal and surface flaws. Modular construction accommodates automatic gates and other plug-in circuits. Freq. range is from 0.4MC to 15MC in 1 module. It features illuminated depth markers on separate trace below the "A" scan; magnification of any portion of the trace; and easily removable PC boards. Magnaflux Corp., 7300 W. Lawrence Ave., Chicago, Ill.

Circle 154 on Inquiry Card

Radome Brochure

A 16-page brochure entitled, "Radome Capability" is available. It describes engineering and manufacturing facilities, and contains data on various weather and doppler radome uses. Also illustrated are various steps involved in proper radome repairs. Lundy Electronics & Systems, Inc., Glen Head, N. Y.

Circle 155 on Inquiry Card

Magnetic Demodulator

Bulletin MM 108 describes type DMD 896-2 magnetic demodulator. The solid-state circuit converts phase reversing ac signal voltages into phase-detected, polarity-reversing dc. Unit operating freq.: 60 CPS to 10KC. General Magnetics, Inc., 135 Bloomfield Ave., Bloomfield, N. J.

Circle 156 on Inquiry Card

DC Modular Power

This catalog describes a comprehensive line of dc modular power supplies. They cover requirements from 0 to 50v. at 0.6 to 10a. and consist of 118 different models. The precision regulated modular units have 0.01% regulation throughout. All silicon solid-state design permits lightweight compact packaging requiring no forced air cooling, heat-sinking or derating at operating temps. up to 71°C. ACDC Electronics Inc., 2979 N. Ontario St., Burbank, Calif.

Circle 157 on Inquiry Card

Power Supply Catalog

This illustrated catalog offers data about high-voltage power supplies, insulation testers and power packs. Included are input and output voltages, % ripple, % regulation, sizes and weights of controls, and cabinets for more than 60 standard high-voltage power supplies and power packs. Kilovolt Corp., 238 High St., Hackensack, N. J.

Circle 158 on Inquiry Card

Radiochemical Catalog

More than 900 off the shelf radioactive chemicals and sources, plus numerous other products and services are described in this radiochemical catalog. It provides data on purity, shelf life, specific activity, price, minimum order, and delivery. Tracerlab, 601 Trapelo Rd., Waltham, Mass.

Circle 159 on Inquiry Card

Capacitor Catalog

This catalog describes the types 20, 25, 26, and 27 high-voltage capacitors. The capacitors operate over a broad range of conditions, including mild ac ripple voltages and discharges with moderate to low duty cycles. Type 20 ratings are 0.25 to 50μf up to 50kv; Types 25, 26, and 27 are rated 0.005 to 1μf up to 200kv. Aerovox Corp., OEM Div., New Bedford, Mass.

Circle 160 on Inquiry Card

Laminate Bulletin

Bulletin C-719-63 describes Vitac electrical insulating laminate for class F and H apparatus. Property degradation comparisons over long term heat aging are indicated by curves for weight loss, dielectric and flexural strength. The Glastic Corp., 4321 Glenridge Rd., Cleveland, Ohio.

Circle 161 on Inquiry Card

DC Transformers

Data is available on a line of transformers for converting low-voltage dc to high-voltage. They are designed for portable power suppliers. Three units are available: TY-200X has 3v. input and 1050v. output; TYP-201TZ has 4v. input and 500v. output; TY-202X has 3v. input and 550v. output. Triad Distributor Div., 305 No. Briant St., Huntington, Ind.

Circle 162 on Inquiry Card

Commutators

Data is available on a series of all solid-state TLC commutators. They are available in all IRIG standard formats as well as special formats. They handle either PAM or PDM. They feature a built in amplifier with adjustable gain which accommodates inputs from 10mv to 1v.; 400K differential input impedance; ±0.3% overall linearity; and withstands overvoltage up to ±15v. Vector Dept. of Norden Div. of United Aircraft Corp., Southampton, Pa.

Circle 163 on Inquiry Card

NEW TECH DATA

Cable. Shielding Bulletin

Bulletin IND-5 describes copper-clad stainless steel shielding material for communication cable. Comparative data on mechanical and physical properties of clad metal vs. solid copper is given. The bulletin also includes information on the amount and types of protection provided, magnetic properties, weight, sizes and forms available. Texas Instruments Incorporated, Attleboro, Mass.

Circle 164 on Inquiry Card

Amplifier Literature

The Model 115 differential operational amplifier may be used for amplification, isolation and null detection. It features wide bandwidth, low drift and noise, high slew rate, and high stability. A full ±10v. output swing is maintained to above 150KC. Output current capability is 4ma. Complete data available from Zeltex Inc., 2350 Willow Pass Rd., Concord, Calif.

Circle 165 on Inquiry Card

SCR Bulletin

Adjustable speed, fractional horsepower SCR drives are described in bulletin LC-13. The publication contains photographs, approx. dimentions and design feature data on the single phase, half wave drives. They consist of controller, operator's pushbutton station, and dc industrial type motor. Cutler-Hammer Inc., 436 N. 12th St., Milwaukee, Wisc.

Circle 166 on Inquiry Card

Megacycle Counter

This brochure describes a versatile, 2MC electronic counter. Model 2810 measures freq. and freq. ratio, totalizes pulses, and measures waveform periods and averaged periods. Complete specs. and output connection diagrams are given. Non-Linear Systems, Inc., P. O. Box 728, Del Mar, Calif.

Circle 167 on Inquiry Card

Transmitter Exciter

Data is available on fully transistorized independent sideband transmitter exciters for linear amplifiers. This unit operates in the following modes: SSB-ISB-FSK-CW-CSSB. It allows the choice of up to 10 r-f freqs. which may be switched remotely. Module construction is used, simplifying maintenance. Kahn Research Laboratories, Inc., 81 S. Bergen Place, Freeport, L. I., N. Y.

Circle 168 on Inquiry Card

Detector Diode

The L-4180 is a high power, high-speed detector diode for use where high output signal levels are required. Output signal levels are up to 10v. at C-band and 5v. at X-band. It detects r-f pulses less than 10nsec. wide. The diode allows very broad band video circuits to be designed without complicated pulse amplification systems. Requests on company letterheads to: Microwave Dept., Solid-State Products Operation, Lansdale Div., Philco Corp., Lansdale, Pa.

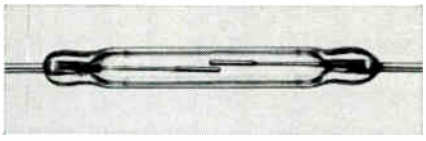
IBM
INDUSTRIAL
PRODUCTS
DIVISION

New IBM miniature dry reed switches give you low contact resistance —less than 100 milliohms throughout life

But that's not all.

These new reed switches are now double plated, rhodium over gold, to give you low noise as well.

And long life too—up to 125 million error-free operations (mean time to first error).



We dynamically set the air gap for each switch (shown here 2X actual size).

Whether you use IBM miniature dry reed switches in relays or magnet actuated applications you get highly consistent performance throughout life. Here's why.

First, we *dynamically* set the air gap between the reeds. This means a stable sensitivity of ± 7 N I (maximum) in every reed switch. No need to select or grade them.

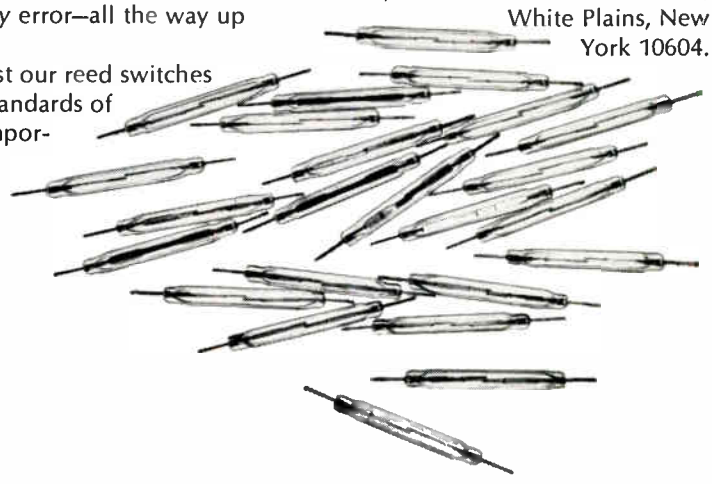
Then we check contact resistance of *each* switch (including leads) under low level conditions. Result: a mean of 50 milliohms.

To verify long switching life we conduct life tests on a regular basis. Here we monitor *every* switching operation to identify *every* error—all the way up to end of life.

Finally we test our reed switches to meet rigid standards of quality in 34 important areas, such as alignment, leakage and voltage breakdown.

But perhaps the best proof of their life/performance is our own testimonial: We use them in practically all of our own computers, including the new System/360.

Why not put IBM miniature dry reed switches to the test in one of your applications. For complete specifications, life ratings and test criteria write to the IBM Industrial Products Division, 1000 Westchester Avenue, White Plains, New York 10604.



NEW TECH DATA

Printers/Disc Files

This 12-page illustrated brochure describes a full line of high-speed printer systems and random access disc files. It also provides data on typical systems developed for government and military use, including aerospace projects. Anelex Corp., 150 Causeway St., Boston, Mass.

Circle 169 on Inquiry Card

Transducer Materials

A complete line of piezoelectric ceramic compositions and a 2000 mechanical Q magnetostrictive ferrite material for solid-state sonic transducer uses are pictured and described in this 10-page brochure. Included are the engineering services offered. Commander Laboratories, Inc., 1177 Santa Fe Ave., Escondido, Calif.

Circle 170 on Inquiry Card

Step-Servomotor

Illustrated technical data sheet Form 3970 describes the B11J commercial step-servomotor for digital control systems. The 2-pole servomotor provides discrete, unambiguous 90° steps when a sequentially switched dc voltage is applied to the 2-control windings. Diehl Div., The Singer Co., Finderne Plant, Somerville, N. J.

Circle 171 on Inquiry Card

Semiconductor Symbols

This chart shows semiconductor circuit symbols and integrated circuit logic elements currently in use. The chart, which has been folded to 8½ x 11 in. size, is on heavy stock, suitable for posting on the wall. Copies may be obtained by writing on business letterhead to "Symbols," Schweber Electronics, Westbury, N. Y.

Tube Accessories

A general catalog is available which describes a line of component holders and clips, tube shields and inserts for industry. The 36-page guide contains illustrations, technical data, sizes available, types of metals and finishes, ordering data, product characteristics and application data. Atlee Corp., 2 Lowell Ave., Winchester, Mass.

Circle 172 on Inquiry Card

Contact Finish

Bulletin TB-510 covers LT-Finish, a new contact surface treatment for silver-refractory contacts. The LT-Finish is not an electro-plate. It is applied to silver-tungsten and other silver-refractory contacts to give a silver-rich surface to a depth of about 0.001 or 0.002 in. Gibson Electric Co., Box 598, Delmont, Pa.

Circle 173 on Inquiry Card

I-F Preamplifiers

Data is available on 2 i-f preamplifiers. Model 4573 at 60MC and Model 4623 at 30MC use all-silicon circuits. Gain is 35db and max. noise figure is 4.0db over the range of −20°C to +65°C. R S Electronics Corp., 795 Kifer Rd., Sunnyvale, Calif.

Circle 174 on Inquiry Card

Roger Bowen
Director of Engineering
Connector & Cable Products

"We call these multi-pin connectors the New Generation. They're the smallest, high-performance circular connectors in the high-density packaging field—61 crimp contacts in an insert the size of a dime. Our smallest models save as much as 61% in weight and 54% in panel space compared to conventional connectors—and without sacrificing performance.

"This newest MARC 53 connector I have here in my hands is a 'high rel' version of our standard 43 series. The MARC 53 features 'Posilock,' a push-pull coupling design that allows mating the highest density connectors with only your finger tips. And it's a dual positive locking action... so there's no chance for accidental disconnect. Also, the MARC 53's 'Posiseal,' is the first multiple, environmental sealing system to provide an environmental integrity never before possible.

"The New Generation also includes the only all-crimp hermetic high-density connectors ...in both the MARC 43 and MARC 53 series. Since no soldering iron is ever used with these hermetic versions, there is no danger of damage to the glass seal—no problem of leaking glass seals.

"The MARC 53 series has been designed to comply with the applicable requirements of the latest Air Force specification, MIL-C-38300 Revision A. It's the finest subminiature circular connector you can use.

"The MARC 43 series, which is the standard push-pull type for normal requirements, meets all applicable specifications. And it's the only high-density circular connector that has a push-pull, positive-locking coupling device with low engaging and separating forces, that will meet the high performance requirements of MIL-C-38300. Mil Specs to match our all-crimp hermetic version haven't been written yet. But deviation requests have been successfully initiated by subcontractors who want—and need—this highly advanced connector.

"See why we call these connectors a New Generation?

"We've been doing a lot of other things, too. For instance, we offer an exclusive mil mating connector—MICRO-MIL—that references MIL-C-22557A. Additionally, we have the 'Golden Crimp,' which is a 100% crimp version of our famous coax line, and MICROCRIMP, a commercially priced crimp-style connector available in over 100 designs.

"In our coax cable product line, we're introducing 'Shield-ax,' a flexible metallic coated cable that achieves 100% shielding without the disadvantages of solid tubing. Within the 'Lerco' hardware line, we're offering greatly improved service in terminals, knobs, and related hardware. It's an interrelated capability—connectors, cable, 'Lerco' hardware, and custom assemblies.

"Write me personally with any questions about the New Generation of connectors, and about putting this total capability to work for you. Or check the reader service card for latest data sheets."

MICRODOT INC.
220 Pasadena Avenue, South Pasadena, Calif.
Overseas: S.A. Microdot—Varec N.V. (Brussels)

NEW TECH DATA

Monolithic Capacitors

An 8-page catalog covering a complete line of "Ceralam" ceramic capacitors is available. It provides detailed technical specs. Ceralam capacitors are available in a wide variety of sizes and geometric configurations. The monolithic structure offers high reliability. Hi-Q Div., Aerovox Corp., Olean, N. Y.

Circle 175 on Inquiry Card

Millivolt Indicator

Bulletin AM-100 describes absolute millivolt indicators for high-precision measurements of transducer characteristics. General specs. are listed on 2 Model 170-AM absolute millivolt indicators that are self-contained, automatically balanced, digital servo units. Gilmore Industries, Inc., 3355 Richmond Rd., Cleveland, Ohio.

Circle 176 on Inquiry Card

Cable Catalog

A 24-page catalog on plastic insulated and jacketed single and multi-conductor cables is available. It describes and lists the characteristics of the various standard wire and cables produced which are in accordance with IPCEA, IMSA, U/L, EIA, ASTM and various Mil specs. Also mentioned are custom cable constructions. Chester Cable Corp., 131 Oakland Ave., Chester, N. Y.

Circle 177 on Inquiry Card

Pulse Generator

Model 125 pulse generator has a rise time of 200 psec. and an output of 10v. Pulse widths of 1nsec. to 100μsec. are continuously variable. Pulse delays are 100nsec. to 100μsec. More details available from E-H Research Laboratories, Inc., 163 Adeline St., Oakland, Calif.

Circle 178 on Inquiry Card

Resistor Covering

The Pyroclad Polymer moisture resistant protective covering is for Mil-R-10509E resistors. It is said to exhibit better humidity resistance than molded units or conventional conformal coated resistors. The covering withstands 30 cycles of moisture under Mil polarized conditions. Complete data available from Pyrofilm Resistor Co., Inc., 3 Saddle Rd., Cedar Knolls, N. J.

Circle 179 on Inqury Card

Reference Elements

Data is available on 3 series of epoxy-encapsulated, high-voltage reference elements. They include: 1N1735 through 1N1742A with voltages from 6.2 through 49.6, and with T/C from 0.01 to 0.005; 1N2765 through 1N2770A with voltages from 6.8 through 40.8, and with T/C from 0.005 to 0.0025; 1N4057 through 1N4085A with voltages from 12.4 through 200, and with T/C from 0.005 to 0.002. U. S. Semcor, Solid State Div., Nuclear Corp. of America, 3540 W. Osborn Rd., Phoenix, Ariz.

Circle 180 on Inquiry Card

NEW TECH DATA

Data Storage System

This 12-page brochure describes the DECtape Transport 555 and Control 552, a low cost in-out data storage facility and updating device. Special features include: fixed position addressing, automatic word transfers, pre-recorded timing and mark tracks, and pocket-size reels. The brochure contains detailed specs., system diagrams, and programming data. Digital Equipment Corp., 146 Main St., Maynard, Mass.

Circle 181 on Inquiry Card

Solid-State Preamps

This engineering bulletin describes the performance, characteristics, and trade-offs of these state-of-the-art r-f components. The product line covers the freq. range from 2 to over 1000MC, with typical noise figures as low as 2db in the 200MC range. Included in this bulletin is information on reliability, overdrive characteristics, noise figure measurement, intermodulation characteristics and system integration. Applied Technology Inc., 3410 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif.

Circle 182 on Inquiry Card

Lettering Machine

The Photo Typositor is ideal for typesetting engineering terminology and nomenclature. It composes physical, chemical and mathematical symbols and equations, as well as Greek and foreign language alphabets. The lettering is set on clear acetate film or photographic paper. A brochure is available from Dept. E, Photo Typositor Div. of Visual Graphics Corp., 1398 N.E. 125 St., Miami, Fla.

Circle 183 on Inquiry Card

Cores

Data is available on horizontal output transformer cores, deflection yoke and convergence cores for the new 90° rectangular color CRT. Cores are made from Ceramag (R), a proprietary ferrite. Electronic Components Div., Stackpole Carbon Co., St. Marys, Pa.

Circle 184 on Inquiry Card

Plastics Catalog

A catalog, "Laminated and Molded Plastics," incorporating technical data and specs. on the various types and grades of material is available. The 12-page, illustrated guide contains a series of charts and tables listing the major properties of the company's complete product line. Thiokol Chemical Corp., N. Enterprise Ave., Trenton, N. J.

Circle 185 on Inquiry Card

Silver Compounds

Data is available on a series of silver-organic compounds for producing electrically-conductive soft-solderable silver films on mica, glass, ceramics and certain types of plastics. They can be applied by brushing, dipping, spraying, machine banding and screen printing. Engelhard Industries Inc., 113 Astor St., Newark, N. J.

Circle 186 on Inquiry Card

NEW TECH DATA

Motor-Driven Switches

Data is available on 2 new current-sensing motor-driven switches. The M945-1 sensor-switch provides protection for nominal 28vdc power sources such as fuel cells or batteries. The M968-1 provides inverse time "trip" protection for 28vdc motor loads with full load ratings of 40 to 50a., and inrush currents up to 400a. Kinetics Corp., 410 S. Cedros Ave., Solana Beach, Calif.

Circle 187 on Inquiry Card

Cermet Potentiometer

Data Sheet 3502 gives dimensional drawings and complete technical data on Type 2-500 ¾ in. dia. dual-construction variable resistor. The unit uses a single shaft to operate front and rear sections together. Included are sales features, resistance range, standard and special tolerances, standard and special tapers, and voltage rating. CTS of Berne, Inc., Berne, Ind.

Circle 188 on Inquiry Card

Cable Support Catalog

This catalog describes a complete line of continuous cable support systems. It features a new cable basket system that is easier to install and stronger than older systems. Tables give loading data, dimensions, and other valuable engineering information as well as suggestions for installation. P-W Industries, Inc., 11,200 Roosevelt Blvd., Phila., Pa.

Circle 189 on Inquiry Card

Silicon Guide

Product guide CDS-129E of silicone products as used in the 30 basic industries is available. Some of the data given in the 2-color publication includes silicone greases, fluids, lubricants, release agents, protective coatings, electrical insulation, and sealants. General Electric, Silicone Products Dept., Waterford, N. Y.

Circle 190 on Inquiry Card

Fastener Bulletin

Electroplated finishes and surface coatings available on Allen socket screw products are listed and compared in Bulletin G-20. Topics such as advantages, limitations, uses, specs., and appearance are presented. Other subjects covered are thickness ranges, allowances and formulas for plated fasteners, test methods used, hydrogen embrittlement, and corrosion resistance comparisons. The Allen Mfg. Co., Drawer 570, Hartford, Conn.

Circle 191 on Inquiry Card

Power Supplies

Catalog #651 describes 2 series of laboratory-type power supplies. The "LS" and "L" comprise 76 different models. The silicon units are said to furnish an extra 100% in voltage or current rating without adding size, weight, and cost. Efficiency is in the order of 80-90%, combined with regulation accuracy up to 0.01% 1mv. Technipower, 18 Marshall St., Norwalk, Conn.

Circle 192 on Inquiry Card

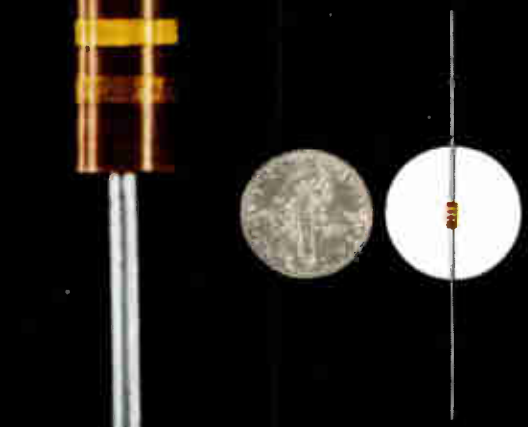
Circle 58 on Inquiry Card →

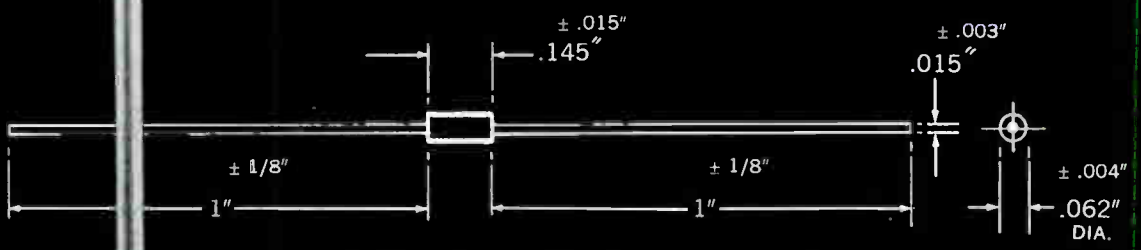
new

Allen-Bradley type BB resistor

⅛ watt insulated hot molded resistor having the identical dependability associated with all A-B hot molded resistors

shown 10 times actual size





ACTUAL DIMENSIONS

■ Here is the latest addition to the Allen-Bradley line of hot molded resistors—the new Type BB. Being so very small, they are ideal for today's miniaturized equipment—and offer a theoretical packaging density approaching 730,000 units per cubic foot. Quality has not been sacrificed for size—the new Type BB insulated resistor provides the same superior performance and reliability for which Allen-Bradley resistors are world famous.

For complete information on these new miniature Type BB resistors, please send for Technical Bulletin B-5005: Allen-Bradley Co., 222 West Greenfield Avenue, Milwaukee, Wisconsin 53204.

In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

CHECK THESE FULL SIZE SPECIFICATIONS

RESISTANCE VALUES: Standard EIA and MIL-R-11 from 2.7 ohms to 100 megohms

RESISTANCE TOLERANCES: Standard ± 5%, ± 10%, and ± 20%

MAXIMUM CONTINUOUS RATED VOLTAGE: 150 Volts RMS or DC

MAXIMUM CONTINUOUS RATED WATTAGE: 0.125 Watt at 70°C. Derate linearly to zero watts at 130°C maximum operating temperature

VOLTAGE CHARACTERISTIC: Less than 0.050% resistance change per volt

TEMPERATURE CYCLING: Resistance change less than 2% in five cycles from − 55°C to + 85°C

LOAD LIFE: Rated continuous working voltage for 1000 hours at 70°C ambient results in a resistance change of less than 8%, with the average not to exceed 6%

SHORT TIME OVERLOAD: Resistance change is less than 2.5% after 5 seconds at 2½ times continuous working voltage (200 volts max.)

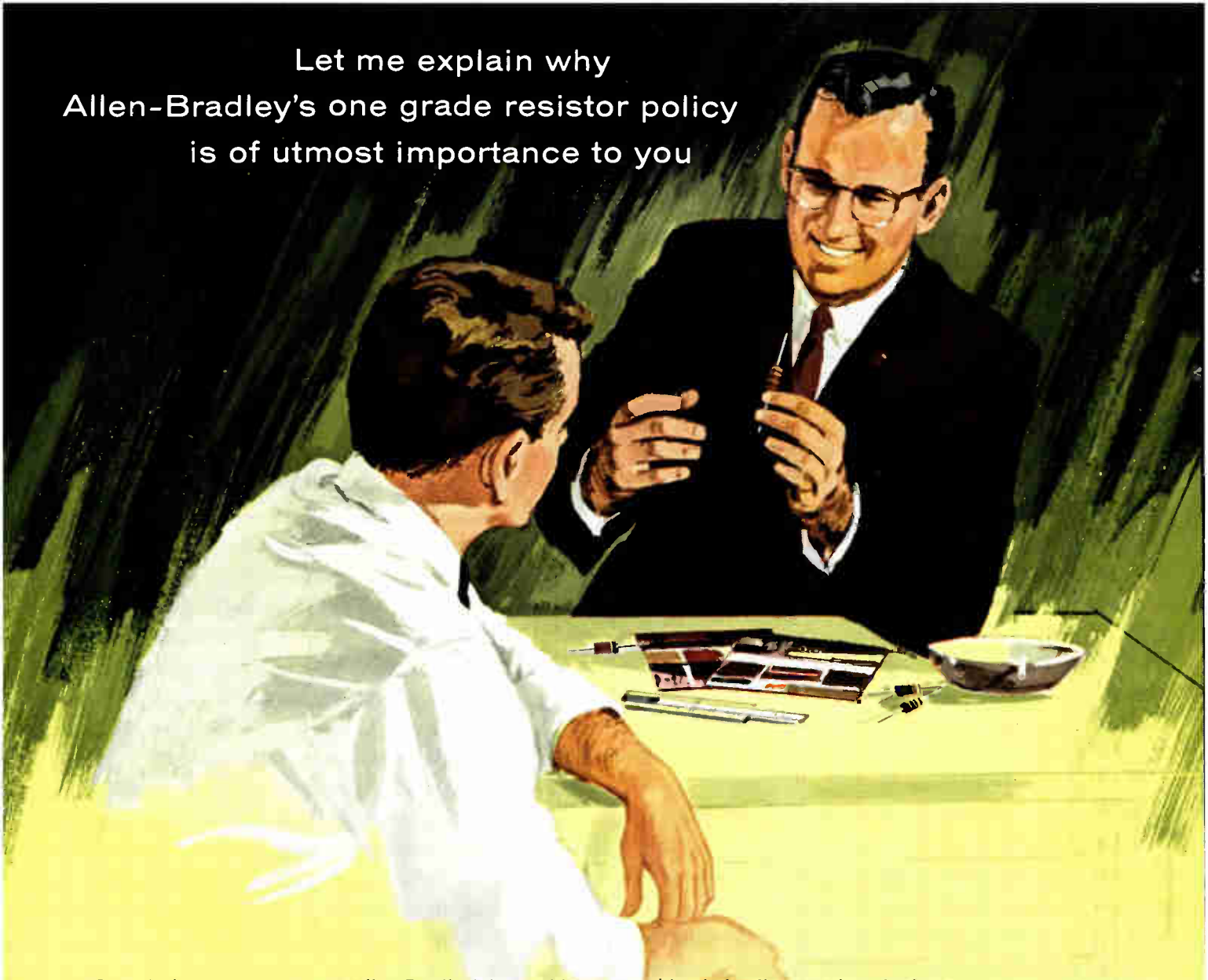
EFFECT OF SOLDERING: Resistance change ± (3% + 0.05 Ω) maximum after 3-second test with leads immersed in solder to ⅛″ of body at 250°C

45-01-SER

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

Let me explain why Allen-Bradley's one grade resistor policy is of utmost importance to you



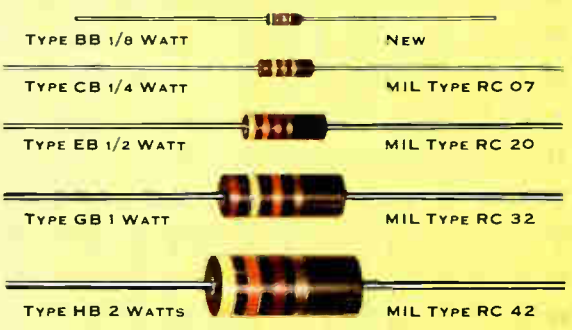
■ Over the last quarter century, Allen-Bradley's hot molded composition resistors in all ratings have established their reputation for being of uniformly consistent quality—not even approached by any other molded resistor on the market. Neither years of service, nor years of only shelf life will affect this uniformity within the rating under which the units were originally purchased.

Allen-Bradley feels that it has a responsibility to its multitude of customers all over the world, that when they order Allen-Bradley resistors they have the confidence—based on years of experience—that the quality and dependable performance will be the same as before! No wide deviations in characteristics—even in isolated resistors—can cause questionable performance in your equipment. Catastrophic failures are an impossibility with A-B hot molded resistors.

Perhaps Allen-Bradley, as the manufacturer, doesn't deserve credit for such uniformity because it results from automatic machinery which completely eliminates the human element. Variations are not tolerated by this machinery.

Besides, if Allen-Bradley had succumbed to the price argument and had placed on the market a lower quality resistor, how would you be able to tell them apart—without having this cost *you* extra money? How about the wrong resistor accidentally getting into the wrong place? This could only be discovered on final test—and correcting such careless mistakes is expensive. Do you really save money when you buy an inferior make of resistor???

Leading electronic manufacturers have found it really pays to standardize on Allen-Bradley quality resistors—you will, too. For complete specifications, please write for Technical Bulletin 5050: Allen-Bradley Co., 222 West Greenfield Ave., Milwaukee, Wisconsin 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.



HOT MOLDED FIXED RESISTORS available in all standard EIA and MIL-R-11 resistance values and tolerances, plus values above and below standard limits. Shown actual size.

43-12-4E

A-B

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

IC WAFER TESTER

Electrical testing of transistors and integrated circuits in wafer form are easily accomplished by the Waferprobe Mk III. Developed by Siliconix Inc., Sunnyvale, Calif. and adjustable to any device pattern, the automatically controlled unit probes 15 contact areas at once, then sequentially marks, records, and steps to the next pattern.

The problem of checking the consistency of repetitive welds appears to be solved by the Model QC-425 welding monitor. By determining peak voltage normally associated with optimum welds, and monitoring the variations from this peak, it determines the quality of the weld. Output is in the form of Go/No-Go lights, but can be connected to alarms. It is a product of Hughes Aircraft Co., Oceanside, Calif.

Linear measurements to millionth-of-an-inch is quite a trick. A model 214 Fringecount not only does this, but virtually reduces the procedure to automation. The unit, developed by General Precision, Binghamton, N. Y., uses fully integrated circuits, and a direct fringe count appears automatically.

Two five day Precision D-C Measurements and Standards Seminars will be conducted this year by Leeds & Northrup Co., Phila. The first will be held May 24-28 and the second Oct. 4-8. The seminar is designed to accomodate the needs of the practicing engineer. Techniques and ideas developed by the NBS are explained, and such problems as noise intereference and high source impedance, when using ultrasensitive detectors, are discussed. For details contact the nearest L&N sales office.

A simple method of testing ferrite memory cores, magnetic logic, transfluxors and thin magnetic films is provided by Model 1010A. Program switches allow operator to select any program of current pulses. Six current drivers each deliver up to 1a. into a 50Ω load with linear rise and fall adjustment from 20nsec. to 1μsec. The max. clock rate is 5MC. The instrument is a product of RFS Engineering Co., Phila., Pa.

The Navy has awarded a contract to Joseph Kaye & Co., Cambridge, Mass., to design and construct special thermocouple reference systems. The equipment will be used in combination with other instruments to continuously monitor energy transfer process between snow, ice, and tundra for a two year period.

A reed relay application note is available from Digital Equipment Co., 146 Main St., Maynard, Mass. It describes a life test to evaluate the reliability and contact resistance of reed relays. Relay contacts were subjected to 1.35 billion current pulses, equivalent to 20,000 8-hour days of operation.

The requirements of ASA S2.2-1959, Calibration of Shock and Vibration Pickups, are easily met by Model 4290. Developed primarily to provide highly accurate accelerometer calibration for freq. from 50CPS to 50KC, it can also be used as a secondary reference vibration standard or a calibration transfer device. Model 4290 is a product of B & K Instruments, Cleveland, Ohio.

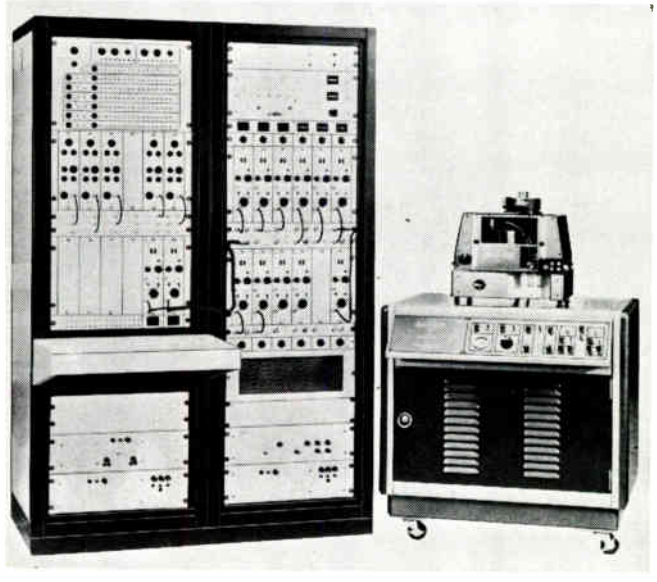
Measuring water in paper either on or off line is accomplished by an infrared moisture gage called Inframike. Developed by General Electric, Milwaukee, Wis., it senses water content from 0-12% for paper with basis weight in range of 6 to 70 lbs./3300 sq. ft. Accuracy is 0.1% moisture.

The Singer Co., Metrics Div., has awarded a Sensitive Research Instrument Authorized Service station franchise to Electrical Instrument Service, Inc., Mt. Vernon, N. Y. Facilities are maintained for repair and calibration of Guideline instruments. Calibration is done per Mil-C-45662A.

Direct reading measurements of inductance over a range from 110 mh to 0.0002μh with a basic accuracy of 0.25% are features of the Model 63H Inductance Bridge. Developed by Boonton Electronics, Parsippany, N. J., it also measures series resistance directly over a range from 11KΩ to 0.002Ω.

MULTIAPERTURE DEVICE TESTER

Using MADs as a non-destructive readout element has been limited by the cost and complexity of the methods needed to test them. Computer Test Corp., Cherry Hill, N. J. and Ramsey Engineering, St. Paul, Minn. have apparently solved these problems with the Model 2046 Tester. It provides complete handling of the devices, and applies a series of complex tests to each one. It analyzes the performance and sorts the devices at 60/min. The system calibrates itself. If a system malfunction occurs, unit stops and cause is indicated.



The Probable Reliability of a Measurement

The development of a means for accurately determining the confidence of reliability for a system. Given is the relationship of measurement accuracies and decision tolerances to the probabilities of undetected defects and false alarms.

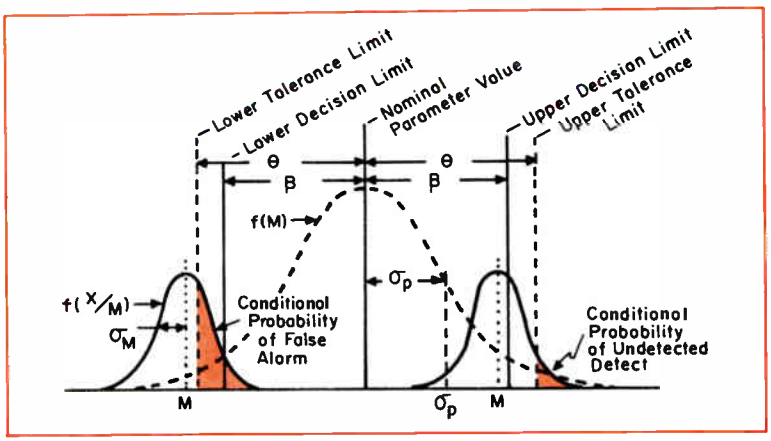


Fig. 1: Graphical representation of conditions forming the basis of derived equations for probabilities of false alarms, P_{fa}, and undected defects, P_{ud}.

UNPRECEDENTED HIGH LEVELS of confidence in system operability are being demanded in the space age and must be confirmed at the start of the mission. Checkouts must reflect this need. As for measurements, investigation such as presented here has shown that care must be taken to select both the proper measurement accuracies and "go/no-go" decision (or test) limits. Improper selection of either can significantly reduce the confidence that can be placed in checkout results. Here is an approach to proper selection:

Checkout Confidence

A system checkout is always made to determine whether the system is or is not capable of performing its intended mission. For proper repair and maintenance action to be taken, a checkout may be extended further to isolate defects in the system. This determination of a system's operational status can be partially or even completely done by measuring various system parameters, to reveal any that are outside of specification tolerances. Two types of error are possible in making such measurements:

(1) *Undetected defect*—failure to detect an existing out-of-tolerance condition. An undetected leak may endanger life, and at the very least reduces the probability of mission success.

(2) *False alarm*—detection of an out-of-tolerance condition that does not actually exist. Detection of a nonexistent defect could result in wasted time, money, and spares while the mission is delayed for unneeded maintenance action.

Error Probabilities

The two types of error—undetected defect and false alarm—can occur even if the parameters to be measured are properly selected. This is because of the possibility of measurement inaccuracy.

A measurement commonly made is one to determine if a parameter is within upper and lower specification tolerances. The possibility of measurement inaccuracy often makes it advisable to base the possibility of go or no-go decisions on tolerances, which are somewhat tighter than specification tolerances, called "decision tolerances."

Equations which express the quantitative probabilities of an undetected defect or a false alarm for a given measurement are as follows: (Refer to Fig. 1.)

$$P_{ud} = \left[\frac{\sigma_M}{2\sqrt{\sigma_P^2+\sigma_M^2}-2\sigma_M}\right]\epsilon^{-1.15\left[\frac{(\theta-\beta)\sqrt{\sigma_P^2+\sigma_M^2}+\beta\sigma_M}{\sigma_M\sqrt{\sigma_P^2+\sigma_M^2}}\right]} - \left[\frac{\sigma_M}{2\sqrt{\sigma_P^2+\sigma_M^2}+2\sigma_M}\right]\epsilon^{-1.15\left[\frac{(\theta+\beta)\sqrt{\sigma_P^2+\sigma_M^2}+\beta\sigma_M}{\sigma_M\sqrt{\sigma_P^2+\sigma_M^2}}\right]} - \left[\frac{\sigma_M^2}{\sigma_P^2}\right]\epsilon^{-1.15\left(\frac{\theta}{\sigma_M}\right)} \quad (1)$$

$$P_{fa} = \epsilon^{-1.15\left[\frac{\beta}{\sqrt{\sigma_P^2+\sigma_M^2}}\right]} - \left[\frac{\sigma_P^2+\sigma_M^2}{\sigma_P^2}\right]\epsilon^{-1.15\left[\frac{\theta}{\sqrt{\sigma_P^2+\sigma_M^2}}\right]}$$

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By WARREN D. MOON*

$$+\left[\frac{\sigma_M}{2\sqrt{\sigma_P^2+\sigma_M^2}-2\sigma_M}\right]^{\epsilon^{-1.15\left[\frac{(\theta-\beta)\sqrt{\sigma_P^2+\sigma_M^2}+\beta\sigma_M}{\sigma_M\sqrt{\sigma_P^2+\sigma_M^2}}\right]}}$$

$$-\left[\frac{\sigma_M}{2\sqrt{\sigma_P^2+\sigma_M^2}+2\sigma_M}\right]^{\epsilon^{-1.15\left[\frac{(\theta+\beta)\sqrt{\sigma_P^2+\sigma_M^2}+\beta\sigma_M}{\sigma_M\sqrt{\sigma_P^2+\sigma_M^2}}\right]}} \quad (2)$$

Eq. 1 is expressed in terms of the ratio of the tolerance of measurement accuracy, A ($A = 3\sigma_M$ for 99.7% confidence), to the specification tolerance, θ, of the parameter being measured.

Eq. 2 is expressed in terms of the ratio of the decision tolerance, β, to the specification tolerance, θ. Conversely, these equations can be used to find the ratios A/θ and β/θ, that are needed when tolerable error probabilities are specified.

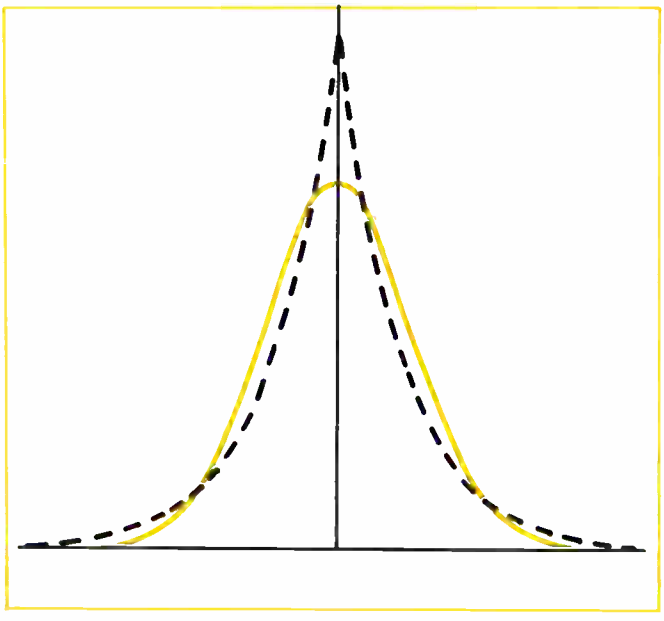
It is assumed that the specification tolerances, θ, for each parameter to be measured are known, and have been properly fixed by the designers of the equipment to be checked. Thus, the determination of the required ratios A/θ and β/θ easily leads to the determination of the required measurement accuracy, A, and the required decision tolerances β. Since the specification tolerances are considered as fixed, the only way to change the ratios A/θ and β/θ is by changing A and β.

Plots of the two equations thus developed are given in Fig. 3. The solid curves were made by holding the measurement accuracy constant at some arbitrary value while varying the decision tolerance. The dashed curves were made by holding the decision tolerance constant at some arbitrary value while varying the measurement accuracy. The point where the two curves intersect defines the probabilities of undetected defect and false alarm for the arbitrarily selected measurement accuracy and decision tolerances. These curves were made from computer solutions to the two error probability equations. For plotting, it was assumed that the upper and lower specification tolerances fell $3\sigma_P$ away from the nominal parameter value (i.e., $\theta = 3\sigma_P$). The measurement accuracy, A, selected was $3\sigma_M$ which gives 99.7% confidence. Certain postulations were made concerning the probability density distributions that describe the measurement error and the true parameter value. These postulations will be discussed later. The curves can be used as follows:

- To select the needed measurement accuracy and decision tolerances when probabilities of undetected defect and false alarm are given. For example, suppose that the tolerable probabilities of undetected defect and false alarm are 0.005 and 0.0008, respectively. The solid curves show the required ratio of measurement accuracy to parameter tolerance to be 0.12; and the dashed curves show the required ratio of decision tolerance to parameter tolerance to be 0.96. It is important to remember that the only way to achieve both an acceptable undetected defect probability and an acceptable false alarm probability is to select both the appropriate measurement accuracy and decision tolerance. It should also be noted that the measurement accuracy selected in this manner may not equal the commonly used rule-of-thumb which states that an accuracy of an order of magnitude better than the parameter tolerance is enough.
- To achieve an optimized trade-off between the probabilities of the two error types, given a fixed measurement accuracy. A fixed measurement accuracy fixed the loci of points defining the possible error probabilities along a specific solid curve. The trade-off is accomplished as the decision tolerances are varied. Probability of an undetected defect can be reduced by tightening the decision tolerances at the expense of increasing the probability of false alarm, and vice versa.

The error probabilities indicated in Fig. 1 are those for an individual measurement. Many such measurements are made during the checkout of a system. Overall probability of experiencing at least one undetected defect and one false alarm in a series of measurements is essentially given by the sum of the individual measurement error probabilities when the individual measurement error probabilities are small.

Fig. 2: Graph shows how "back-to-back" exponential curves are used to approximate the Gaussian curve. For details see the text.



Assumptions and Postulations

For those who are more interested in the availability of working equations and graphs than in how they were derived, the foregoing may suffice. But, for those desiring a fuller understanding of the principles involved, the following will be of interest.

The mathematical derivation of the probabilities of undetected defect and false alarm is based on Fig. 1.

The parameter in Fig. 1 has a nominal value with upper and lower specification tolerances. As part of a checkout, a measurement is to be made to determine if the *actual* parameter value is or is not within these tolerances. As a lemma, accept the existence of decision tolerances which are somewhat tighter than specification tolerances. The "go/no-go" decision for the parameter is based on whether the *measured* value is or is not within these tolerances.

For the type of measurement in question, measurement analyses generally postulate a random measurement error such that the measurement value M of the parameter is related to the actual value x according to a Gaussian probability density function with standard deviation. There are two ways of considering the relationship between M and x.

(1) The density function with standard deviation σ_M could be considered as centered at the actual value, x, of the parameter. In this case, the density function describes the distribution of the possible measured values that could result, given that the actual value is x. Or,

(2) The density function with standard deviation σ_M (the same σ_M as above) could be considered as centered at the measured value, M, of the parameter. In this case, the density function describes the distribution of the possible actual values that could have resulted in a given measured value, M.

The validity of both ways of considering the relation of M and x is discussed in Ref. 8. The first of these ways of looking at the error density distribution is commonly used in measurement analyses. The problem treatment in this article, however, uses the more unconventional second way because it becomes convenient in determining conditional error probabilities given specific measured parameter values obtained during actual checkouts (Ref. 6). The equation for the Gaussian probability density function describing the measurement error now takes the form

$$f(x \mid M) = \frac{1}{\sigma_M \sqrt{2\pi}} \epsilon^{-\frac{1}{2}\left(\frac{x-M}{\sigma_M}\right)^2}$$

A plot of $f(x \mid M)$ is shown in Fig. 1.

The actual parameter value, x, is also a random variable with a probability density function $f(x)$. This analysis treats the case where the actual parameter value has a Gaussian probability density distribution about the nominal parameter value. (The standard deviation is hereinafter designated as σ_P.) If there is no bias error in the measurement device, the measured parameter value, M, will also have a Gaussian distribution about the nominal parameter value with density function $f(M)$. The standard deviation for the measured parameter value is $\sqrt{\sigma_P^2 + \sigma_M^2}$.

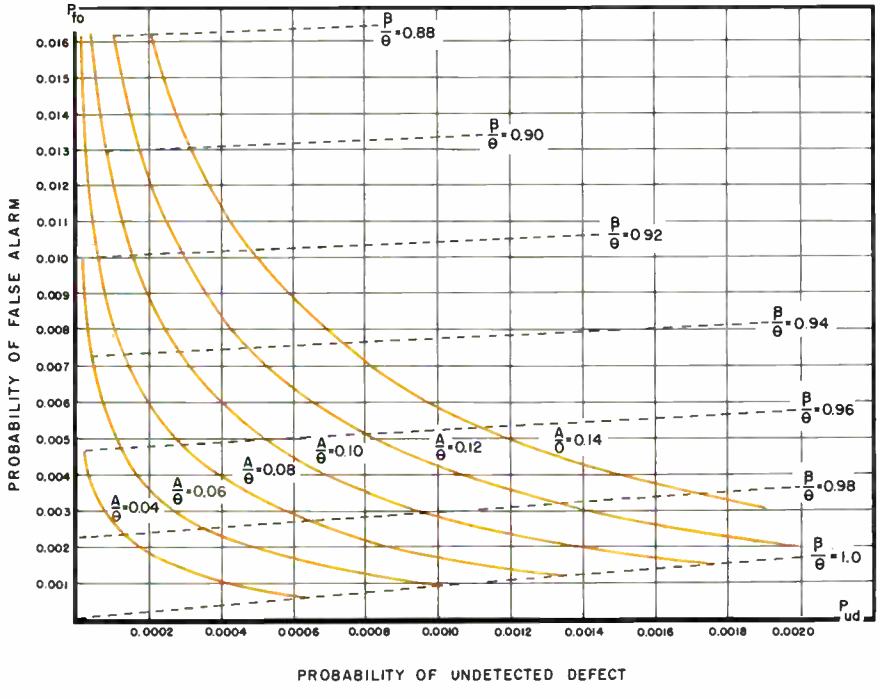
The equation for $f(M)$ is

$$f(M) = \frac{1}{\sqrt{(2\pi)(\sigma_P^2 + \sigma_M^2}} \epsilon^{-\frac{1}{2}\left(\frac{M^2}{\sigma_P^2 + \sigma_M^2}\right)}$$

A plot of $f(M)$ is shown in Fig. 2.

In the derivation of Eqs. 1 and 2, the Gaussian probability density distributions in the above equations preclude obtaining problem solutions in closed form. Therefore, these probability density distributions are approximated with back-to-back exponential curves, Fig. 2.

Fig. 3: Plots of P_{ud} vs P_{fa} for practical values of A/θ and β/θ.



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ELECTRONIC INDUSTRIES WHAT'S NEW

INTEGRATED CIRCUIT HOLDER ELIMINATES BROKEN LEADS

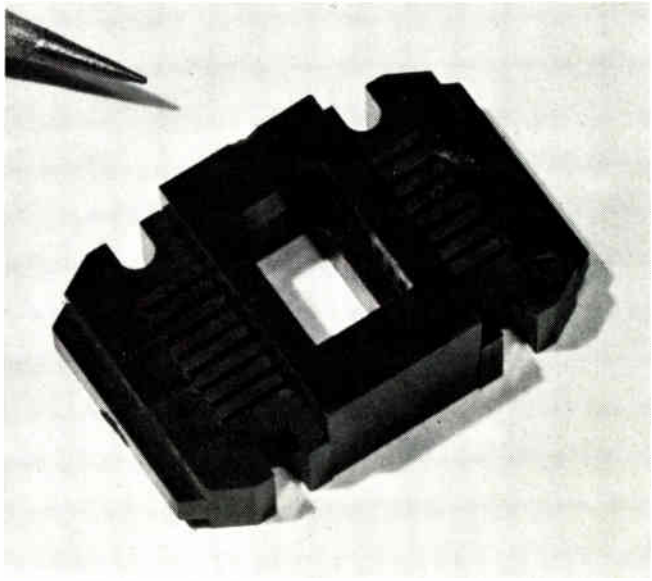
A NEW SYSTEM FOR TESTING INTEGRATED CIRCUITS by means of epoxy plastic circuit holders has been developed by the Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp., Palo Alto, Calif. These holders eliminate the chance of breaking fragile leads of flat packs and TO cans.

The Epiall® epoxy circuit holder consists of a base with two mating parts or top plates. One is used for flat packs and the other for TO cans. Epiall molding compound is made by Mesa Products, Plastics Div., Allied Chemical Corp., Morristown, N. J. Epoxy was chosen because its electrical properties are excellent. Low dielectric loss and high dielectric strength are maintained even at high temp. and humidity. Epiall has high mechanical strength in both thin and heavy sections. It is easily molded with no difficulty in obtaining sharp, clean corners. Dimensional stability is required for the close fit of the mating parts and for exact registry with circuits in the test system.

The circuit is locked in the carrier by a close mechanical fit between the base and either top plate. The leads are exposed for testing in the Series 4000M Fairchild Automatic Integrated Circuit Test System. Integrated circuits are tested automatically, and as many as 60 tests/sec. can be performed. Carriers are loaded in chutes, fed onto rails and transported to the test station where the circuits are checked.

The circuits and carriers are handled at high speed in the test system, and are shipped as a unit to customers. The carriers can be reused.

Epoxy circuit holder allows high-speed testing of integrated circuits with minimum danger of damaging leads of flat packs.



Our new Mother...all-silicon solid state

We're normally a hard-nosed, unsentimental bunch at CMC, dedicated to giving the other two major makers of electronic counters (Hewlett-Packard and Beckman) a run for their money. So you wouldn't think we'd have time for motherhood or advancing the counter art. **But,** we've scored on all three with our new 600-Series. (1) It's the first all-silicon solid state counter. (2) We're the first of the big three to use the advanced "Mother-Board" technique. So we've cut size, weight, and components while increasing reliability and ease-of-maintenance. (3) Operating temperatures from −30° to +75°C are available. (Other folks we know strain to claim −25° to +65°C). Model 607 provides a frequency range of 0 to 5 Mc and period measurement of 0 to 1 Mc. Other models have readout from 2 cps to 2.5 Mc. That's eight times faster than any competitive counter at the price. All this, and a price that's competitive with ordinary germanium counters. **Something free!** We give a glorious Crusading Engineers' medal to engineers who have the courage to compare **everyone's** performance specs before buying a counter. Get yours by writing today for our new stimulating technical catalog. It's free, too. And your Mother will be so proud of your shiny medal.

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WHAT'S NEW

DECENTRALIZED VOLTAGE REGULATION

THE CENTRAL POWER SOURCE may be on the way out—at least as far as microcircuits are concerned. General Instrument Corp., Hicksville, N. Y., has developed a unique group of voltage regulator microcircuits which make possible voltage regulation at individual points throughout electronic equipment.

The first-of-their-kind devices permit the voltage regulation system to be decentralized, or sectionalized, into a series of tiny microcircuits. They are being manufactured in both flat pack (0.375 in. sq. and 0.100 in. max. thick) and TO-5 can (0.325 in. max. in dia.).

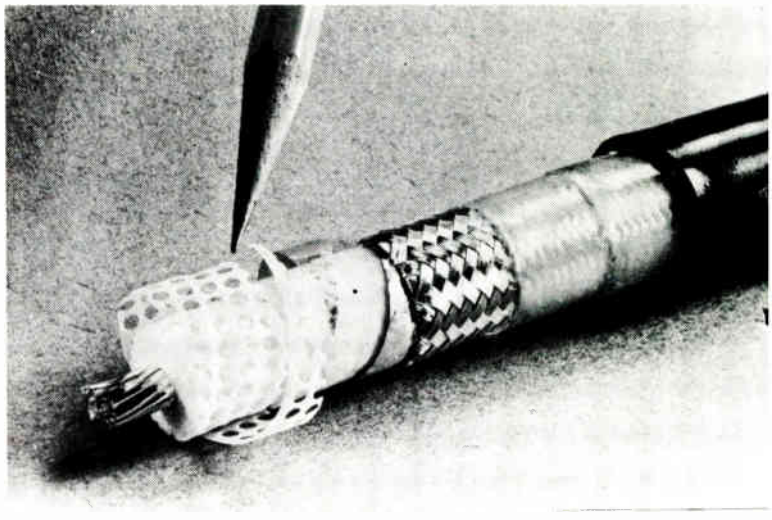
The new microcircuits come in two models: one with overload protection (PC 501-504) and one without protection (PC 511-513). A typical unit—the PC 501—uses high current epitaxial silicon transistors for the series elements, and high gain, low-noise transistors in the regulator section. For a reference element, a zener diode is used whose characteristics match those of the associated transistors. In addition, a series resistor network is trimmed to provide an output within 1% of the nominal output voltage. There is sufficient loop gain to insure 0.2% or better load regulation over the useful temp. range of −55°C to +125°C.

MICROWAVE CABLE MAY REPLACE WAVEGUIDE

AN ULTRA-STABLE COAXIAL CABLE which can replace waveguide at freqs. to 5GC has been developed by the Amphenol Cable Div. of Amphenol-Borg Electronics Corp., Chicago, Ill. Designated RG-326 ( )/U, the cable has an attenuation factor of 10.0db/100 ft. at 5GC, and a nominal VSWR of 1.2.

The ultra-stable cable is made in eight layers: (1) the

Perforated Teflon tape acts as a semi-solid dielectric due to air spaces trapped inside layers. Dielectric constant is 2.



center conductor; (2) the main dielectric perforated Teflon® tape; (3) a wrapping of unperforated Teflon tape; (4) a gap-spaced layer of spirally-wound, silver-plated copper foil; (5) a high-density braid of silver-plated copper wires; (6) and (7) two nylon tensioning layers; and (8) an environment-resistant polyurethane jacket.

The foil design and braid shield is one of the most significant features of the cable. Besides offering a braid coverage of nearly 100%, the two layers reduce contact resistance to a minimum. The spirally-wound, gap-spaced foil covers large areas of the cable with a solid shield, yet does not significantly affect flexibility. By wrapping the foil with gaps between each turn, changes in contact resistance due to shorting cannot occur during flexing. The high-density braid layer offers the shielding required to cover gaps in the foil.

Electrical stability of the braid-to-foil-to-dielectric contact is insured by a double layer of nylon fabric. This compresses the outer conductors firmly against the dielectric layers. The compression reduces outer conductor contact resistance, resulting in the low attenuation and VSWR factors of the cable.

MICROMINIATURE UHF TRANSCEIVER

Artist's rendering of the top of the AN/PRC-66 transceiver shows freq. selectors for 3500 UHF channels and other controls.

THE ARMED FORCES WILL SOON HAVE AT ITS DISPOSAL a compact UHF transmitter-receiver with 3500 channels. The unit, AN/PRC-66, is being developed by Collins Radio Company of Canada, Ltd.

The transceiver design consists of all solid-state devices, including integrated circuits, thin-films, and discrete components. Nearly all active circuits are microelectronic. The only exceptions are the power amplifier and r-f amplifiers.

Because of the low power requirements and high-efficiency of the transceiver, a compact battery may be used as a power source. The battery will be attached to the transceiver with slide fasteners so that it can be replaced easily and quickly.

The transceiver, without battery, measures 1½x4x6 in. and weighs less than 2 lbs. With battery, its weight is less than 10 lbs.

PROGRAMMABLE CHECKOUT SYSTEM

SPEED, ACCURACY, AND SELF-CHECKING are some of the features of the Type S-3901 Digital Readout System. A product of Tektronix, Inc., Beaverton, Oregon, it is used for programmed testing of systems, including integrated circuits.

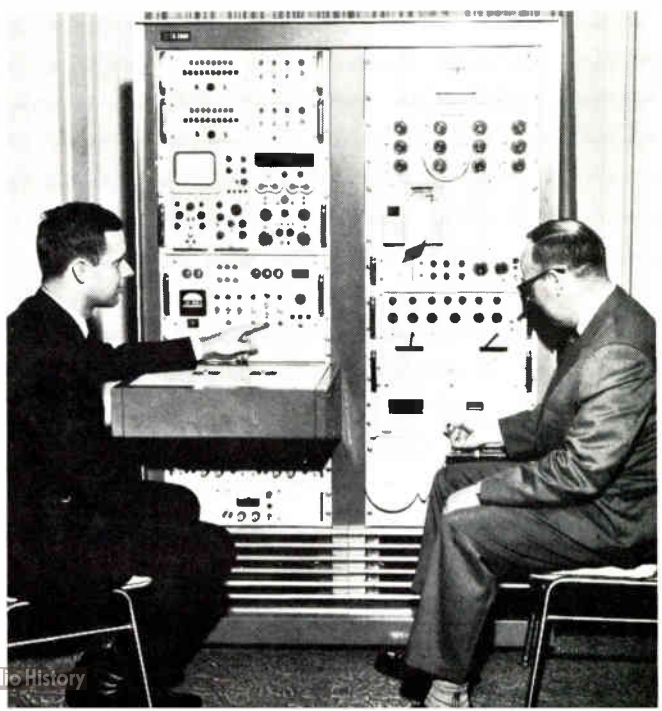
The basic system consists of an RM 567 oscilloscope and a 6R1A Digital Unit. The system is complemented by adding optional equipment. One such option is a signal processing plug-in, an instrument package for automatic readout of waveform measurement quantities. Performance parameters span the time domain from 1 nsec./event to 0.1 msec/event.

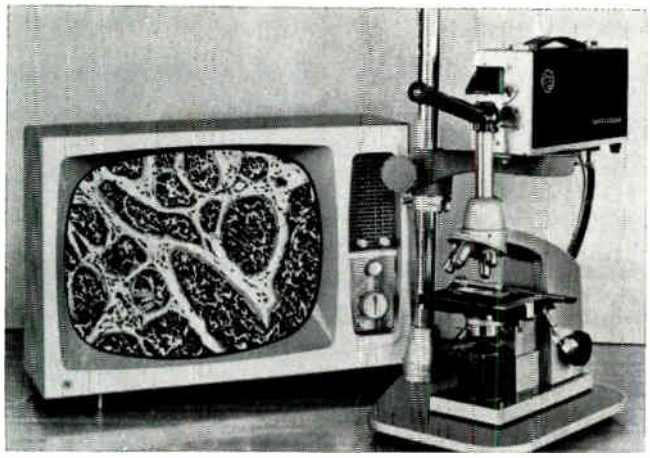
Along with testing speed comes the need for assuring the validity of the results. Frequency calibration checks can be made by simply programming the system to measure known quantities. An out-of-tolerance condition is signaled by the programmed GO, NO-GO comparators. Where there is a narrow tolerance on the measurement accuracy, an automatic recalibration feature is useful. This is offered in an optional self-calibration unit which uses the inhibit signals from the comparators to adjust the calibration. Time base ranges and dual channel sensitivity ranges can be set within ±1%.

A step towards computer control of system operations is provided by an 8-channel tape system. On this tape can be placed up to 256 bits in a program block. This block may be visualized as an addressable memory plane.

Some of the advantages of stored program control can be had without programming the entire system. For instance, a 262 Programmer can store 8 measurement programs for the 6R1A in wired plug-in cards. The card performs most of the functions that would otherwise require manipulation of the 6R1A front panel controls. Three 262's can be connected to the 6R1A, making up to 24 stored programs accessible. These programs are automatically connected when needed.

Gordon Long and George Edens of Tektronix adjust controls of the S-3901 programmable measurement system for i/c modules.





CLOSED CIRCUIT TV MICROSCOPE

New system for TV microscopy includes camera, monitor, scope with demonstration eyepiece. Camera works on 525-line system, 60 fields per second. Dual output of video and radio are available at the same time. System, made by William J. Hacker & Co., can feed a single receiver at a distance of 3,000 feet without loss of picture quality.

1965 National Telemetering Conference

The 1965 National Telemetering Conference will be held April 13 through 15 at the Shamrock Hilton Hotel in Houston, Texas. All four major areas of telemetry will be well covered in the technical program. These four areas (aerospace, industrial, biomedical and oceanography) will be covered in more than 70 talks and several panel sessions.

The conference is sponsored by the Instrument Society of America (Host), the American Institute of Aeronautics and the Institute of Electrical and Electronics Engineers.

There will be a commercial and scientific exhibition. It will be held in the Hall of Exhibits of the Shamrock Hilton. Over 100 booths will feature the latest developments in telemetry systems, equipment and accessories.

Pre-registration fees for society members (ISA-IEEE-AIAA) will be $12.00 and $15.00 for nonmembers. At conference registration fees will be $15.00 for society members and $18.00 for nonmembers. All of the papers will be published in a Proceedings and distributed to all registrants at the meeting. Registration will take place in the lobby of the Shamrock Hilton.

The technical program will include sessions on Data Compression; Adaptive Telemetry; Modulation and Detection; Biotelemetering; Oil and Gas Telemetry; Vehicle Borne Data Handling; Oceanography; Industrial Telemetry Technology; Ground Data Handling; Space Science; and Water, Auto and Power Telemetry. In addition there will be several panel discussions. Over 90 scientists, engineers and educators are authors of the papers.

There will be various tours and social functions during the conference. Included in these is a tour of the NASA Manned Spacecraft Center (Charge—$2.00). The program planned for the ladies includes luncheons, tours of gardens, museums and fashion shows.

EDITOR'S NOTEBOOK

ELECTRONIC PIANO reportedly the world's first, uses all-electronic tone generation and is now being tested in the labs of Allen Organ Co., the developing firm. For 60 days keys will be struck 40 times a minute, a total of nearly 3,500,000 beats for each of 88 keys. This is about 12 to 15 years of average piano playing.

SQUARE DANCERS, some 20,000 in all, are to be registered, housed, and categorized according to terpsichorean ability, while Southern Methodist University Computing Center "calls the tune." A Control Data Corp. 1604 will process all registrants for the 14th National Square Dance Convention in Dallas, set for June 24-26. The system won't call out "circle eight in the middle of the floor," though.

RECORD FACTS now on record by Jensen Industries, needle makers, include the following, gleaned from a sampling of 700 phonograph owners: records are played an average of 4½ hours a week; but average among teenagers is twice as high; the Beatles were most played in 1964; classics represent less than one-fifth of total listening. All in all, Americans played an average of 570 records each last year. To Jensen queries, most owners could not remember when they had changed needles last.

FLIP-TOP CANS may be an unprecedented breakthrough over Iron Curtain competitors for other things besides beer and soda. Eitel-McCullough engineers, as they drank their morning orange juice, pondered the problem of a quick-open package for their high-priced, sensitive transmission tubes that would also provide protection against corrosion and breakage. The answer stood mutely on the table before them. Now Eimac is packing tubes in easy-open tab-top cans.

TAX RETURNS will be processed in first broad-scale use of computers to analyze and compute 1964 filings. Some 500,000 taxpayers in eastern and western states will use a new service called COMPUTAX on two of the nation's largest and fastest computers in Mineola, N. Y., and Los Angeles. Developed by Computer Sciences Corp., the system will be available through accountants and tax services. There may be an estimated 10,000,000 taxpayers using such systems by 1970, says CSC.

MICROELECTRONIC CIRCUITS have come into their own at ground breaking ceremonies. For the opening of a new Delco (GM) plant, a light-dependent resistor picked up a press camera flash. The microelectronic amplifier-switch circuit amplified the signal, 2,000 times. A resulting pulse triggered throttle controls for two diesel engines for an earthmoving machine.

EXPLODING WIRE system developed for the Air Force can help in laboratory studies of nuclear explosion phenomena, according to Field Emission Corp., McMinnville, Ore. Energy packed in small volume is released in titanic power pulses at peak power of 20 billion watts at 50nsec. into a tiny wire about 0.003" thick and about 3" long. Energy is deposited so fast the wire has no time to expand. High temperature (1,000,000°F) causes the wire to explode violently.

AUTOMATIC DRAFTSMAN, which costs much less and takes less space than present models, is being perfected by Professor Leon J. Arp at Iowa State Univ. The machines will be in a 30-inch cube and will perform around the clock from taped data.

MICROELECTRONIC DEVELOPMENTS . . .

CBS Laboratories will feature its integrated and thin film circuits at the London International Engineering Exhibition, April 21-30, 1965. CBS Labs will show how "low-power microelectronics will help manufacturers make products more reliable, cheaper, smaller, and how the new technology will open doors into an undreamed-of future in manufacturing."

A microelectronics facility for assembly of high-density electronic equipment that uses a large amount of semiconductor integrated-circuit devices was disclosed by International Telephone and Telegraph Corp. The new production facility will assemble, package, and interconnect a variety of transistorized microelectronic devices.

The Semiconductor Division of Sylvania Electric Products Inc. disclosed plans for "a major expansion of manufacturing, engineering, and research facilities for integrated circuits." Sylvania's circuits, engineers report, are made on silicon base by monolithic epitaxial technique which "provides greater noise protection, higher switching speeds and higher fan out . . ."

A seven-year R&D program in cermet hybrid circuits has resulted in a new Micro-Electronic Division by Columbia Technical Corp. at Woodside, N. J.

Signetics Corp. announced availability of seven new integrated digital circuits. Based on a previously established Utilogic family, the new LU-Series of Utilogic devices provides 800mv noise margins, fan-out up to 17, high capacitive drive, and temperature range of +10°C to +55°C.

International Resistance Co. has formed a Microcircuits Division to make a broad line of microelectronic products. The new facility will produce standard custom hybrid microelectronic circuits for linear and digital applications, as well as a wide variety of passive networks.

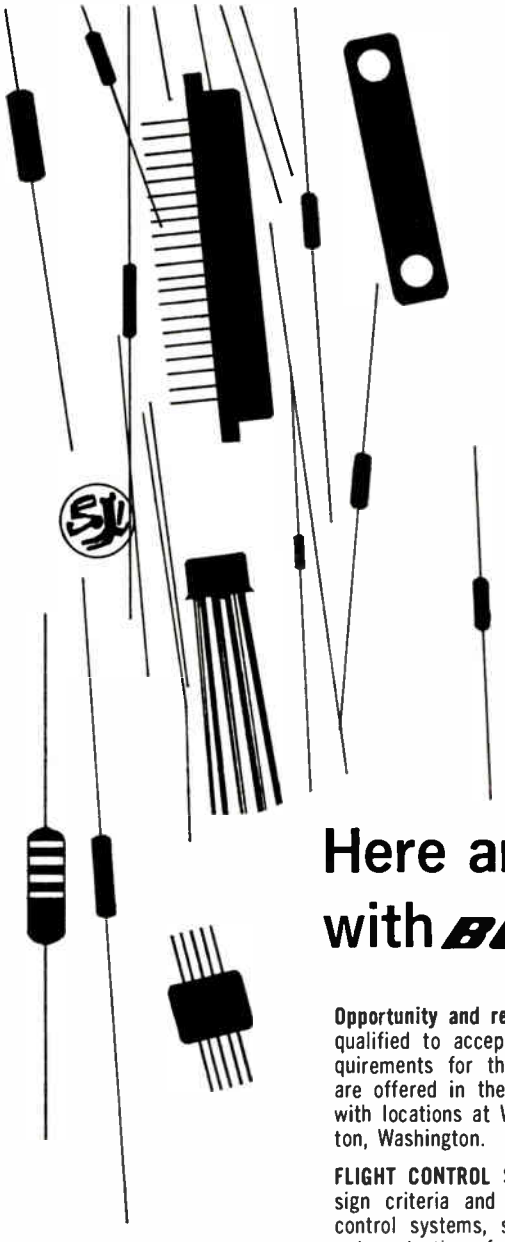
A new West Coast sales and engineering headquarters has been opened by Amphenol Microelectronics, Amphenol-Borg Electronics Corp. Located at Chatsworth, Calif., the new office will cover all engineering and sales west of the Rocky Mountains.

NEW A-TO-D CONVERTER USES MICRO CIRCUITS

Low power requirements, and size and weight reductions by a factor of five are key features of CBS Laboratories' analog to digital converter Model CA-3. The unit, designed for space and other severe environments, converts analog input signals to an eight-bit binary code. It has both serial and parallel outputs, and performs up to 3300 eight-bit conversions per second.

The digital section of the converter is in integrated circuit form. It uses CBS Laboratories' micropower logic circuit to keep power drain below 10 mw. The analog section, using a combination of conventional components and integrated circuitry, requires 140 mw. Total power drain is 150 mw.

The micropower integrated circuits are manufactured using a technology in which deposited thin-film resistors and passivated transistors and diodes form a monolithic structure in a single silicon wafer. A typical CBS Laboratories flip flop dissipates 60 μw per stage and has a total power consumption of 180 μw.



Here are interesting challenges with BOEING Airplane Division

Opportunity and responsibility to engineers qualified to accept immediate staffing requirements for the following assignments are offered in the firm's Airplane Division with locations at Wichita, Kansas and Renton, Washington.

FLIGHT CONTROL SYSTEMS — Establish design criteria and specifications for flight control systems, subsystems and components; selection of components; and monitoring of flight test.

CONTROL DYNAMICS — Servo control analysis to develop automatic terrain-following concepts, load-alleviating stability augmentation systems and automatic flight control systems. Experience in analog computer programming and familiarity with digital computer techniques.

FLIGHT TEST INSTRUMENTATION — Perform instrumentation design, coordinate instrumentation requirements, monitor installation, and perform preflight and postflight checks.

ANTENNA SYSTEMS — Design, performance evaluation, and analysis of radome, antenna, and RF transmission systems. Experience in antenna, radome, or wave propagation.

NAVIGATION AND GUIDANCE SYSTEMS — Analysis of electromechanical systems and derivation of system transfer functions to quantitatively predict system performance. Experience in feedback control systems.

RADAR TECHNOLOGY — Perform analytical studies of airborne reconnaissance sensors, data processing, and digital transmission techniques as pertain to beyond-line-of-sight transmission of high density information.

WEAPONS DELIVERY SYSTEMS — Analysis of weapons delivery problems and solution techniques. Establish requirements of systems, select equipment by trade-off studies and system analysis, and present results for proposed new weapon delivery system.

ELECTRICAL SYSTEMS — Design and load analysis of aircraft electrical power generation systems. Experience in power factor and load balancing parameters.

OTHER POSITIONS AVAILABLE IN: FLIGHT TEST OPERATIONS • FLIGHT TEST DATA PROCESSING • ELECTRONIC COUNTERMEASURES

All positions require a B. S. or advanced degree in engineering, physics or mathematics.

Assignments are available in both these locations:

Mr. Gerald Caywood, Dept. BCA	**Mr. Tom Sheppard, Dept. BCA**
Boeing Airplane Division	**Boeing Airplane Division**
4300 East MacArthur Road	**P. O. Box 707**
Wichita, Kansas 67210	**Renton, Washington 98055**

BOEING

AIRPLANE DIVISION

WICHITA, KANSAS ■ RENTON, WASHINGTON

AN EQUAL OPPORTUNITY EMPLOYER

ELECTRONIC INDUSTRIES

PROFESSIONAL GUIDELINES

Reporting late developments affecting the employment picture in the Electronic Industries

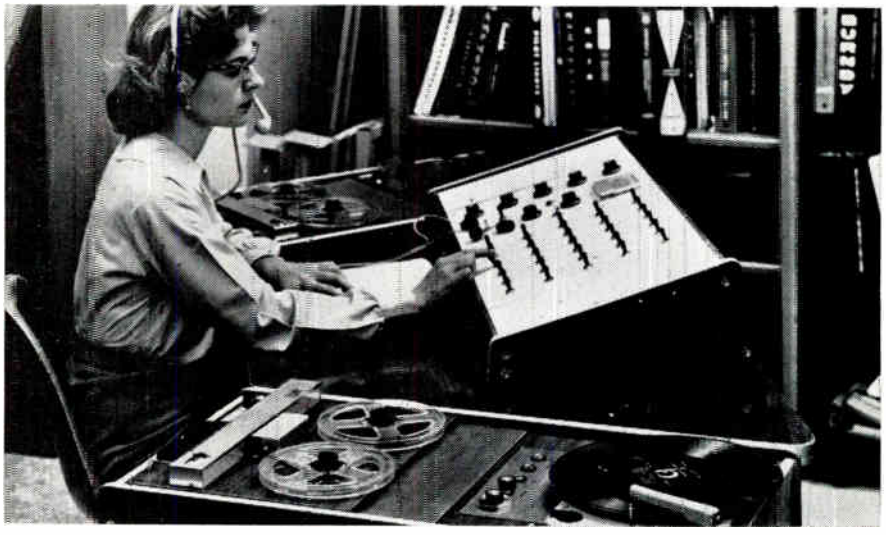
FEDERAL WOMEN ENGINEERS RISING, SAYS NASA ENGINEER

The number of women earning more than $10,000 annually in government jobs concerning computers, mathematics and mathematical statistics, and physical sciences has increased dramatically since 1959, according to a systems engineer at NASA.

Mrs. Catherine Dryden Hock, reliability and quality assurance systems engineer at the NASA Headquarters Office of Manned Space Flight, said that the interest in the space programs appears to have reversed the declining trend of women among government engineers.

Between 1959 and 1963, Mrs. Hock said, the number of women in government grades of GS-12 and above in the computer fields rose 790%, in mathematics and mathematical statistics 137%, and in physical sciences 122%.

REMOTE EDUCATIONAL LEARNING CENTER



Customized console for new RL-6800 Learning Center developed by Educational Electronics Div., Dage-Bell Corp. In this modular add-on audio system student recorders and amplifiers are in remote compact cabinet under teacher control. Cabinet may house as many as 18 recorders. All student tape deck functions are under the instructor's control.

PENN SEMINAR WILL COVER SYSTEMS COMPATIBILITY

A two-week seminar on "Systems Electromagnetic Compatibility" will be offered at The Moore School of Electrical Engineering of the University of Pennsylvania beginning on June 14, 1965. Its purpose is to quantify this critical technical problem for the benefit of engineers.

Enrollment fee is $250 (a special institutional rate of $125 is available to educators). Applications or further details may be obtained by writing to Special Summer Sessions Office, The Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa., 19104.

RCA-PURDUE TV CENTER

An RCA Television Engineering Advanced Methods Center has been established at Purdue University's Industrial Research Park it was disclosed jointly by the Radio Corp. of America and Purdue University.

The RCA Center, to be adjacent to the Purdue campus at West Lafayette, Ind., will be dedicated to "developing new sights and sounds for tomorrow's home entertainment."

1965 STARTS WITH UPSURGE IN DEMAND FOR ENGINEERS

The Deutsch & Shea Engineer/ Scientist Demand Index showed a continuing uptrend in the search for technical people as 1965 began. After a seasonal drop in December, 1964, the January Index figure reached 112.6, the first time since April, 1963 that it has topped the 100.0 mark.

This represents a gain of 43.3 over December, or, more significantly, a 20.8 upturn from November, the highest month in 1964. The January Index figure remains below the 1962 and 1963 figures for the month, but tops January, 1961 by 15.0 and January, 1964 by 35.6.

This would indicate that 1965 may show a higher level of demand for technical people than for 1964.

Recruiting activity during January was strongest on the West and East Coasts, but was up throughout the country. Display advertising showed moderate gain in technical journals, sparked by aerospace and electronics.

PROFESSIONAL GROUP SEEKS U. S. ENGINEER WAGE STUDY

The National Society of Professional Engineers has urged President Johnson to direct an immediate study of federal engineering salaries by the Civil Service Commission to determine whether an increase is needed for engineers in grades GS-12 and above.

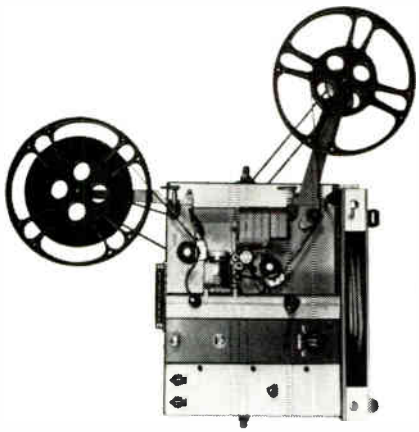
Above-minimum rates are now in effect for engineering grades GS-5 through GS-11 under CSC administrative action, as authorized by the Federal Salary Reform Act of 1962.

FROSH ENGINEER ENROLLMENT ROSE 12% IN FALL 1964

College freshman enrollments in engineering totaled 73,700 last fall, an increase of 12%, reports the Office of Education, U. S. Department of Health, Education, and Welfare.

The rise contrasts with only a 1.6% increase in the fall of 1963. The enrollment count was made at all 254 institutions of higher education granting degrees in engineering.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 152.



Many Technical Films Available for Engineers

Some of the more important tools in any engineer training program are technical films. The problem is how to choose and find them.

By SIDNEY FELDMAN, Associate Editor, ELECTRONIC INDUSTRIES

SEVERAL HUNDRED THOUSAND industrial, educational and technical films are now available from nearly 4,000 film sources across the nation. Many have been prepared for engineers and scientists by electronic and aerospace firms. Some have been prepared by U. S. Government agencies, often in conjunction with defense contracts. Others have been made and distributed by trade, technical, commercial, scientific, and educational organizations.

Films for engineers usually are of three types:
(1) Advanced technical subjects to up-date engineers.
(2) Basic and advanced information in the sciences.
(3) Techniques of cutting costs and improving management.

Most film users in industry have some sort of planned training or educational program but their problem is how to choose the best films most closely related to needs. They may rely upon printed descriptions, or risk ordering films by title alone. They may also telephone distributors for details, read film reviews, or ask someone who has used the films.

It is usually advisable to preview films right at the distributor's facilities where possible. Some distributors permit such previews for fees that average $2.50 an hour on the premises. One such is the Audio-Visual Center of the Bernard M. Baruch School, The City College of New York, 17 Lexington Ave., 10010.

Two useful publications sold by National Audio-Visual Association (NAVA), 1201 Spring Street, Fairfax, Va., 22030, are: "NAVA Membership List and Trade Directory" (50¢), (it lists films, services, and equipment available at manufacturers' representatives); and "The Audio-Visual Equipment Directory" ($6.00), which names firms, shows models and current prices. NAVA also offers a free booklet called "Talk is Not Enough," which discusses use of audio-visual tools.

Another list of useful publications on audio-visual equipment, materials and uses is available from: Publication Sales, National Education Association, 1201 16th Street, N.W., Washington, D. C., 20036.

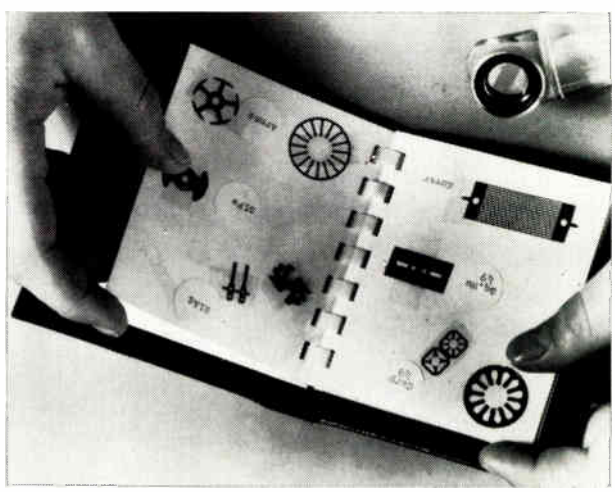
A free booklet on "Look, Listen, and Learn—Getting the Most from Educational Films," is available from Coronet Films, Coronet Building, Chicago, Ill., 60601.

Most films are standard 16mm. There is a trend to 8mm films, many of which are pre-loaded in cartridges, doing away with handling and film-threading.

Following is a list of literature, catalogs, and sources on training films, audio-visual equipment suppliers, and related materials and services.

Dr. C. G. B. Garrett, Bell Labs Optical Electronics, presents electromagnetics for understanding of laser in Bell film.

Sample book Chemical Micro Milling Co. uses with Eastman Co. film to show how Kodak Photo Resist is used to make resistors.



PUBLICATIONS & CATALOGS ON AVAILABLE FILMS

U. S. GOVERNMENT PUBLICATIONS

NATIONAL UNION CATALOG, LIBRARY OF CONGRESS
Volume 28: Motion Pictures and Filmstrips, 1953-1957: $20.75.
Volume 53: Motion Pictures and Filmstrips, 1958-1962: $41.00.
Volume 54: Motion Pictures and Filmstrips, 1958-1962: $41.00.
Rowman & Littlefield, Inc., 84 Fifth Avenue, New York City, 10011.

LIBRARY OF CONGRESS: MOTION PICTURES AND CATALOGS
Three quarterly issues, and a cumulative annual issue: $8.00.
Card Division, Library of Congress, Washington, D. C. 20540.

These publications attempt to cover all educational or instructive films released in the U. S. and Canada. Catalog data are provided by film producers or their distributing agencies.
U. S. Government films are cataloged through cooperation of the Visual Education Service of the U. S. Office of Education.

DIRECTORY OF 3,660 16-MM FILM LIBRARIES
Department of Health, Education & Welfare Bulletin 1959, No. 4: $1. Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402

Lists film libraries by state and city to help locate local or regional film libraries. Includes business firms, institutions and organizations that lend or rent 16-mm films in U. S.

GOVERNMENT FILMS FOR PUBLIC EDUCATIONAL USE—1963
Department of Health, Education & Welfare. Issued 1964. OE-34006-63, Circular No. 742: $3. Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

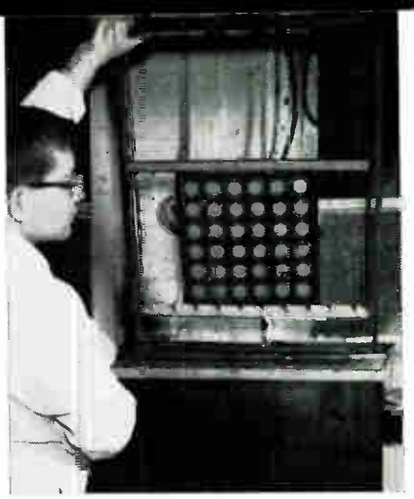
Films by title and subject, film services of U. S. Government, sources of U. S. Government films, U. S. Government films for public educational use.
Agencies of main interest to electronic companies include: Air Force, Army, Atomic Energy Commission, Federal Aviation Agency, National Aeronautics and Space Administration, Navy, among others.

ATOMIC ENERGY COMMISSION MOTION PICTURE FILM LIBRARY
Professional Level Catalog of 16-mm films: Free. Audio-Visual Branch, Division of Public Information, U. S. Atomic Energy Commission, Washington, D. C. 20545.

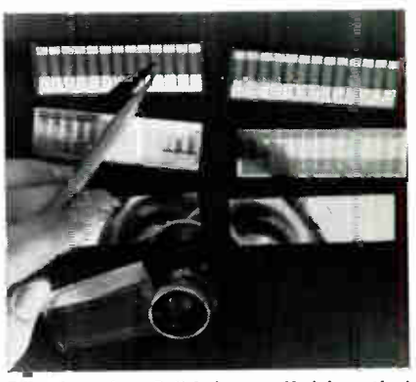
Special catalog of professional films of interest to scientists and engineers. Films may be duplicated in publication cited above.

CATALOG OF FILMS FOR CIVILIAN EXHIBITION
Headquarters First U. S. Army Pamphlet 108-2: Free. Director, Central Audio-Visual Communication Center, Governors Island, New York City, 10004.

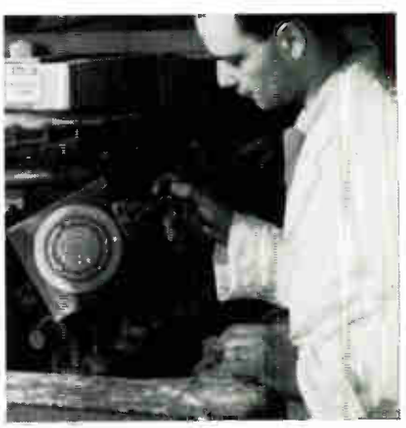
Headquarters of the various continental U. S. armies maintain an audio-visual communication center. Full details may be obtained from each area's headquarters. For example, the First U. S. Army unit is listed above. In turn, it has a regional center in Schenectady, N. Y., and in Boston, Mass.
Such centers are sources of Armed Forces Information Films, Armed Forces Screen Magazine, Combat Bulletins, Civil Defense, Army Research & Development Progress Reports, Professional Medical Films, Training Films on varied subjects, from "Principles of Operation and Applications of Traveling Wave Tubes/Types" to "How to Operate the Army 16-mm Sound Projector Set," various films about defense procurement, and miscellaneous films which discuss subjects ranging from "AN/FPS-16 Instrumentation Radar at White Sands" to "Data for Service Test Evaluation of Army Air Defense Systems." *(Continued)*



Eastman film shows how chemical milling is used with Photo Resist instead of stamping.



Film shows how Bell Labs uses Kodak method to process resistors on tantalum and glass.



A feature of Kodak film is a rotor stator used in tape systems for numerical control.

TV film (left) partly sponsored by IEEE features prominent medical men and stresses vital role electronics plays in medicine.

Bell film "Physical Chemistry of Polymers" (right) shows "rubber molecules" in thermal stress.

TECHNICAL FILMS (Continued)

TECHNICAL, EDUCATIONAL, TRADE ORGANIZATIONS AND DISTRIBUTORS

"AEROSPACE INFORMATION INDEX," Free.
Mike Donahoe, Education Programs and Services, NASA, 150 West Pico Blvd., Santa Monica, Calif. 90406.

Aerospace resource list of films and brochures for educators. Special project of Aerospace Committee, Los Angeles Chamber of Commerce, and Office of Educational Programs & Services of National Aeronautics and Space Administration, Western Operations Office.
Published for educators "to reduce the time gap between the development of new knowledge by the aerospace industries and its introduction into the classrooms of America."
Subjects include aircraft, flight controls, Army-Navy instrumentation program, satellites, quality assurance, Delta progress reports, materials, etc.

"AMA MANAGEMENT FILM CATALOG 1964-1965," Free.
American Management Association, 135 West 50th Street, New York City, 10020.

Various management films, including: Pert Applications and Principles, and Profitable Computer Systems.

"ASSOCIATION FILMS, INC., CATALOG: 1964-1965," Free.
Association Films, Inc., 347 Madison Ave., New York City, 10017.
List of varied, general and mostly no-charge-for-use films. Subjects include engineering and technical films, space-science-communications, business and industry.

Hughes Aircraft Co.
International Airport Station,
P.O. Box 90515, Los Angeles, Calif., 90009
Attention: K. G. Brown, Public Relations & Advertising Building 114, Mail Station 13

"Film Catalog," showing type of audience interest, is available. Films are lent free. Subjects include airborne weapons, radar systems in air defense, electronic manufacturing and reliability.
However, if film is classified, then borrower must have clearance and demonstrate a "need-to-know."

International Business Machines,
Film Library:
425 Park Avenue, New York City, 10022
618 South Michigan Avenue, Chicago, Ill., 60601
3424 Wilshire Boulevard, Los Angeles, Calif., 90005

"IBM Motion Pictures Catalog 1964-65" describes free loan films on computers, data systems, computer control, simulation, others.

Pesco Products, Borg-Warner Corporation,
24700 North Miles Road, Bedford, Ohio, 44014
Attention: R. H. Montgomery, Advertising Manager

"Cryogenics Progress Report" of interest to persons working with cryogenic liquid propellants, components and systems.

Radio Corporation of America,
30 Rockefeller Plaza, New York City, 10020
Attention: Leo Popkin, Johnny Victor Theatre

Offers general interest electronic films, with possible engineer interest in "Silent Power" (direct energy conversion), BMEWS, Intercontinental TV, and Tiros I.

Communications Systems Division,
CSD Presentations & Photographic Group,
Building 10-4, Camden, N. J.
Attention: P. Boffo, or Stallings

List of CSD films seems most useful for engineer use. Subjects include: Automatic Wire Wrap; Code Division Multiplex; Hardened & Dispersed Minuteman; Experimental Micro Module Facilities; AN/FPS-49 Tracking & Radar; Minuteman High Reliability Manufacturing; Precision Optical Surveillance; Digital Communication Principles; Solid State Space Age Microwave; and Numerical/Control.

"ELECTRONICS AT WORK"
P. O. Box 96, Barrington, N. J. 08007.

This is a series of 90 half-hour educational television lectures, available in 16-mm. film for non-broadcast use. Six main areas are: Electrostatics and DC Circuit Principles; Electromagnetism and its Applications; Power Supplies and Basic Electronic Components; Vacuum Tubes and Reactive Circuits; Audio Communication Systems; TV Communication Systems.
This series is an introductory course. Though it is not intended to train electronic engineers at college level, the lecturer-producer says "substantial numbers of professionals are using current broadcasts." Study guides, teaching guides, and practical exercise manuals are available.
The project was conceived and produced by John W. Wentworth, an engineer on leave from RCA. However, RCA is not involved in the content, production or distribution of the course.

"INDUSTRIAL EDUCATION FILM LIBRARY CATALOG," Free.
Industrial Education Films, Inc., 195 Nassau Street, Princeton, N. J. 08540.
221 Columbus Avenue, Boston, Mass.

Subjects here concentrate on technical management. Films include: The Principles of PERT/Cost; The Search For Savings (value analysis); Work Sampling; Functional Drafting; and Controlling Quality.

"NATIONAL FILM BOARD OF CANADA FILMS FOR RENTAL/PURCHASE IN U. S. 1964-65"
National Film Board of Canada, 680 Fifth Ave., New York City, 10019.

Free catalog of 16-mm. films on: radar, Alouette—Canada's First Satellite, antenna fundamentals, wave propagation, and other subjects.

PHYSICAL SCIENCE STUDY COMMITTEE PHYSICS FILMS
Distributed by Modern Learning Aids, Modern Talking Picture Service, Inc., 3 East 54th Street, New York City, 10022. Free descriptive folder available.

Group of 53 films to help teach the basic concepts of physics. Subjects include crystals, optics, light waves, electric fields, electron mass, electromagnetic waves, photons, photo-electric effect, and matter waves.
These 16-mm. films may be used with textbooks. There is a teacher's guide for each film.
Three special films treat the energy transfer in electric circuits: Elementary Charges and Transfer of Kinetic Energy; EMF (the energy per elementary charge delivered by a battery); and Electrical Potential Energy and Potential Difference.

"SCIENCE AND ENGINEERING TELEVISION JOURNAL"
225 West 57th Street, New York City, 10019.

American Association for the Advancement of Science will coordinate production of 20 half-hour telecasts. Programs also will be reproduced as 16-mm. films. This series seeks to inform scientists and engineers of developments in fields outside their own specialties.
Sponsors are the National Science Foundation and The Timken Roller Bearing Co. Programs will be distributed by National Educational Television to about 75 educational TV stations, starting in March 1965.
Among 20 participating societies is the Institute of Electrical and Electronics Engineers. IEEE will report on Traffic Control Techniques.
Topics of other societies include: supersonic air travel; environmental control; information for effective engineering; operations research; fiber optics; cryogenics; and weather.

CROSS-SECTION OF COMPANY FILM CATALOGS AND FILMS

American Telephone & Telegraph Co.

Each of the 21 associated companies of the Bell Telephone System offers a catalog and the free use of films. Most useful here are college science films made by Bell Telephone Laboratories.
Two typical films are, "Principles of the Optical Maser" and "Physical Chemistry of Polymers." For information, write or telephone the Program Bureau, Public Relations Department, of your local or regional telephone company.

General Electric Co.
Film Production Operation, Advertising & Sales Promotion, 60 Washington Street, Schenectady, N. Y., 12305.

"Films Available For Sale" are listed by this operation. Also write for "New Motion Picture Teaching Aids," to GE Educational Films, at the address above.

The quality and delivery of technical papers are not keeping pace with today's industry. The shortcomings can be overcome with a few simple steps described here. But first management and engineers must jointly attack the problem.

Needed: Better Technical Papers

A worthwhile paper and good delivery are essential to any engineering presentation. Advance rehearsal is necessary.

SYMPOSIUM TECHNICAL SESSIONS are fast becoming the step children of our major engineering meetings. The trend is to bigger and better exhibits with the session speakers being left to fend for themselves. Since there is general agreement that the exchange of technical information is basic to a progressive technology, this trend is a curious one.

* * *

Any company is interested in engineering meetings for at least two reasons. One is a desire to stimulate scientific inquiry and the exchange of technical information. The other is the use of such meetings as show cases for new products.

A quick check of the exhibit area of any major symposium will verify the fact that industry has done an outstanding job on product exhibits. The same company, however, which may devote much time, manpower, and money to its latest exhibit often falls short at the technical sessions.

When you consider that a customer more often assays a company's technical competence in the lecture hall than at the marketing booth, this neglect is a strange policy indeed. It becomes even more ludicrous when the potential customer gathers a handful of promotional literature extolling the company's virtues at a booth and then strolls into a darkened technical session. Here he hears a poorly prepared engineer from the same company make a few "off-the-cuff" remarks. These remarks are backed up by an amateurish set of slides that no one beyond the fifth row can read. And to add insult to injury, the engineer is describing a marginal development. The composite impression is precisely the opposite of the one which the flashing lights of the exhibit proclaim. But alas the customer is conditioned to distrust exhibits and advertising . . . so he accepts the engineer as representative and deposits the brochures in the nearest trash can.

The Problem

This is admittedly overdrawn to make a point, but the rash of criticism of technical meetings is a good indication that something is wrong. The obvious question is: what is it and who is to blame?

The responsibility must be shared. It is partly management's fault for not paying more attention to the quality of such papers. It is partly the fault of the professional societies for padding programs with marginal papers. But most of all it reflects the unwillingness or the inability of the nation's engineers to report to their colleagues on their work.

Certainly there is no lack of significant engineering projects worthy of publication at the technical meetings. Even if we eliminate projects whose military classification precludes publication; and even if we withhold the developments whose release would harm a company's proprietary interests, there is still enough raw material to fill the trade press, the pro-

By ROGER M. D'APRIX
Light Military Electronics Dept.
General Electric Co.
Utica, New York

Since writing this article Mr. D'Aprix has taken a position with Consolidated Vacuum, 1175 Mt. Read Blvd., Rochester, N. Y.

Now...
Six 10-amp Relays for Punishing Applications

Having trouble specifying relays for space radiation environments? Cryogenic temperatures? Peak overload? "Mil-Spec-plus" conditions? Babcock now offers a choice of six rugged, high-reliability relays to solve hard-to-specify dilemmas.

Overload is typical. In firing squib circuitry, each BR-19 withstands a 500 amp capacitive discharge for 3 milliseconds . . . 50 times its rated load. The next Ranger lunar spacecraft will carry Babcock BR-19s instead of solid state switching devices. Each is required to undergo an 80 amp surge decaying to 16 amps steady state . . . half again their nominal rating.

New techniques have been developed for handling the unique demands of space environments. Special models for NASA are now regularly performing at LOX and LN_2 temperatures. Others are operating equally well at +300°C. High gamma or neutron radiation problems have also been solved. Hardened models have shown no measurable degradation after absorbing 0.9 x 10^8 Roentgens of gamma radiation. Many of these specially hardened units are operating dependably in USAF and NASA space vehicles today.

What's your punishing application problem? Chances are, we can help. Send for complete information.

BR-7: Standard hi-rel series, SPDT or DPDT contact forms.

BR-9: Magnetic latching version. DPDT only.

BR-14: Standard 4PDT series.

BR-18: Magnetic latching version of 4PDT series.

BR-19: All-welded version of standard BR-7. SPDT or DPDT.

BR-20: All-welded version of magnetic latching BR-9. DPDT only.

BABCOCK BR RELAYS

A DIVISION OF BABCOCK ELECTRONICS CORPORATION
3501 HARBOR BLVD., COSTA MESA, CALIF. • (714) 540-1234

Circle 69 on Inquiry Card

fessional press, and many more meetings than are now scheduled to overflowing.

The problem is not a lack of good engineering activity. It is a reluctance on the engineer's part to write. There are many reasons for this, but they fall chiefly into one of two categories. First, the engineer may make the erroneous judgment that he has nothing to say. This is the most common problem.

It is based on the mistaken belief that a paper must be written about a new and startling development never before reported. A minute's examination of the convention records of any of the large meetings will show that this notion is not true.

Many of the best papers are written about small developments, but they are the kind which the audience is looking for to solve their immediate problems, or to stimulate new solutions for old problems.

What all of the best papers have in common is some relevance to the audience's difficulties. In brief, they strike a responsive chord even if it's no more than a sympathetic nod of the head.

The point is that although you the engineer may not feel that your idea is earth-shaking, it may be just the missing link that someone else has been searching for. Often you are simply too close to your work to see its significance. The solution? Try your material out in outline or abstract form and let the papers chairmen and the magazine editors determine its value.

Technical papers can also be important adjuncts to a company's marketing efforts if the engineer will only recognize the informational value of his development work. Although there is no precise measure of such things, countless preliminary sales contacts have been made by the competent engineer describing technically sound work to a symposium audience. This is a hard audience for any company to duplicate. They have *chosen* to hear the engineer's message because of their own interest.

The second set of circumstances working against the production of technical papers by the engineering force is the normal daily work load. All too often the engineer pleads—and many times with some legitimacy—that, "I have no time to write, and besides I am paid to be an engineer, not a writer."

"The professional and technical societies comprise, in the aggregate, a 'supreme court' of informed scientific opinion. The verdict of this court concerning the importance of scientific work generally transcends the opinions of the author or the sponsors of the work. To be sure, the verdict may not be explicit nor prompt, but it is generally final and inescapable."

C. G. Suits
Vice President and Director of Research
General Electric Co.

Why Write?

This is true if we consider only the work week, but there is hardly a one of us who cannot make some time to do the things we want to do, provided we feel such projects are rewarding. Consider for a minute some of the possible rewards for writing a good technical paper.

To begin with, such a paper extends knowledge and permits scientific progress. It also puts the writer in touch with others having similar interests, sometimes spawning life-long professional associations.

The technical paper also builds personal prestige and tends to establish a reputation for the author. It is frequently the man who *reports* his work who gets the credit, rather than the man who does the innovating.

The paper is also valuable as a reference for résumes, technical societies, and the "Who's Who" books. And finally, it promotes individual development by forcing the engineer to sharpen his thinking, to evaluate the usefulness of his work, and to practice oral and written communication, two useful skills in the engineering world.

Help for the Engineer

Management can encourage the engineer by relieving him of some of the unfamiliar routine associated with the preparation of a technical paper.* Obviously, industry has much to gain from such a free exchange. Why more firms have not attempted to assure the success of these technical sessions is a mystery. A manager may well risk a technical reputation by permitting his engineers to make shoddy presentations with poor visual aids and even questionable engineering content.

The unfortunate result in most firms has been that engineers write papers as the spirit moves them, with little or no guidance or assistance. This has had three important consequences:

1—The engineer writes only when he can find time. Thus information of urgent interest sometimes is reported long after the fact;

2—At the same time a good many marginal projects get reported in detail by less busy technical people;

3—The craftsmanship of the writing and of the visual material leaves much to be desired.

There are many ways to insure improved technical papers and articles. But by far the most effective is to assign a small group of technical writers to this function on a full or part-time basis, depending upon the work load.

It is impossible to hypothesize a writing group that would be suitable for all companies. Most publication efforts, however, do follow a regular order, making it possible to review such a group's contribution step by step.

A prerequisite to the publication cycle is informing the engineer of the various symposia which may be of interest to him. This calls for some research to

Possible pitfalls of presenting a technical paper are being discussed with five engineers prior to their appearance.

find out which engineers can write papers on the subjects requested in the calls for papers. Keeping this information up to date and complete, and making it known in time to meet the various deadlines set by the papers committees is a continuing activity.

Once a call for papers is suitably matched to an engineer's background and talents, the next task is to produce a good abstract. This is the first time that writing assistance is provided. In most cases the technical writer helps the engineer to organize his idea and then edits the rough draft until it is suitable for submission. The best results are achieved when the writer and the engineer work as a team, with the engineer supplying all of the rough material and the writer doing the polishing and acting as liaison man with artists, photographers, etc. This keeps control of the technical content. At the same time the engineer is relieved of tasks outside of his experience and interest.

Management Policy

Generally management has an established review policy for abstracts, papers, and articles. This review is designed to prevent compromise of proprietary rights or the release of "sensitive" information.

After the paper is cleared, it is next sent to the symposium papers committee for review. If it is accepted, the abstract is expanded into a full-scale paper and resubmitted for final management review.

What happens after this depends on the symposium's needs. If there is to be a convention record, the writing group ordinarily converts the engineer's rough draft into a manuscript for publication. More and more this has come to mean getting it "camera ready." Here is one area where the group can make a real contribution by relieving the engineer of unfamiliar graphic arts chores and providing the symposium with a professional-looking, well-written paper.

The selection of visual aids is still another area where the engineer should be given guidance. Type of slide, lettering size, and art format are only a few of the decisions requiring professional advice.

The writing group can also take over the important job of running rehearsals for the engineer before he presents his material. Here the emphasis is mainly on bolstering his confidence, rather than trying to make a polished speaker of him. Too much coaching or criticism will only serve to shake whatever faith he does have in his speaking ability.

Finally, the group has responsibility for obtaining recognition for the author in company and local press, as well as in the trade press. This effort can be augmented by supplying reprints of the paper for distribution.

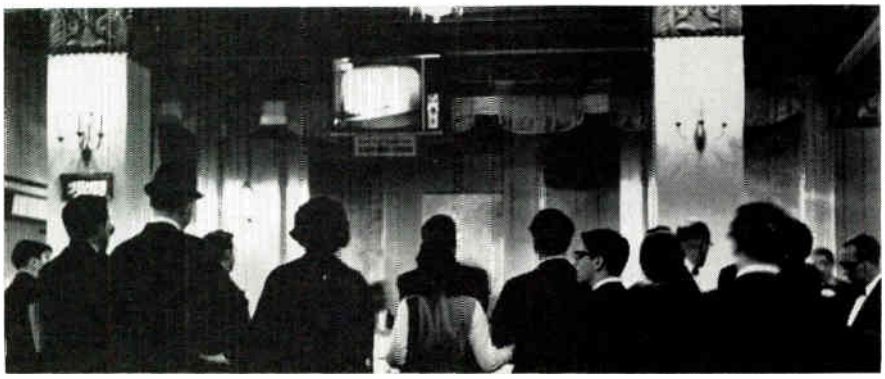
Conclusion

There is a growing tendency to subvert the real purpose of technical meetings, with the exchange and revitalization of technical information giving way to elaborate product shows. One important reason for this is a collective failure to encourage and assist the engineer in presenting papers. Because individual inertia and busy engineering schedules tend to relegate publication to a marginal role, the number of quality papers is dwindling. As a result, the standards of papers committees must be lowered.

If this situation is to be corrected and the technical symposium prevented from becoming a trade show, industry must recognize its obligation to encourage and assist the engineer in writing papers. In turn the engineer must understand the benefits both to his own career and to his company's technical image. The exchange of scientific information in these days of the ultra specialist is perhaps more than ever before the lifeblood of modern technology. Clearly, there is too much at stake to leave this activity to chance and the engineer's good intentions.

*See "How Technical Articles Groups Help Engineers into Print" by J. Eimbinder, *Electronic Design*, May 10, 1962.

STANDING ROOM WAS NOT SO BAD



Closed circuit television donated by Blonder-Tongue Foundation allowed late arrivals to see and hear Artur Rubenstein during his first selection while waiting in the lobby of a Newark, N. J., Theater. Equipment included 27" Magnavox receivers, B-T TC-1 camera.

ENGINEERS SUGGEST A RING OF SATELLITES AROUND MOON

U.S. astronauts anywhere on the moon could talk with each other and with earth by using a ring of 15 satellites around the moon, report engineers of an International Telephone and Telegraph Corp. subsidiary.

M. E. Brady and R. C. Davis of ITT Intelcom, Inc., said that the main problems of lunar communications stem from the moon's small size and the lack of atmosphere and ionosphere, based on current knowledge. Astronauts only as much as five miles or more apart from each other on a lunar plain would be below the horizon, hence "out of sight." They could not then communicate with low-power, light equipment.

Another problem, is contact with earth from the far side of the moon. A proposed solution is a system of very small moon satellites.

FREQUENCY STANDARD

New low-cost, miniature R-20 Rubidium Frequency Standard by Varian Associates. Believed world's smallest atomic frequency standard, the device has long-term stability of 5×10^{-11}. Thomas McReynolds, product manager, holds aluminum housing for rubidium vapor element.

TRANSVERSE WAVE TUBES AID COMMUNICATIONS

A new type of microwave device known as a transverse wave tube has been used recently with effect in space-probes, radar, satellite and missile tracking systems, radio astronomy and long-range navigation.

Dr. Russell Hays, University of Colorado Electrical Engineering Department, describes transverse wave tubes as devices which generate and amplify high frequency electromagnetic signals. The tubes, he said, might be useful with telephones, telegraph systems and television, as well as in improving space communications.

Dr. Hays and his staff, under a National Science Foundation grant, are studying the characteristics of transverse waves.

A MAGNETIC COIL with a field of 132,000 gauss has been demonstrated by the G.E. Research Laboratory in Schenectady, N.Y. It uses 3500 ft. of a commercially available niobium-tin wire. The coil consists of four concentric sections and operates at liquid-helium temperature (4.2°K). It measures 4 in. in outside diameter and is 6 in. long. The magnetic field exists in a ¼ in. hole through the center of the coil.

A GaAs INFRARED LASER is being used by ITT Corp. in a short-distance transmission system for speech and music. The system is suitable for communication across rivers and canals and on construction sites where wire lines cannot be used. The narrow transmission angle of the beam deters unauthorized interception.

A COOL 400 V

Delco Radio's new DTS 413 and DTS 423 power transistors, are conservatively rated at 75 and 100 watts. Our standard TO-3 package assures low thermal resistance (junction to heat sink 1.0°C per watt) for cool power. The silicon element gives you high voltage protection, high frequency response and low saturation voltage.

The price is low (less than 3¢ a volt for sample quantities) for two reasons: special inter-digitated geometry of the devices and our unique 3D* process for high yields.

Now you can reduce current, the size of other components, and increase efficiency in high energy circuits. Vertical and horizontal TV outputs, for example.

Your Delco Radio Semiconductor distributor has these two new power transistors on his shelf. Call him today for data sheets, prices and delivery.

*Triple sequential diffusion

RATINGS	DTS 413	DTS 423
VOLTAGE		
V_{CEO}	400 V (Max)	400 V (Max)
V_{CEO} (Sus)	325 V (Min)	325 V (Min)
V_{CE} (Sat)	0.8 (Max)	0.8 (Max)
	0.3 (Typ)	0.3 (Typ)
CURRENT		
I_C (Cont)	2.0A (Max)	3.5A (Max)
I_C (Peak)	5.0A (Max)	10.0A (Max)
I_B (Cont)	1.0A (Max)	2.0A (Max)
POWER		
	75 W (Max)	100 W (Max)
FREQUENCY RESPONSE		
f_t	6 MC (Typ)	5 MC (Typ)

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DELCO RADIO
Division of General Motors

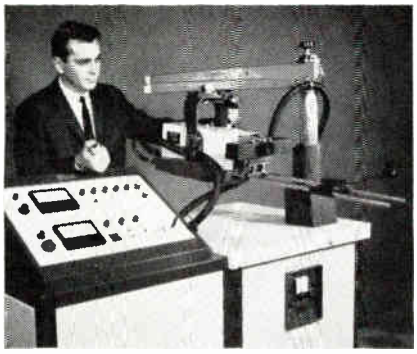
NEW RADAR RECEIVER DEVELOPED BY RADC

A palm-sized radar receiver that will perform as well as other models 200 times as large and 50 times as heavy has been developed by engineers at Rome Air Development Center, Griffiss AFB, N. Y.

A number of uses are seen by engineers for the new receiver—from limited warfare areas to sophisticated fixed-site radar systems. The unit is believed to be the first microminiaturized wideband limiting amplifier ever developed with an output 6,000 times as strong as the input signal—a gain of some 39 db. It has a bandwidth ratio of 12 to 1, that is, capable of amplifying signals over a range of 1gcs. to 12gcs.

Engineer David T. Craig, director of the project, reports that the effort had two objectives. One was a performance comparison between thin film, miniaturized integrated circuit systems and older designs for high quality, high reliability functions in radar and communications equipment. The other was to develop the first subassembly for use in a future simple, effective, low cost, general purpose radar signal processor.

BIO-MEDICAL LASER



A new laser system by Raytheon Company incorporates pulsed and CW lasers. Project engineer Fred Roeber works positioning arm as he sights along the laser applicator, a sighting device that assures the operator of desired output energy levels for bio-medical use. Output is 50 joules or greater.

RELAY GROUP ELECTION

At the Annual Membership Meeting of the National Association of Relay Manufacturers, held at The Alisal near Solvan, Calif., the following were elected Officers for 1965: President—Louis DeLalio, Filtors, Inc., Vice Pres.—R. F. Stockton III, G-V Controls, Inc.; Secretary—C. G. Braun, Branson Corp.; and Treasurer—A. C. Johnson, The Adams & Westlake Co.

AF ENGINEER COMBINES TW TUBE POWER OUTPUTS

An Air Force Systems Command engineer has combined power outputs of two high-power C-Band traveling-wave amplifier tubes in an experiment at Rome Air Development Center, Griffiss AFB, N. Y.

In experiment performed by Engineer Merton C. Kraft, combined pairs of tw amplifiers produced 8 megw. of peak output power. He used a newly-developed tube providing an output of more than 4 megw. over a 500MC band. Peak power in this band had been limited to about 2 megw.

PACKAGING CONFERENCE

Nineteen speakers will present the latest knowledge in modern electrical controls and systems at the fifth annual Packaging Industry Technical Conference to be held May 4, 5, and 6 in Milwaukee, Wis. This conference is sponsored by The Institute of Electrical and Electronics Engineers, Milwaukee section, and the Packaging Industry Subcommittee.

To register, contact William Timmler, Jr., Louis Allis Co., 6700 Industrial Loop, Greendale, Wis.

SILICON WEB CRYSTALS, announced about a year ago by Dow Corning, are now available in limited production quantities. There has been a 70% price reduction as compared to research quantities previously available. The crystals are expected to be used in solid-state devices. A web crystal is a single crystal in the form of a long, thin ribbon or web between two dendrites.

HI-FI TERMINOLOGY has so confused the public that hi-fi sales have not measured up to their potential according to Karl Jensen, president of Jensen Industries. He says that instead of selling home entertainment, we are confusing and confounding the public with technical verbiage. Emphasis should be properly placed on listening enjoyment instead of technical data, according to him.

SWITCHING SPEEDS of a new Philco Corp. high-speed, low-power RTL microcircuit family are faster than standard Milliwatt Micrologic which the company produces under a cross-licensing agreement with Fairchild Camera and Instrument Corp. An example of the improvement in switching speeds is the dual 3 input gate—reduction has been made from typically 30 nsec. to 13 nsec. Similar delay improvements have been made with other elements.

RADAR PRINCIPLES are being used by scientists to "look" at parts of the earth that have been always hidden to men's eyes. U. S. scientists at the South Pole have perfected a new method to chart the contours beneath icecaps. The method uses the principle of radar by bouncing radio waves off the bottom of the ice and timing the echo's return to determine ice depth. Measurements that often took a full day with the seismic method can now be done instantaneously. The University of Wisconsin geophysicists worked under a grant from the National Science Foundation.

NAVY CAPTAIN PLOTS COURSE OF NAVAL COMMUNICATIONS

Vastly increased efficiency in use of available transmission media will be one of the most significant advances in communications of the 1970s, declared an official of the U.S. Navy.

According to Capt. Daniel B. James, Director, Communications Plans and Policy Division, Office of Naval Communications, the useable electromagnetic spectrum will be considerably extended. Its use will cover the complete range from extremely low frequency to visible light, and perhaps higher frequencies. All of these advances, of course, will include extensive use of sattelites, Capt. James said.

He observed that an important feature of Naval communications will be completely integrated systems of ships and other mobile units.

In the communications spaces themselves, he reported, the big "black box" will make way for microminiaturized components. Such components will reduce size of equipment by a factor of 5 to 100, and weight by 3 to 50. Power needs will drop by a factor of 2 to 20.

Reliability of such components will be measured in years, rather than in hours MTBF (Mean Time Between Failures.) Maintainability will be improved by modularization, redunancy, and self-checking features.

Spare parts inventory will be reduced through maintenance module replacement.

SPIRAL TESTER

This spiral "staircase" has speeded manufacture of solid-state rectifiers, reports GE Rectifier Components Dept. Semi-automatic tester can handle about 1,300 new rectifiers per hour. Rectifiers are oven heated to operating temperature, then they spiral down to a special device which grades them according to forward and reverse leakage current.

CANADIAN FIRM DEVELOPS COMPACT COOLING MODULES

Multi-stage, fully-sintered, thermoelectric cooling modules (Cascades) are now being designed with a new computer program resulting in production of more compact and economical coolers, reports Frigistors Ltd., of Montreal.

Development of improved Cascades is part of Frigistors' effort to devise new design tools to help reduce costs of cooling systems by better use of existing materials.

Up to four stage designs of minimum size, requiring minimum power consumption, can be provided at lowest costs, reports the firm.

VIDEO-IR DATA SYSTEM

A new video tape information storage and retrieval system which offers substantial advantages over conventional microfilm systems has been developed by Dixon Industries, Inc., Gaithersburg, Md.

The VIDEO-IR System uses video tape in place of conventional microfilm to record printed data. A single 3,600 foot video tape reel can store nearly 400,000 standard-size pages.

NEW U. S. 'SPIN-OFF' PROGRAM DEPENDS ON LOCAL GROUPS

Getting "spin-off" technology from federal research into the hands of companies who can use it to expand and improve is the object of a new U. S. Department of Commerce program, in cooperation with state and local organizations.

The program has been developed by the Institute for Applied Technology, National Bureau of Standards. State universities, commerce and development agencies, and similar organizations are cooperating in the program in a rapidly-growing number of states. The role of these organizations is to serve as distributors of informational materials supplied by IAT, and to help IAT determine what type of technology can be used most effectively by firms in their areas.

Informational materials from IAT consist largely of two regular services. One is the "Fast Announcement Service" designed to inform industry promptly of new Government R&D reports determined by National Bureau of Standards scientists and engineers to be of special significance to industry.

The other service is a "Package" program for the retrospective presentation of government R&D. Under this program, searches for relevant reports are conducted through government R&D literature over the last two years on subjects recommended largely by State development and university-industry groups and trade associations.

RANGE-FINDING WITH LIGHT

RCA-built laser range finders using a unique Bausch & Lomb laser optical system are among first military devices using lasers to be produced in the U. S., according to Bausch & Lomb. Military laser devices offer rapid high accuracy from a single location and a degree of security not found with radar.

RAYTHEON BUYS PHILCO COMPUTER MEMORY DIV.

Raytheon has purchased the computer memory business of Philco's Aeronutronic division.

To be integrated into the Raytheon Computer operation at Santa Ana, Calif., the purchase includes: BIAX, a proprietary high-speed computer memory device, along with associated research and development; and Micro-BIAX, a recently announced ultra high-speed memory unit.

Annual volume of Aeronutronic's memory business is between $1 and $2 million.

DRUG, ELECTRONIC PACT AIMED AT MEDICAL MARKET

Warner-Lambert Pharmaceutical Co. and the Hallicrafters Co. of Chicago, Ill., have disclosed a collaborative program to develop and market new products in medical electronics.

The first product from this partnership is "the world's lightest and most compact, solid-state electrocardiograph." Readings can be fed from the patient's heart through a special device that permits transmission over conventional telephone lines.

NAB OKS MULTIPLEX MONITOR, OPPOSES COSTLY EQUIPMENT

The National Association of Broadcasters has agreed with the FCC on the need for an approved monitor for FM multiplex signals, NAB, however, questioned FCC's criteria on grounds that they might require sophisticated equipment of prohibitive cost.

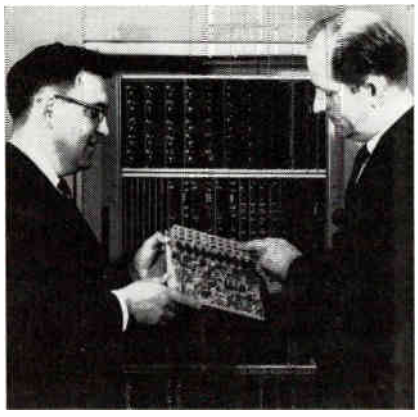
NAB urged the Commission to defer any adopted proposal for one year to allow manufacturers time to produce required equipment. This would also give FM licensees time to get equipment.

The proposal would apply to all FM stations now using multiplexing for stereophonic broadcasting on main and sub-channel. It would apply also to those which provide special "SCA" background music on the sub-channel.

George W. Bartlett, NAB engineering manager, pointed out that it would impose a special hardship on many FM stations which now operate with remote control facilities. To comply, these stations would have to adopt "extensive modifications" of existing facilities.

He said a system of "approved monitoring" would end confusion.

PABX CIRCUIT BOARD



Keith L. Liston, vice president, research and development, and Nicholas Mansuetto, manager of electronic switching, ITT Kellogg Telecommunications Division, examine all-solid-state PABX board. The transistorized board now serves 100 lines and 16 trunks. It can be expanded to serve about 400 lines.

FAIRCHILD AIMS FOR LARGE CUT OF MICROWAVE MARKET

In seeking an "increased share of the solid state microwave component market and the high performance microwave diode and transistor market," Fairchild Semiconductor has disclosed a new Microwave Products Group at Mountain View, Calif.

EIA PUSHING U. S. COLOR TV AS EUROPE NEARS DECISION

The U. S. Commerce Department is working now with the Electronic Industries Association to inform other nations about the advantages of the U. S. system of color television. The time draws near for a decision that will carry great weight with European nations on their individual choices of color systems they will adopt.

EIA has also petitioned the White House Office of Science and Technology for support in its effort to get the U. S. color system accepted as standard in other countries.

AMPHENOL ENTERS TEST GEAR, CB TRANSCEIVER MARKETS

Amphenol-Borg Electronics Corp. is planning to add citizen's band transceivers and TV test equipment to its product lines.

Amphenol's entrance into the commercial electronic equipment market was announced by Robert E. Svoboda, president of the Amphenol Distributor Div. The division will direct marketing and promotional efforts for the new lines.

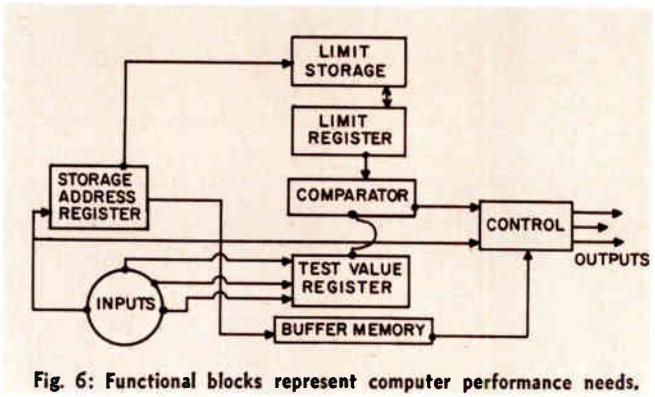


Fig. 6: Functional blocks represent computer performance needs.

Table 4

PARTS LIST & TYPICAL FAILURES

Item	# Parts	Typical Failure Mode	Cause
Diodes	112	Voltage Breakdown (VBD)	Heat and/or excessive current
Microminiature resistors	112	Open(s)	Heat and/or excessive current
RLC integrated Transistor circuits	154	VBD	Heat and/or excessive current
Pulse Transformers	2	Opens/Shorts	Temp and vibration
Miniature Relays	6	Opens/Shorts	Thermal Shock; misuses
Microminiature Capacitors	14	Corrosion and/or VBD	Anode Corrosion

(*Continued from page* 86)

(e) Outputs: Three channels of digitized information, S/N > 10^3

(f) Thermal Environment: 200°K to 400°K

(g) Reliability Requirement > 96% for 100 hr mission

2. Requirements Analysis

Fig. 6 indicates seven functional blocks as capable of operationally representing computer performance needs. With reference to the maximum of 400 parts specified, the following preliminary assumptions are made: (1) Input and power supply design needs are not properly parts of the computer needs; (2) Use of integrated semiconductor circuitry is permissible; (3) Burden of reliability can be represented as a cross-product of magnitudes equally divided between the seven functional blocks. Parts-list in Table 4 is so based.

Column 4 in Table 4 shows the relative importance of the thermal environment in successful accomplishment of computer functions. Accordingly, reference

(*Continued on page* 132)

DESIGN GUIDE-LINES (Concluded)

is made to "Thermal Control, Tabular Data." Suggested are the following procedures:

(a) Coat computer components with epoxy;

(b) The shelves and cabinet structure should be designed to form an effectual heat-sink so that maximum component temperature over mission life time will not exceed 300°K. Reference Fig. 3, and Table 1. Al thus appears ideally suited as the material for shelf and cabinet.

Parts Derating using the Mission Environmental Modifier of 1.075 and subsequent reliability predictions can be made as done in the preceding example.

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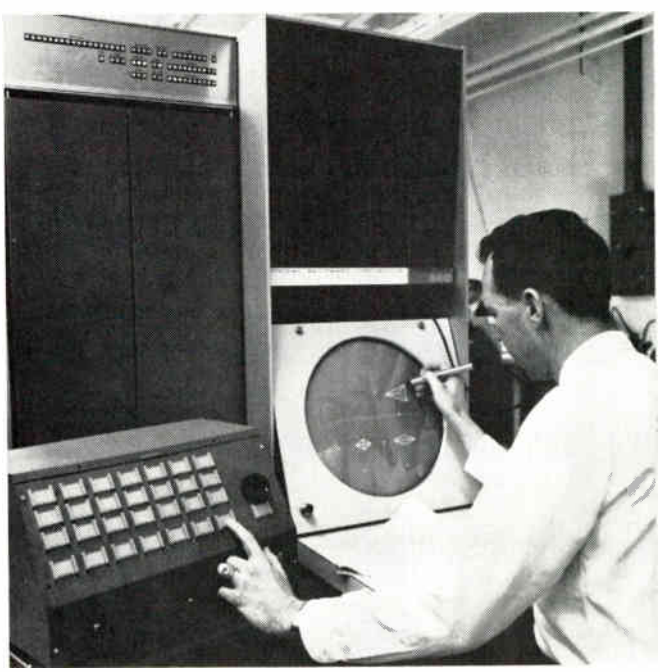
• A REPRINT of ANY ARTICLE in this issue is available from ELECTRONIC INDUSTRIES Reader Service Department.

MAGIC DRAWING 3-D VIEWER

Aircraft design specialist R. Q. Boyles at Lockheed-Georgia Research Center, guides UNIVAC 418 computer and DEC 340 display scope in creating a design. Design is drawn with a "light pen." Computer remembers what has been created, and can call forth the memory in 3-D.



ELECTRONIC INDUSTRIES Electronic Engineering Profile—1965

Here's your chance to help the editors of ELECTRONIC INDUSTRIES develop important information about you, and about our industry. Won't you please read, fill out, and return this questionnaire to us at your earliest convenience?

We are gathering this information in order to update our present Electronic Engineering Profile records. You are not required to sign your name or identify your company. However, if you so desire, we will be glad to send you a copy of our 1965 Electromagnetic Spectrum Chart in appreciation of your cooperation and assistance.

Previous profile surveys were conducted in 1959 and in 1962. The questions being asked at this time are designed to reflect the effects of occupational changes that have taken place in our industry over the past two years. We are particularly interested in your present day attitude and future outlook on such topics as technological obsolescence, continuing education, commercial-industrial interests, etc.

We would like to have all readers participate in this year's Electronic Engineering Profile Study!

If you pass your copy of ELECTRONIC INDUSTRIES on to other readers, won't you please leave a note in this issue telling them that additional copies of the questionnaire may be obtained by sending us a postcard or a letter requesting "Electronic Engineering Profile-1965." Our address is:

ELECTRONIC INDUSTRIES, Chestnut & 56th Streets
Philadelphia, Pa. 19139

Tear along this line.

1. Which of these is your ultimate goal?

	(CHECK ONE)
Design Engineering	1
Supervisory Engineering	2
Engineering Research	3
Sales Engineering	4
Corporate Management	5
Other (specify)	6

2. If you had to decide your career all over again what would you do? Would you:

	(CHECK ONE)
Consider study in a different field?	1
Study engineering in a different field?	2
Study engineering and management?	3
Follow the same field of study?	4

3. If Applicable: What would you do differently? Give an example if possible.

4. If a high school student came to you for advice about his career, would you recommend electrical engineering? (Check one)

Yes	1
No	2

4a. (If not) Why not?

5. In which of these areas do you feel that you would have liked to have additional education or training?

	(CHECK) YES	NO
Social Studies	1	2
English	1	2
Mathematics	1	2
Business Administration	1	2
Marketing	1	2
Other – What:	1	2

6. How secure do you feel in your present job?

	(CHECK)
Very secure	1
Secure	2
Not secure at all	3

7. What future prospects do you see in your present job?

8. Place a check below in the first column opposite the area in which you are now working, and another check in the second column to indicate the area you would like to change to.

	(CHECK) Area In Now	Want To Change To
Defense Electronics	1	1
Aerospace Electronics	2	2
Consumer Electronics	3	3
Industrial Electronics	4	4
Other – What?		

9. When is your anticipated next promotion?

	(CHECK)
Within 3 months	1
Within 6 months	2
Within 1 year	3
Don't Know	4

10. Suppose you were to consider a new job with another company, how would you rank the following aspects of employment?

	RANK FROM 1 TO 6
Year-round recreational facilities	
Freedom to work with less tape	
Opportunities for further education	
Added fringe benefits	
Security	
Geographical location	

11. As the situation stands now, would you say that:

	(CHECK ONE)
You are satisfied with your job?	1
You have already looked for a new job?	2
You are just now looking for a new job?	3
You are just thinking about looking for a new job?	4

(NOTE: This questionnaire also appeared in the March 1965 issue. Please do not fill out twice.)

"PROFILE OF TODAY'S ELECTRONIC ENGINEER—1965"

12. (If Applicable:) What are the main reasons why you are thinking about or looking for a new job?

13. Have you ever considered working as a technical civil service employee for a Federal Government agency in an administrative, engineering or other capacity?

	(CHECK ONE)
Yes, administrative capacity	1
Yes, engineering capacity	2
Yes, other capacity What?	3
No	4

14. Which of the following sources do you use most often to keep up to date technically?

Read trade magazines?	1
Read professional journals?	2
Attend technical meetings?	3
Attend conventions and exhibits?	4
Read books?	5
Other – What? _____	

15. Place a check in the box which indicates how interested you are in:

	Very Int.	Int.	Mildly Int.	Not Int.
Business/Industry?	1	2	3	4
Engineer Personnel?	1	2	3	4
Book Reviews?	1	2	3	4
International News?	1	2	3	4
Stock Market?	1	2	3	4
Political News?	1	2	3	4
Technical News?	1	2	3	4

16. To enable magazines to help you as a continuing means of adult education, how would you rank the following typical editorial features in order of preference?

	RANK FROM 1 TO 7
Feature design articles	
State of the art reports	
Management articles	
Marketing articles	
How-to-design articles	
Staff studies on specific subjects	
Others – What?	

17. How important would you say technical magazines are in your job?

	(CHECK)
A must	1
Very important	2
Useful	3
Marginal	4
Little value	5

18. In time of professional and vocational need, to what groups or organizations do you believe the engineer may turn?

19. Following is a list of statements about different feelings engineers may have about themselves or their jobs. Based on your first impressions, just check the box corresponding to how strongly you agree or disagree with each statement.

	STRONGLY AGREE	MILDLY AGREE	NEITHER AGREE OR DISAGREE	MILDLY DISAGREE	STRONGLY DISAGREE
Electrical engineers have actually achieved a very small degree of professionalism.	1	2	3	4	5
In my present job, I consider myself to be a professional part of labor.	1	2	3	4	5
In my present job, I consider myself to be a part of management.	1	2	3	4	5
Engineers should not belong to unions.	1	2	3	4	5
In most cases, engineers are being exploited.	1	2	3	4	5
A lot of the work engineers do can actually be done by technicians.	1	2	3	4	5
Much of an engineer's work is actually sub-professional work.	1	2	3	4	5
Working overtime without pay is part of an engineer's job.	1	2	3	4	5
Most engineers have a non-professional attitude.	1	2	3	4	5

20. Now just a few questions about you, your background and interests: First of all . . . . How old are you?

	(CHECK)
Under 25	1
25 – 29	2
30 – 34	3
35 – 39	4
40 – 44	5
45 – 49	6
50 – 54	7
55 or over	8

21. How many different companies have you worked for since you started your career in engineering?

# OF COMPANIES	

22. We are interested in your job functions, past and present. Please do the following:

-- In column 1, check off all functions you have ever done since you started your career.

-- In column 2, check off all functions you now do.

-- In column 3, check off the one function you consider to be your primary function.

Job Functions	Col. 1 All Functions	Col. 2 Current Functions	Col. 3 Primary Functions
Corporate Management	1	1	1
Operating or Production Management	2	2	2
Technical or Engineering Management	3	3	3
Design Engineering: Equipment Design	4	4	4
Design Engineering: Systems Design	5	5	5
Design Engineering: Components Design	6	6	6
Research and Development Engineering	7	7	7
Reliability & Quality Control Engineering	8	8	8
Mechanical & Electromechanical Engineering	9	9	9
Value and Evaluation Engineering	0	0	0
Standard and Test Engineering	1	1	1
Application Engineering	2	2	2
Production Engineering	3	3	3
Sales and Advertising	4	4	4
Purchasing	5	5	5
Other (PLEASE SPECIFY BELOW) _____ _____			

"PROFILE OF TODAY'S ELECTRONIC ENGINEER—1965"

23. Which group represents your total annual salary before taxes?

	(CHECK ONE)
Under $ 6,000	
6,000 – 7,449	1
7,500 – 9,999	2
10,000 – 12,449	3
12,500 – 14,999	4
15,000 – 17,999	5
18,000 and over	6

24. How many persons are there in your household including yourself?

Number:	

25. What is the highest level of education you have attained thus far and year completed?

	(CHECK)	YEAR COMPLETED
Some college	1	
College degree	2	
Degree plus graduate work	3	
Master's Degree	4	
Doctorate	5	
Other – What? _____		

26. Please list courses of study in which you obtained degrees.

DEGREE	STUDY

27. Since your last degree have you pursued studies in any subject to further your education?

	(CHECK)
Yes	1
No	2

28. (If applicable:) What subjects or courses and at what college or university? (List below)

NAME OF COURSE OF STUDY	COLLEGE

29. Have you ever taught school, contemplated teaching or do you actually plan to teach?

	(CHECK)
Taught school	1
Contemplated	2
Plan to teach	3
None of above	4

30. Please check any of the following activities in which you participate?

	CHECK AS MANY AS APPLY
Civic Organizations	1
Social Welfare	2
Veteran's Organizations	3
Church groups	4
Fraternal and Service Organizations	5
Country Clubs	6
Other Sports Clubs	7
Professional Business Associations	8
Other Organizations What? _____	

31. Do you hold any outside remunerative jobs after hours?

	(CHECK)
Yes	1
No	2

32. (If applicable:) Is this job in the electronic field or is it outside of the electronic field?

	(CHECK)
Electronic Field	1
Outside of electronic field	2
Specify _____	

33. Which of the following are included in your retirement plans from an electronic field?

	CHECK AS MANY AS APPLY
Pension Plan – Company	1
Pension Plan – Personal	2
Profit Sharing	3
Own Business	4
Own Stocks	5
Mutual Funds	6
Other – What? _____	

34. Do you own stock?

	(CHECK)
Yes	1
No	2

35. Do you own stock in your own company?

	(CHECK)
Yes	1
No	2

36. In what state do you work?

_____

37. Please add any additional comments or opinions here.

Announcing PMI's

NEW

U SERIES

PRINTED MOTORS

Now at 50% lower cost!

Two years of engineering research and development now enable Printed Motors, Inc. to offer design engineers the new U SERIES — at less ***than half the cost of printed circuit armature motors previously available.***

Models in the new U SERIES are priced as low as under $40.00 in quantity — and give you every unique advantage of printed motors' superior electrical performance and reliable mechanical characteristics.

Practically, nothing is changed but the price. This means that the U SERIES brings printed motors within the reach of every manufacturer who needs the exceptional speed of response, smooth torque with no cogging, and the wide speed range these motors provide.

Four models in the new U SERIES are available. Possible applications include: tape capstans, reel drives, line printers, business machines, process controls, machine tools, packaging machinery, emulsion coating drives and printing equipment.

To find out how this printed motor advance can help solve your design problems, write or phone: Printed Motors, Inc., 33 Sea Cliff Avenue, Glen Cove, New York. Telephone: 516 OR 6-8000.

PMI **PRINTED MOTORS, INC.**

GLEN COVE, NEW YORK

Engineering, Manufacturing and Sales by:

Photocircuits CORPORATION

INTERNATIONAL NEWS

London — Marconi Company has formed a microelectronics division to exploit new techniques from firm's research. Division will also provide design and advisory service for the world electronic industry, in addition to its own development and sales activities in microelectronics.

London — Ministry of Aviation is buying 18 new Marconi high-brightness radar displays, which can be used under any lighting condition. Display system is more than 1,000 times brighter than a conventional radar display and some 20 times brighter than TV scan conversion techniques.

Paris—A new instrument plant is in operation at Arras (near Lille), built by Foxboro France S.A., subsidiary of The Foxboro Company (U.S.). The plant covers 12,000 sq. ft. and is expected to "meet the needs of instrument users throughout France."

Farnborough—Device called Thermo-Probe TP 10 has been introduced by England's Solartron Electronic Group Ltd. It is portable and designed to induce temperature variations on small components to assist in prototype design and development. The firm reports it will also have uses in chemical and medical research.

Toronto—H. Stephen Marmorek, has been named president of Sprague-TCC (Canada), Ltd., the joint Canadian subsidiary of the Telegraph Condenser Company Ltd., of London, and the Sprague Electric Company, of North Adams, Mass.

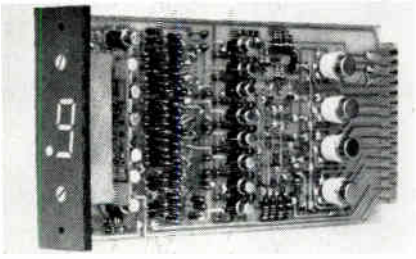
Munich—Siemens & Halske A.G. and RCA have disclosed patent license and technical information and sales agreements which they believe will materially strengthen the position of both companies in the world-wide computer market. The ten-year patent and technical data pact is effective immediately.

Anthorn—New super-power NATO fleet communications system has been installed in the Cumberland town near the Scottish border by prime contractor Continental Electronic Systems, Inc., subsidiary of Ling-Temco-Vought, Inc. Site was chosen as suitable for VLF operation.

NEW PRODUCTS

INTEGRATED DECADE COUNTER

Uses a hybrid combination of integrated circuits, transistors, and SCRs.

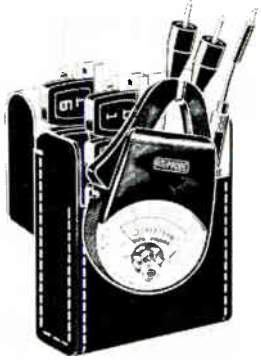


Model BCD8 integrated circuit Decade Counter can be used as a 3MC decade counter, or 8 line BCD to decimal display, or 1MC shift register. To go from one operational mode to another, only the connector wiring has to be changed—no changes are required on the module board. The display features wide angle viewing. Lamps have a 100,000 hr. life. Supply requirements are 12v. @ 260ma for logic circuit and 5v. @ 60 cycles for lamp display. Robotronics Research, Div. MB Electronics, Dept. B8, 4504 N. 16th St., Phoenix, Ariz.

Circle 233 on Inquiry Card

CONDUCTOR TRACER

Pocket-sized conductor tracer also checks for voltage, current, and continuity.



The Line-Probe tester enables one man to ring out circuits 10 times faster than conventional methods. It will trace up to 10 separate pairs of conductors at one time and eliminate the need for bells and buzzers. To trace individual conductor pairs, Line-Probe numbered station markers are clipped onto one end of the conductors. Then, the other ends are tested. For each conductor probed, the meter needle swings to the dial number that corresponds to the marker at the other end. No time is lost handling conductors needlessly, while searching for the one that is wanted. Amprobe Instrument Corp., Dept. ALP, 620 Merrick Rd., Lynbrook, N. Y.

Circle 234 on Inquiry Card

BOOKS

AC Carrier Control Systems

By Keith A. Ivey. Published 1964 by John Wiley & Sons, Inc., 605 Third Ave., New York, N. Y. 10016. Price $12.00. 349 pages.

Broad coverage of the analysis and design of ac carrier control systems is offered, together with a description of the operating characteristics of many of the components used in these systems. Principles of operation of several components used in the physical realization of ac carrier control systems are expounded, and a detailed description is given of a derivation of the transfer function of the carrier process. The many aspects of the design of carrier control systems are described.

Radio Spectrum Utilization

Published 1965 for the Joint Technical Advisory Committee by The Institute of Electrical and Electronics Engineers, Inc., 345 East 47 St., New York, N.Y., 10017. Price $10.00. 272 pages.

Book is a report of The Joint Technical Advisory Committee of the IEEE and Electronic Industries Association, 1964.

The accelerated growth of science has highlighted the need for a world-wide review of radio spectrum use. Appreciation of this fact has resulted in the compilation of this broad treatise and reference volume.

The book presents a view of our state of knowledge of the electromagnetic spectrum as a natural resource. It also presents some problems which must be solved if continued growth of spectrum use is to be developed.

Space-Age Acronyms: Abbreviations and Designations

By Reta C. Moser. Published 1964 by Plenum Press, 227 W. 17th St., New York, N. Y. 10011. Price $17.50. 427 pages.

Only technical and industrial acronyms (over 10,000 acronyms with more than 17,000 definitions) have been included in this compilation. Such overlapping areas as professional societies, trade and international organizations, foundations, and other nontechnical acronyms have been eliminated. Aim of the book has been to collect and define in one central source the acronyms most useful to industrial and military personnel concerned with Army, Navy, Air Force, NASA, and other scientific projects.

Cross-references have been provided for acronyms that are either obsolete or not preferred in contemporary usage—referring the user to the latest preferred definition or designation. Many Russian acronyms and abbreviations likely to be found in technical translations are included.

There is also a special section listing the missile, aircraft, ship, and communications electronic equipment designating systems.

Data Transmission

By William R. Bennett and James R. Davey. Published 1965 by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 10036. Price $14.50. 356 pages.

This book covers the important principles of modern-day data communication. Coverage extends from a brief account of the first known digital signaling systems to such recent data transmission methods as differential phase detection, suppressed-carrier vestigial-sideband and duobinary signaling, including new material on the probability of errors in angle-modulation systems.

Among the important topics discussed are: the optimum spectral shaping of data signals to achieve maximum tolerance to noise; commonly encountered transmission impairments and their effects; characteristics of the telephone voice channel.

Optimal Estimation, Identification, and Control

By Robert C. K. Lee. Published 1964 by The M.I.T. Press, Cambridge, Mass. 02142. Price $6.00. 152 pages.

The fundamental problems of estimation, identification, and control of dynamic systems from the viewpoint of modern control theory are covered in this book. It reviews existing concepts of optimal control and estimation theory in order to ascertain their relative merit and their limitations. Extensions of this knowledge are then developed and discussed.

Books Received

Nondestructive High Potential Testing

By Harold N. Miller. Published 1964 by Hayden Book Co., Inc., a division of Hayden Publishing Co., Inc., 850 Third Ave., New York 22, N. Y. Price $7.95. 160 pages.

The Structure and Properties of Materials, Vol. 2 — Thermodynamics of Structure

By J. H. Brophy, R. M. Rose and J. Wulff. Published 1964 by John Wiley & Sons, Inc., Publishers, 605 Third Ave., New York 16, N. Y. Price $2.95. 216 pages, paperback.

Measurement Engineering, Vol. I: Basic Principles

By Peter K. Stein and contributing experts in various fields. Published 1964 by Stein Engineering Services, Inc., 5602 East Monte Rosa, Phoenix, Ariz. 85018. Price $13.00 cash or $15.00 if invoice is required.

Selected Papers on Semiconductor Microwave Electronics

Edited by S. N. Levine and R. Kurzrok. Published 1964 by Dover Publications, Inc., 180 Varick St., New York 14, N.Y. Price $2.25. 297 pages, paperback.

Practical PERT

By B. J. Hansen. Published 1964 by America House, 1001 Vermont Ave., N. W., Washington, D. C. 20005. Price $2.75 plus $0.25 handling charge. 191 pages, paperback.

The Uses of Ferrites at Microwaves

By L. Thourel. Published 1964 by Pergamon Press Ltd. & The MacMillan Co., 60 Fifth Ave., New York 11, N. Y. Price $6.50. 100 pages.

Introduction to Semiconductor Devices

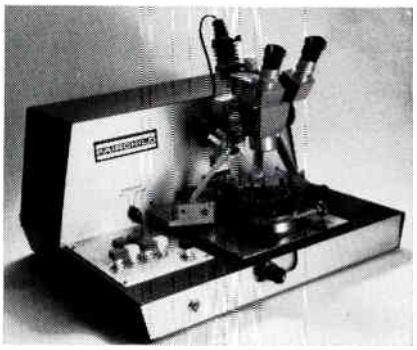
By M. J. Morant. Published 1964 by Addison-Wesley Publishing Co., Inc., Reading, Mass. Price $2.95. 126 pages.

NEW PRODUCTS

". . . advancing the STATE-OF-THE-ART in Components & Equipment.

WAFER AND DIE SORTER

Tests transistor and IC dice before they are separated from processing wafer.

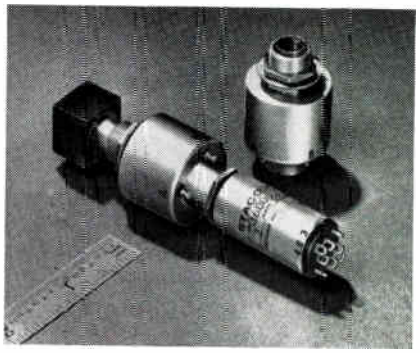


The Model 1000 has an assembly of 18 probes on interchangeable rings which are adjustable in all 3 planes, each with its own pressure setting. The probe head cycles from die to die, feeding test signals back to the test console. Four separate ink markers are triggered according to pre-programmed instructions to indicate the performance of each device tested. No particular operator skill is required to run the unit. Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif.

Circle 193 on Inquiry Card

ILLUMINATED SWITCHES

Six lens styles in 7 color choices are available for each switch.

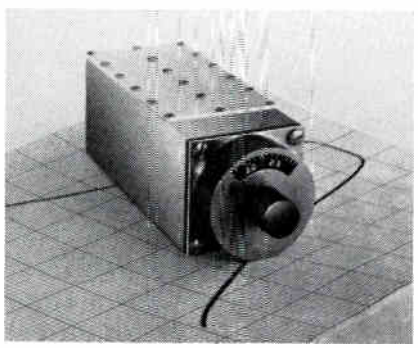


In the 36200 series, 10 different configurations, single pole through 6 pole, double or single throw and alternate or momentary actions are available. The units are solenoid held with manual override of the solenoid, or momentary switch operation when the solenoid is not energized. Life expectancy is in excess of 30,000 switching operations at rated load and 100,000 switching operations at reduced load. Staco, Inc., 1139 Baker St., Costa Mesa, Calif.

Circle 195 on Inquiry Card

TUNABLE MICROWAVE FILTERS

Direct dial reading, requiring no reference chart or external calibration.

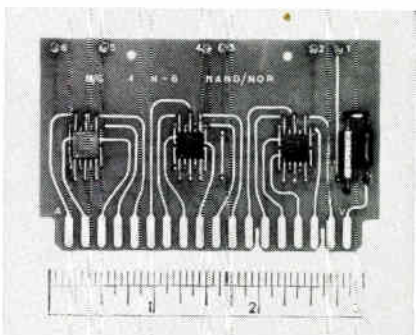


Two tunable microwave filters are available which cover the 2 GC to 4 GC freq. range. Accurate to within ±1% of the dial setting, these new filters are supplied in 3 and 5-section versions under model Nos. TTA 3000-5-3EE and TTA 3000-5-5EE respectively. Insertion loss of the 3 section unit is typically 0.4db, max. 0.8db; for the 5 section model these figures are 0.6db and 1.0db. Bandwidths at 3db for both types is 5% ±1%, max. VSWR at center freq. is 2:1 and nominal impedance is 50Ω. Telonic Engineering Co., 480 Mermaid St., Laguna Beach, Calif.

Circle 194 on Inquiry Card

INTEGRATED LOGIC CARDS

Up to 2000 F-F circuits can be contained in 3½ in. of a 19 in. relay rack.



A new family of high density packaged, 10MC integrated circuit logic cards are available. The all silicon DTL integrated circuit cards come in 2 grades: a premium grade for military environments, −55°C to +125°C, and a low cost commercial quality line, 0°C to 70°C. Also offered are compatible interface cards containing combinations of discrete components as well as integrated circuits. These can be used for relay switching, Nixie drivers and uses where component circuit interface problems exist. Microsystems Components, 5353 Topanga Canyon Blvd., Woodland Hills, Calif.

Circle 196 on Inquiry Card

GRID DRILL

For use in fabricating circuit boards and multi-layer circuits.

The 15J series Grid Drill is a numerically controlled machine. It is designed to accommodate the close tolerances and small hole sizes needed in fabricating circuit boards and multi-layer circuits. It can drill small holes in other materials difficult to machine. Units have spindles which operate at 50K RPM. An infinitely variable speed control from 10K to 50K RPM is included. Drill provides cycle rates as low as 500msec. Gardner-Denver Co., Gardner Expressway, Quincy, Ill.

Circle 197 on Inquiry Card

SCOPE RECORDER

Reproduces an oscilloscope display on a 5 x 5 in. paper facsimile of scope graticule.

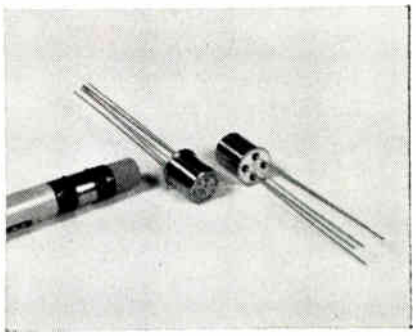
The recording method used by the SR100A is said to be faster, more convenient, and less costly than conventional X-Y recorders and oscilloscope cameras. One-time calibration eliminates time-consuming set-up operations. Recorded traces represent the actual presentation to within ±1%. Reproductions can be made every 90 sec. or every 22 sec., depending upon chart speed selected by panel toggle switch. The SR100A is designed for use with most sampling oscilloscopes. Nesco Instruments Div., Datapulse Inc., 509 Hindry Ave., Inglewood, Calif.

Circle 198 on Inquiry Card

NEW PRODUCTS

MILLIWATT RELAY

Contact rating of 1 million operations at 0.5a. and 10 million at low level.

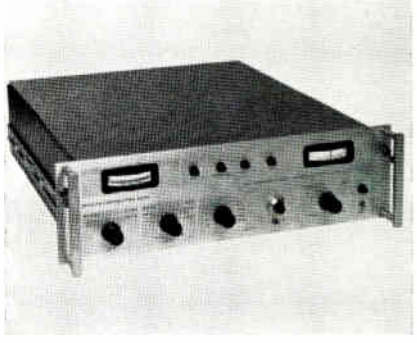


The 430/431 Series Relay is a SPDT, high sensitivity type design. The unit requires 40mw of operating power. Operate time is 3.5msec. at rated voltage. This compact rugged relay can withstand 800G's shock and operates in an amb. temp. range from −65°C to +125°C. It is hermetically sealed and all welded in a TO-5 type case, and meets applicable requirements of Mil-R-5757D. All standard coil voltages are available. Teledyne Precision, Inc., 3155 W. El Segundo Blvd., Hawthorne, Calif.

Circle 199 on Inquiry Card

SIGNAL CONDITIONER

Adaptable to all PCM telemetry ground stations; optimum decoding accuracy.



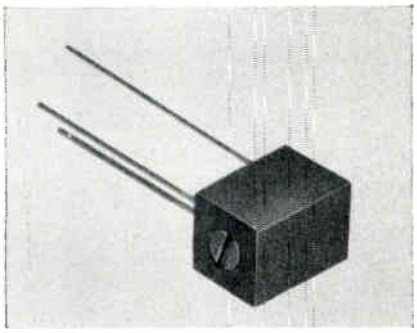
The Model SC-1100 features plug-in modules of silicon solid-state circuitry. It generates a clock signal in synchronization with the serial PCM signal input. It also reconstructs the incoming signal in noise free NRZ(C) and split phase format for decoding or retransmission. The unit is said to provide 3db advantage over most conventional methods of reconstructing split-phase data. Continuous bit rate coverage from 8 bits to 1 Meg bits/sec. is provided. Data is reconstructed with a bit error rate probability within 1db of the theoretical performance curves. The Bendix Corp., Bendix-Pacific Div., 11600 Sherman Way, N. Hollywood, Calif.

Circle 200 on Inquiry Card

NEW PRODUCTS

MINIATURE POTENTIOMETER

Measures 0.250 x 0.250 x 0.350 in.; standard resistances from 20Ω to 15k.

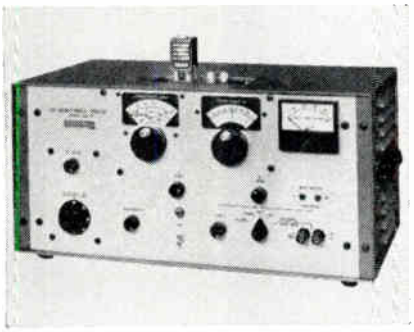


Series MP5 is a low-cost, reliable trimmer potentiometer for PC mounting. End resistance is less than 1% or 2Ω, whichever is greater. Resolution is 0.25% to 1.50%, depending upon resistance value. Power rating of ¼w. @ 50°C linearly derated to 0 @ 105°C. The insulation resistance is greater than 1k megohms @ 500vdc. It operates from −55°C to +105°C, and without noise or change of setting at 20 G, 30 to 2000 CPS vibration, 50 G shock for 11msec. Minelco, 600 South St., Holbrook, Mass.

Circle 235 on Inquiry Card

ADMITTANCE BRIDGE

1MC to 100MC unit measures low capacitance values with 1.002pf resolution.

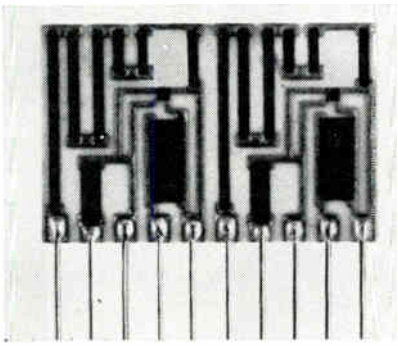


Model 33A-S7 r-f admittance bridge provides direct reading h-f capacitance measurements. It has a resolution of 0.002pf and a basic accuracy of 1% over a range from 0 to 15pf with a low test signal level. It also measures conductance with a resolution of 0.5 micromho. Basic accuracy is 2% over a range from 0 to 25,000 micromhos. It is useful for determining shunt inductance, shunt or series resistance, dissipation factor, and Q. Boonton Electronics Corp., Parsippany, N. J.

Circle 236 on Inquiry Card

FLIP-FLOP REPLACEMENT

Latch circuit uses a silicon controlled switch as the active element.



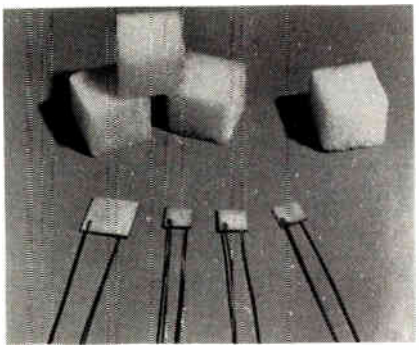
The BIP-6002 may be used as a replacement for flip-flops in memory circuits for both numeric and alpha-numeric Nixie tubes. With minor variations they may be used as logical elements in binary counters, ring counters, shift registers, etc. The new circuits consist of a single-sided, silicon-controlled switch and cermet resistors mounted on a ceramic substrate. The latch circuit contains 2 complete latches mounted on a ceramic substrate roughly the size of a postage stamp. It performs the function of 2 flip-flops which would require 2 transistors, 4 resistors and several diodes and capacitors. Burroughs Corp., Electronic Components Div., Plainfield, N. J.

Circle 237 on Inquiry Card

NEW PRODUCTS

CUBE THERMISTORS

Used for temp. compensation of transistor circuits and relays.

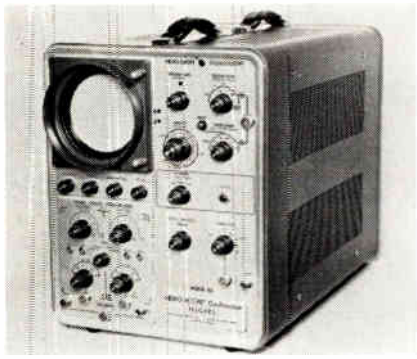


These cube thermistors are for special temp. measurement and control uses. The cubes actually are thin thermistor squares 0.012 in. thick. They provide max. surface area/unit mass for best power dissipation. Resistance values are from 10KΩ to 1Ω and resistance ratios from 48.78 to 12.95. General Electric Co., Magnetic Materials Section, P. O. Box 72, Edmore, Mich.

Circle 238 on Inquiry Card

STORAGE OSCILLOSCOPE

Writing speed of 1 million in./sec. and tube brightness of 20 ft.-lamberts.



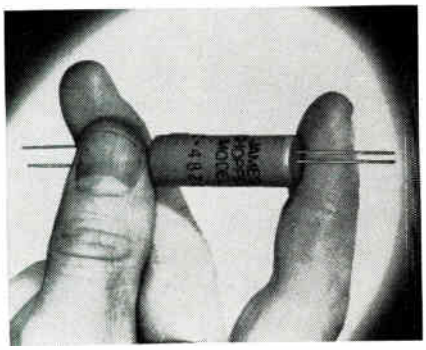
Model 110 operates both as a conventional CRT and as a storage oscilloscope. Bandpass is 10MC and new circuitry insures continually bright, clear consecutive traces without the appearance of blooming. The storage tube has a 1-year or 1000 hr. warranty. Controls are functionally grouped and color coded. They include a 23-position sweep time switch which can be operated without looking away from the display. Other new features designed for ease of operation include a single trace lighted push-button reset and vernier position on the horizontal position control. Hughes Instruments, 2020 Oceanside Blvd., Oceanside, Calif.

Circle 239 on Inquiry Card

NEW PRODUCTS

PHOTO-RESISTIVE SWITCHES

Composed of a photo-resistive cell driven by a neon lamp; offer solid-state design.

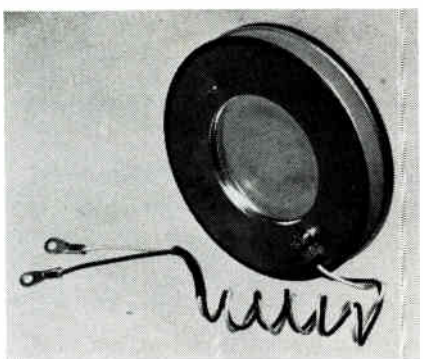


Model 4820 has a resistance of 50KΩ in the operate condition and 100 megohms in open circuit. For Model 4821, resistances are 500KΩ and 1000 megohms; Model 4822—60KΩ and 100 megohms; Model 4823—250KΩ and 1000 megohms. Operate time for Models 4820 and 4821 is 2msec., nominal; for Models 4822 and 4823, it is 15msec., nominal. Release times are approx. equal to operate times. The Photocom series offer low electrostatic magnetic and thermal noise. James Electronics, Inc., 4050 N. Rockwell Ave., Chicago, Ill.

Circle 206 on Inquiry Card

SILICON THYRISTORS

Packaging allows operation as a high surge device or high current density unit.



This disc-type thyristor operates at 1kv. The silicon slice, which is 32.5 mm in diameter, uses a disc encapsulation technique which allows easy pressure bonding of its leads. The new packaging method allows heat to be dissipated on both sides. Thus, it is possible to keep the silicon-slice temp. low, which gives great surge resistance; or it can be operated at very high curent densities without exceeding the junction temperature. With forced air cooling a single cell can handle 500 amps; with water cooling up to 700 amps. Siemens and Halske, Erlangen, Germany.

Circle 207 on Inquiry Card

ELECTRONIC INDUSTRIES Professional Profile

Please type or print

The ELECTRONIC INDUSTRIES Job Resume Form for Electronic Engineers

Name _____ Tel. No. _____

Street Address _____ Zone _____

City _____ State _____

☐ Single ☐ Married ☐ Citizen ☐ Non-Citizen Date of Birth _____

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 _____

Professional Memberships _____

College or University	Major	Degree	Dates

RECENT WORK EXPERIENCE

Company	Div. or Dept.	Title	Dates

SIGNIFICANT EXPERIENCE AND OBJECTIVES

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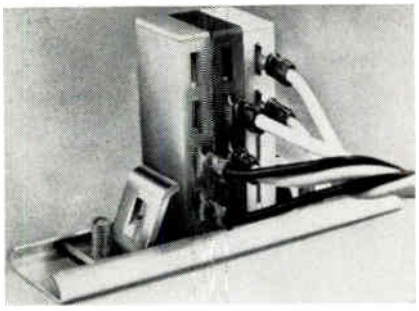
Mail to: ELECTRONIC INDUSTRIES—Professional Profile—56th & Chestnut Sts.—Philadelphia, Pa. 19139. This resume is confidential. A copy will be sent only to those Companies advertising for engineering personnel in this issue, whose number you circle below.

800 801 802 803 804 805 806 807 808 809 810

NEW PRODUCTS

CONNECTOR

For added versatility in high-density uses in switchboards, panelboards, etc.

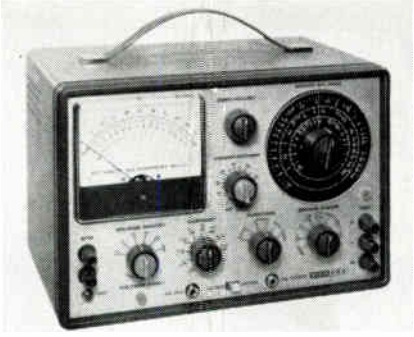


Terminals can be inserted and removed without tools with these Termi-Block™ vertical connectors. This reduces the danger of shorting or grounding, provides utmost speed and convenience in handling, and makes wiring more compact. Connector modules can be removed or added by loosening the end lock which holds them in the track. The blade-type terminals accept wire sizes 14 to 22 AWG and operate at 20a. continuous current or wire temp. of 105°C. AMP Inc., Harrisburg, Pa.

Circle 208 on Inquiry Card

BRIDGE-ANALYZER

Resistance-capacitance bridge and resistance-capacitance-inductance comparator.



The 965 FaradOhm Bridge-Analyzer combines the functions of a resistance-capacitance bridge and resistance-capacitance-inductance comparator, a capacitance leakage/I-R analyzer, a dc VTVM, and a dc VT nano-micromilliameter. It is intended for use in design laboratories and for quality control and maintenance. The 6-range dc vacuum tube voltmeter and 11-range dc vacuum tube nano-micro-milliameter required for capacitance leakage /I-R analysis may be used externally. The full-scale dc voltage ranges extend from 1.5v. to 500v. with an input impedance of 10 megohms on all ranges. EICO Electronic Instrument Co., Inc., 131-01 39th Ave., Flushing, N. Y.

Circle 209 on Inquiry Card

NEW PRODUCTS

CRYSTAL DETECTOR

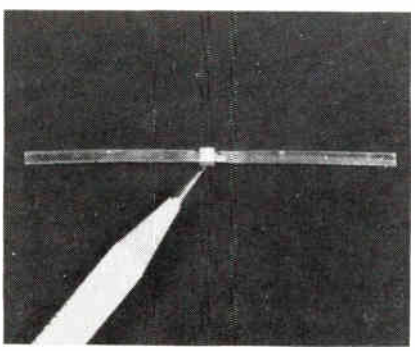
Flat freq. response of better than ±0.5db over the 10MC to 12.4GC range.

Model 1001 has an output capacitance of approx. 30 pf. A power input no greater than 0.4mw is required to produce 0.1v. rectified output; sq. low response is within ±0.5db from low level to 1mw output power. The unit is 2.4 in. long, 0.8 in. in dia. SWR is less than 1.4 over the entire freq. range. It is ideally suited for a variety of uses such as power leveling, absolute and peak power measurements, broadband detection and in reflectometer systems. Alfred Electronics, 3176 Porter Dr., Palo Alto, Calif.

Circle 210 on Inquiry Card

CERAMIC CAPACITOR

Microminiature unit offers 1000 pf and a min. Q of 5000. Working voltage, 500vdc.



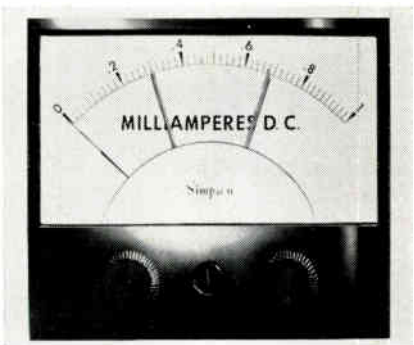
The ATC 100 series microminiature precision high Q capacitors have a case size of 0.1 x 0.1 x 0.075 in. They feature a min. Q of 5000 and a working voltage of 500vdc (no derating —55°C to +125°C). Leads are available in all configurations, both in solderable and solderable weldable ribbon and wire alloys, or without leads for direct soldering. The ATC 100's minimal size, versatility, and extremely high Q lends itself to VHF UHF applications, cordwood packaging pellet circuitry, and integrated circuits. American Technical Ceramics, CEREL: Electronic Components Div., 241 E. 127th St., New York, N. Y.

Circle 211 on Inquiry Card

NEW PRODUCTS

CONTACTLESS METER RELAYS

Sensing is accomplished by an infinite-life lamp and photo-conductors.

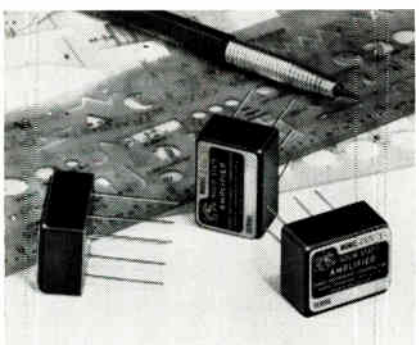


Model 3324XA has set points which are adjustable over 95% of the scale arc. This is done by an external, front-adjusted gear drive. Separate lance pointers indicate the 2 set points. A solid-state switching circuit and DPDT slave relay are contained internally for each control point. The slave relays will switch 10a. at 150vac. Calibration accuracy is ±2% of full scale. Power requirements are 115vac, 50-500 CPS. Simpson Electric Co., 5200 W. Kinzie St., Chicago, Ill.

Circle 212 on Inquiry Card

DC AMPLIFIER

Uses no choppers and has differential and/or single ended input and output.



Teledyne® Series 215 is a subminiature instrument with wide application in airborne and ground support systems, low level signal conditioning systems, and analog computers. With 4 operating modes, the unit can be used with non-bridge sensors such as thermocouples, where grounds must be provided to insure proper system operation. A unique signal conversion circuit provides a versatile dc amplifier capable of single-ended or differential output at low impedance. In the single-ended output mode, the amplifier can drive load resistances as low as 1KΩ to the 5vdc level. Taber Instrument Corp., 107 Goundry St., N. Tonawanda, N. Y.

Circle 213 on Inquiry Card

NEW PRODUCTS

SSB TUBE

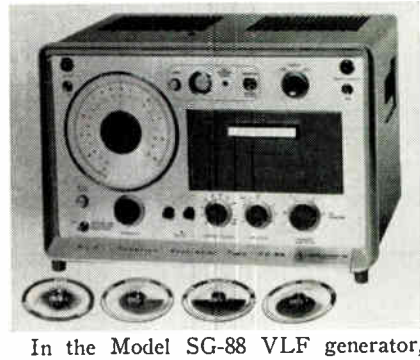
R-f amplifier for freq. to 60MC. New geometry gives good linearity.

The 8579 is a beam power tetrode. Third order distortion products are down better than 30db; 5th order products are better than 42db down. It can supply 110w. PEP in Class AB_1 SSB service under CCS conditions. It may also be used as an amplifier; under Class C telegraphy conditions, it provides 110w. output with a plate voltage of 600v. The tube provides 94w. under telephony conditions. A pair of 8579's used as a Class B audio amplifier modulator can produce 200w. output. Amperex Electronic Corp., Hicksville, L. I., N. Y.

Circle 214 on Inquiry Card

FUNCTION GENERATOR

Generates any wave shape—mathematical or non-math., complex or irregular.



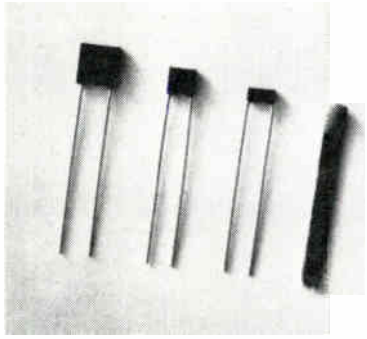
In the Model SG-88 VLF generator, the conventional oscillator circuit is replaced by a rotating disc scanned by a narrow light beam. Silk-screened on each disc is an opaque pattern representing in polar-coordinates the waveform or function to be produced. The beam is concentrated through a lens system onto the disc, providing a radial sweep as the disc rotates. Output freq. is variable from 0.005 CPS to 50 CPS. Dc voltage level at output terminals can be set to any value between ±25v. from ground. Houston Instruments Corp., 4950 Terminal Ave., Bellaire, Tex.

Circle 215 on Inquiry Card

NEW PRODUCTS

CERAMIC CAPACITORS

For miniature and subminiature packaging. Capacitance range 10pf to 0.027 mfd.

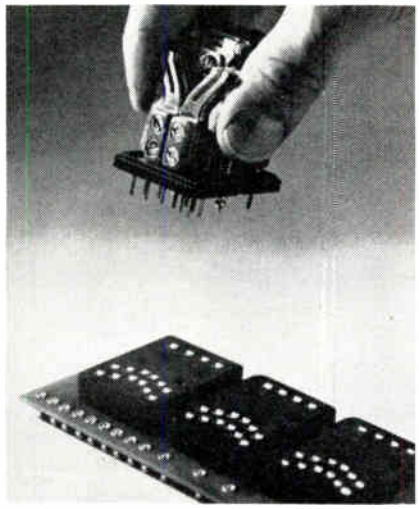


The EPC capacitors are produced from Neolythic™ ceramic, a new polyplanar dielectric construction of modified barium titanate. The Neolythic construction affords a small package size. The Nailhead™ case size is 0.2 x 0.1 x 0.1 in. They are designed for use in filters, coupling networks, phase shifting and most general-purpose circuitry. Electron Products, 1960 Walker Ave., Monrovia, Calif.

Circle 216 on Inquiry Card

RELAY SOCKETS

Allows Class E relays to be inserted into a socket instead of the circuit board.



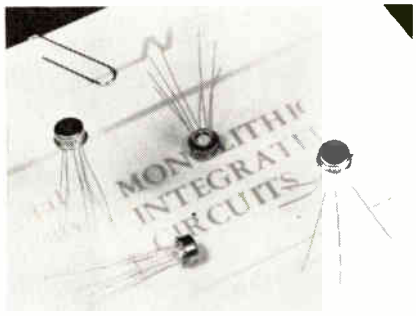
The terminals of the Series ETA socket are plugged in and soldered to the PC board. Matching PC terminals of the Class E relays can then be inserted into the socket. This eliminates the need for soldering and provides instantaneous removal and replacement. The socket accommodates a relay with either a single- or double-wound coil, and up to 4C spring combinations. Also available is a protective plastic cover, cover retaining clip, terminal reinforcement plate, and 2 locking pins. Automatic Electric Co., Northlake, Ill.

Circle 217 on Inquiry Card

NEW PRODUCTS

MONOLITHIC RTL DEVICES

Can be combined to provide every NAND/NOR function for digital systems.

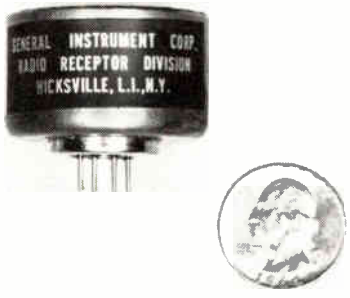


This new line of Monolithic integral circuits is divided into devices specified from −55 to +125°C operation (the NB1000 series) and for 0 to +100°C uses, (the NB2000 series). In both categories devices such as flip-flops, 3- and 6-input gates, buffers, half adders and counter adapters are available. Also available are half-shift registers and dual 2- and 3-input gates. All are packaged in low-profile modified TO-5 enclosures with 8- and 10-lead configurations. There are 14 elements in each series. National Semiconductor Corp., Danbury, Conn.

Circle 218 on Inquiry Card

MICROMINIATURE DELAY LINES

Associated read-write amplifier circuits are in microelectronic form.



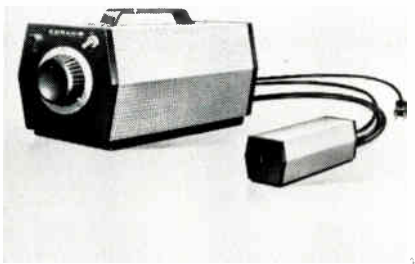
The MMDL series magnetostrictive delay lines are 2 in. in dia., ½ in. high, including 7-pin connector, and weigh less than 1½ oz. They are available in delay ranges of 10 to 500μsec., and are longitudinal in type. They use a method of soft encapsulation of the entire media package, which provides high shock and vibration performance. They operate dynamically at shocks of over 100Gs and in vibration as high as 20Gs in each of 3 planes. Temps. coefficients of delay are 20 ppm/°C. Radio Receptor Div., General Instrument Corp., 173 Andrews Rd., Hicksville, N. Y.

Circle 219 on Inquiry Card

NEW PRODUCTS

PORTABLE LASER

Produces a continuous output of ½w. at wavelength of 1.06 microns.

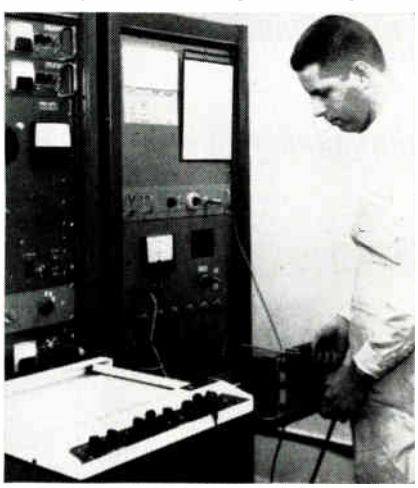


The K-Y1 portable yttrium aluminum garnet (YAG) laser operates from a 110v. outlet. The combined weight of the laser head and control unit is 20 lbs. The YAG laser is limited only by the life of the tungsten lamps which excite it. These are rated at approx. 2000 hrs. Korad Corp., 2520 Colorado Ave., Santa Monica, Calif.

Circle 220 on Inquiry Card

RESISTOR TESTER

Reduces to seconds the hours needed to perform reliability screening.



The GARD (Graphic Analyzer of Resistance Defects) system is said to effect drastic reductions in resistor test time. Reliability screening operations which presently require up to 250 hrs., and temp. coefficient measurements which require several hours of testing and handling can both be reduced to 5 sec. using this system. At the same time, the results achieved are said to have greater validity than present testing methods. Test capability includes any type of resistor—wirewound, film, composition and resistor networks in a range from 0.1Ω to 5 megohms. Dale Electronics, Inc., P. O. Box 488, Columbus, Nebr.

Circle 221 on Inquiry Card

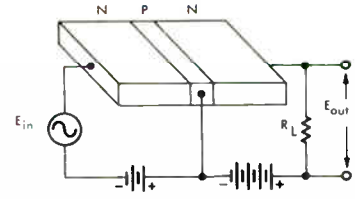
Is Your Knowledge of Computer Fundamentals &

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.

INTRODUCTION TO TRANSISTORS



29.

(a) The NPN transistor circuit illustrated above operates as a(n) _____.

(b) 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:

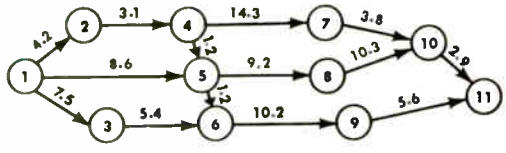
A. base-collector junction — 1.___high impedance

B. emitter-base junction — 2.___input impedance

3.___low impedance

4.___output impedance

PERT



12. Examine the network you have just constructed.

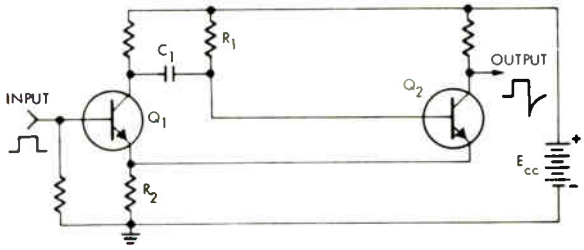
(a) Identify the critical path by giving the sequence of events along the path: _____.

(b) Give the T_E which you calculated for the ending event of the network _____ weeks

(c) 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

(d) If the changes mentioned in (c) 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?

BASIC TRANSISTOR CIRCUITS



27.

(a) The schematic diagram above shows an emitter-coupled one-shot _____.

(b) In the stable state Q_1 is ☐ on ☐ off and Q_2 is ☐ on ☐ off.

(c) The positive pulse turns on Q_1 which in turn: ☐ cuts off Q_2 ☐ turns on Q_2.

(d) When C_1 discharges, Q_2 is: ☐ cut off ☐ turned on.

(e) When Q_2 conducts, drawing current through R_2, Q_1 becomes _____ biased.

COUNTING SYSTEMS & BINARY ARITHMETIC

3. PERFORM THE FOLLOWING ARITHMETIC CONVERSIONS.

(a) CONVERT the decimal numbers 85 and 35 into binary equivalents and

(b) ADD their binary equivalents, then

(c) CONVERT the sum back to decimal

(d) CONVERT the decimal number 26 into its binary equivalent and

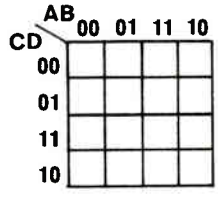
(e) SUBTRACT it from the binary sum you found in (b)

(f) CONVERT the result back to decimal

(g) CONVERT the decimal number 20 into the form it would have been in number systems with a base of 2___5___8___.

BOOLEAN ALGEBRA (in development)

SHOW the Karnaugh map of the function $AB\bar{D} + A\bar{C}\bar{D} + B\bar{C}\bar{D} + \bar{A}\bar{B} + \bar{A}CD$ by SHADING the appropriate boxes in the diagram below:



The Karnaugh map shows that the minimum inputs required for this function are_____.

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CAN YOU REALLY AFFORD THE TIME TO UPGRADE YOUR KNOWLEDGE IN THESE ELECTRONICS GROWTH AREAS ?

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.

PROGRAMMED INSTRUCTION COULD BE THE ANSWER FOR YOU—TAKE A LOOK AT THE PERFORMANCE DATA:

With the 5 subjects now available as the initial courses in a new programmed instruction series, you can master an entire subject in a day—and score 90% or better on a comprehensive final exam.

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	Foreman	Ops. Mgr.	Proj. Eng.	Supervisor		Pers. Mgr.	Chief Eng.	Traffic Mgr.
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 rate your own performance and skill needs in these subjects:

1) **Send for your 10-day review copies of the self-instructional programs.**

2) **Try the final examination included with each program.**

3) **If you are convinced that the skills imparted by the program are valuable, honor the enclosed invoice. Otherwise, return the programs and completed exams and pay nothing.**

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Title_____

Address_____

City_____ State_____

Company_____

☐ My check or company purchase order is enclosed.

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Clip and send this coupon to:

Please send me the programs designated below. At the end of 10 days, I'll either send the indicated price, plus a few cents for packing and postage, or return the program and my completed final examination and owe nothing.

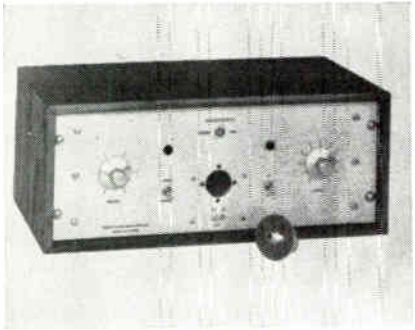
TITLE	PRICE	
PERT	$12.50	☐
Introduction to Transistors	9.50	☐
Basic Transistor Circuits	9.50	☐
Counting Systems and Binary Arithmetic	7.50	☐
Applied Electricity	12.50	☐

BASIC SYSTEMS INCORPORATED 880 THIRD AVENUE / NEW YORK, N. Y.

NEW PRODUCTS

PULSE SOURCE

Fast-pulsing mercury arc features rise and fall times within 2nsec.

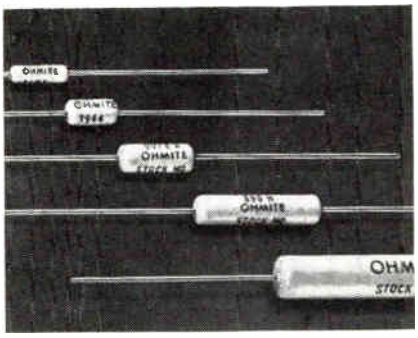


The Nanosource Model 450A is used for calibrating laser detectors, photomultiplier time constants, and photovoltaic and photoconductive detector time constants. The high-pressure mercury arc source emits in the ultraviolet, visible, and near-infrared region pulses of permanently selected width (3 to 30nsec. range) at 60 pps. Peak output is 1w./steradian. It operates on 115v. 60 cps or 50 cps. Electro-Nuclear Laboratories, Inc., 2433 Leghorn St., Mountain View, Calif.

Circle 222 on Inquiry Card

AXIAL-LEAD RESISTORS

Available in 5 sizes: 1½, 2¼, 3¾, 5 and 11w. Tolerance is ±5%.

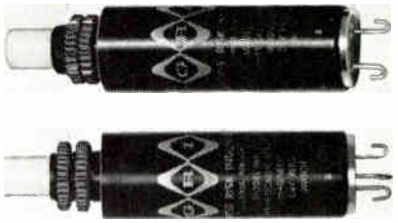


The Series 99 wirewound resistors offer a wide selection of stock values. The 11w. size is stocked in 146 different resistance values from 1.0 to 51KΩ. Series 99 are said to be the first resistors to have a molded vitreous enamel coating. The thicker, more uniform coating provides 1kv ac insulation; withstands temp. to 1500°F without deformation or loss of markings; resists chipping and breaking, particularly where leads enter resistor body. Ohmite Mfg. Co., 3646 Howard St., Skokie, Ill.

Circle 223 on Inquiry Card

PUSHBUTTON SWITCH

Uses magnetic lines of force to open or close switch contacts.



With this dry-reed switch, magnetic holding pressure on the contacts is independent of the pressure actuating the pushbutton. This makes the switch more positive in action and reduces the possibility of failure due to operator fatigue. Switch life is rated at 20 million operations with full load. Available in 3 standard forms: SPST-NO, SPST-NC and SPDT-break-make. Contact ratings of up to 1a. or 15w. @ 250vac. George Risk Industries, Inc., 672 15th Ave., Columbus, Nebr.

Circle 224 on Inquiry Card

NEW PRODUCTS

SWEEPING OSCILLATOR

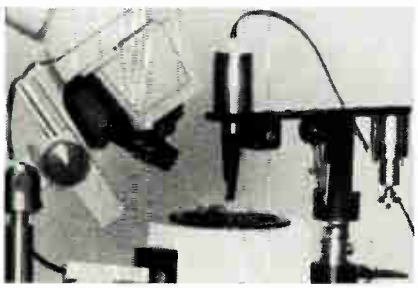
Sweeps a full octave, anywhere in the 100MC to 1KMC range.

The 1400 series sweeping oscillators provide full 2 to 1 fundamental freq. sweep to display broadband circuits in a single sweep. The instruments may also be used as continuously variable (both width and center freq.) narrow band sweeping oscillators. A 200-400MC model sweeps 225-400MC receivers. The instrument is said to sweep the entire input simultaneously, without spurious signals, and provides an excellent waveshape. Sweep can be narrowed-down for i-f response. I-f bands @ 20MC, 60MC, etc. are available. Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.

Circle 225 on Inquiry Card

WIRE BONDING METHOD

Wire bonding method for wiring of semiconductors with or without heat.



Thermosonic bonding combines heat and ultrasonic vibration. Here the energy is applied along the load line instead of perpendicular to it. Thus temp. does not cause any hazard to the operator or even the most sensitive thin films. The bonds are small and strong with heat optional (where no heat is desired, unit is available without heat column). The Thermosonic method forms small well-controlled bonds. For example, 2 mil dots in teardrop patterns on transistors can be bonded readily with 1 mil aluminum wire. Bonds aluminum, gold wire and many other materials. Axion Corp., Saw Mill Rd., New Fairfield, Conn.

Circle 226 on Inquiry Card

new, low cost!

Reliable Circuit Breaker

Model 375 at 90¢ (prod. qty.) designed with the famous TAYLOR Bi-metal patented Blade for unsurpassed repeatability and reliability.

Write for Data Sheet 375.

WOOD ELECTRIC CORPORATION

244 Broad Street, Lynn, Mass. (617) LY8-5313

Circle 121 on Inquiry Card

SPLICING IN THE MIDDLE of a TAPE CABLE?

Stripping high temperature insulation such as nylon and Teflon is difficult enough — even tougher when it's in a tape cable. The controlled flame of the Henes Oxyhydrogen Flame Generator will quickly cut through nylon or Teflon without even scorching the wire or neighboring insulation. Your splice area is clean and precisely where you want it.

For any high temperature insulation removal, the Henes Water Welder* Flame Generator provides a faster, more positive method than mechanical or hot-wire devices. It's simple to use, easy to handle and costs only pennies per day to operate, for it generates its own fuel continuously from distilled water. And you can also use it for welding, soldering, brazing, annealing and glass working.

Priced from $219.00 to $1,150.00 in six different models. Descriptive brochure on request.

HENES MANUFACTURING CO.

4301 East Madison Street, Phoenix, Arizona 85034

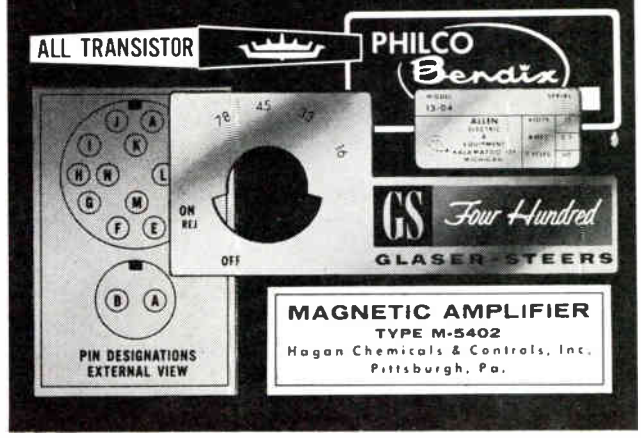
Tel: (602) 275-4126 *T.M.

Manufacturers of the Weld-Lite* light for continuous-visibility arc welding.

Circle 117 on Inquiry Card

BRADY® SELF-BONDING Poly-Plates™

Permanently Protected Identification



Here are permanent, abrasion-resistant nameplates you can apply *exactly where they're needed.* No moistening, screws or rivets required. Self-bonding Poly-Plates adhere tightly to any clean, dry surface. Made of miracle sub-surface printed Mylar*. Non-conductive . . . safe on or near energized equipment. Any wording, shape, size or color, including rich gold or silver. Low cost.

Write for bulletin and samples. 143

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W. H. BRADY CO., 749 W. Glendale Ave., Milwaukee 9, Wis.

EST. 1914

Manufacturers of Quality Pressure-Sensitive Industrial Tape Products, Self-Bonding Nameplates, Automatic Machines for Dispensing Labels, Nameplates, Masks and Tape

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GET CRYSTAL ACCURACY AT AUDIO FREQUENCIES WITH A

TUNING FORK OSCILLATOR

Accuracy .1 to .002% without oven, over a wide temperature range. Frequency Range: 1 CPS to 30 kc. Other features available: Low distortion, sine wave filter, binary divider count-down or power output. Stock delivery for some frequencies. Special units built to order.

Write or phone for details . . .

FORK STANDARDS, INC.

219 Main Street • West Chicago, Illinois

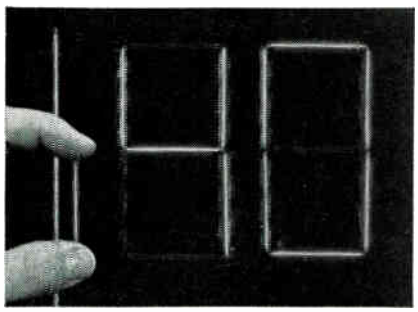
Telephone (312) 231-3511

Circle 118 on Inquiry Card

NEW PRODUCTS

LINE FILAMENT LAMP

Rearranging filament causes 40 times more light to be given off.



The spaghetti thin line filament lamps give 40 times more light than conventional lamps mainly because the filament is closer to the subject. Conversely it requires less wattage for comparable surface illumination. A lamp and resistor, or 2 lamps in series, can be run off line current eliminating need for filament transformer. All lamps, aged and selected for high reliability, have 25,000 hr. life at rated volts and can be operated up to 160% of rated volts. Los Angeles Miniature Products, Inc., 17000 S. Western Ave., Gardena, Calif.

Circle 227 on Inquiry Card

VACUUM RELAYS

Switches up to 5kv in 500μsec. Supplied in SPST N.O. or N.C. and SPDT.

Model H-5/H-7 relays are finding wide application in ECM, communications, sonar, radar, pulse-forming networks, and other high-voltage equipment. The SPST type measures 2 in. long and 13/16 in. high. Nominal coil voltage is 24vdc; max. current: 300ma or 1a. pulse. Weight 1 oz. High Vacuum Electronics, Inc., 538 Mission St., So. Pasadena, Calif.

Circle 228 on Inquiry Card

TAPE READER

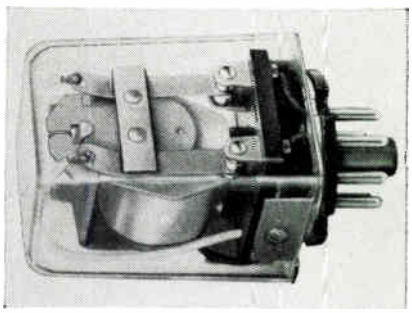
Bi-directional photo-electric unit rated at a speed of 1000 characters / sec.

The Model B3000 reader is bi-directional and all solid-state. It has self-adjusting brakes and reads 5-, 6-, 7- or 8-level tapes. Silicon photo-diodes in the read head service all 8 data channels, plus sprocket channel. Positive or negative-going output signals, variable tape guides and dual speed motors are optional. Model 6090 spooler handles 10½ in. reels @ 1000 characters/sec. Digitronics Corp., Albertson, N. Y.

Circle 229 on Inquiry Card

PLUG-IN RELAY

For heavy-duty SPDT, DPDT or 3PDT switching on ac or dc inputs.



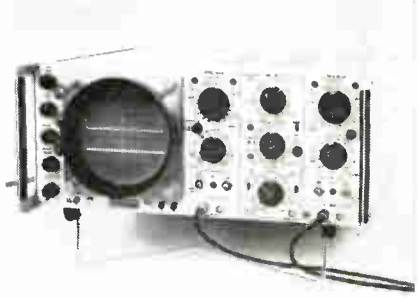
The 22AP relay is rated at loads of 5 or 10a., 115vac. They feature low pull-in voltages (dc: 70% of nominal voltage; ac: 75% of nominal voltage). The ac version has operating voltages of 0.5 to 250; current range is 0.005a. to 10a., and temp. range is −55°C to +72°C. The dc version has operating voltages of 0.2 to 130; current range is 0.005a. to 10a., and temp. range is −55°C to +85°C. Coil voltages on the ac range from 6 to 230, and on the dc from 6 to 110. E. W. Bliss Co., Eagle Signal Div., Davenport, Ia.

Circle 230 on Inquiry Card

NEW PRODUCTS

DUAL-BEAM OSCILLOSCOPE

Features 10μv. sensitivity and a high resolution CRT. *Bandwidth is dc to 500* KC.

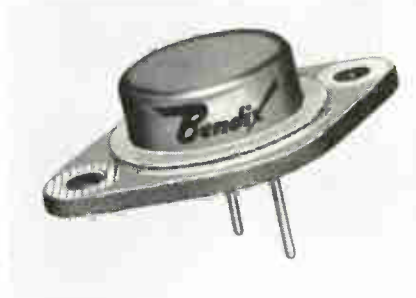


The type 708A oscilloscope uses simple panel controls for ease of operation. Its electrometer type input stage gives very good amplifier position stability. The sweep is wide from 100nsec./cm to 1 min. full scale. The dual-beam CRT achieves high brightness with 5kv accelerating potential, and is driven by transistorized amplifiers. Scientific Instrument Dept., Fairchild Camera & Instrument Corp., Du Mont Laboratories Divs., 750 Bloomfield Ave., Clifton, N. J.

Circle 231 on Inquiry Card

HIGH-VOLTAGE TRANSISTORS

For TV use. Reduces size of output transformer. Simplifies yoke design.



These high-voltage silicon and germanium transistors are for TV receiver horizontal and vertical deflection circuits. Silicon horizontal deflection NPN transistors feature VCES from 500 to 700v. with collector current fall time 2μsec. max. at 2 to 4a. Germanium diffused alloy power DAP PNP transistors feature VCES from −150 to −325v. with current fall time of 2μsec. max. at −6a. Silicon diffused mesa NPN transistors for vertical deflection circuits feature VCBO to 300v. with dc current gain (hFE) 15 min. at 0.4a. Germanium alloy power PNP transistors feature VCBO from −57v to −200v. with hFE from 50 to 400 @ 0.5a. Bendix Semiconductor Div., The Bendix Corp., Holmdel, N. J.

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A COMPUTER is controlling the testing of blood at Kings County Research Laboratories, Inc., Brooklyn. The IBM 1710 computer is being used to monitor, calculate and speed the results of patient's blood tests. Ten separate tests are performed simultaneously on one blood specimen. Average time to complete the 10 tests is two minutes. The usual laboratory method would take two to three hours and would not be as accurate.

REUSEABLE R-F ADAPTERS

R-F CONNECTORS, as originally supplied in accordance with military specs, are complete male-female sets. If they are broken apart for servicing, it is usually required that the male part be replaced. The Thomas & Betts Co., Inc., Elizabeth, N. J. has adapters available for this, Fig. 1. These adapters, like the original r-f connectors, are matched impedance connectors, providing for secure metal-to-metal contact. They have advantages over the original connector in that they may be repeatedly disassembled, can be readily inspected, are simple, and can be quickly installed.

In place of the inner sleeve used on coaxial cables, pre-matched r-f adapters (Fig. 2) are available which provide a complete, secure threaded joint. The adapter is put in position and crimped. Installation is completed by crimping a contact pin on the conductor. For a UHF connector a solder pot is crimped on the end of the conductor instead of a contact pin.

Fig. 1: Various steps needed to assemble the r-f adapter are shown in the diagram.

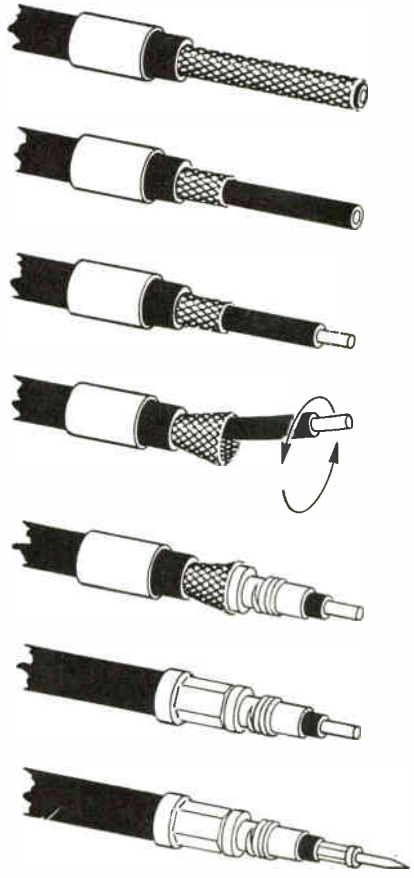
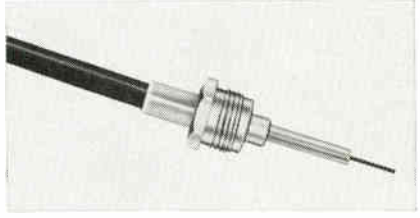
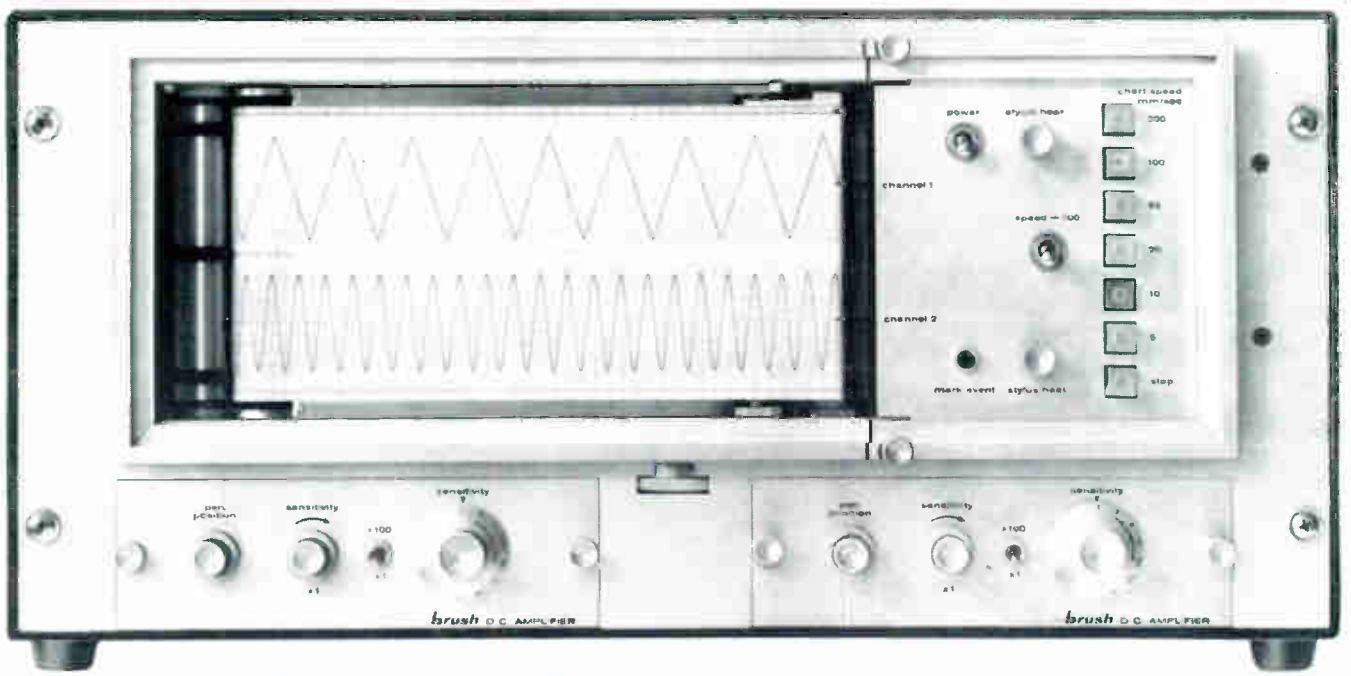


Fig. 2: This r-f adapter provides a secure threaded joint. Installation is completed by crimping a contact pin on the conductor.



New Brush Mark 842



Highest useable frequency response of *any* direct writing recorder

Here's the Recorder some people thought was years away . . . a completely self-contained system for general purpose or specialized requirements.

Useable frequency response . . . 75 cps full scale; flat to 150 cps at reduced amplitude.

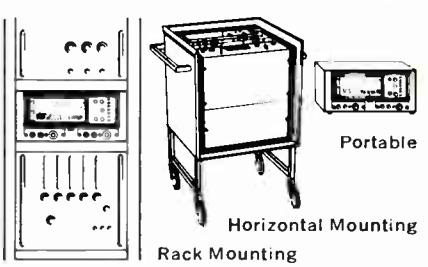
½% Linearity . . . assured by *tangent-correction.*

Plug-in preamplifiers . . . design your own recorder.

Complete simplicity . . . push a button and it's "go".

All solid state electronics.

And new high-torque penmotors permit greater stylus pressure without loss of accuracy . . . assure uniform accurate recording of high speed transients. Rugged styli deliver crisp, clear traces on heat sensitive paper. Wide "off-the-shelf" selection of plug-in modular preamplifiers, lets you match a Mark 842 system to *your* specific recording requirements. Variety of mounting possibilities, including RETMA standard. Simple, reliable, flexible . . . designed to fill your needs for years to come. Complete details on request. Brush Instruments Division, Clevite Corporation, 37th & Perkins, Cleveland, Ohio 44114.



CLEVITE

brush INSTRUMENTS DIVISION

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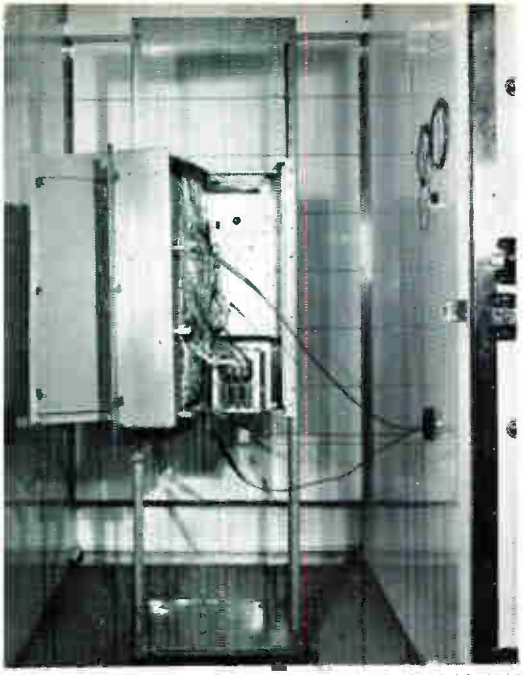
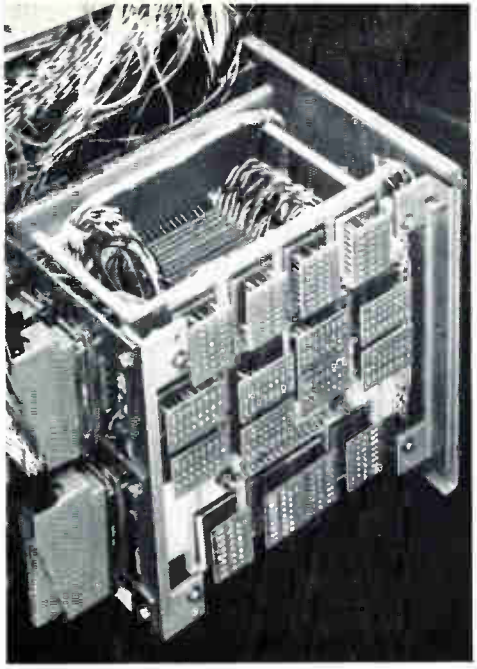
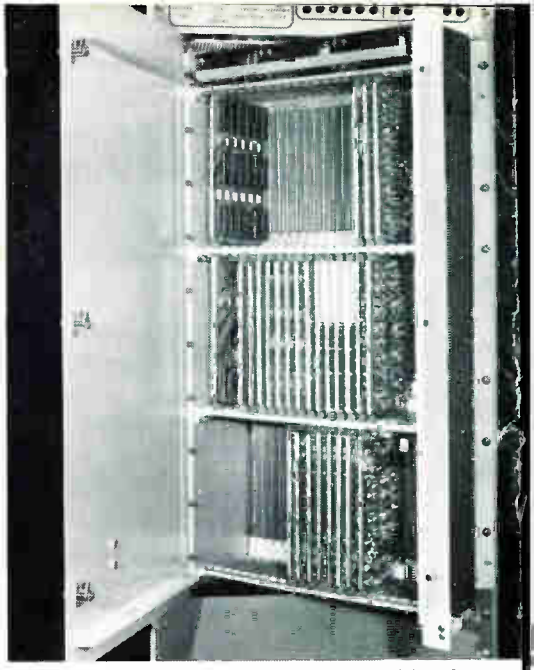


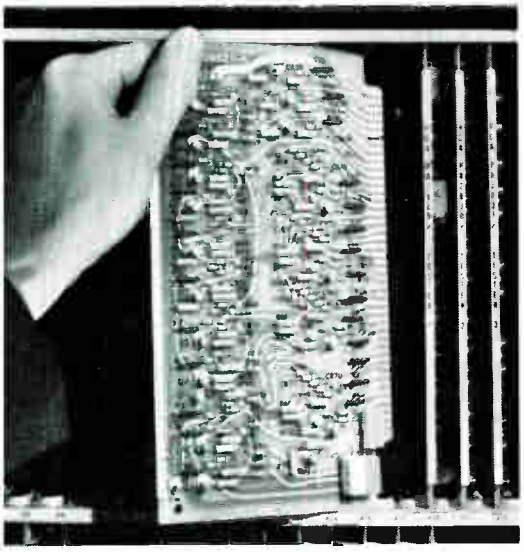
TEMPERATURE STABLE. Each unit worst-case tested in hot/cold chamber over specified temperature range.



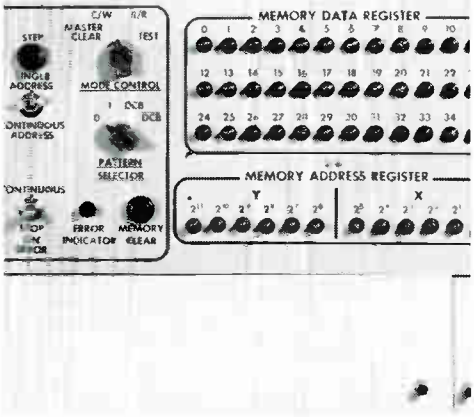
EASY ACCESS TO MEMORY STACK. Stack capacity of 8192 words, 36 bits. Systems available to 32,768 words, 72 bits.



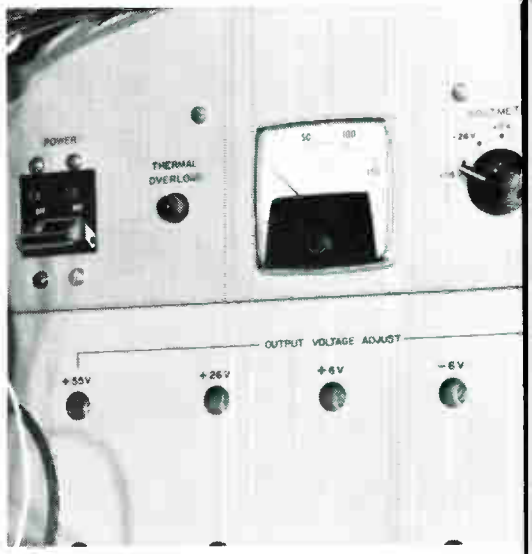
EASY ACCESS TO PRINTED CIRCUIT BOARDS. Provisions for adding many optional features plus system expansion.



EFFICIENT CIRCUIT BOARD DESIGN. Vertical installation provides 86 connections per board, shorter current path.



SELF-TESTING. RCA MS-1 systems can be supplied with built-in tester to locate read-in and read-out errors.



EASY ACCESS TO POWER SUPPLY... simply by opening the hinged circuit-board panel door.

New RCA MS-1 Coincident Current Memory System...

COMPLETE READ/WRITE CYCLE IN ONLY 1 MICROSECOND

You're looking at one of the fastest, most versatile coincident-current computer memory systems now commercially available: the new RCA MS-1. Consider its outstanding features:

- *Switches a full word (up to 36 bits) in 1 microsecond* with a single memory stack as shown. Can be expanded to switch 72 bits per microsecond.
- *Stores up to 8192 words, 36 bits* in the unit shown above. System can be modified to attain capacities to 32,768 words by 72 bits.
- *No temperature compensation required.* With RCA wide-temperature-range memory cores, system operates normally from −40 to +80°C.
- *Can be built to MIL-SPEC's.* Designed to meet applicable portions of MIL-E-4158. Conforms to MIL-Q-9858. Designed to meet NASA Specification MSFC-PROC-158B, and inspected to NPC 200-2 when required.
- *All silicon semiconductor devices* for improved high-temperature performance and increased reliability.
- *Upright insertion of circuit boards* provides space for 86 connections on a board only 8 inches high . . . increases computer speed by shortening current paths from outer edge of each board.

Similar systems, with operation cycles ranging from 1.5 to 6 usec, are also available. Let us give you a quotation. Call your nearest RCA Field Representative...or write, wire or telephone RCA Electronic Components and Devices, Memory Products Operation, Section FJ4, 64 "A" Street, Needham Heights 94, Mass. Phone (617) HI 4-7200.

The Most Trusted Name in Electronics

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