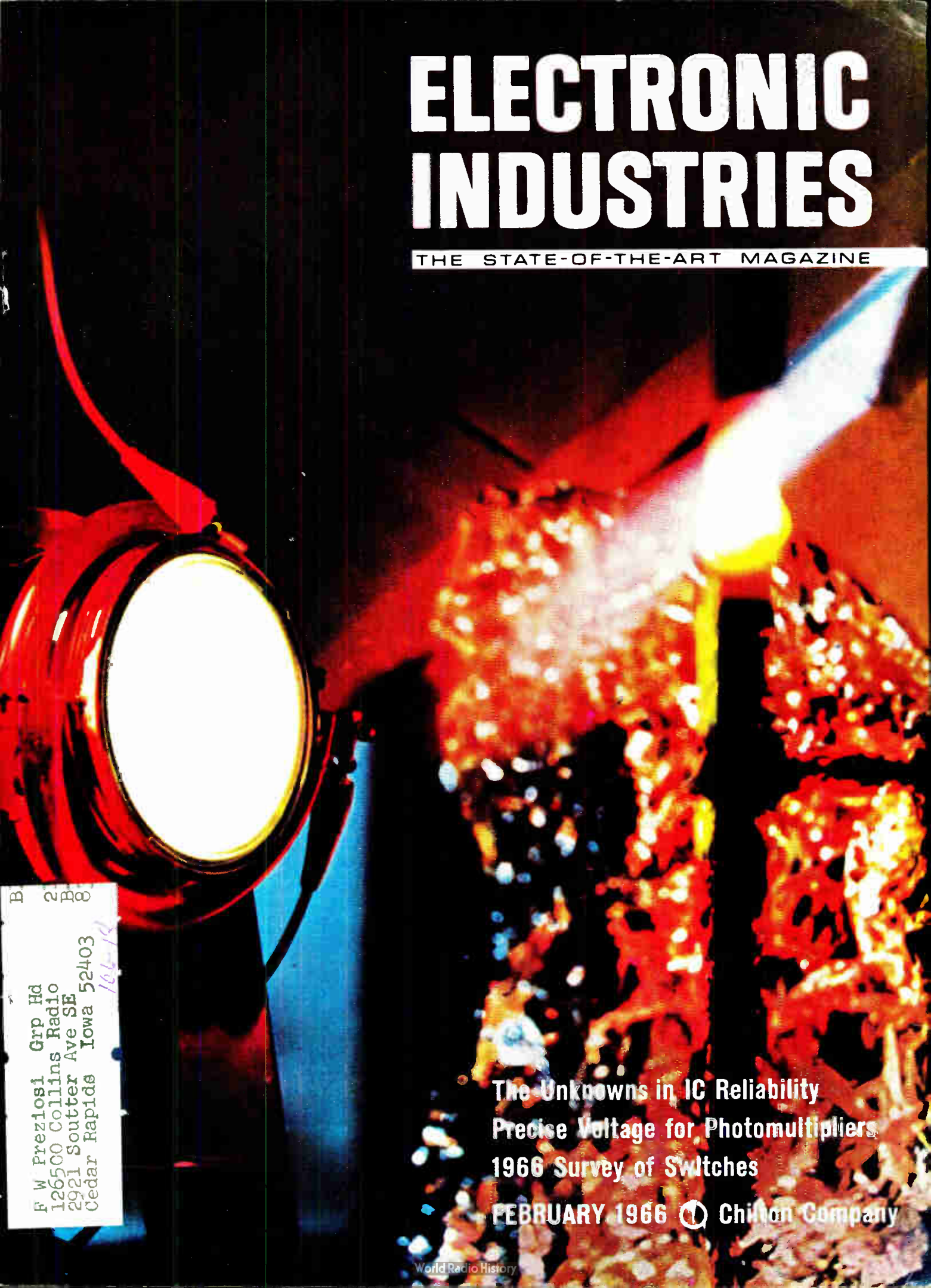
ELECTRONIC INDUSTRIES

THE STATE-OF-THE-ART MAGAZINE



The Unknowns in IC Reliability
Precise Voltage for Photomultipliers
1966 Survey of Switches

FEBRUARY 1966 Chilton Company

No need to scrap reliability for low price ...get both with DALE METAL FILM RESISTORS

LOW NOISE CONSTRUCTION. Maximum for standard resistance range: 0.10 micro-volt per volt over a decade of frequency. Low and intermediate values: below 0.05 micro-volt per volt. Terminating band of low-resistance metal alloy is deposited in same vacuum as metal film element resulting in *oxide-free*, low-noise contact area between film, terminating band and press-fit cap.

CONTROLLED T.C. Ten standard T.C. codes from 0 ± 150 ppm/°C to 0 ± 25 ppm/°C available in operating temperature range of −55°C to +175°C. Close matching between pairs or sets available.

GOOD HF CHARACTERISTICS. Low reactance gives excellent stability at high frequencies. Non-helixed or laterally adjusted units supplied for extremely critical applications above 100 mc.

SPECIAL REQUIREMENTS. Special terminals, special matching, special pre-conditioning, special networks and mountings can be quickly supplied by our Special Film Products Department.

WRITE FOR CATALOG A

DALE ELECTRONICS, INC.

1304 28th Avenue, Columbus, Nebraska

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

SEE OUR SPECIFICATIONS IN VSMF THE MICROFILM CATALOG FILE

MFF Epoxy coated. Meets electrical and environmental requirements of Char. B, C. D. E; MIL-R-10509E, but is dimensionally smaller.

MFH Hermetically sealed in ceramic tube. Meets requirement G; MIL-R-10509E.

MF Transfer molded in epoxy. Meets all requirements of Char. B, C, D, E; MIL-R-10509E.

DALE TYPE	MIL TYPE	125° C RATING	RESISTANCE RANGE	DIMENSIONS (L×D.)
MF 50	RN-50 (Proposed)	1/20 watt	49.9 Ω to 60K Ω	.140x.065
MF-1/10	RN-55	1/10 watt	49.9 Ω to 200K Ω	.250x.093
MF-1/8	RN-60	1/8 watt	30 Ω to 550K Ω	.406x.140
MF-1/4	RN-65	1/4 watt	30 Ω to 1 Megohm	.593x.203
MFS-1/2	RN-70	1/2 watt	49.9 Ω to 2 Megohms	.750x.250
MF-1	RN-75	1 watt	49.9 Ω to 6 Megohms	1.093x.375
MF-2	RN-80	2 watts	100 Ω to 15 Megohms	2.188x.375

Tolerance: ±1% standard; ±.5%, ±.25%, ±.1% available.

ENVIRONMENTAL SPECIFICATIONS

Dale MF resistors are manufactured to the environmental specifications of MIL-R-10509E. Characteristics D, C or E apply depending on T.C. Code specified at purchase.

DALE T.C. CODE	Applicable Char. of MIL-R-10509E
T-1 (100 P.P.M./°C)	D
T-2 (50 P.P.M./°C)	C
T-9 (25 P.P.M./°C)	E

*Specifications for MFF and MFH are similar, but vary dimensionally.

Circle 98 on Inquiry Card

Did You Know Sprague Makes 51 Types of Foil and Wet Tantalum Capacitors?

125 C FOIL-TYPE TUBULAR TANTALEX® CAPACITORS

Type 120D polarized plain-foil
Type 121D non-polarized plain-foil
Type 122D polarized etched-foil
Type 123D non-polarized etched-foil

ASK FOR BULLETIN 3602C

Circle 11 on Inquiry Card

FOIL-TYPE RECTANGULAR TANTALEX® CAPACITORS

Type 300D polarized plain-foil
Type 301D non-polarized plain-foil
Type 302D polarized etched-foil
Type 303D non-polarized etched-foil

ASK FOR BULLETIN 3650

Circle 12 on Inquiry Card

FOIL-TYPE TANTALUM CAPACITORS TO MIL-C-3965C

CL20, CL21 tubular 125 C polarized etched-foil
CL22, CL23 tubular 125 C non-polar etched-foil
CL24, CL25 tubular 85 C polarized etched-foil
CL26, CL27 tubular 85 C non-polar etched-foil
CL30, CL31 tubular 125 C polarized plain-foil
CL32, CL33 tubular 125 C non-polar plain-foil
CL34, CL35 tubular 85 C polarized plain-foil
CL36, CL37 tubular 85 C non-polar plain-foil
CL51 rectangular 85 C polarized plain-foil
CL52 rectangular 85 C non-polar plain-foil
CL53 rectangular 85 C polarized etched-foil
CL54 rectangular 85 C non-polar etched-foil

Circle 13 on Inquiry Card

85 C FOIL-TYPE TUBULAR TANTALEX® CAPACITORS

Type 110D polarized plain-foil
Type 111D non-polarized plain-foil
Type 112D polarized etched-foil
Type 113D non-polarized etched-foil

ASK FOR BULLETIN 3601C

Circle 14 on Inquiry Card

SINTERED-ANODE TUBULAR TANTALEX® CAPACITORS

Type 109D elastomer seal 85 C
Type 130D elastomer seal 125 C
Type 137D hermetic seal 125 C

ASK FOR BULLETINS 3700F, 3701B, 3703

Circle 15 on Inquiry Card

SINTERED-ANODE CUP STYLE TANTALEX® CAPACITORS

Type 131D 85 C industrial-type
Type 132D 85 C vibration-proof
Type 133D 125 C vibration-proof

ASK FOR BULLETINS 3710B, 3711

Circle 16 on Inquiry Card

SINTERED-ANODE CYLINDRICAL TANTALEX® CAPACITORS

Type 140D
up to 175 C operation, ⅞" diam.

Type 141D
up to 175 C operation, 1⅛" diam.

ASK FOR BULLETIN 3800

Circle 17 on Inquiry Card

SINTERED-ANODE RECTANGULAR TANTALEX® CAPACITORS

Type 200D negative terminal grounded

Type 202D both terminals insulated

ASK FOR BULLETIN 3705A

Circle 18 on Inquiry Card

SINTERED-ANODE TANTALUM CAPACITORS TO MIL-C-3965C

CL14 cylindrical, ⅞" diam.
CL16 cylindrical, ⅞" diam., threaded neck
CL17 cylindrical, 1⅛" diam.
CL18 cylindrical, 1⅛" diam., threaded neck
CL44 cup style, uninsulated
CL45 cup style, insulated
CL55 rectangular, both terminals insulated
CL64 tubular, uninsulated
CL65 tubular, insulated

Circle 19 on Inquiry Card

For comprehensive engineering bulletins on the capacitor types in which you are interested, write to:
Technical Literature Service
Sprague Electric Company
233 Marshall Street
North Adams, Mass. 01248

ABC-8156

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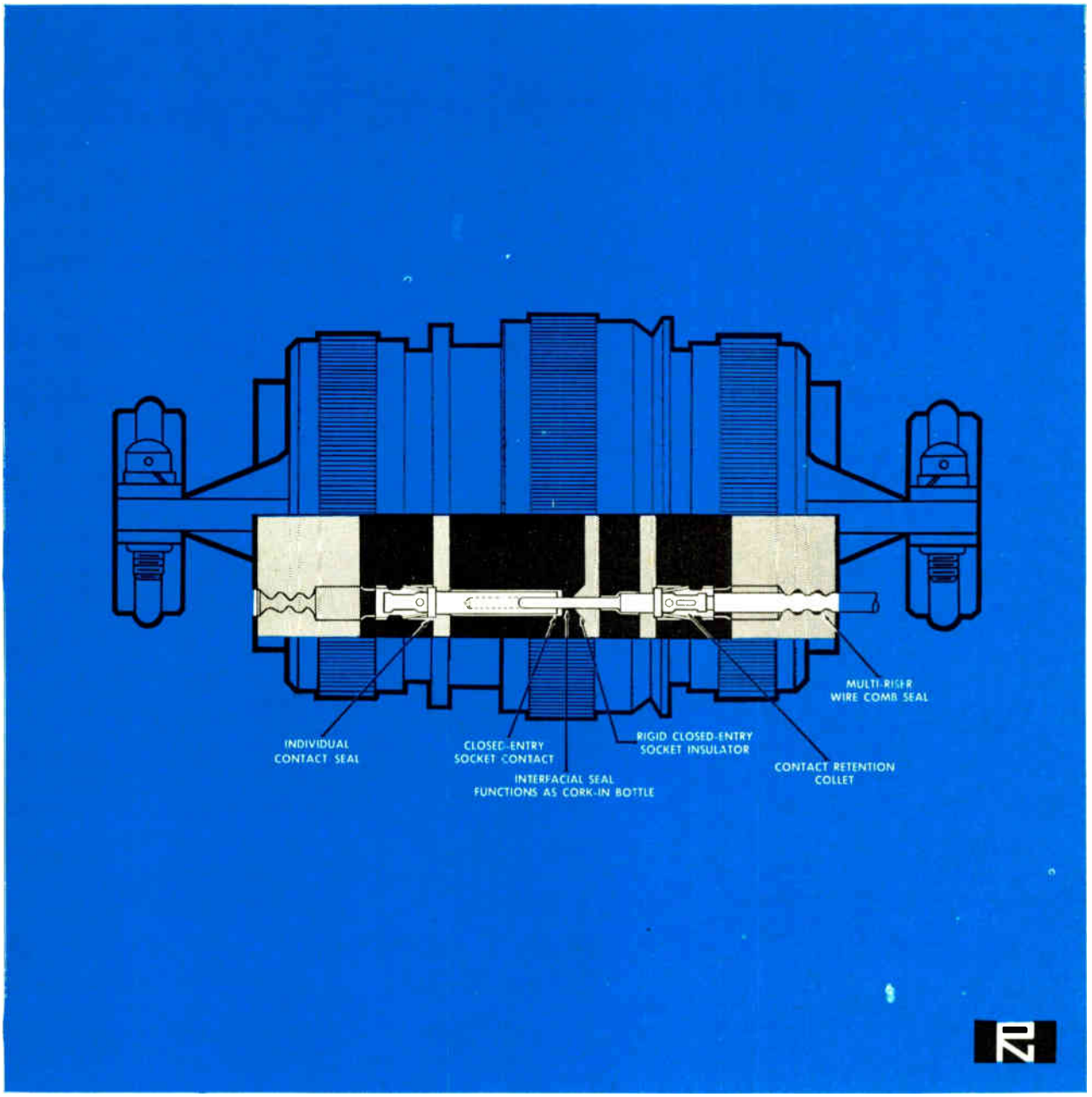


IT'S WHAT'S INSIDE THAT COUNTS—NAS 1599 specifications are exceeded in Pyle-Star-Line Venus Series Connectors. Environmental sealing of individual contact pins and sockets is a feature proved over a period of years in hundreds of thousands of the original Pyle-National Neptune Series Connectors. Now this feature along with interfacial cork-in-bottle seal and multi-riser wire seal is available in these new Venus EB Series Connectors. Bayonet coupling types mate with MIL-C-26482 connectors in shell sizes 10, 12, 14, 16, 18, 20, 22, 24 with full sealing capabilities. Above connectors are also available with threaded coupling to mate with MIL-C-26500B.

For further information and specifications regarding the Venus Series NAS 1599 Connectors send for Bulletin No. 681.

CONNECTOR DIVISION, THE PYLE-NATIONAL COMPANY, 1334 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS

Also manufactured in Canada by: Pyle-National (Canada) Ltd., Clarkson, Ontario

Pyle-National

ELECTRICAL CONNECTORS LIGHTING EQUIPMENT CONDUIT FITTINGS

FEBRUARY 1966, Vol. 25, No. 2

ELECTRONIC INDUSTRIES

The STATE-OF-THE-ART* Magazine

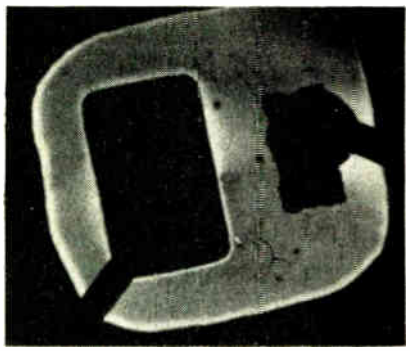
COVER: THE F3518 Iatron is a direct viewing storage tube designed primarily for high brightness television and radar displays. This dramatic picture was taken during the "bake-out" of the tube at the Fort Wayne, Indiana plant of I.T.T. Industrial Labs.

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

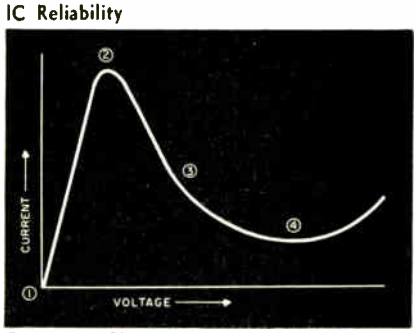
BPA AMERICAN BUSINESS PRESS, INC.

ELECTRONIC INDUSTRIES

HIGHLIGHTS

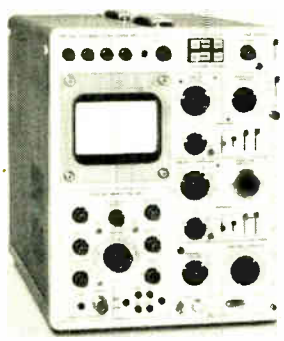


IC Reliability



Tunnelling Phenomenon

Switch Survey Part 2



Storage Scopes

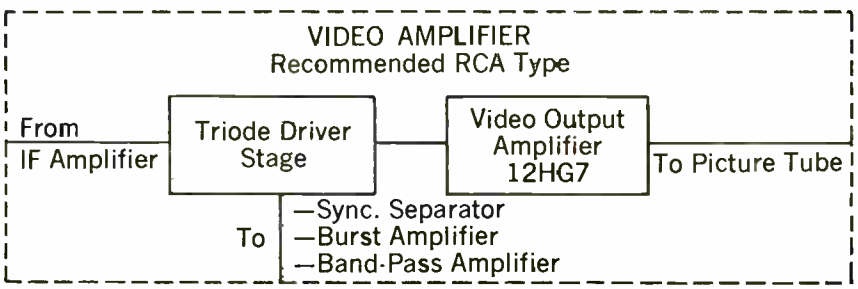
EIA/JEDEC Device Registration

FREE REPRINT of ANY ARTICLE in this issue is available from ELECTRONIC INDUSTRIES Reader Service Department, 56th & Chestnut Streets, Philadelphia, Pa. 19139

Now, you can eliminate one stage and reduce the number of components in your video-amplifier circuit with the new RCA-12HG7 COLOR-TV RECEIVING TUBE. This FRAME-GRID, Sharp-Cutoff Pentode offers these benefits to the circuit designer:

- *high transconductance — 32,000 μmhos* — provided by the FRAME-GRID construction, permits you to drive the color-TV picture tube with only two stages of video amplification.
- *high dissipation capability* — 10 watts (maximum) plate-dissipation rating eliminates the need for a series plate-circuit dropping resistor and its associated by-pass capacitor. Greater margin between maximum rating and usual operating values will contribute to greater reliability and longer life expectancy.
- *high plate current "knee" characteristic* — permits high output and good linearity over a "B" supply voltage range of 270 volts to 400 volts or more.
- *RCA Dark Heater* — reduces temperature and contributes to long life and dependable performance.

VIDEO AMPLIFIER
Recommended RCA Type



RCA's knowledge and experience in color television have led to the design and selection of tubes, such as the RCA-12HG7, which offer the color-TV set manufacturer *the best combination of price, performance and reliability on the market today.* For more information on the RCA-12HG7 and other RCA COLOR-TV RECEIVING TUBES, call your nearest RCA District Office or write RCA Commercial Engineering, Harrison, New Jersey 07029.

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, NEW JERSEY

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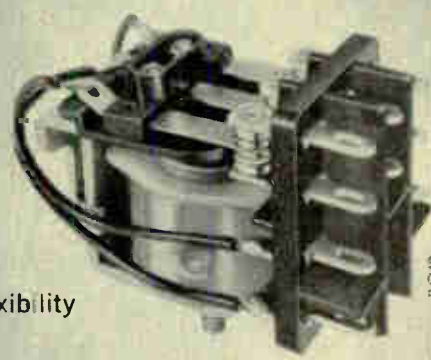
Better Life Characteristics

COMPARE
Higher Reliability



Eagle 25AA
General Purpose
Relay (Actual Size)

COMPARE
Fewer Parts

COMPARE
More Design Flexibility

COMPARE
Lower Pull-in Voltages

COMPARE THEM!

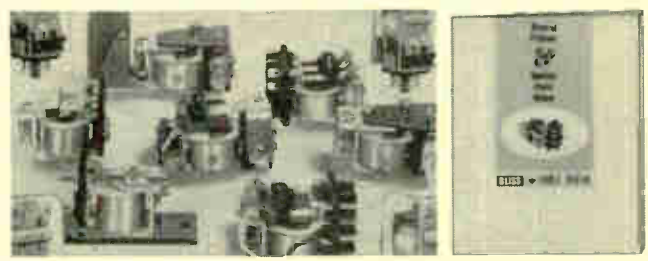
New Eagle relays...more than 3,000 types...are the best you can get anywhere. Be crafty. Check the specs and the product. Convince yourself.

One example: Gold-plated contacts are *standard* on every general purpose Eagle relay. And on medium power relays, silver cadmium oxide contacts are standard, since they deliver the best possible current-bearing characteristics in this power range.

Check some more. Note the sturdy designs...the ratings that exceed all other competitively-priced units...the precise engineering and inventive use of materials. They're all what you'd expect from Eagle—leaders in time/count control devices.

If you've ever dealt with Eagle you'll expect more, and you'll get it. We're talking about unequalled service...service that frankly has never before been available from any relay manufacturer.

Compare. You'll choose Eagle.



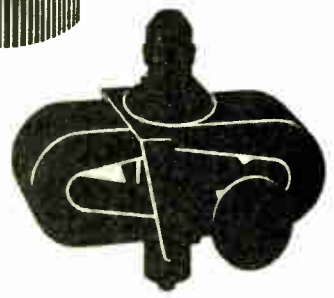
Part of the "big" picture...more than 3,000 types: plug-in with dust covers; dual latching; hermetically sealed; custom-engineered styles.

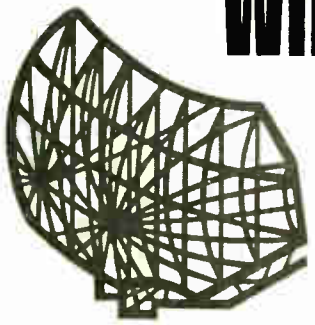
Get full details in our new, 16-page color catalog. Send for your free copy to Eagle Signal Division, E. W. Bliss Company, Federal Street, Davenport, Iowa.

BLISS **EAGLE SIGNAL**
A DIVISION OF THE E. W. BLISS COMPANY

Electro-Mechanical, Electronic, Solid State Timing/Counting/Programming Controls ☐ General Purpose, Medium Power Relays

NEED HIGH POWER at WIDE BANDWIDTHS?





TELONIC PD SWEEP GENERATORS DELIVER 4 WATTS OF SWEPT RF

...for frequency testing of networks, filters, transmission lines, varactors, klystrons, and other systems at high power levels.

Telonic's PD Series of sweep generators supplies maximum versatility for testing, aligning, and adjusting operations. First – they may be used in 4 modes, swept RF, modulated swept RF, CW, and modulated CW, and secondly – they supply as much as 4 watts of output, providing power levels at which the unit under test will actually be functioning.

Considering all this versatility and their ability to provide *more test data in less time*, the PD Sweep Generators become necessary instrumentation in any application using tedious, single-point, signal generator techniques.

SPECIFICATIONS	PD-2	PD-3	PD-7	PD-8
CENTER FREQUENCY	20-100 MHz	100-250 MHz	200-375 MHz	375-1000 MHz
SWEEP WIDTH	0.2-15%	0.2-15%	0.2-10%	0.2-15%
SWEPT RANGE	18-105 MHz	90-260 MHz	190-385 MHz	330-1010 MHz
SWEEP FUNCTION Attenuator out Attenuator in	14 v RMS into 50 ohms (4 watts) 10 v RMS into 50 ohms (2 watts)			
CW FUNCTION Attenuator out Attenuator in	2 watts into 50 ohms 1 watt into 50 ohms			
PRICE	$2750			

Complete specifications on the PD Sweep Generators and all Telonic swept frequency instrumentation is available in General Catalog 64-A-1. Yours on request.

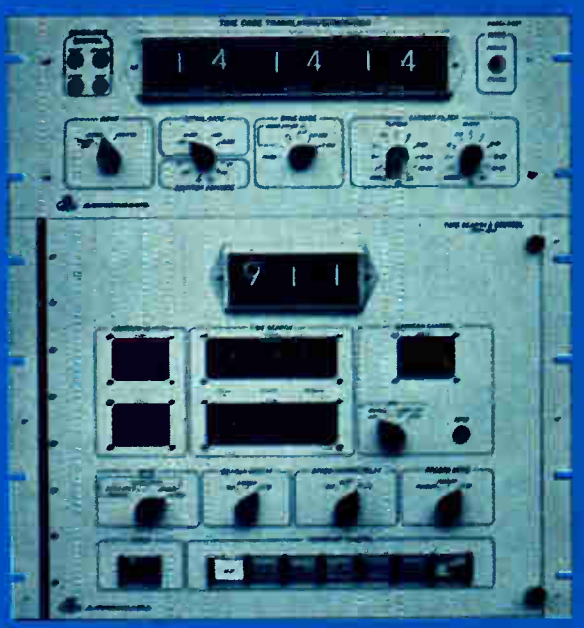
Telonic® INDUSTRIES, INC.

60 NORTH FIRST AVE., BEECH GROVE, INDIANA
TEL.: (317) 787-3231 TWX: 810-341-3202

World Leader in Swept Frequency Instrumentation.

Representatives in all major cities in the U.S. and Overseas.

Here's how to cut the time and cost of data reduction



by 50 percent

Faster set-up, more automatic control, immediate feedback of test results. Wherever data is gathered and searched on magnetic tape, the Model 5600 Tape Search System can provide these advantages. First, because it combines Time Code generation and translation of time/ID information into one compact, programmable unit.

MULTIPLE OPERATIONS

You have complete control over the RECORD, SEARCH, and PLAYBACK of magnetic tape transports. In RECORD, the unit provides both automatic and manual control; and generates serial time codes for mag tape transports and oscillographs. In SEARCH and PLAYBACK, the 5600 translates and uses previously recorded time/ID data as a reference in programming the tape transport. This means you can check back over your test results immediately, providing unusual flexibility in planning or re-designing experimentation, and rapid correlation of data.

MULTIPLE ECONOMIES

The Model 5600 allows numerous economies lacking in conventional tape search procedures, particularly in applications with numerous, repetitive data runs. In bio-medical applications, for example, separate generation and translation systems usually mean high equipment costs, laborious set-up, and delays in interpretation of up to one day or more.

IRIG "B" TIME CODE: Model 5600 generates and translates IRIG Format B time codes, modified to include BCD seconds, minutes and hours, and the 3-digit identification code.

SELECTABLE ASTRODATA "A" TIME CODES: Four speeds are available for output to oscillographs. Rates range from a time frame of 1 second to 10 min.

FOUR MODES OF SEARCH: Searching may be accomplished by RECYCLE, SINGLE CYCLE, SEARCH/STOP, MANUAL SEARCH. The search select may be set to TIME, ID ADDRESS, or combined TIME-ID ADDRESS.

WIDE ANGLE SUPER NIXIE DISPLAYS: Accumulated time-of-day or elapsed time in hours, minutes and seconds, along with ID data programmed into the time code, appears on the front panel with polarized filters for maximum visibility. Up to three remote displays can be connected.

CARRIER FILTERS: Ten band-pass filters are selectable from two front-panel rotary switches. One switch selects the proper filter for tape playback speed; the other selects the proper filter for search speeds. Extra switch positions permit by-passing a filter or inserting external filter via connector.

SYNCHRONIZATION MODE (ERROR BY-PASS): This enables operator selection of by-passing 0, 1, 2, 3, or consecutive time words decoded erroneously without reflecting these errors in the output register.

SINGLE-CYCLE NOISE REJECTION: Noise or dropout of a single cycle or less occuring on the input will not affect the decoding process.

For complete technical information, contact your nearest Astrodata representative or write direct on your company letterhead.

ASTRODATA

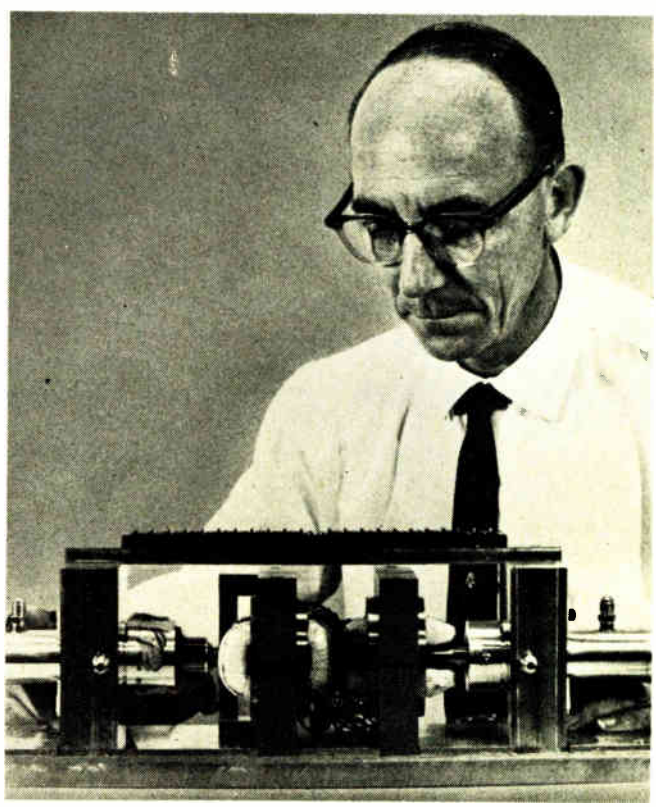
P. O. Box 3003 ■ 240 E. Palais Road, Anaheim, California ■ 92803

SILICON NITRIDE is being used as an insulating material for better yield of more electrically stable diodes, transistors and integrated circuits. Sperry Rand Corp., Sudbury, Mass., scientists have been doing experimental work in its use. Instead of growing the normal insulating oxide layer on the silicon wafer, they use a deposition process for the nitride. The silicon nitride can be applied ten times faster than silicon oxide can be grown. And it can be done at much lower temperatures. Thickness can be accurately controlled. Trial metal nitride semiconductors (MNS) insulated-gate FETs have been made and tested by Sperry Rand.

THIN FILM HYBRID MICROCIRCUITS are produced with "flip channel" transistor methods. This permits high volume output. Simplified manufacturing methods result in lower circuit modular costs. Mepco, Inc., Morristown, N.J., says that they can supply circuits a customer needs, including planar type or special transistor elements. In making the circuits, they use a heating unit that automatically makes all terminal attachments at one time.

TRANSMISSION SYSTEM sends 625 line TV signals by PCM. The experimental, all-solid-state system was developed by a British subsidiary of ITT, Standard Telecommunication Labs., Harlow, England. Other systems often used electron beam coding tubes. This system uses only discrete solid-state components. System samples signal at 12.5 MHz and uses parallel encoder to generate an 8-digit unit-distance code, providing 81 quantization levels. Only one level is used for TV synchronizing pulse. The encoder is linear, and divided into 14 identical subunits. Each of these discriminates a group of 6 adjacent levels. Outputs are interconnected to produce the appropriate codes.

LONGER LIFE high-power klystrons and TWT's appear possible because of a new long-life "coated powder" cathode invented at Bell Telephone Labs. The usual carbonate powder is chemically coated with a thin film of nickel before being sprayed onto the cathode base. The nickel increases conductivity of the cathode, and improves its ability to sustain high current densities. Life expectancy is 20 to 30,000 hrs. at 0.5 a/cm² and 810°C, and is predic-



▲ **BROADBAND SPECTROMETER**

Dr. G. Peterson uses new spectrometer he invented at Bell Telephone Labs. Device detects resonance signals from nuclei that are quadrupolar (nonspherical) in their electrical make-up. New nuclear quadrupole resonance (NQR) spectrometer is very sensitive over a band of frequencies greater than that of previous devices.

ably the same at 1 a/cm². Cost is close to normal oxide cathodes and much less than for the matrix cathode. Greater coating adhesion, higher electrical conductivity, and faster processing are among its features.

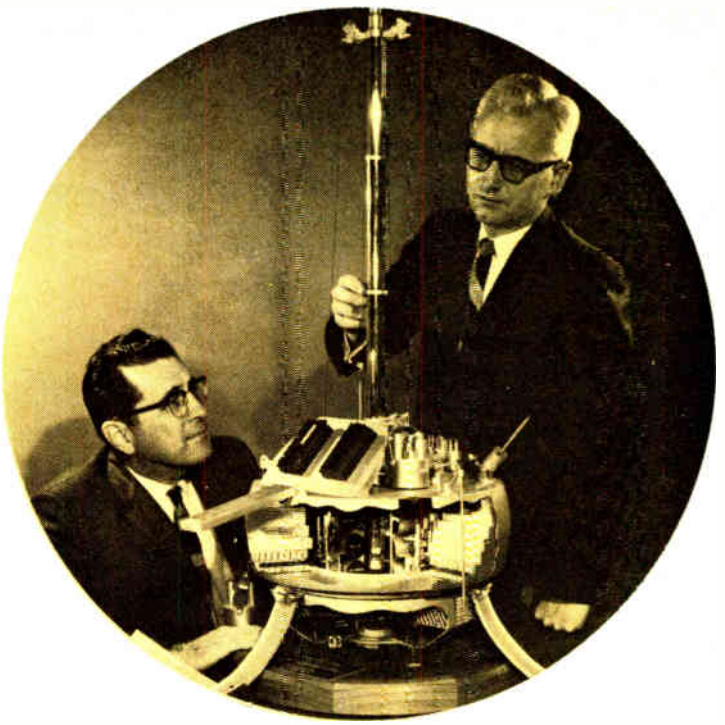
EXPERIMENTS WITH "HOT ELECTRONS" being carried out at NASA's Electronic Research Center, Cambridge, Mass., indicate a promising advance in microwave research. Higher frequency microwaves have been generated by means of a recently discovered phenomenon. The microwaves are produced by interaction of "hot electrons" in solid state component material. In the method a low voltage is applied across a crystal (bulk GaAs semi-conductor material) which is less than 1/1000-in. thick. A conversion of dc to continuous microwave power was achieved at frequencies as high as 12 GHz.

NEW AUTOMATIC DEVICE for quantitative and qualitative X-ray analysis of solids and liquids was announced by Toshiba of Japan. The unit completes calculations more than twice as fast as normal equipment. According to the material to be analyzed, the proper crystal spectrum, opening, and illumination angle can all be preset on a memory device. When the test material is in position the unit is started by a pushbutton and the results are automatically produced on a recorder. It can be used to improve research, and quality control.

HIGH-POWER SCRs have been developed by the Electronic Components Div. of General Electric Co., Schenectady, N. Y. The ac switch can handle 1200 a. RMS continuous current with blocking to 1800 v. This permits switching of 1.5 Mw loads. High-power is due to water cooling and a heat transfer method which dissipates heat on both sides of the SCR junction. Samples will be available in about 60 days.

◀ THREE-DIMENSIONAL MOTOR

Three-dimensional motor that can simultaneously rotate and push and pull a shaft is examined by its inventor, Stanley Cory, of ITT Federal Labs, San Fernando, Calif. Between one stroke and 32 strokes per revolution are possible. Most practicable size for such a motor appears to be in a range from 1/1000 hp to 5 hp.



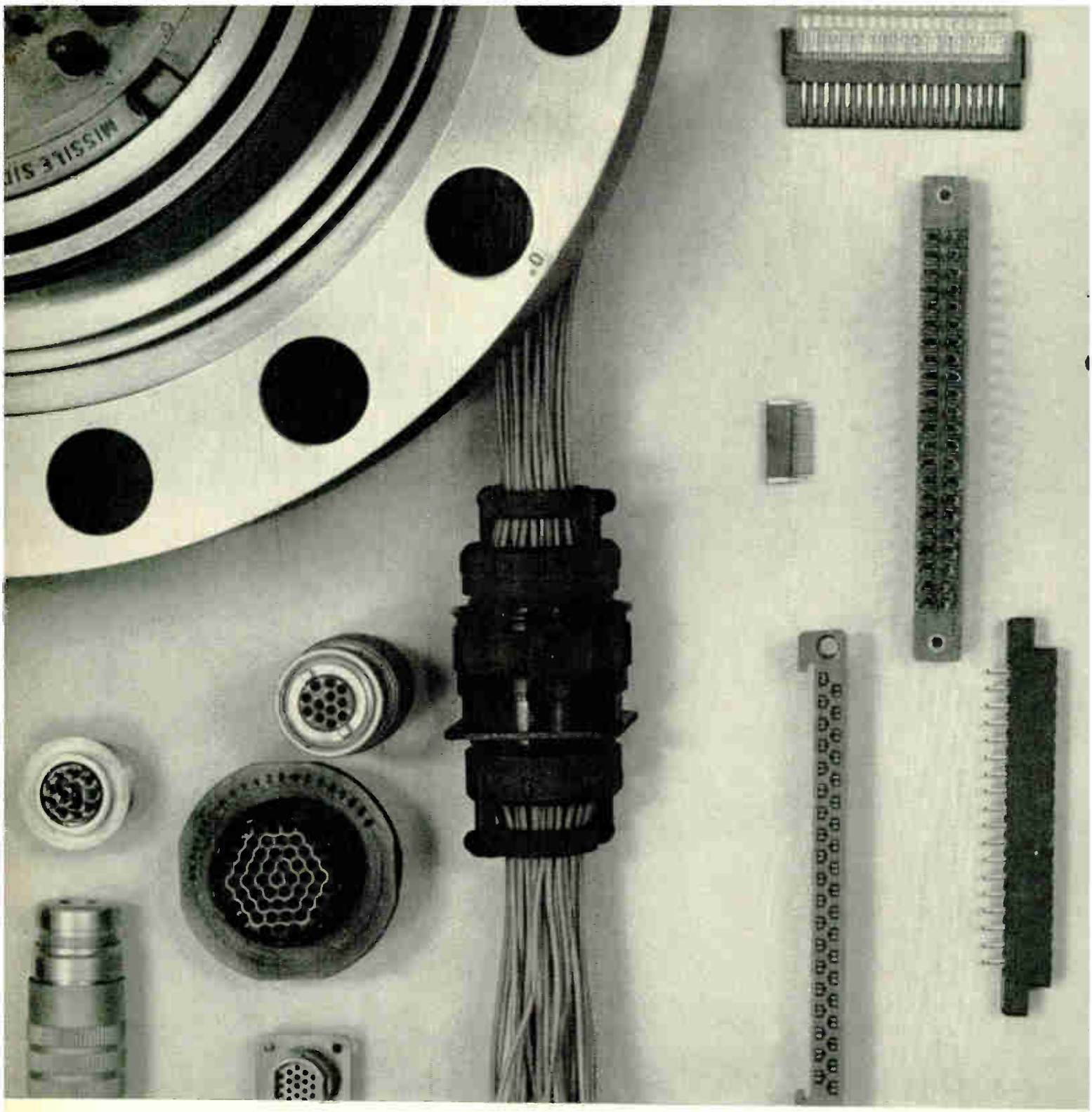
AUTOMATED BIOLOGICAL LABORATORY

Model (¼ size) of Automated Biological Laboratory (ABL) being designed by Philco's Aeronutronic Div., Newport Beach, Calif., under a NASA contract, is checked by executives C. Grant (l), and W. Hostetler. ABL will be a fully automated and miniaturized biology lab, capable of performing tests on the surface of Mars.

TV CAMERA using solid state and four plumbicon tubes is being made by Marconi Co., England. Except for a nuvistor in each of the four vision head amplifiers, and the pickup tubes, it is fully transistorized with thin film resistors. A major advantage is that color pictures are not so dependent on accurate registration of the three color tubes. Camera produces good black and white pictures. It can be switched to either 525 or 625 line standards, and can be used with the proposed systems—NTSC, PAL, or SECAM. The main market is aimed at the U. S. and Canada.

A NEW ULTRAVIOLET LASER has been developed by Avco-Everett Research Laboratory. The 50-kw, UV, pulsed gas laser is based on a 200-kw experimental lab model. The new laser uses commercial-grade nitrogen. It produces self-terminating pulses lasting 10-20 nsecs., with a variable rep rate of 1-10 pulses/sec. Output wavelength is 3371 Å; output bandwidth is less than 1 Å. Since the pulse is self-terminating, Q switches are not needed. The high power amplification of this laser transition allows it to operate without a resonator and with only one pre-aligned mirror.

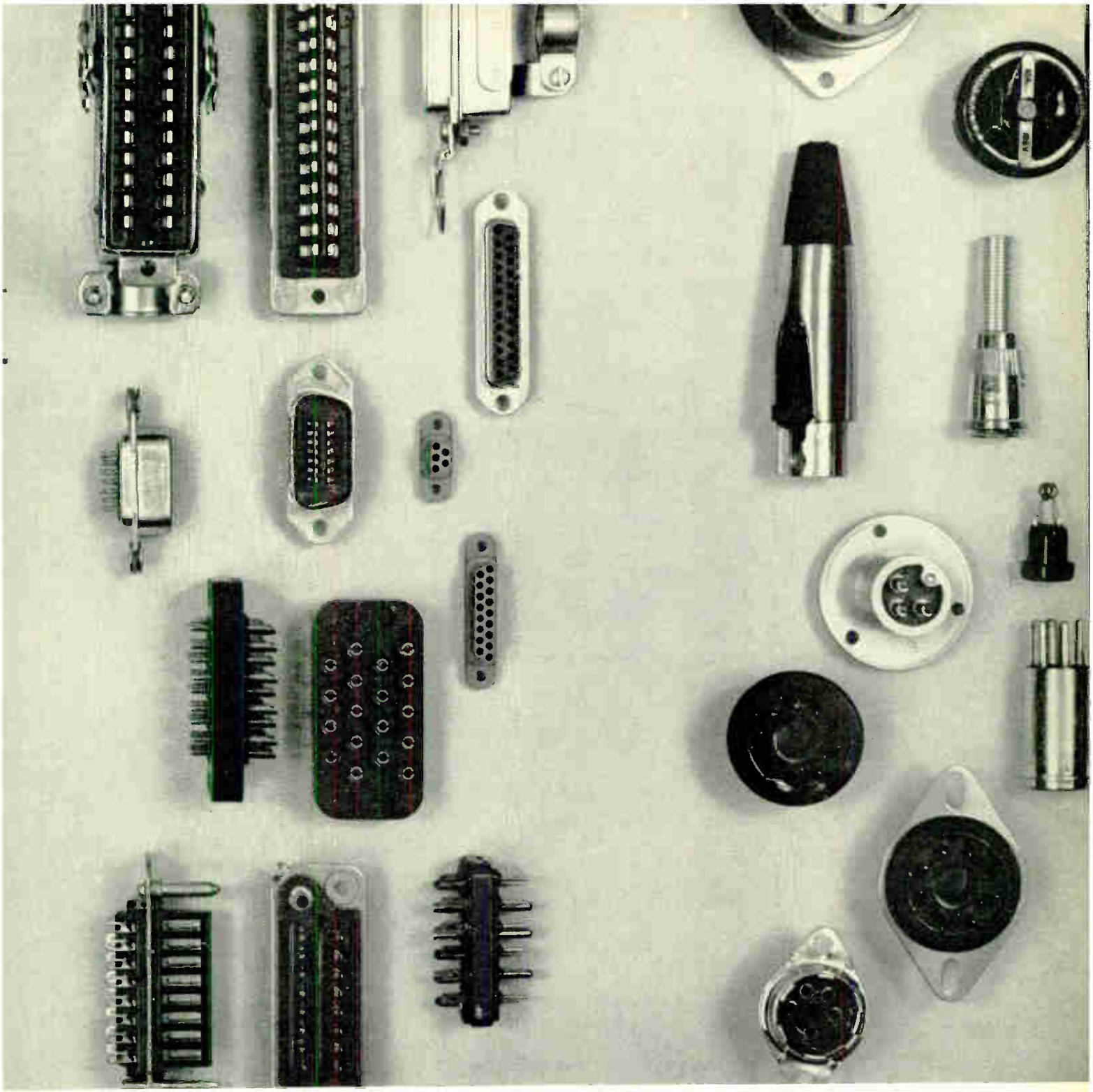
OPTICAL SUPERHETERODYNE RECEIVER has been built by Sylvania Electric, Waltham, Mass. It will be used to evaluate laser beams in space-ground communications. Built for NASA, it can extract incoming laser signals with accuracy needed for coherent communications.



Here are just 36 of the 36,000 Amphenol connectors

Why so many? Because interconnection jobs have become so diverse and complex. On a Polaris, you may need a big aft umbilical connector that withstands 5000°F for 2½ minutes. But if you're miniaturizing a strip chart recorder, you can pack 50 contacts into a 1" connector. What else?

MILITARY CONNECTORS. (Far left) We make all the standard AN/MS and other Mil-spec types, including



MIL-C-26500 and MIL-C-38300 circular environmental connectors. (Incidentally, we have a Space and Missile Systems facility just for specials.)

PRINTED CIRCUIT CONNECTORS. (Middle left) There are actually thousands. Everything from the microminiature 64 Series to the bellows-contact type 225 Series to the new Amphenol Flex-1 connector that welds directly to unstripped flat cable.

RACK AND PANEL CONNECTORS. (Middle right) There's the Min-Rac 17, with its extremely uniform body contacts. For the ultimate in mating reliability, consider our new Series 217. It is 99.99% reliable with three positive seals: around the contacts, at the rim, and at the lip. Or for easy blind mating, choose the Amphenol Blue Ribbon connector with sturdy, wedgelike contacts.

COMMERCIAL PLUGS AND SOCKETS. (Far right) Pick from a long list of tube sockets, microphone plugs, cable jacks, tip jacks, heavy duty industrial sockets—all you'll ever need.

Delivery? The fastest in the business. Ask your nearest distributor or Amphenol Sales Engineer. (Or write to us.) *Amphenol Connector Division, 1830 South 54th Avenue, Chicago 50, Illinois.*

AMPHENOL CONNECTOR DIVISION
AMPHENOL CORPORATION

Specify Amphenol . . . the leading name in cable, connectors, assemblies, RF switches, potentiometers, motors, microelectronics

Circle 6 on Inquiry Card

COMING EVENTS

February 1966

Feb. 9-11: Int'l Solid-State Conf., U. of Pa., IEEE; Univ. of Pa., Sheraton Hotel, Phila., Pa.

March

Mar. 2-4: Scintillation & Semiconductor Counter Symp., IEEE; Shoreham Hotel, Washington, D.C.

Mar. 21-24: IEEE Int'l Conv., IEEE; Coliseum & New York Hilton Hotel, New York, N.Y.

Mar. 26: Quality Control and Reliability Conf., American Society for Quality Control; Hofstra Univ., Hempstead, L.I., N.Y.

'66 Highlights

IEEE Int'l Conv., Mar. 21-24; Coliseum, New York, N.Y.

WESCON Western Electronics Show & Conv., Aug. 23-26, WEMA, IEEE; Sports Arena, Los Angeles, Calif.

Nat'l Electronics Conf., Oct. 3-5, IEEE; McCormick Place, Chicago, Ill.

April

Apr. 4-5: Rubber & Plastics Industries Tech. Conf., IEEE; Sheraton-Mayflower Hotel, Akron, Ohio.

Apr. 12-14: Int'l Symposium on Generalized Networks, IEEE, OSA, Brooklyn Polytech, et al; Hotel Commodore, New York, N.Y.

Apr. 12-15: 4th Quantum Elect. Conf., IEEE; Towne House, Phoenix, Ariz.

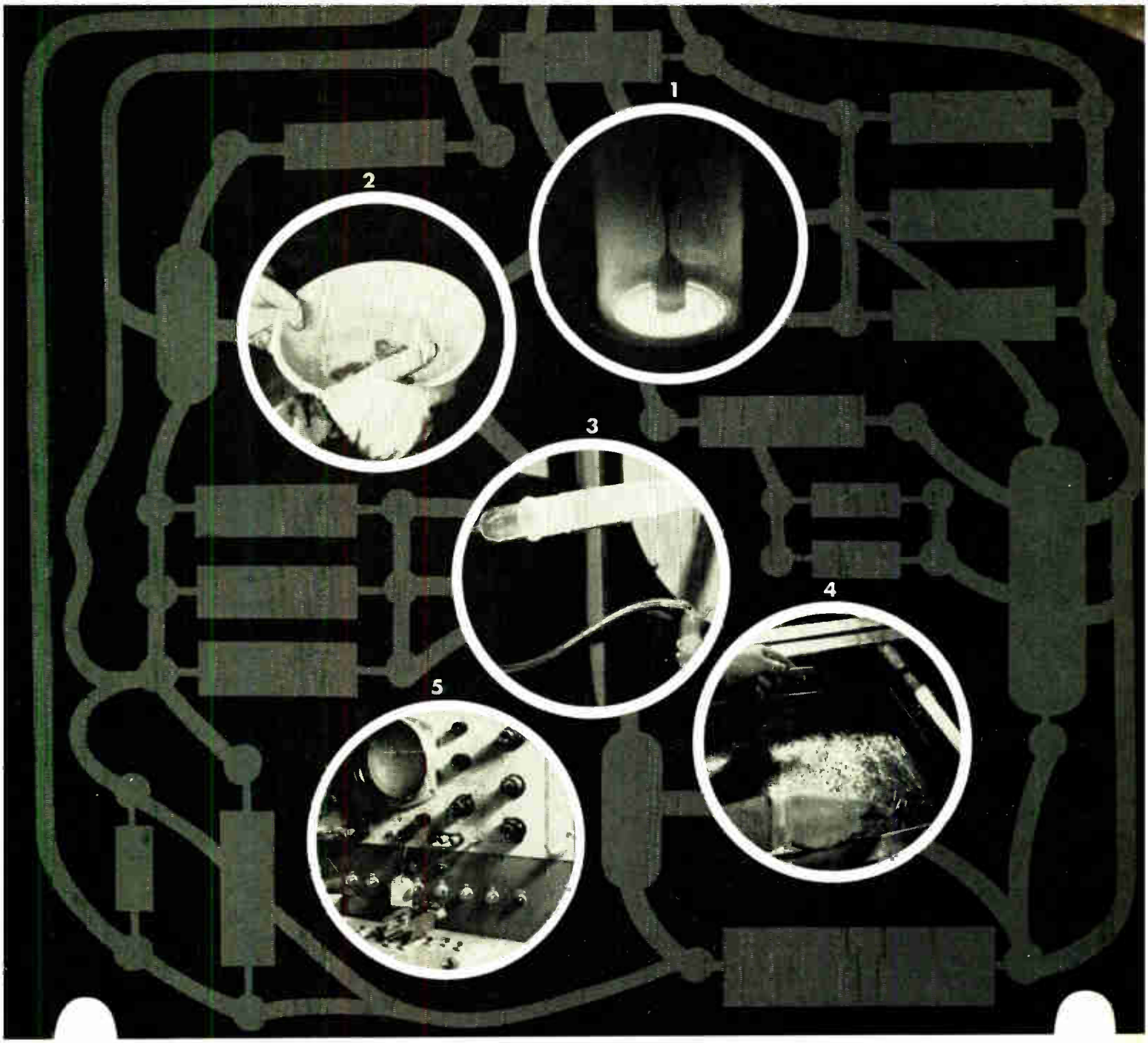
(Continued on Page 16)

ELECTRONICS CONFERENCE RETURNS TO CLEVELAND

The annual Cleveland Electronics Conference returns to the Cleveland Engineering & Scientific Center in 1966, after an absence of three years.

The date for the 13th annual Conference has been set for April 12-14. Five technical seminars are again planned as in the two previous conferences. Conference Director Mike Lapine, of Mike Lapine, Inc., reports that 65 exhibit spaces are available. Exhibit show hours will be from 1 to 9:30 P.M. daily, except for a 6:30 P.M. closing on Thursday, April 14th.

Technical sessions will be staged in the Lecture Room at 2 and 7 P.M. on Tuesday and Wednesday and at 2 P.M. on Thursday. Chairman of the Technical Committee is Robert Stroup of Reliance Electric & Engineering Co.



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For more information on Silicon Crystals circle No. 11, on Etchants circle No. 12, on Dopants circle No. 13, on Solvents circle No. 14.

Circle 8 on Inquiry Card

COMING EVENTS

(Continued from page 14)

Apr. 18-21: Spring URSI-IEEE Mtg., URSI, IEEE; Nat'l Academy of Sciences, Washington, D.C.

Apr. 19-21: 20th Annual Frequency Control Symp., U.S. Army Electronics Command; Shelburne Hotel, Atlantic City, N.J.

Apr. 20-22: Southwestern Conf. & Exhibition, IEEE; Memorial Audit., Dallas, Tex.

Apr. 26-27: 14th Annual Nat'l Relay Conf., Oklahoma State U., Nat'l Assn. Relay Mfrs.; Student Union Bldg., Stillwater, Okla.

Apr. 26-28: Spring Joint Computer Conf., IEEE, AFIPS, ACM; Boston Civic Ctr., Boston, Mass.

Apr. 26-28: Future Eng'g for Earth & Space Conf., IEEE; Pioneer Int'l Hotel, Tucson, Ariz.

May

May 2-4: Communications Satellite Systems Conf., AIAA, IEEE; Washington, D. C.

May 4-6: 1966 Electronic Components Conf., IEEE, G-PMP, EIA; Marriott Motor Hotel, Washington, D.C.

May 5-7: 7th Symp. on Human Factors in Electronics, IEEE, G-HFE; Minneapolis, Minn.

May 9-10: Midwest Symp. on Circuit Theory, IEEE, Oklahoma State U.; Oklahoma State U., Stillwater, Okla.

May 10-12: Nat'l Telemetering Conf., IEEE, G-AES, G-Com Tech., AIAA-ISA; Prudential Ctr., Boston, Mass.

NEW FIRM CATEGORY ADDED TO 1966 ELECTRONICS WEEK

A new category of electronic manufacturers will be eligible to display wares at NEW—1966 National Electronics Week, May 30 to June 5, 1966, according to Kenneth C. Prince, general manager of Electronic Industry Show Corp.

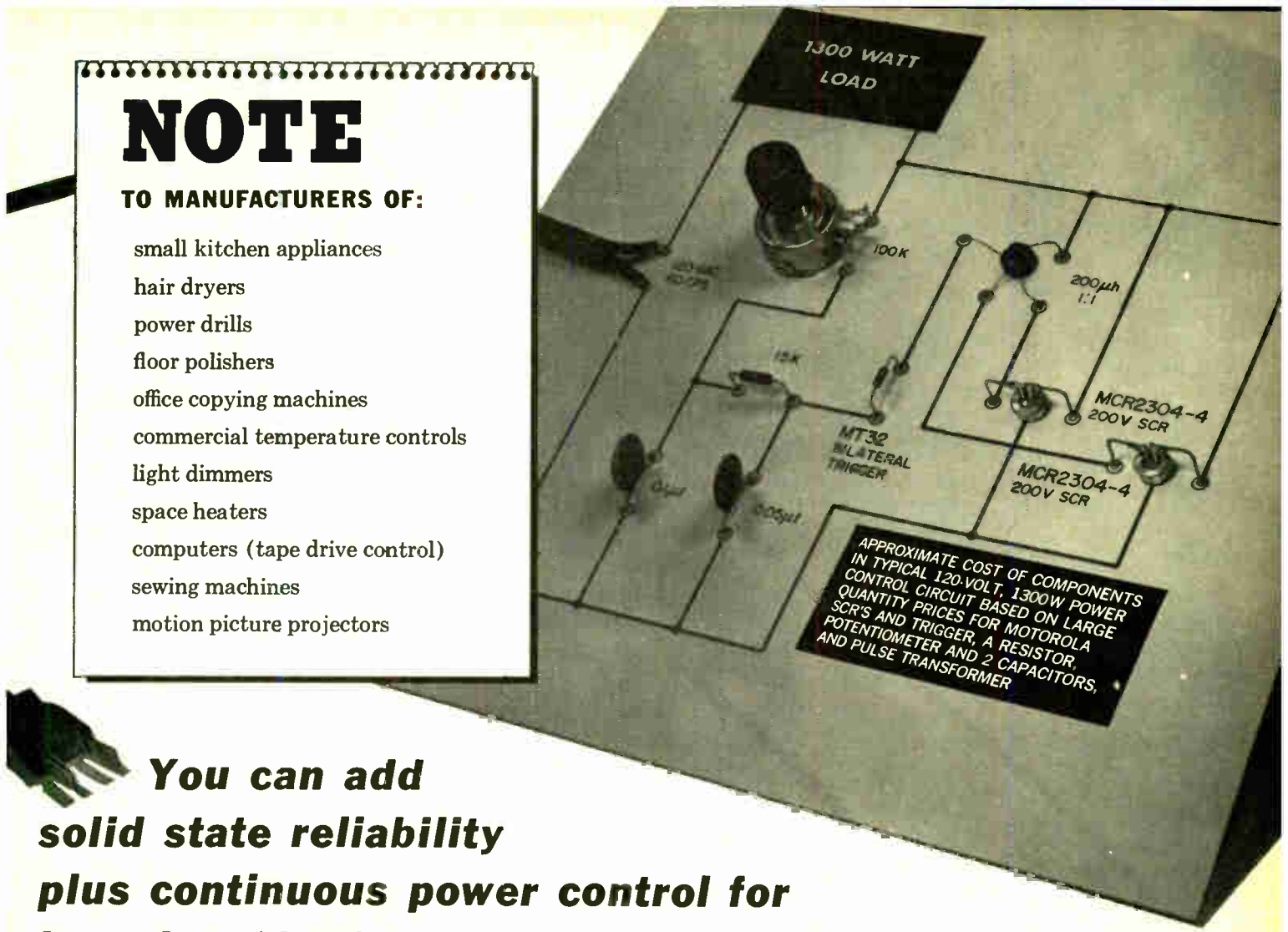
The San Francisco NEW will mark the first time that manufacturers who sell products, equipment, or services to distributors for use of consumption will be eligible to participate. In the past, exhibits were limited to products sold through distributors, sound contractors, high fidelity specialists, and similar trade categories.

Companies that manufacture electronic data processing equipment, office equipment and copying machines, automation devices, and similar products, or who sell services and systems, are expected to take advantage of this important market place, now open to them for the first time.

NOTE

TO MANUFACTURERS OF:

small kitchen appliances
hair dryers
power drills
floor polishers
office copying machines
commercial temperature controls
light dimmers
space heaters
computers (tape drive control)
sewing machines
motion picture projectors



You can add solid state reliability plus continuous power control for less than $2.50 in total component cost...

Continuing development of the Elf® thyristor – Motorola's popular low-cost 8-ampere SCR – has opened up unlimited areas for stepless control of 120- and 240-volt operated electrical equipment. Now the Elf truly satisfies the current and power requirements of virtually every product using continuous control of motor speed, heat or light... retains all the safety features essential to reliable SCR circuit operation in these products... yet costs little more than non-hermetically-sealed devices having only a fraction of its current-handling capability.

Without waste, wear and repair...

common to expensive electro-mechanical switches and controls, the midget-sized "Elf" SCR's give you these design advantages:

- high power handling capability at elevated temperatures – 5 amperes (AV) at 75°C, case
- minimum power loss – low 1.3-volt forward voltage drop (max.) @ 5A @ $T_J = 25°C$
- mounting versatility – 12 different hermetic cases (plus reverse polarity)
- immunity from false triggering due to noise – a realistic 10mA (typ.) gate firing level
- current surge protection – 100 amperes for 1 cycle, 60 cps, minimizes chances for damage from transients

Get symmetrical firing characteristics...

with the MT32, bilateral trigger – a versatile companion in value that replaces neon lamps, unijunction transistors, and other thyristor triggering devices requiring complex circuitry.

Investigate these products NOW...

Call your Motorola distributor for off-the-shelf engineering units... And for ideas that can help accelerate your thinking about electrical control designs, write for our set of "applications unlimited" thyristor circuits and device data sheets.

MOTOROLA *Semiconductor Products Inc.*

P.O. BOX 955, PHOENIX, ARIZONA 85001

WASHINGTON TRENDS

COST-CUTTING EXPLAINED—Need to know more concerning cost-cutting on defense contracts? Department of Defense is sponsoring five regional briefings on cutting of costs: Boston, March 3, 4; Atlanta, March 9, 10; St. Louis, March 16, 17; San Francisco, April 12, 13, and Washington, April 27, 28. DOD promises to present 350 specific examples of contractor efficiencies that resulted in lower costs to the government.

NEW DESCRIPTOR VOCABULARY—Department of Defense is compiling a broader vocabulary of descriptors for computer usage. Purpose: to increase effectiveness and use by industry of the rapidly-expanding deluge of technical information. The new technical thesaurus is being compiled under the direction of John S. Foster, Jr., defense research and engineering chief.

UNLIMITED COMSAT USE ASKED—Industry spokesmen have asked FCC to permit all manufacturers to use private satellites without limitation. FCC also is asked to clear the way for private firms to launch their own satellite systems if needed. Industry urges that FCC encourage use of space communications by U. S. and foreign industries. They also warned that undue limits would hinder advance of communication needs.

VISUAL SPACE BEACON

Ionized argon gas laser to be used as a visual beacon from earth to orbiting Gemini craft under test at Electro-Optical Systems, Inc. The unit broadcasts at varied wavelengths in the visible blue-green spectrum. In space operation, rotating disk chops the laser's wave.

STANDARDIZATION PUSHED—Defense officials are pressing electronic and aerospace industries to step up progress in standardization of microelectronic circuits. The Pentagon's interest stems from the drive originated by Sec. McNamara to bring about lower costs via standardization of components. In Pentagon talks, industry men have pointed out the obvious need for a free exchange of ideas between systems designers and components fabricators. Outlook is for increasing pressure from military men to bring about further standardization in this area.

SPACE BUDGET CUTS LIKELY—High cost of the Vietnam war is causing budget officials to take a second look at some projected space programs, unless a peace is effected. Some cuts have already been ordered. Research projects are likely to be hard hit. NASA is asking $5.5 billion for the fiscal year ending June 30, 1967, as compared with about $5.1 for the 1966 fiscal. Budget Bureau is recommending that NASA hold spending down to the current level. It's always possible, of course, that Congress will override White House recommendations.

PATENT RULES CHALLENGED—NASA soon will be under more heavy pressure from Congress to change its patent policy. NASA Administrator James E. Webb is faced with a patent case involving rocket engine development by an aerospace company. If Webb rules in favor of the company, as expected, he will incur the wrath of some congressmen. These congressmen have been criticizing NASA's patent policy for years. This year they plan to settle the question once and for all. Expected is a government patent policy for all federally-financed inventions.

NEW STANDARDS SYSTEM SET—The Johnson Administration has revised procedures for developing voluntary product standards in industry. As adopted by the Commerce Department, all standards more than five years old will be reviewed for adequacy. J. Herbert Hollomon, Assistant Secretary of Commerce for Science and Technology, says the new rules will set requirements for general acceptance of new standards, and provide safeguards to protect public interest. A standard will be revised if any portion of it is obsolete, technically inadequate, or no longer acceptable to or used by an industry. It will also be revised if any part is being used to mislead consumers, or is against their best interests. Also, a standard being used to limit production, set prices, create economic advantages for one segment of an industry, or constitute unreasonable restraint of trade or create illegal dominance will be revised.

A REED RELAY ENGINEERING DESIGN KIT

15 pages of clearly written and illustrated information and a complete selection of parts to bread-board prototypes of, for instance:

ELECTROMAGNETIC RELAYS
Std. and min. size SPST—NO
Multiple contact relay: SPST, DPST, 3PST—NO and NC
Electrical latching relay
Magnetic latching relay SPST—NO
Permanent magnet biased relay SPST—NC

COMPUTER LOGIC ELEMENTS
AND, OR, and EXOR circuits
Single mode matrix element
Crosspoint memory matrix element

PROXIMITY TRANSDUCERS
For biasing, rotation, switching, shielding, and proximity switching

THE PARTS include 9 std. and 6 min. switches in 3 sensitivity ranges . . . std. and min. test coils . . . logic coil, 4 magnets.

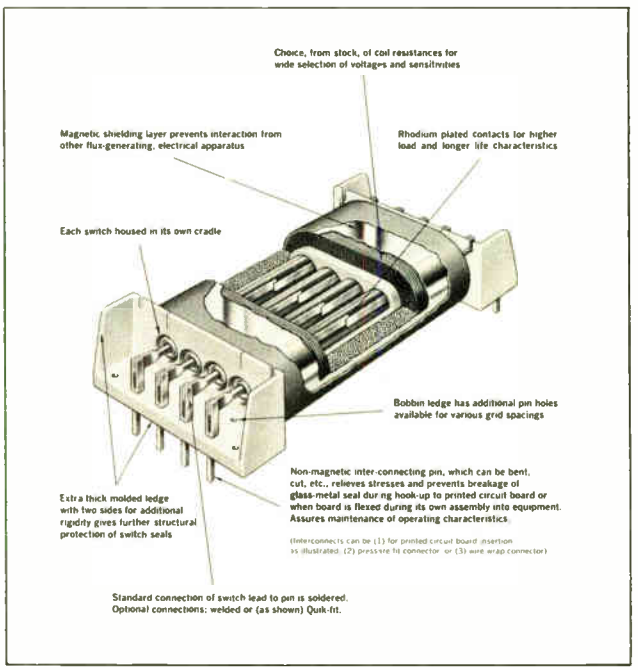
THE PRINTED MATTER also covers operation and application considerations that suggest when NOT to use reed switches or reed relays!

THE WHOLE KIT costs $10 and is available from stock. Please order Part No. 67-001.

FROM THE COMPANY THAT MAKES THEM LIKE THIS

With the kit, you automatically receive complete specifications of NPE's standard and special reed switches and reed relays. ■ If you want only product literature, without the kit and without charge, write for:

NPE Reed Switch Specifications Bulletin
and/or
NPE Reed Relay Specifications Bulletin
and/or
An Introduction to Reed Device Applications



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NEW PRODUCT ENGINEERING, INC.
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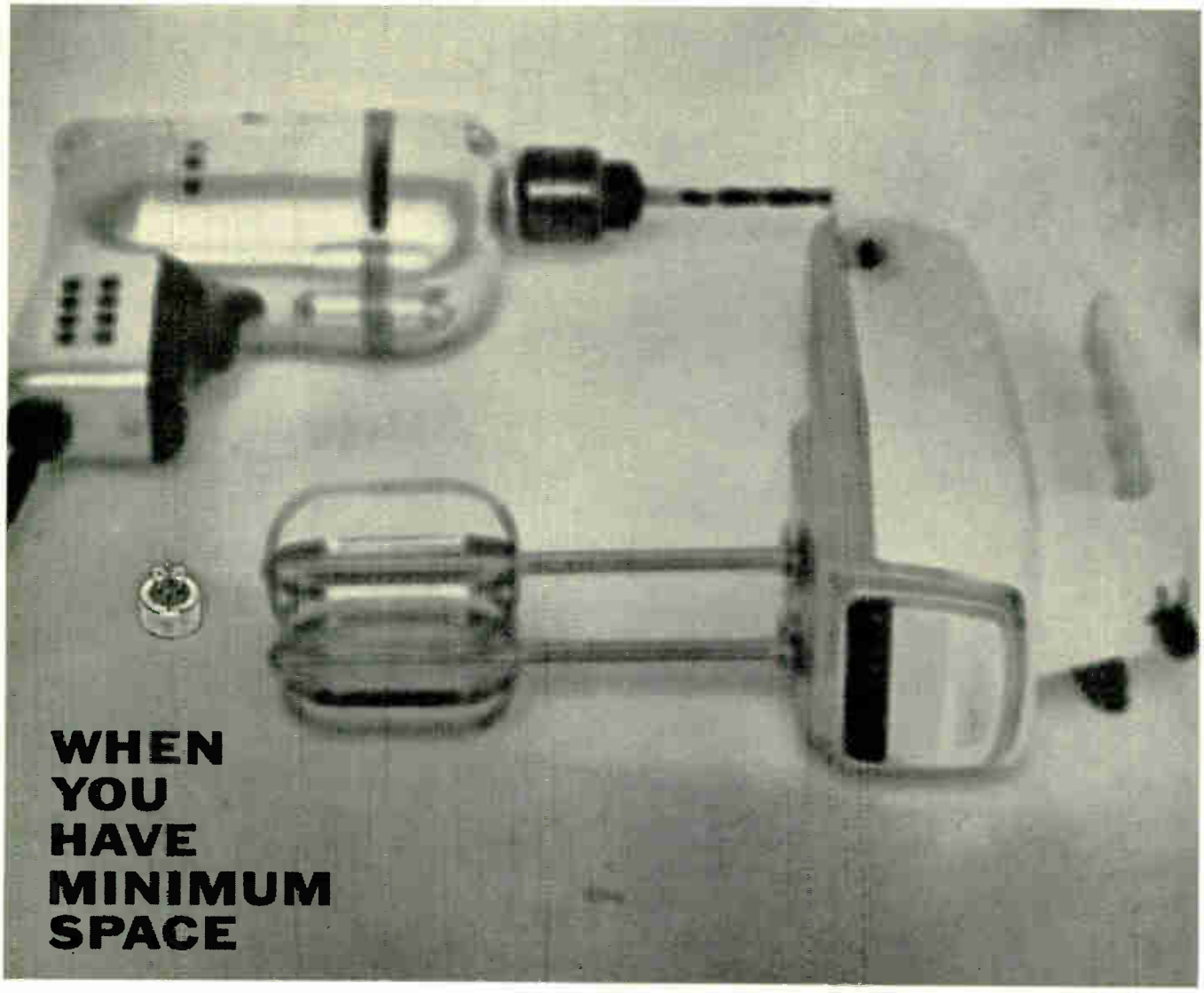

and need maximum power-

IBR®

SILICON AVALANCHE INTEGRATED BRIDGE RECTIFIERS

When your design must deliver maximum performance, and you have tight space requirements, Varo's IBR® devices can be a low-cost solution to your rectifier problems.

The IBR® is a **full-wave bridge in one small package** with SAR® (silicon avalanche) characteristics to control transient overvoltages. All devices feature 2000 V minimum circuit-to-case insulation. They are available with 3 versatile mounting methods: press-fit; single-stud; and TO-3 mounts.

For full-wave bridge applications: the 1N4436 (250 V min BV_R), 1N4437 (450 V min BV_R), and 1N4438 (650 V min BV_R). Output current is 10 amps at 100°C (T_C). Three-phase, half, and full-wave rectifiers, full wave center tap rectifiers, and voltage doublers are also available in the IBR® line.

Write today for complete information and a better solution to all your rectification problems.

VARO INC

SPECIAL PRODUCTS DIVISION 2201 WALNUT ST., GARLAND, TEXAS 75041, (AREA CODE 214) 276-6141 TWX 214-276-8577

It seems like only yesterday

that phase-lock frequency control was so new that it was a status symbol to have a "phase-lock-box" in your lab. Crude and tricky as those early designs were, they gave you more-or-less **tunable crystal stabilization** of just about any UHF/SHF oscillator...and they made wonderful "conversation pieces", too. Nowadays, ordinary phase-lock is old-hat—to be "one-up", you must own a POLARAD Model 3815—the "Rolls-Royce" of **Continuously Tunable Phase-Lock Frequency Controls.** Then you can "spec-drop" with confidence, for the Model 3815 has **at least an order of magnitude higher stability and resolution** than any other design; and it will **stabilize a wider range** of signal generators, signal sources, oscillators, klystrons, BWO's and receivers, too—not only all 27 POLARAD **Instrumentation Modules,** from 950MC to 12.4GC, but just about **anybody's stabilizable signal circuit.** Best of all, you can own this "Rolls" for about what you'd pay for that funny-shaped foreign compact. Call us for a free test drive—(212) EX 2-4500—and **move up** to a 3815.

Model 3815 Frequency Stabilizer

Continuously Tunable

HIGHEST STABILITY—Proportional oven, unique circuitry!

averaging time	stability
1 millisecond	1 part/10^9
100 milliseconds	4 parts/10^9
1 hour	1 part/10^8

HIGHEST RESOLUTION—Continuous tuning (no "spots") 0.95 to 12.4 GC, discrete coverage down to 500 MC. (Usable to 21 GC with Polarad Models 1709 and 1710.)

HIGHEST SENSITIVITY

L Band .....—30 dbm X Band .....—10 dbm

WIDEST RANGE OF STABILIZATION—Stabilizes reflex klystrons, voltage-tuned magnetrons (VTM) or backward wave oscillators (BWO) with either helix or cathode grounded. Isolation: ±3000 VDC to ground. Control output: 0-40 MA, ±15 V. Discriminator bandwidth: 6 MC. Modulation sensitivity: 0.12 to 8 MC/Volt.

POLARAD®

World Leader in Microwave Instrumentation

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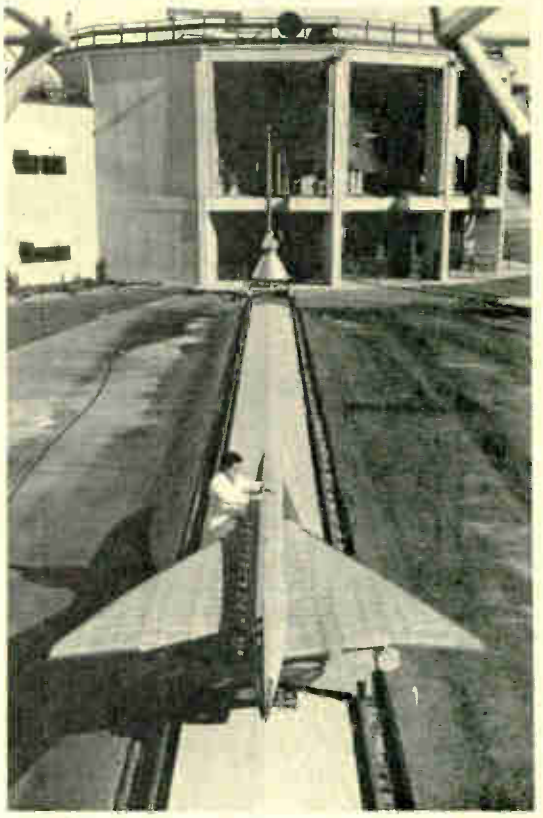
ELECTRONIC INSTRUMENTS
A Division of Polarad Electronics Corporation
34-02 QUEENS BOULEVARD
LONG ISLAND CITY, NEW YORK 11101

Circle 21 on Inquiry Card

▲ CLOSED CIRCUIT OFFICE MONITOR TV

Telephone operators at Bethlehem Steel Corp. use TV system produced by Sylvania Electric Products, Inc., to view sales areas not in line of sight. By looking at monitors, operators can determine if a salesman is available for incoming calls.

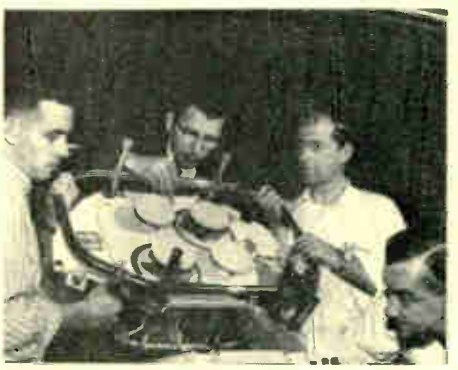


▲ EYES, EARS AND VOICE

—for delta wing supersonic transport of the 1970s, being tested at Lockheed-California Research Lab., which may relay communications from 70,000 feet-plus. SST model serves as conductor for hf. About 28 antennas for communications may be mounted on the SST.

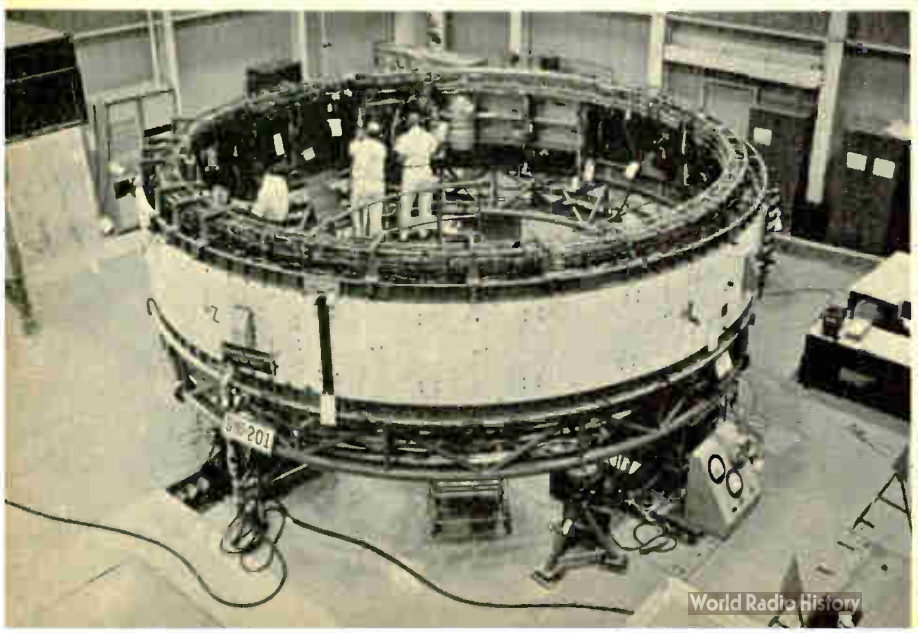
ELECTRONIC SNAPSHOTS

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



▲ BACK FROM SPACE

Gemini 6 radar which helped U. S. astronauts achieve man's first rendezvous in space is back at Westinghouse (Baltimore) for study. Engineers say the radar came through re-entry in good shape; they are making adjustments before giving the radar an electrical test.



◀ INSTRUMENTS FOR SATURN

Electronic instrument unit for first Saturn IB in test cycle at IBM Space Guidance Center, Huntsville, Ala. Technicians check inside of 22-foot section. The unit, command post for Saturn IB and V, issues commands for steering, stage separation, and ignition; it monitors performance. On Saturn V, unit will stabilize last propulsion stage of Apollo.

BOURNS TRIMPOT® POTENTIOMETERS

World's largest selection — longest record of reliability

Units shown approximately 3/5 actual size.

TRIMPOT® POTENTIOMETERS—UNSEALED

General-Purpose Wirewound Model 200. Max. temp. 105° C / L, S, P terminals / 0.50 watt at 70°C / 10 ohms to 100K.

General-Purpose RESISTON® Carbon Element Model 215. Max. temp. 125°C / L, S, P terminals / 0.25 watt at 50°C / 20K to 1 Meg.

High-Temperature Wirewound Model 260. Max. temp. 175°C / L, S, P terminals / 1.0 watt at 70°C / 10 ohms to 100K.

TRIMPOT POTENTIOMETERS—HUMIDITY PROOF

General-Purpose RESISTON Carbon Element Model 235. Max. temp. 135°C / L, S, P terminals / 0.25 watt at 50°C / 20K to 1 Meg.

General-Purpose Wirewound Model 236. Max. temp. 135°C / L, S, P terminals / 0.8 watt at 70°C / 10 ohms to 100K.

Micro-Miniature High-Temperature Wirewound Model 3000. Max. temp. 175°C / P terminals / 0.5 watt at 70°C / 50 ohms to 20K.

Micro-Miniature High-Temperature RESISTON Carbon Element Model 3001. Max. temp. 150°C / P terminals / 0.20 watt at 70°C / 20K to 1 Meg.

Sub-Miniature High-Temperature Wirewound Model 220. Max. temp. 175°C / L, W terminals / 1.0 watt at 70°C / 10 ohms to 30K / Mil-Spec style RT10 and meets MIL-R-27208A.

High-Temperature Wirewound Model 224. Max. temp. 175°C / L, S, P terminals / 1.0 watt at 70°C / 10 ohms to 100K / Mil-Spec style RT12 and meets MIL-R-27208A.

Ultra-Reliable High-Temperature Wirewound Model 224-500. Max. temp. 150°C / L, P terminals / 0.5 watt at 70°C / 100 ohms to 20K. Performance and reliability statistically verified to customer.

High-Temperature, High-Resistance RESISTON Carbon Element Model 3051. Max. temp. 150°C / L, S, P terminals / 0.25 watt at 50°C / 20K to 1 Meg / Mil-Spec style RJ11 and meets MIL-22097B.

High-Temperature High-Resistance PALIRIUM® Film Element Model 3052. Max. temp. 175°C / L, P terminals / 1.0 watt at 70°C / 20K to 1 Meg.

High-Temperature, Low-Resistance PALIRIUM Element Model 3053. Max. temp. 175°C / L, P terminals / 0.5 watt at 70°C / 2 ohms to 100 ohms.

High-Temperature Wirewound Model 3010. Max. temp. 175°C / L, P terminals / 1.0 watt at 70°C / 10 ohms to 100K / Mil-Spec style RT11 and meets MIL-R-27208A.

High-Temperature RESISTON Carbon Element Model 3011. Max. temp. 150°C / L, P terminals / 0.25 watt at 50°C / 20K to 1 Meg / Mil-Spec style RJ11 and meets MIL-R-22097B.

High-Temperature High-Resistance PALIRIUM Element Model 3012. Max. temp. 175°C / L, P terminals / 1.0 watt at 70°C / 20K to 1 Meg.

⅜"-Square Wirewound Model 3280. Max. temp. 175°C / L, P, W terminals / 1.0 watt at 70°C / 10 ohms to 50K.

⅜"-Square RESISTON Carbon Element Model 3281. Max. temp. 150°C / L, P, W terminals / 0.5 watt at 50°C / 20K to 1 Meg.

½"-Square, High-Temperature Wirewound Model 3250. Max. temp. 175°C / L, P, W terminals / 1.0 watt at 70°C / 10 ohms to 50K / Mil-Spec style RT22 and meets MIL-27208A.

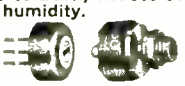
½"-Square High-Temperature RESISTON Carbon Element Model 3251. Max. temp. 150°C / L, P, W terminals / 0.50 watt at 50°C / 20K to 1 Meg / Mil-Spec style RJ22 and meets MIL-R-22097B.

BOURNS® SINGLE-TURN POTENTIOMETERS

3/16"-Diameter Micro-Miniature High-Temperature Humidity-Proof Wirewound Model 3300. Max. temp. 175°C / W, P, S terminals / 0.5 watt at 70°C / 10 ohms to 20K.

3/16"-Diameter Micro-Miniature High-Temperature Humidity-Proof RESISTON Carbon Element Model 3301. Max. temp. 150°C / W, P, S terminals / 0.25 watt at 70°C / 10K to 1 Meg.

Sub-Miniature Wirewound Model 3367. Max. temp. 105°C / P, S terminals / 0.5 watt at 70°C / 10 ohms to 20K / meets steady-state humidity.



Sub-Miniature RESISTON Carbon Element Model 3368. Max. temp. 105°C / P, S terminals / 0.25 watt at 50°C / 20K to 1 Meg / meets steady-state humidity.

LOW-COST COMMERCIAL POTENTIOMETERS

Wirewound TRIMIT® Potentiometers Models 271, 273, 275. Max. temp. 105°C / L, S, P terminals / 0.5 watt at 25°C / 50 ohms to 20K.

RESISTALOY® Carbon Element TRIMIT Models 272, 274, 276. Max. temp. 105°C / L, S, P terminals / 0.2 watt at 25°C / 20K to 1 Meg.

Wirewound E-Z-TRIM® Potentiometer Model 3067. Max. temp. 85°C / S, P terminals / 0.5 watt at 25°C / 50 ohms to 20K / Priced under $1 in production quantities.

Carbon Element E-Z-TRIM Potentiometer Model 3068. Max. temp. 85°C / S, P terminals / 0.2 watt at 25°C / 20K to 1 Meg.

SPECIAL-PURPOSE POTENTIOMETERS

High-Power (2 watts) High-Temperature Wirewound Model 207. Max. temp. 175°C / L terminals / 2 watts at 50°C / 100 ohms to 100K. As Rheostat Model 208, available 100K to 200K.

High-Power (5 watts) Humidity-Proof Wirewound Model 3020. Max. temp. 200°C / L terminals / 5.0 watts at 25°C / 100 ohms to 50K.

Dual-Element Wirewound TWIN-POT® Potentiometer Model 209. Max. temp. 135°C / L terminals / 0.50 watt (each element) at 70°C / 10 ohms to 50K.

15 watts, High-Temperature Wirewound Model 3030. Max. temp. 265°C / L terminals / 15 watts at 25°C / 10 ohms to 10K.

Radiation-Resistant, High-Temperature Wirewound Model 3040. Max. temp. 350°C / W terminals / 150 megarad / 5 X 10^{15} neutrons per sec. / 5.0 watts at 70°C / 500 ohms to 20K.

PANEL-MOUNTED POTENTIOMETERS

Most models are available with panel mounting. Unique design permits quick factory assembly to "on-the-shelf" units. In addition, mounting screws, brackets and clip brackets are available to meet almost any mounting requirement.

KEY TO TERMINAL TYPES

L=Insulated stranded leads

S=Solder lugs (includes panel-mounting bushing on Models 3367S, 3368S, 3300S and 3301S only)

P=Printed-circuit pins

W=Uninsulated wires (edge-mounting 3250, 3251, 3280 and 3281).

Write TODAY for detailed specifications on any model in the large BOURNS® Potentiometer and TRIMPOT® Potentiometer line AND a list of factory representatives.

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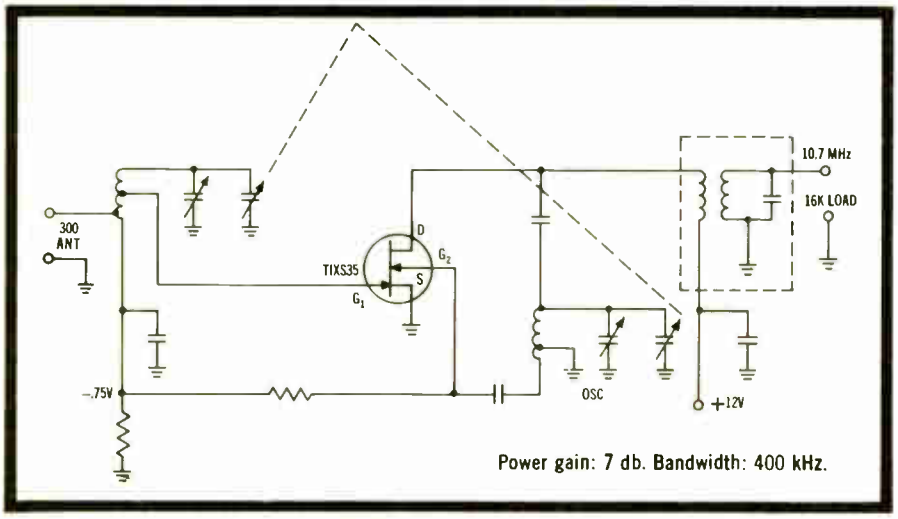
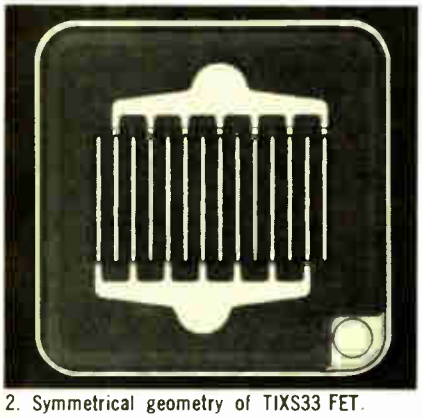
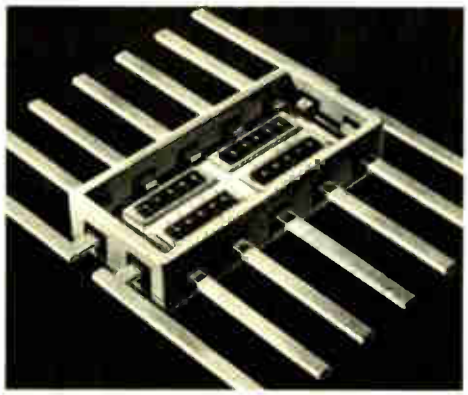
Six Semiconductor Innovations Help



1. Unique autodyne mixer employs TIXS35 FET which functions as both mixer and local oscillator.



2. Symmetrical geometry of TIXS33 FET.



3. Up to 20 diodes may be packaged in a single case.

TI cannot assume any responsibility for any circuit shown or represent that they are free from patent infringement.

1. New tetrode FET attains 8000 μmhos

Very high transconductance, frequency capability into the uhf range — these are the major advantages you get with TI's new TIXS35 N-channel tetrode field effect transistors. These represent a two-to-one improvement over currently available tetrode FETs.

Transconductance is typically 8000 μmhos with substrate gate connected to source, and 10,000 μmhos minimum with gates connected together. Other characteristics: $V_{(BR)GSS}$ = 30 V min; C_{rssl} = 1.4 pF max; C_{issl} = 8 pF max.

Isolation between gates minimizes "pulling" in mixer applications and greatly reduces skewing problems in AGC applications at IF. In autodyne mixer circuits like the one at left, the TIXS35 reduces circuit components. Circle 71 on Reader Service card for data sheet.

2. New N-channel FET features 60 ohms $R_{DS\ (ON)}$

TI's new TIXS33 field-effect transistor features a very low drain-source resistance of 60 ohms maximum. This makes it ideal for a wide range of switching applications such as low-level choppers and commutators as well as low- and medium-frequency amplifiers.

This planar epitaxial device offers high transconductance ($Y_{fs} > 12{,}000$ μmhos), high drain current (> 25 mA), low leakage ($I_{GSS} < 1$ nA), and low capacitance ($C_{DG} < 5$ pF and $C_{ISS} < 20$ pF).

Symmetrical geometry makes drain and source leads interchangeable. This permits use in multiplex and sample-hold circuits and allows replacement of older devices with non-standard lead configurations. Package is the TO-72 (four-lead version of the TO-18). Circle 72 on Reader Service Card for data sheet.

3. High-density diode arrays save space, improve product

Custom monolithic and discrete diode arrays, combining up to 20 diodes in standard flat-pack, low-profile TO-5 and TO-18 packages, are available from TI.

Benefits include high-density packaging, compatibility with integrated circuits, uniformity of parameters, and close thermal tracking. Core drivers, diode AND gates, common-anode and common-cathode arrays are typical of devices that are available. Circle 75 on Reader Service Card for information.

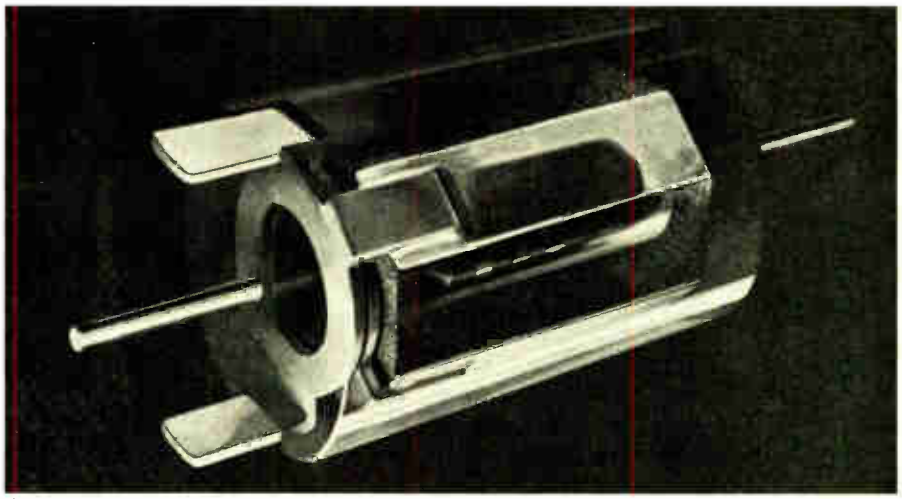
You Improve Performance, Reduce Cost

4. New diodes employ oven for high stability, low cost

TIXD746 – 759 temperature-compensated reference diodes offer temperature coefficients as low as 0.001%/°C and voltage ratings from 3.3 to 33 volts. Cost is less than conventional multi-junction reference diodes.

The unique unit comprises a Moly/G® diode within a self-regulating polycrystalline semiconductor oven as shown at right. The oven holds 120°C within ± 8°C from —55°C to +100°C and within ±2°C from —10°C to +50°C. Temperature is held within 1°C over a 10% voltage change. The oven operates on 24 V ac or dc.

Typical applications include regulated power supplies, high-frequency crystals, differential amplifiers, and instruments requiring voltage reference. Circle 73 on Reader Service Card for data sheet.



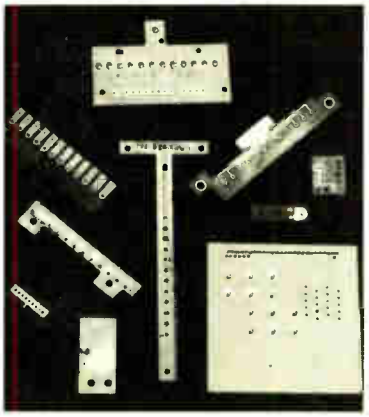
4. Unique construction of TIXD746 — 759 series temperature-compensated reference diodes.

5. Simplify assembly with TI customized light sensor arrays

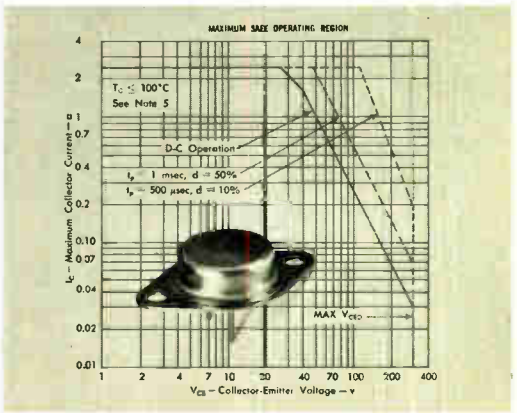
Now you can reduce manufacturing costs, increase reliability, improve performance, and minimize optical crosstalk with PC-board light sensor and light emitter arrays from TI.

You can reduce assembly, testing and inventory costs because TI arrays are preassembled and pretested units ready for installation. Reliability is improved because PC-board design is inherently more rugged than individually wired sensing devices. All components are hermetically sealed for long life.

LS600 planar light sensors give high, uniform sensitivity. Typical output is 1 mA, light, and 0.01 μA, dark, at 25°C. Sensitivity can be matched to ±20% across arrays. Lens confines admission angle to 10° off axis, minimizing optical crosstalk with close sensor spacing. Circle 74 on Reader Service Card for information.



5. Typical light sensor arrays produced by TI.



6. High voltage capability of TIP04 permits simple circuitry.

6. 400 V power transistors permit simplified circuitry

TIP04 NPN silicon transistors feature 400 volt minimum $V_{(BR)CBO}$ — permitting simplified circuitry for high-power line-operated equipment and circuits with inductive or capacitive loads.

Low saturation voltage (1V max at 2A) gives high efficiency. Low leakage (I_{CEX} = 10 mA max at 400 V and 100°C T_C) permits high-impedance bias circuitry for high gain. Other features include an f_T of 3 MHz and fast switching speed. Circle 76 on Service Card for data sheet.

"the rumor was true, Boris... Guardian has added ***QUICK-CONNECT*** *terminals to their 98¢ relay"*

If Boris could have waited we would have given him all the details! Engineers have been asking for a 3/16" *quick-connect* version of the famous Guardian 98¢ Relay for some time now. It's here at last. The ideal unit for any applications where maintenance and down-time are critical. This relay snaps in place quickly, ends costly soldering and maintenance expense. A quality unit, made in the U.S.A., it outperforms relays costing far more. Simplified design enables 8 parts to do the work of 22! One-piece field and core. New capsulated coil with cover. Contacts: DPDT with rating of 10 amps at 110VAC resistive load. Coil: Voltages 24, 115, 230VAC or 6, 12, 24VDC. This new 910 "quick connect" Series Relay is *available right now from stock*—minimum order, 200 pieces. **(Or, it is available from your Guardian authorized Distributor in quantities up to 199 units.)** Write for further information.

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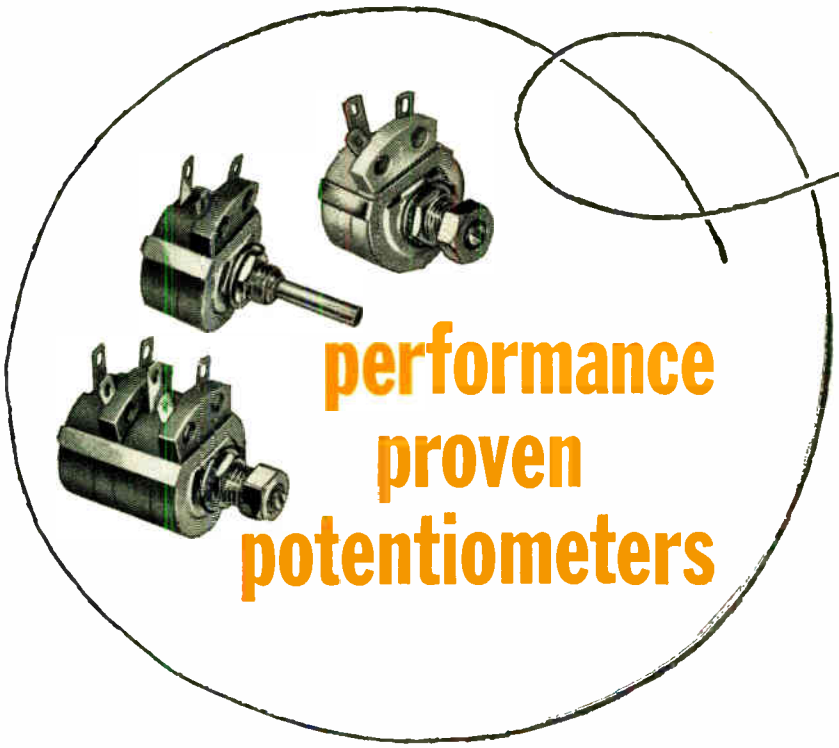

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Clarostat Series 49M Single-Turn, 1.5 Watts Miniature Potentiometers

. . . literally hundreds of thousands of these miniaturized units have proved their outstanding dependability and performance in critical electronic assemblies. Now, improved and streamlined manufacturing techniques make it possible to offer these potentiometers at **new penny-pinching prices (as much as a 100% reduction)** to meet the cost requirements of almost any electronic assembly.

Series 49M pots are available as single or dual units, with a choice of standard or split-bushing mountings. They're perfect for trimmer requirements calling for high resolution. Units are manufactured to MIL-R-19 specifications, Style RA 10.

SPECIFICATIONS: Power Rating 1.5 watts @ 40°C, or .005 watt per degree of effective rotation maximum. Derated linearly to zero power @ 125°C. Working Voltage 175 volts maximum. Resistance Range 1 ohm to 20,000 ohms linear functions. Resistance Tolerance ±10%, closer tolerances on order. Effective rotation 300° ±5°. Mechanical & Electrical Rotation - 300° ±5°. Torque: .3 to 6 oz. in. Locking type bushing: 20 oz. in. minimum with jam nut tightened. Typical Weight .02 lb.

Consider these brief, but outstanding specifications for your application—then call or write Clarostat today for full details and the new penny-pinching prices.

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FIRMS EXPAND TO MEET PREDICTED COLOR TV BOOM

Three of the nation's leading electronic firms have disclosed plans for further multi-million-dollar expansion into production for color TV tubes.

The Scranton, Pa., Keystone Industrial Park will be the site of an RCA 300,000 sq. ft. plant to produce color TV picture tubes. Cost will be $26 million, part of the firm's $195 million program to expand and modernize plant facilities in 1966.

RCA also plans to spend $25 million to establish a color CRT facility for its RCA Victor Company, Ltd., in Montreal; the move is expected to be the largest single expansion program in the history of the Canadian electronics industry. The new plant, in Midland, Ontario, to be completed in mid-1967, will have an annual capacity of 300,000 rectangular color CRTs.

Philco Corp. announced that it will spend about $20 million to build and equip a color TV tube plant at Lansdale, Pa., which is expected to be in operation early in 1967. Output by the end of the year will be 200,000 tubes. Eventual output capacity, according to Philco spokesmen, is predicted at 500,000 tubes yearly.

Zenith Radio Corp. has purchased a plant in Melrose Park, Ill., as a major part of its plan to increase output of color TV picture tubes by 50% before the end of 1966. The expansion will cost $17,000,000 and will step up monochrome tube output as well. Zenith spokesmen report that the firm is currently producing tubes at the rate of 900,000 annually. The new Melrose Park facility will be modified "into a highly mechanized color tube processing plant," and it is expected to be producing by the end of summer, 1966.

FM SALES TRIPLE SINCE 1960, 40% RISE SEEN BY 1966 END

Sales of home and auto radios with FM reception have more than tripled since 1960 and an increase of 40% above 1964 sales is expected by the end of next year. This is from findings in an analysis of FM factory sales by the Electronic Industries Association.

EIA statistics, which include domestic and foreign-label sets, show that one out of every four home radios sold in 1964 could receive FM, with the proportion expected to increase to one out of three by 1966. In 1960, the start of the FM boom, the ratio was one receiver with FM capability of every nine sold.

Sales of FM auto radios, first marketed significantly in 1962 with 100,000 sets sold, are expected to rise five-fold by the end of 1966.

ELECTRONIC CHECK CHECKER

Supermarket clerk uses new Telecredit-100 system to instantly verify customer's check-cashing status, cutting bad check risks and check-stand bottleneck. Built by General Precision's Librascope Group for Telecredit, system can verify credit status of any one in 100,000 customers in 1/10 of a second.

4 MILLION COLOR SETS MAY BE SOLD IN 1966

Color TV sales volume for 1965 exceeded even the most optimistic projections made early in the year. A report issued by Value Line Investment Survey states that, barring unlikely severe turndown in national economy, sales outlook for 1966 is even brighter. It predicts that four million color TV sets will be sold in 1966—a jump of better than 50% over 1965's volume.

According to the report, the total number of sets sold in 1966 may be limited by supply problems rather than by consumer resistance. Value Line predicts that selling prices and profit margins will remain firm.

The report cautions that two factors could help spoil this bright prospect. These include a wide assortment of picture tube sizes, and early obsolescence of the current industry mainstay—the 21-inch round color tube.

U. S. TAKES BIGGEST SPACE AT LONDON ELECTRONIC SHOW

At least 10-million-pounds worth ($28 million) of foreign electronic equipment will be shipped to London for the International Instruments, Electronics and Automation Exhibition set for May 23-28 at Olympia. The U. S. will hold down the biggest single stand in the 11-acre show. At the last IEA there were 148 overseas exhibitors. For the coming show this figure may reach 300.

INDUSTRIAL CONTROLS SEEN AT $1 BILLION BY 1975

Opportunities are overemphasized for new companies in the field of instruments and control in process industries. So states Al Lee, Director, Process Industries and Industrial Controls in the Industrial and Development Economics Area, Stanford Research Institute.

He indicates that many market forecasts are optimistic, but must be thoroughly investigated before they are used for business planning.

This field is estimated by Mr. Lee to double from about $500 million at present to about $1 billion by 1975. Two reasons he cites for caution in evaluating process instruments and control markets are: inadequate amount of sound data published in the market, and potential customers' expressed desires for certain equipment does not always convert into equipment orders.

Highest growth among process instrument and control suppliers would be in computers, and the lowest in recorders, says Mr. Lee. Computers' share of the market should double by 1970, while recorders' share may decrease by one-third. Mr. Lee says the industry's largest supplier has less than 20% of this market of about $500 million.

He believes no giant will dominate this industry by 1970 because the market is too diversified. As evidence, Mr. Lee indicates that out of hundreds of products in this field, fewer than 10 probably have markets exceeding $20 million annually.

MANUFACTURER PREDICTS RISING CONNECTOR SALES

"The growth rate in sales of electronic connectors this year will exceed current growth rate of 6.9% per year for electronic circuit components in general. Growth will adhere closely to the 11% annual growth experienced by the aerospace industry, a prime connector market," reports Boris A. Jackson, President of U. S. Components Inc. He predicted that total connector sales for 1965 will finally be about $165 million.

Referring to sales growth of connectors since 1961, he said that total shipment value of all types of connectors rose from $360 million to $600 million collectively by the end of 1964. Important factors in this healthy growth have been low dependence on direct government business and a wide market among all facets of industry.

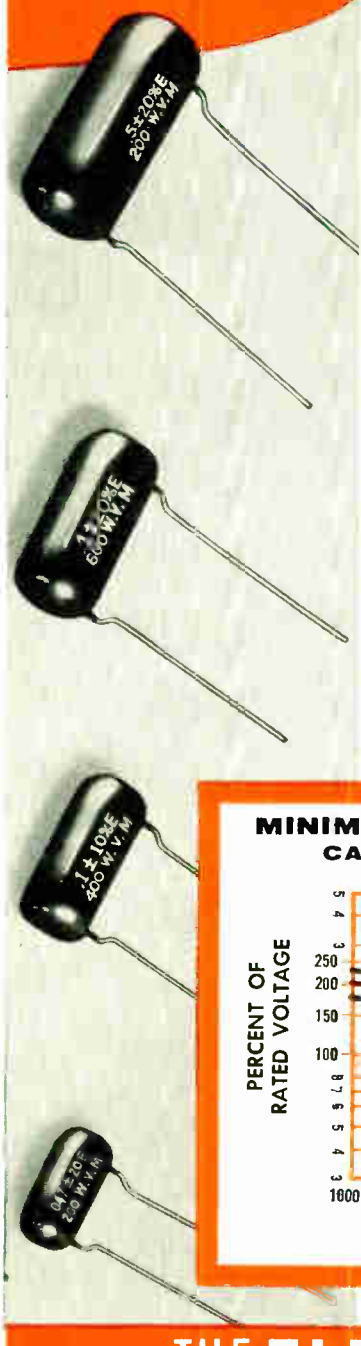
Mr. Jackson placed the current size of the European market for connectors at about $75 million.

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

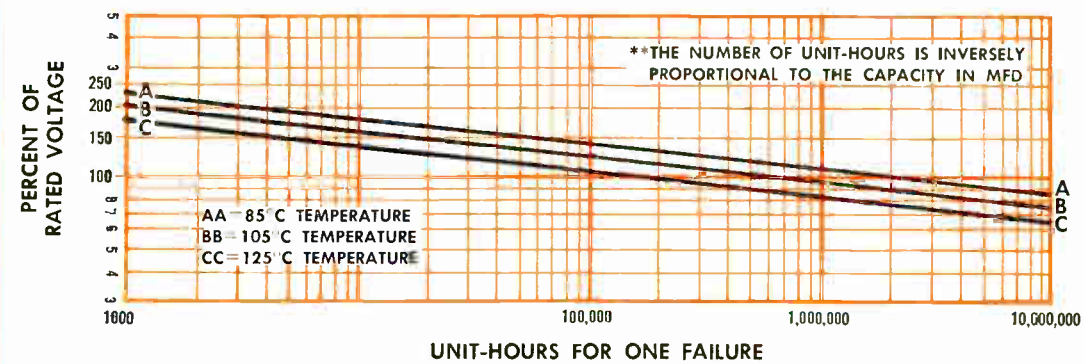
SPECIFICATIONS

- **TOLERANCES:** 10% and 20%. Closer tolerances available on request.
- **INSULATION:** Durex phenolic epoxy vacuum impregnated.
- **LEADS:** No. 20 B & S (.032") annealed capper clad steel wire crimped leads for printed circuit application.
- **DIELECTRIC STRENGTH:** 2 or 2½ times rated voltage, depending upon warking voltage.
- **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-microfarads.
- **POWER FACTOR AT 25°C:** 1.0% maximum at 1 KC

These capacitors will exceed all the electrical 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



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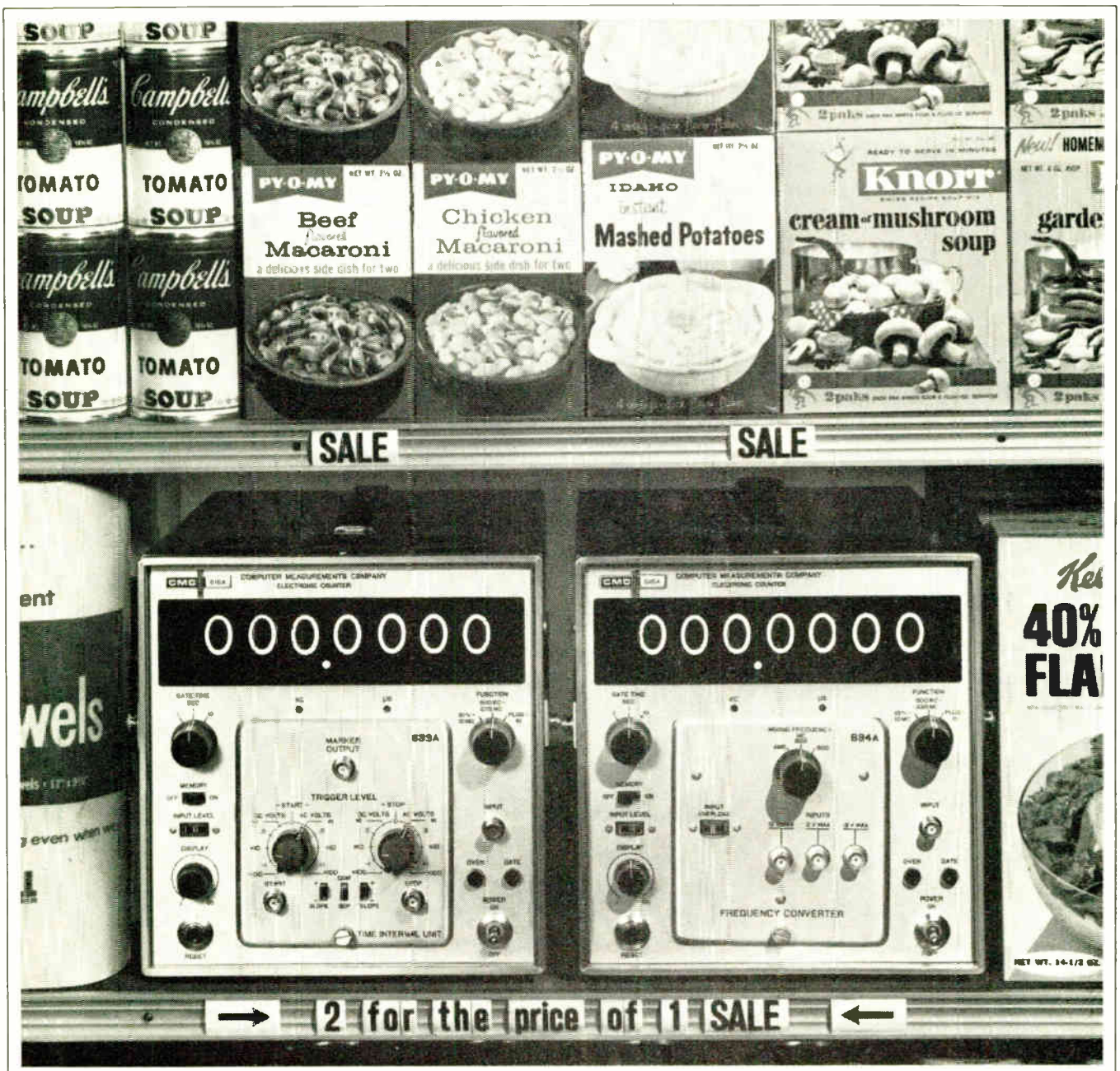

No, it's not the start of a price war. We're simply demonstrating that our new solid-state Model 616A frequency meter costs about half the price of any other comparably performing instrument now available. But, since the 616A is so versatile, who needs two of them anyway? This clever little instrument, with all silicon semiconductor insides, gives you direct frequency measurement through the entire 225 Mc telemetry band, and as high as 12 gigacycles with one plug-in. That's because we cunningly built in the prescaler.

But Hewlett-Packard and Beckman didn't. Theirs is a plug-in to a counter, and the total cost is twice that of our 616A. Then they sell you a second plug-in to measure above 400 Mc. Speaking of plug-ins... the 616A comes well equipped! Slip in a frequency converter or other special CMC frequency extender plug-ins, and your frequency measurements can soar to 1,000 Mc, 3,000 Mc, and even a phenomenal 12 gigacycles! Or, with our time interval plug-ins, measure time from .1 μsec. to 1 sec., or 1 μsec. to 10 sec.

Not only is the Model 616A half the price, but notice, it's half-rack size too! One reason is because, like others in the 600-Series, it features an advanced "mother board" technique. Lost are excess size, weight, and components; gained are new shape, reliability, and ease-of-maintenance. Button it up with its front cover and this rugged 28-pound wizard goes right out in the field.

All this for just $2,185. Interested? Then send now for the complete specs. And, if you're new at comparing our specs to high-powered H-P and big, bad B, you can earn a glorious Crusading Engineers' medal which reveals to everyone that you had the guts to look at somebody else for a change. It's also a great conversation opener for sweet young things you want to dazzle at your next T. G. I. F. party!

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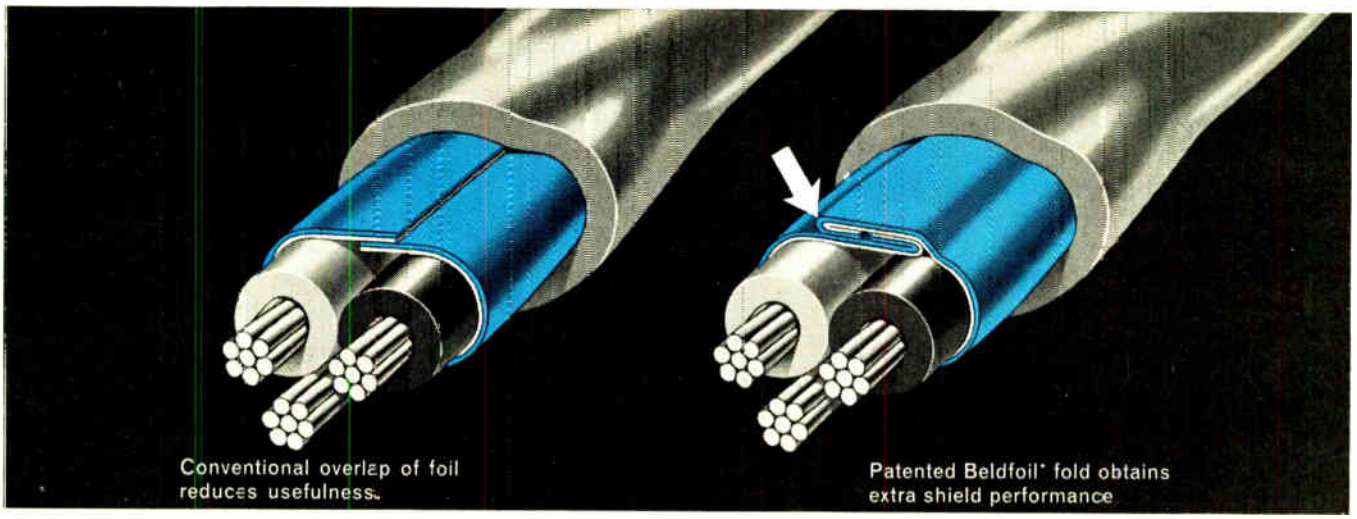


It's in the fold!

By Frank Timmons, Chief Engineer, Electronics Division, Belden Manufacturing Company

There are a number of cables on the market today which utilize Mylar† Aluminum Shielding to eliminate noise, hum and cross-talk. These cables have been developed to meet the needs of equipment engineers who have found that standard braided and spiral shields are inadequate in reducing pick-up and transmitted noise.

There is a big difference in the various cables available . . . and the big difference is in the manner by which the Mylar Aluminum Shielding is applied to the cable. The cable which does the most effective job of eliminating noise, hum and cross-talk uses a unique, patented wrapping process that "folds back" one or both edges of the Mylar Aluminum Shielding. It provides "total shielding" and was introduced in 1957 by the Belden Manufacturing Company under the trade name, "Beldfoil."

It is evident that many interested persons do not completely understand the manner in which Mylar Aluminum Shielding is used in the manufacture of Beldfoil cable. Therefore, Frank Timmons, Chief Engineer of the Electronics Division at Belden's Richmond, Indiana plant answers some of the more frequently asked questions, and points up some of the more important benefits offered by Beldfoil.

Q. *You talk about a patented process wherein the Mylar Aluminum Shielding is folded back . . . on one or both edges. Just how is this done?*

A. First, let us define Mylar Aluminum Shielding . . . it is a lamination of Mylar insulation film from 0.0005" to 0.001" thick and aluminum foil of .00035" to .001" thickness, applied spirally around the shielded conductor or conductors to give 100% shield coverage.

In some instances the wires are wrapped with the metal foil on the outside as shown in the cross-sectional drawing Fig. 1.

Fig. 1

Note the heavy black line showing the foil edge folded back so that a full layer of Mylar "bonus insulation" is provided between the conductors and the foil shield, increasing the reliability of the cable.

Cables to be used at radio frequencies, or sensitive to radio frequency interference, may need the fold shown in Fig. 2. This fold creates a metal-to-metal connection which eliminates any possible inductive effect, and makes the shield the electrical equivalent of a solid aluminum tube.

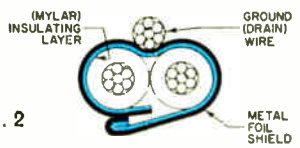


Fig. 2

Shields shown in Fig. 1 and 2 are used for cables with one pair of conductors.

For cables carrying multiple pairs of conductors, a different technique is used. On each pair, the aluminum foil is placed on the *inside*, with the Mylar layer on the *outside* (See Fig. 3). This is important because if the aluminum surface were on the outside we would have random metallic contact between the shields on the different pairs of wires. This would permit the voltages existing on one shield to generate currents in the adjacent shield, creating a transfer of energy or cross-talk between circuits.

Note that the outer edge of the shield is folded to tuck the edge of foil out of the way where it cannot short to the adjacent shield.

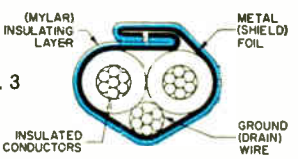


Fig. 3

The inner fold again provides the electrical equivalent of a solid aluminum tube. Belden calls this combination of two folds in one shield a "Z" fold because an end view of the unwrapped tape looks like the letter "Z".

Q. *How much signal isolation results between pairs, when aluminum foil is on the inside, and Mylar layer outside?*

A. This type of construction obtains isolation of more than 100 db between pairs, per thousand feet of cable, at 10 Kc. The short-circuited tape shield makes the cable quite suitable for use at frequencies ranging from audio to RF.

Q. *Do any contact-resistance problems arise between the drain wire and the aluminum foil shield on Beldfoil?*

A. No. Belden design and field service experience on millions of cable-feet in wide service environment have proved this point of reliability.

Q. *Can Beldfoil shields be used over small single conductors as well as over large complex cables?*

A. Yes. Belden applies it on groups from .050" to 1.25" OD.

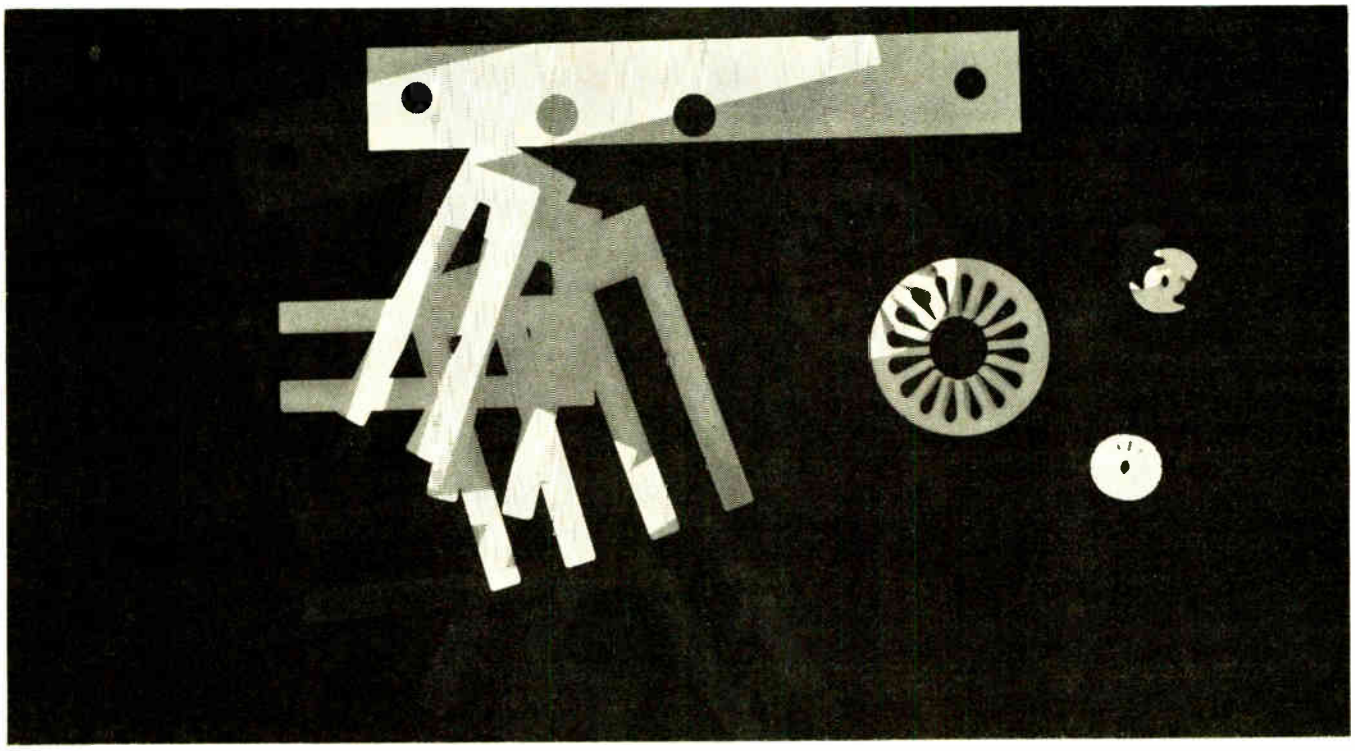
Q. *Design engineers are constantly faced with miniaturization problems. What about the size of Beldfoil shielded cables?*

A. Beldfoil definitely reduces the diameter of multi-conductor cables . . . in some instances by as much as 66⅔%. The small diameter provides design engineers with extra conduit space, extra raceway, extra console and rack space.

Q. *How can I determine which type of shield I should choose for a given cable?*

A. Belden application engineers are available for engineering assistance. Or, you can obtain preliminary printed information by writing to Belden Manufacturing Company, Advertising Department, P.O. Box 5070-A, Chicago, Illinois 60680.

Cut energy loss reduce core size decrease weight



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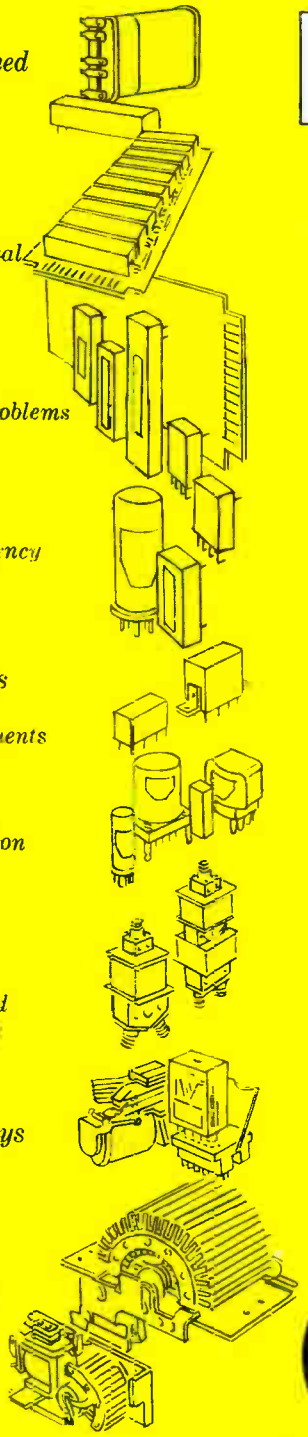

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- Contact load versatility...low level to 50 va
- One to twelve contacts
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See Clare Bulletins 900, 951, 127, 128.
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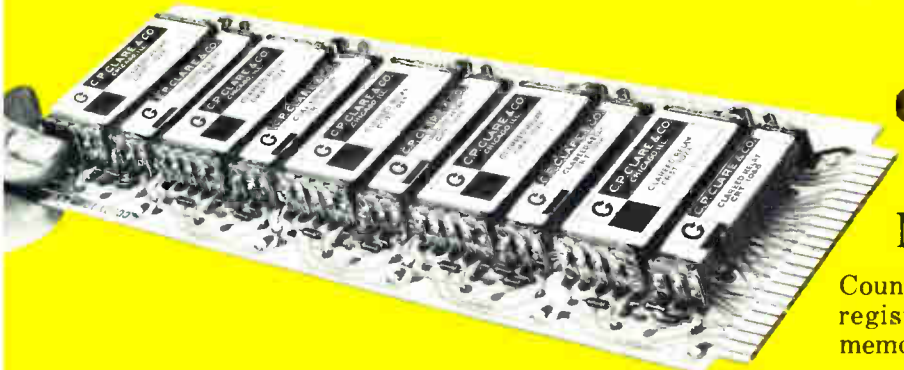

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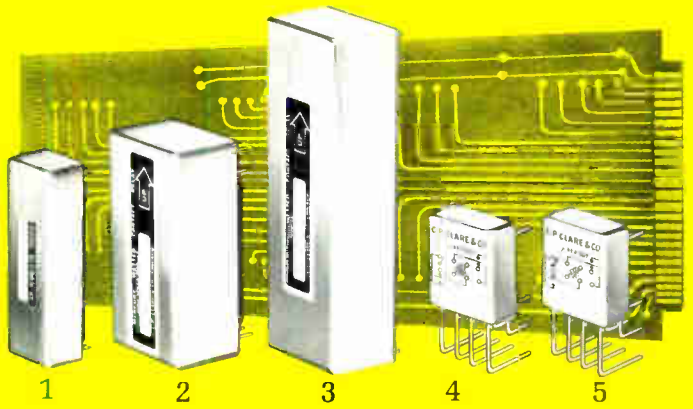

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- Life as great as 20 x 10^9 operations
- Pcb module packaging for convenient mounting

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MicroClareed® switch for quickest noise reduction

2 **Type HGS2MT**
Mercury-wetted contacts...fast, sensitive ...minimal contact noise and thermal emf

3 **Type HG2MT**
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- Variety of terminals...solder, pcb, direct plug-in
- Highly reliable contacts, with independent twin contact surfaces
- Stable, adjustment-free operation
- Consistently reliable performance at low cost

See Clare Bulletins 500, 551A, 552A.
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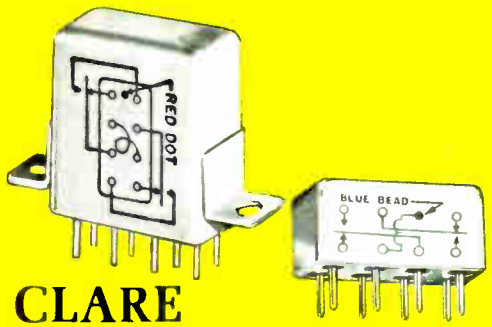
BULLETIN 299-1



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- Clare quality assured by Clare Quality Assurance Program
- Long electrical and mechanical life, under extreme conditions of temperature, shock, vibration, linear acceleration
- Wide range of relay types...standard, extra-sensitive, latching, miniaturized
- Sensitivities ranging from 40 to 250 mw
- Versatile contact capability, low level to 2 amp. Gold-plated contact areas...bifurcated contacts, with high contact pressures and positive wiping action

See Clare Bulletins 129A, 203A, 700, 755 and Reliability Manual 710A. Circle 103 on Reader Service Card.

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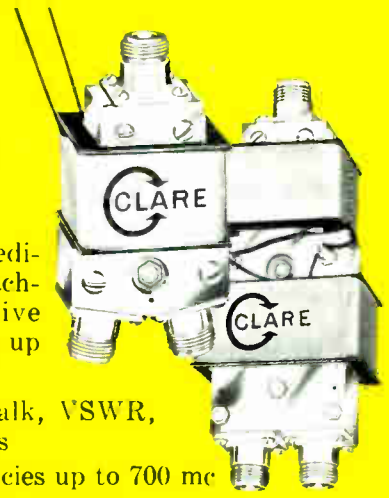

Microwave intermediate frequency switching, transmit-receive antenna switching up to 700 mc range

- Very low crosstalk, VSWR, and insertion loss
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- Low and consistent contact resistance (mercury-wetted contacts)
- Bounce-free contact operation

See Clare Bulletin 854. Circle 102 on Reader Service Card.

For additional Clare Contact Switching components, turn the page

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Mass sequential switching—counting, totalizing, scanning, sequence control, circuit monitoring

- Lower cost scanning and counting
- Maximum switching density
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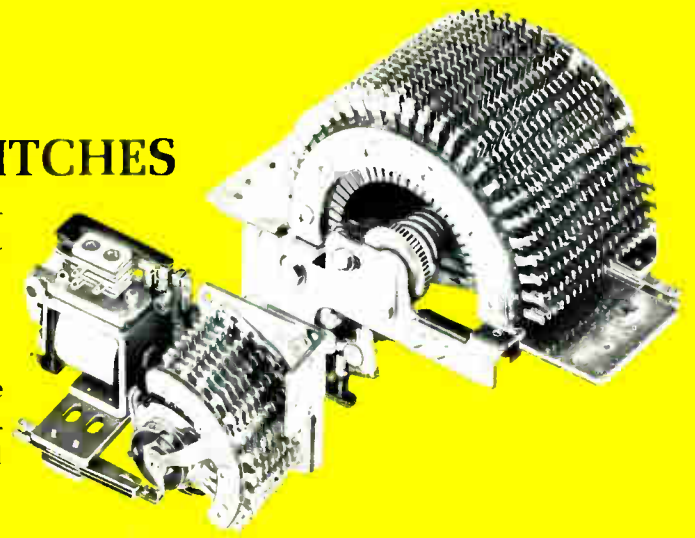
- Special modifications and functional assemblies for handling complex sequential switching problems



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See Clare Manuals 600, 601, 602, 651-1, 651-2. Circle 105 on Reader Service Card.

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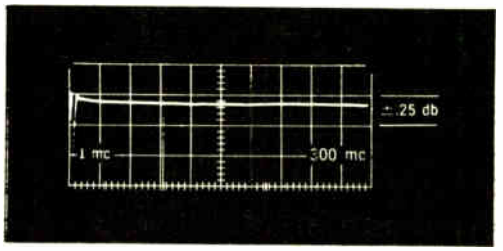
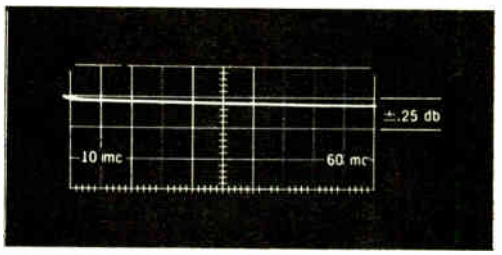


Full 300 MHz Wide Video Sweep



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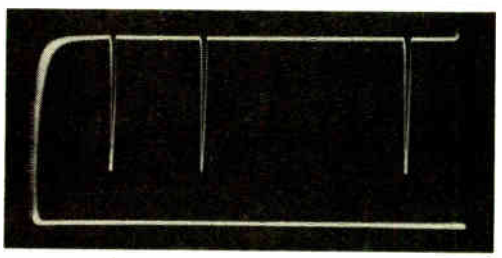
Marker Generator

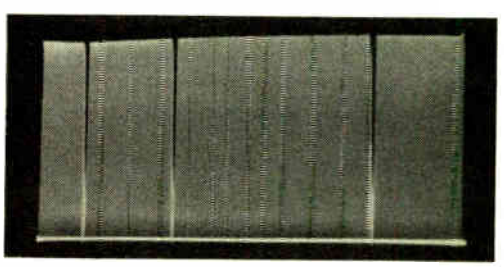
Pulse-Type Markers

Harmonic (or Comb) Birdie Markers

Single-Freq. Type Birdie Markers



Detected Turn-Off Markers



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PM 7650 Plug-in:
Pulse Markers
0.5 to 100 MHz

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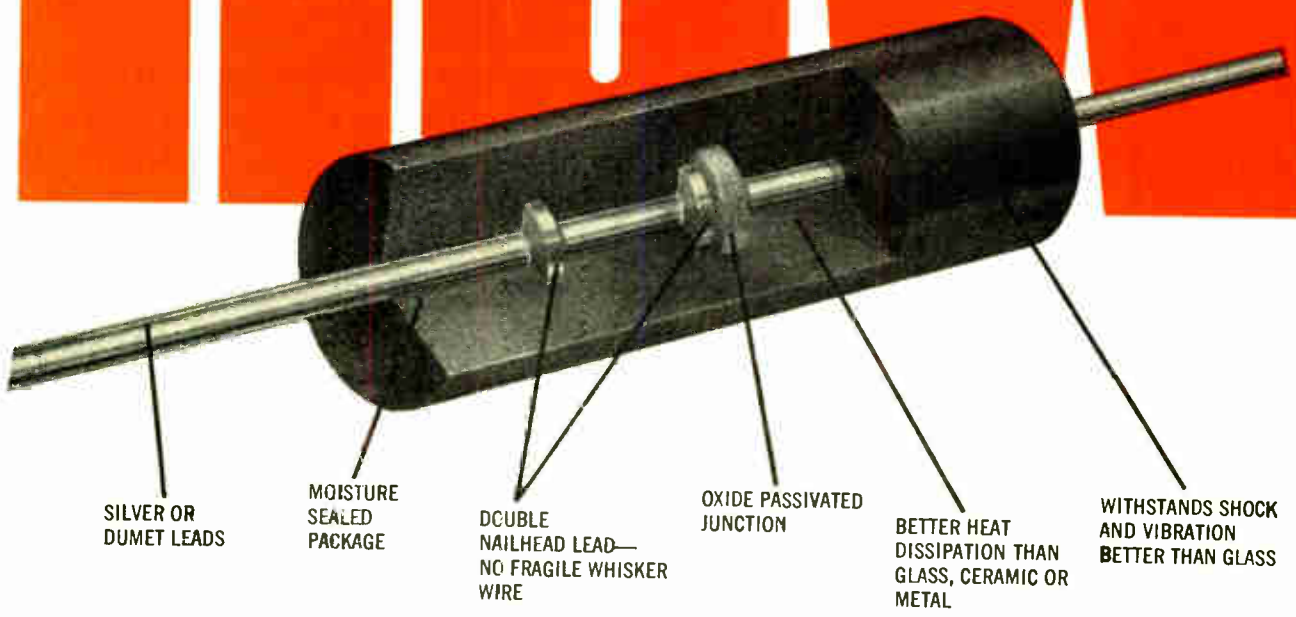

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Studying and Controlling IC Reliability

By H. T. GO Product Reliability Consultant, Aerospace Division Westinghouse Defense & Space Center, P. O. Box 746, Baltimore 3, Md.

ANALYSIS OF FAILED IC's show that most of today's reliability problems stem from their processing. We can enhance our knowledge of IC Reliability, if the following factors are studied, analyzed, and determined on a qualitative, as well as a quantitative basis:

1. The Effect of Manufacturing Processes on Device Reliability
2. The Measurement and Verification of Device Reliability
3. The Derivation of Reliability Predictors and Screens

A study program, described here, would yield a method to control and monitor IC reliability through process control. Also, potential failures can be screened out, while an estimate of individual device reliability is feasible.

The Effect of Manufacturing Processes

The reliability of a product is set by its design and manufacturing. It is, therefore, essential that there be control points in any critical part of the manufacturing. In the case of semiconductor devices, enough solid state theory is known to assure a good design. The many variables in the processing are still a source for variation in the reliability level. Since reliability is a function of design and processing, a numerical relation ship between processing and reliability of a finished product can be found by way of:

1. A lot identification system to maintain the production history for each group of devices. Then it becomes possible to relate failures from any source back to the processing.
2. An in-process quality control system which has inspection stations at critical points. Inspection results shall be plotted into statistical control charts where trends in quality levels can be watched.
3. A system which verifies the reliability level of the products at given time intervals.

A lot identification system is an administrative matter which should be designed for one specific need.

Process Control Charts

To obtain a continuous measure of process performance, statistical control charts are a must. Generally, two kinds of control charts can be used:

1. Charts for variables. (X, S-charts)
2. Charts for attributes. (p-charts; c-charts)

The control limits for the charts are calculated as the average value ± 3 times the standard deviation.

$$\bar{X}\text{-chart} : \bar{\bar{X}} \pm 3\sqrt{\frac{\sum_{i=1}^{n}(x - x_i)^2}{n(n-1)}}$$

$$p\text{-chart} : \bar{p} \pm 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

$$c\text{ chart} : \bar{c} \pm 3\sqrt{\bar{c}}$$

The existence of control limits on a statistical control chart show that because of process limitations, defec-

Effective reliability improvement and control can only be achieved when the effect of processing variables on reliability of the device is known and understood. To establish this correlation, a method must be developed that accurately and economically estimates device reliability.

tive items still have a change of being accepted and further processed into the final product. In other words, there are some discrepant units escaping through each check point. To show the numerical level of escape, an index is used which gives the difference in the observed and nominal value in units of standard deviation, for example:

$$\bar{X}\text{-chart : Index} = \frac{\bar{\bar{X}} - \bar{X}_i}{S/\sqrt{n}} = \frac{\bar{\bar{X}} - \bar{X}_i}{\sqrt{\frac{\sum_{i=1}^{n} (\bar{x} - x_i)^2}{n\,(n-1)}}}$$

$$\text{p-chart : Index} = \frac{\bar{p} - p}{S} = \frac{\bar{p} - p}{\sqrt{\frac{\bar{p}\,(1-\bar{p})}{n}}}$$

$$\text{c-chart : Index} = \frac{\bar{c} - c}{S} = \frac{\bar{c} - c}{\sqrt{\bar{c}}}$$

According to Q.C. practice, an index value greater than 3 points to an "out of control" condition of the process.

Reliability Verification

For semiconductor devices, reliability verification can be a stabilization bake, burn-in, step-stressing or add-on life testing. This should be done on a continuous basis. From the verification test, an estimate can be made of the device failure rate. This, along

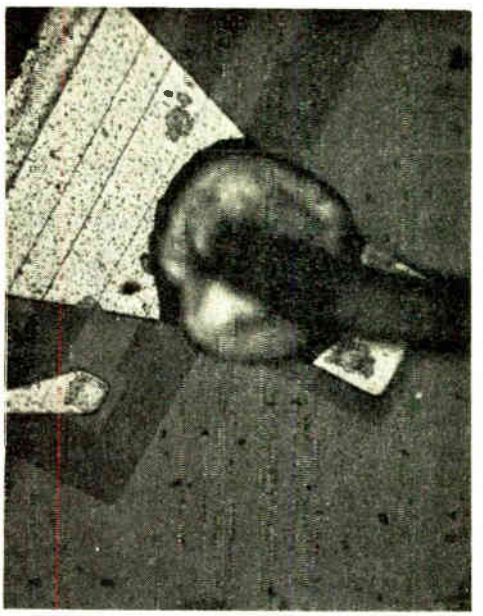
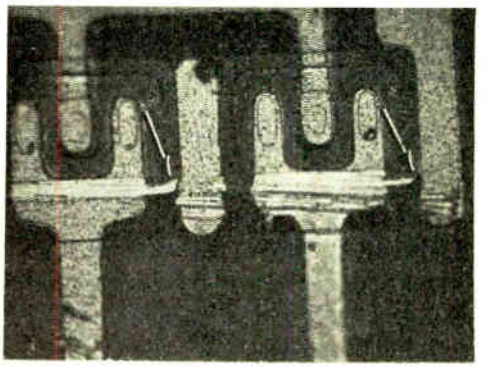
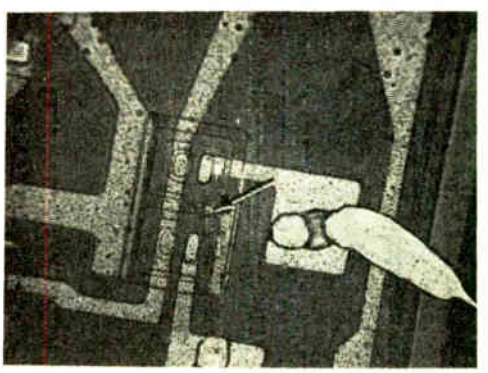


Photo shows the formation of the infamous "purple plague" which has appeared in semiconductors.



Shorted base-collectors were caused during handling by aluminum being dragged across the junctions by a worker with tweezers.

This photo chemistry fault is most probably a flaw of the mask, connecting the base area of the two transistors as shown.



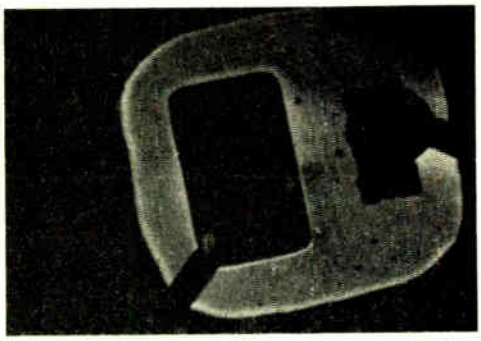
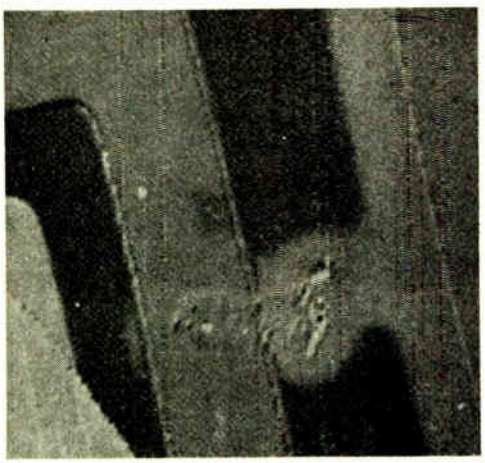
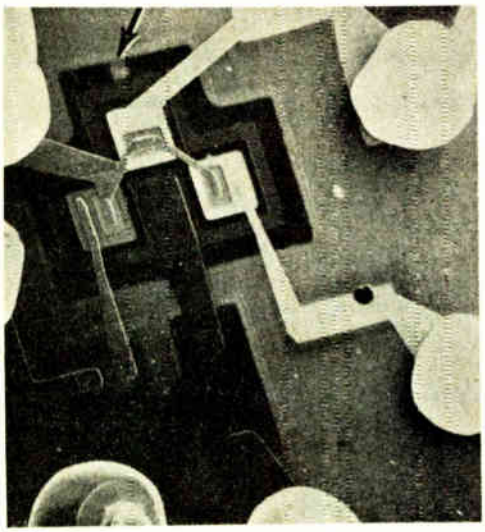


Photo voltage picture of the base-emitter region of a mesa transistor. Dark lines and spots indicate regions of high recombinations. Light shading between contacts indicate channelling.

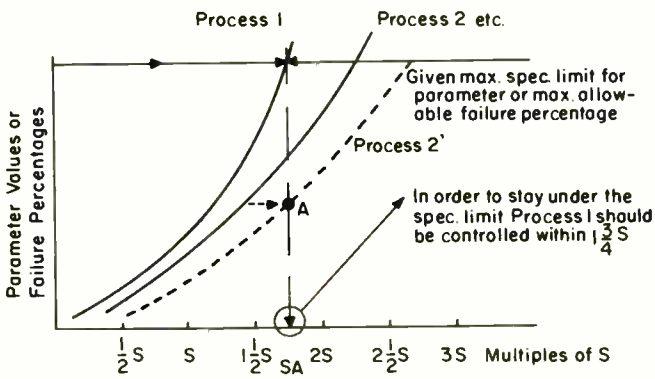


Scanning electron photomicrographs (above & below) of a biased DCTL NOR gate, showing irregularity in the p-wall isolation of the transistors.



IC RELIABILITY (Concluded)

with a lot identification system and the escape index, yields information about the relationship of process control and reliability by constructing the following graph:



Each point represents an individual lot that went through processing steps 1, 2 . . . n and finally life tested. The slopes of the curves show the effect a certain process step has on the reliability. Thus, a direct relationship is set between the process quality level and the Failure Rate, that is, *control limits can be determined for each processing step to assure that each lot will not exceed a given failure rate goal or parameter limit.*

This approach can also be applied to check the control we have in achieving desired device characteristics in terms of parameters. Instead of the Failure Rate, parameter values or drift can be plotted on the vertical axis. The effect of process changes on reliability can also be studied. For instance, the "student's" t significance test is based on the ratio of t

$$= \frac{\text{Error in Mean}}{\text{Standard Error of Mean}} = \frac{\bar{X} - \bar{x}}{S/\sqrt{n-1}}$$

$$= \frac{/\bar{X} - \bar{x}/\sqrt{n-1}}{S}$$

Since the horizontal axis is already in multiples of S, the t value of each point in the graph can be found by multiplying it with $\sqrt{n-1}$ (n = sample size). Supposedly, point A is the result of a change is process 2, the significance of the change can be found by multiplying S_A with $\sqrt{n-1}$ to obtain the Student t value. Thereafter, with a given number of degrees of

freedom, the significance level of the process change can be learned.

Reliability Measurement & Verification

Reliability is defined as the probability that a device will operate within given parameter limits for a given time, under given operating conditions. Normal component reliability life tests become too costly for ICs. A less costly accelerated stress type test is needed.

When an accelerated stress-time relationship has been set and validated on a product, it should be tried on ICs made by others for general applicability. The study must be a complete and thorough analysis of external, was well as internal failure mechanisms noted during the test. This approach should be checked by comparing the failures under stressed conditions, as shown in the tests, as being basically the same as those occurring at normal ambients. This will validate the above-mentioned aging methods. Once found to be valid, an accelerated testing method, is very useful in estimating product failure rate. Also, for learning the effect of process or design changes and reliability improvement measures.

Some work has been done in the failure pattern of ICs under accelerated temperature stress. Early data points to the Log-Log and Eyring eqs. as the best fit:

Log-Log Relation: $F = F_o T^m$ where T is the temp. in °C and m is a time dependent constant.

Eyring Relation: $F = F_o Te^{-\frac{C}{T}}$ where T is the absolute temp. given in °K and C is a constant depending on the activation energy.

The time element of the Log-Log relationship seems to be in the exponent m which approximated the relationship $m = t^a$, where t is time in hours, and a is a constant, which is less than unity. This means that when plotted on log-log paper, the failure curves have higher slope values for greater time intervals, giving converging failure curves. In the case of temperature stress, this shows that at highly elevated temperatures, material degradation is more heat than time dependent. The same test data that has been fitted to the log-log relation is tested for fit with the Eyring equation. A very good fit is also obtained as shown in Table 1, where R:

$$\text{Correlation Index} = \sqrt{1 - \frac{(S_y)^2}{(s_y)^2}}$$

S_y = Standard error of estimate of the Y value.

s_y = Standard Deviation of the Y value.

Table 1

TEMPERATURE STEP-STRESS TEST RESULTS

	Log-Log	R	Eyring	R
48-Hr Step	$F = 0.27\ T^{2.8}$	0.99	$F = 1.1\ Te^{-\frac{1787}{T}}$	0.97
96-Hr Step	$F = 0.54\ T^{1.2}$ (T = °C)	0.97	$F = 0.9\ Te^{-\frac{132}{T}}$ (T = °K)	0.87

The log-log has the advantage of simplicity, while the Eyring Eq. opens the opportunity to relate device failure to device geometry. When gross mechanical failures are eliminated from IC's, the Eyring Eq. is more accurate in describing failure occurrence. More tests should be done to pin-point the time relationship of these two.

Reliability Predictors & Screens

Several screening methods are available, of which the following are most interesting, because of their non-destructive nature.

Scanning Electron Microprobe: The working of the Scanning Electron Microprobe is based on the emission of secondary electrons from the specimen under study. An electron collector, biased at high potential with respect to the specimen, attracts secondary electrons and provides a proportional signal. This signal is converted into a picture, where the modulation of intensity corresponds with the quantity of secondary electrons from the specimen surface. This picture is of surface potential which may be affected by the electrical biases applied to the specimen (which can be a functional microelectronic block).

The detection of a failure in such a complex structure would be an almost hopeless task without a tool such as this. Here external biases may be varied while observations of those transistors cutoff and those saturated may be made. Then, by comparing observed conditions with those expected for the impressed biases, you can learn which circuits are okay, and which have failed.

Infrared Techniques (IR): Most failures are of a chemical or electrochemical nature which is speeded by heat. The heat from a device under bias might thus be used as a sign of potential (un)reliability. The

Table 2

FAILURE MECHANISMS IN INTEGRATED CIRCUITS

The failure mechanisms observed for present day ICs are dominated by mechanical type failures as shown below:

Cause	Failure Mechanism
Electrical overstress.	Melting of the lead wires and metallic interconnects creates an open connection.
Poor bonding technique and control.	The lead wires were touching either the substrate edge or the package lid.
	Plague formation created an open.
	Gold splatter during the bonding operation created a shorting path between two adjacent connections.
	Lifting of bond created an open.
Poor alloying technique.	Aluminum "over-run" created a short between adjacent connections.
Dirty surface and poor passivation.	Leakage between adjacent junctions.
Poor design.	Leakage between adjacent junctions.
Poor workmanship and visual inspection.	Scratched or open interconnect.
Poor photochemistry.	Missing oxide and random Al-strips.
Poor workmanship.	Wrong markings.
Contaminated evaporator or dirty oxide surface.	Lifting of aluminum interconnect.
Misalignment.	High resistance contact.
Dirt particle acts as a mask against diffusion.	Incomplete diffusion.
Mechanical and environmental stress.	Package Failures. Two kinds of package failures can be distinguished. a. mechanical—non hermetically sealed package. b. electrical—stray current path among the package terminals caused by residue of conductive chemicals. Inadequate leak detection techniques are part of the problem. The widely used combination of gross leak and helium leak test does not completely cover the total leak spectrum. A gap exists for the detection of leaks in the 10^{-4} to 10^{-5} cc/sec. range. The use of Kr^{85} (krypton) to cover the complete spectrum of $10^{-2.5}$ – 10^{-9} cc/sec., showed good results.
Imperfect oxide.	Oxide Failures. a. Voids or holes in the oxide layer expose the silicon. The metallized interconnect pattern, which is deposited on top of the oxide layer, can thus penetrate the oxide protection and make contact to the silicon substrate. These holes can be created by faulty oxide growth, damaged mask, poor photoresist and so-called undercut by etching. b. The oxide on the surface of a junction, consists of several layers successively grown at different diffusion steps. And as such may contain different impurities and contaminants. It can make the oxide conductive, resulting in the creation of channels.
Bulk Imperfection.	Bulk Failures. Most of present day bulk problems are associated with the imperfection in the silicon crystal. Dislocations of the crystal lattice results in the formation of epitaxial spikes, which during diffusion create non uniform junctions and "pipes".
Moisture inside package.	Deterioration of interconnects. This failure mechanism is closely related to package failures. Moisture or any corrosive substance inside the package attacks the aluminum interconnects resulting in an open circuit.

IC RELIABILITY (Concluded)

heat dissipated by energized components is measured by its IR emission. In other words, every component is transmitting, by way of IR, the proportional amount of current flowing through it.

In the same group of heat detection methods through IR, the "Thermographic Technique" is also worthwhile mentioning. Here, a high resistivity thermographic phosphor is sprayed on top of the component. When irradiated with an ultraviolet light, the bright yellow fluorescence is quenched or darkened by the heated component, proportional to its temperature.

Noise Measurements: Five basic types of noise can be detected in a semiconductor device:

Thermal Noise—Generated by random thermal motion of changed particles.

Shot Noise—Generated as a result of the random passage of discrete carriers across a barrier or discontinuity, such as a semiconductor junction.

Excess Noise—Results from the passage of current through a semiconductor material.

Avalanche Noise—Carriers in a high voltage gradient develop enough energy to dislodge more carriers through physical impact.

Multistate Noise—Consists of erratic switching that is generated within the device at various sharply defined levels of applied current.

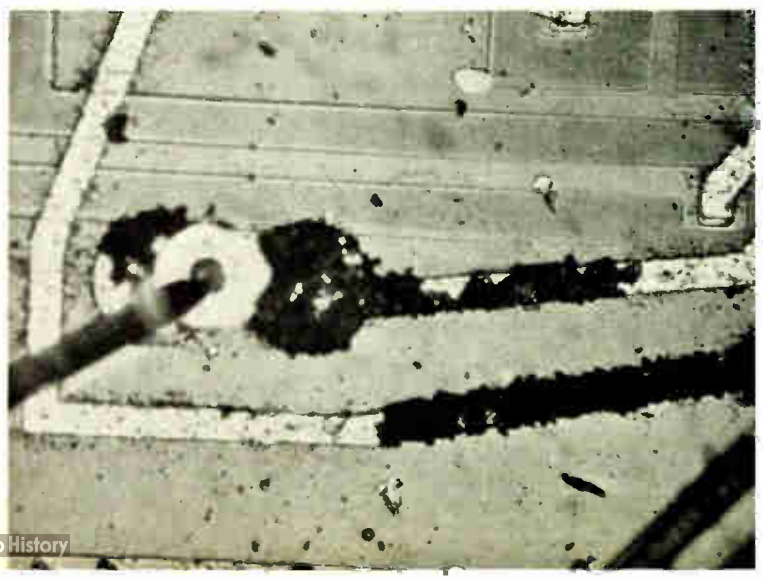
Abnormal noise in a semiconductor device stems from *abnormality* within the device. Excess noise and avalanche noise have been claimed, for resistors and transistors, to be a good sign of potential unreliability. More work is needed here.

Here is a suggested plan for investigation:

a. Develop suitable bias conditions for measurement of noise.

b. Measure many devices and sort out very high and very low noise blocks. Study reasons for relative amount of noise.

This represents a failure because of deterioration of the interconnects due to moisture or corrosive substance inside of the package.



c. Measure noise of a number of ICs. Stress to failure, analyze, and see if noise and stress resistance correlate.

d. If shown to be feasible in (c), develop a production screen.

Mathematical Screening — Linear Discriminant Analysis: Mathematical Screening is based on the philosophy that physical faults contributing to device degradation, in one way or the other, affect the device parameters. Device parameters are studied for any statistical correlation between behavior and following failure. Here is a suggested plan for investigation:

a. Using test data from accelerated as well as conventional life testing performed at fixed time intervals, parameter distribution patterns can be set as a time and stress dependent. The parameters most sensitive to drift and/or sudden failure can be found and assigned a weight factor, based on the frequency of occurrence of the parameter as a failure mode.

b. Investigate the applicability of the method by comparing the weight factors of different device types and finding any existing relationship between device type and weight factor. Also, the effect or operational time and environment on the weight factor shall be analyzed and determined.

c. Determine the efficiency and thus the feasibility of using the screening method.

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HIGHLY ACCURATE PEDESTAL

A UNIQUE METHOD OF LOCATING AND GRINDING eccentrics on elevation bearings has produced a highly accurate pedestal. The pedestal, an elevation-over-azimuth type, can be used in ground-based or shipboard tracking. Currently, system accuracy for such pedestals exceeds 0.5 mils and digital-data pick-off and alignment errors are 0.05 mils peak.

Verticality of the mount is established with electronic split-bubble levels to accuracies better than 5 sec. of arc. Train bearing and elevation axis wobbles are limited to ±5 sec. of arc and axis. The unique method of locating and grinding eccentrics on the elevation bearings shows its advantages in the inorthogonality. Tests to locate an inorthogonality of 0.00005 in. across 75 in. failed to reveal even this much error.

The mount gives continuous azimuth rotation and coverage in elevation from −16° to +196°. The type 2 servo system which meets these requirements has the following features: chopper-stabilized operational amplifiers; acceleration coefficient of 180/sec² at the highest bandwidth setting; direct drive to dc torquers which completely eliminate backlash; slave, manual and autotrack modes; tracking and slew rates up to 60°/sec. in azimuth and 30°/sec. in elevation; and 5 selected bandwidths. A type 3 servo system could be provided for even more stringent uses. The pedestal uses 17-bit encoders, along with 0.05% sin/cosine potentiometers.

The reflector used is a 12 ft. fiberglass honeycomb unit with an R^2 distribution of error. Reflectors as large as 30 ft. can be used with no redesign required.

The antenna assembly has a max. deflection of 0.07 mils under all environmental conditions. Optical deflections are limited to 5 sec. of arc. Electronic Specialty Co., 4561 Colorado Blvd., Los Angeles, Calif. 90039.

Pedestal has inorthogonality of less than 0.00005 in.

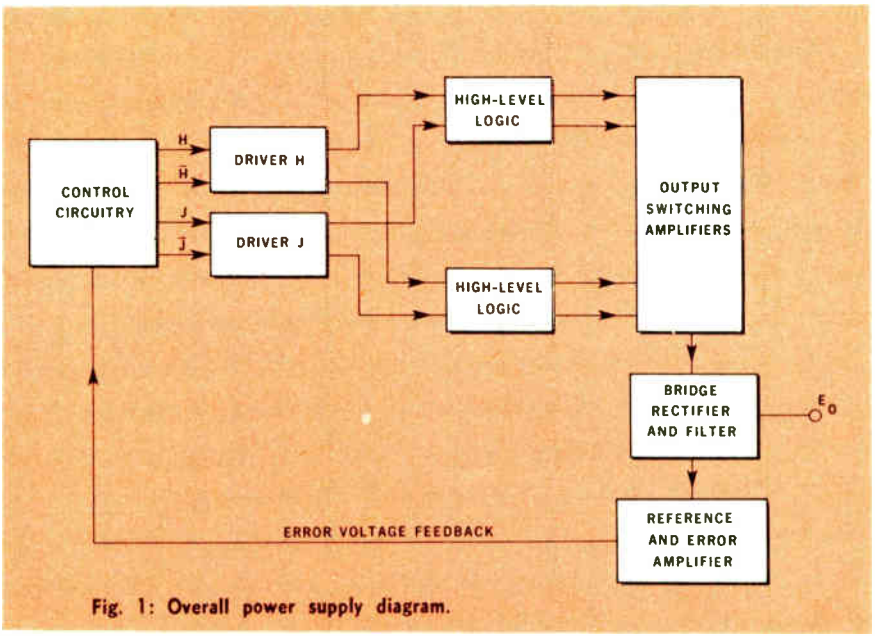


Fig. 1: Overall power supply diagram.

High-Efficiency Power Supply

A design for a switching-type high-efficiency power supply with feedback regulation is described. Using integrated circuits and ultra high speed power output transistors, its performance is excellent. It is well suited to applications requiring compactness and small size as well as low assembly and maintenance costs.

THE LARGELY INTEGRATED CONTROL section in this design makes it possible to build small, compact units having low assembly and maintenance costs. Also, the very fast turn-on and turn-off times of the output devices minimize switching dissipation. Thus, high operating frequencies can be used and the power transformer can be small.

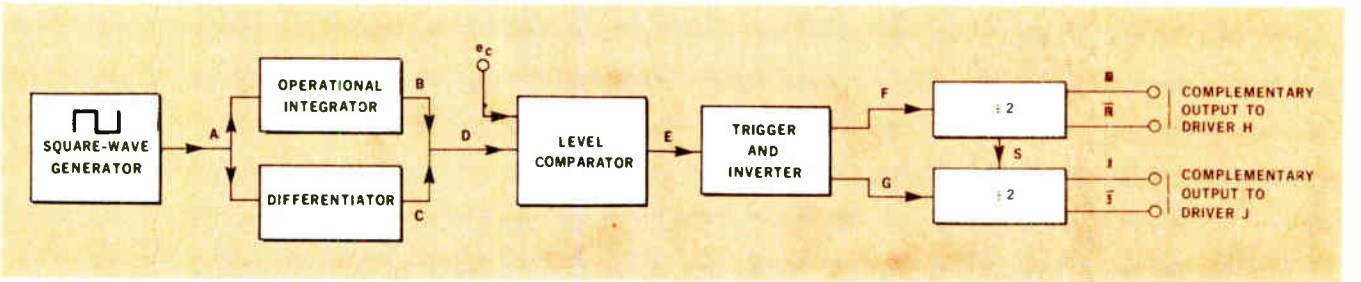
Although the unit described here provides a dc output of +20v, the design can easily be adapted to supply almost any voltage desired; e.g., 3.5v for μL elements in an airborne use or both +12v and −6v for transistor circuitry in a variety of uses. These uses include computers, radar and navigational equipment, etc. The design described uses largely industrial/commercial grade μL elements, but the military components suggested in Tables 1 and 2 can be substituted if necessary.

Voltage regulation for the +20V supply is 1% for a load variation of 0—5a, and could be improved by providing higher gain within the feedback loop.

Fig. 1 is a diagram of the overall power supply. It includes: (1) the largely integrated control section, which supplies symmetrical waveforms to the driver and power output stages, thus greatly facilitating transformer construction; (2) the driver and "high-level logic" stages, which provide power gain; and (3) the output stage. Voltage regulation is provided by feeding back an error voltage from the output to the operational amplifier in the control circuitry. This is used to adjust the conduction time of the output switching amplifiers.

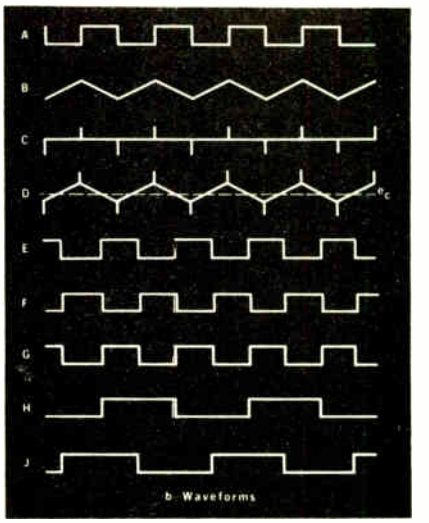
Control Circuitry

Fig. 2 is a block diagram of the control circuitry; Fig. 3 shows the waveforms at indicated points; and Fig. 4 is a schematic diagram. The design is a combination of analog and digital methods. The square wave generator output (A) is separately integrated and differentiated. It produces waveforms B and C, whose sum (D) is a triangular peaked waveform. This waveform appears at one input to the level comparator,



▲ Fig. 2: Control circuitry block diagram.

Fig. 3: Control circuitry waveforms. ▶



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Uses Micrologic

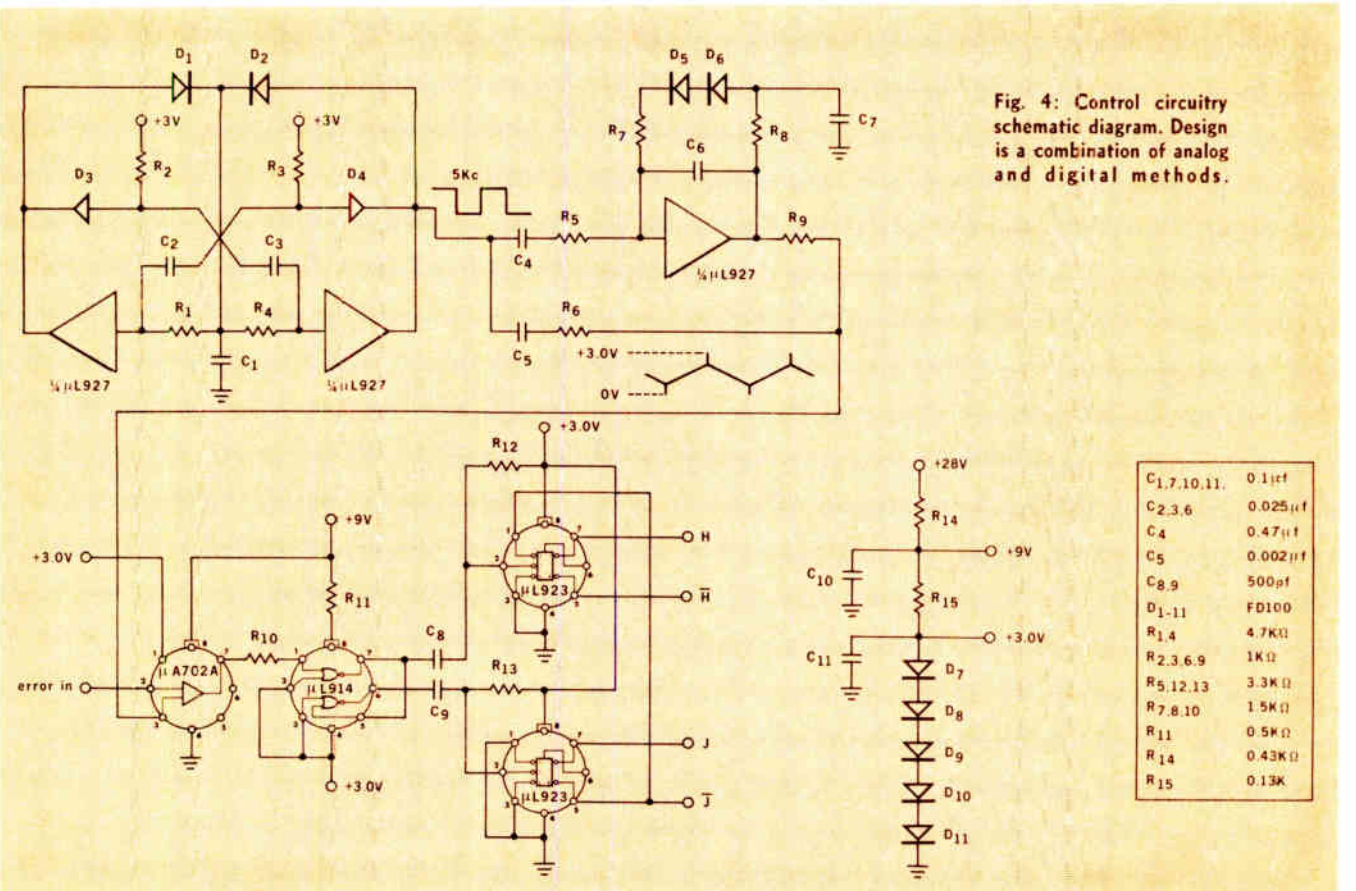


Fig. 4: Control circuitry schematic diagram. Design is a combination of analog and digital methods.

$C_{1,7,10,11}$	0.1μf
$C_{2,3,6}$	0.025μf
C_4	0.47μf
C_5	0.002μf
$C_{8,9}$	500pf
D_{1-11}	FD100
$R_{1,4}$	4.7KΩ
$R_{2,3,6,9}$	1KΩ
$R_{5,12,13}$	3.3KΩ
$R_{7,8,10}$	1.5KΩ
R_{11}	0.5KΩ
R_{14}	0.43KΩ
R_{15}	0.13K

MICROLOGIC POWER SUPPLY (Continued)

while a steady error or control voltage e_c appears at the other. Twice per cycle, the instantaneous value of D passes above or below e_c. This causes the comparator output to change level, forming a square wave. If the level of e_c shifts up or down, the leading and trailing edges of the output square wave shift about the peaks of the triangular wave. Symmetry is thus preserved. The spikes on D prevent an inoperative condition when e_c becomes larger or smaller than the peak values of the triangular wave alone.

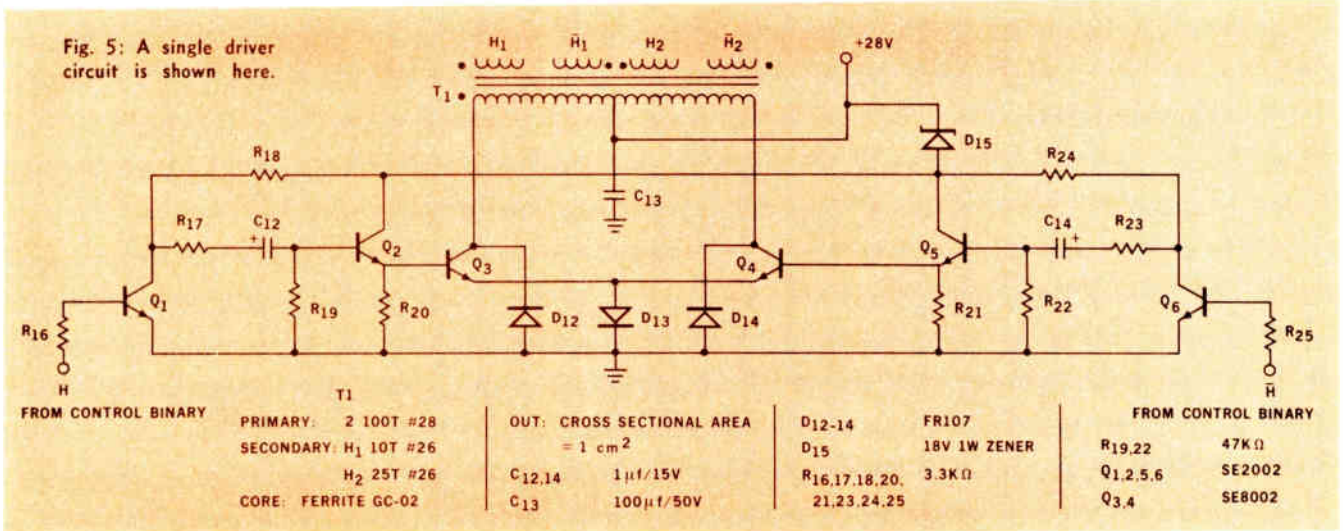
The trigger and inverter circuit decreases the rise time of the comparator square wave and produces complementary waveforms (F and G). These waveforms drive the binaries, whose outputs are directly coupled to the associated driver circuits. The binaries are interconnected so that the state of one controls the state of the other. This is done to prevent a 180° phase ambiguity which could otherwise occur in the binary outputs when dc supply power is first applied. Each binary puts out a pair of complementary square waves (H, $\overline{H}$ and J, $\overline{J}$), whose frequency is half that of the square wave generator output and displaced ¼ cycle from the output of the other binary.

Square-wave generator—The square-wave generator is a self-starting symmetrical multivibrator (MVB) composed of two of the gates in a µL 927 quad inverter. Its frequency (5 KHz) is controlled by the equal-time-constant pairs R_1 C_2 and R_4 C_3. Proper initiation and maintenance of MVB action is insured thusly: The collector of each µL 927 inverter is connected through a diode (D_1 or D_2) to capacitor C_1, which supplies drive to the bases of both inverters. D_1 and D_2 form a logical "OR" gate which allows C_1 to become charged if either or both outputs from the inverter collectors go in the positive direction. Thus, it is impossible for both inverters to be saturated at once since this condition would eliminate both base drives. After the MVB is running normally, the needed charge on C_1 is maintained by alternate conduction of D_1 and D_2.

To insure a square-wave output of about equal rise and fall times, the collector of each inverter is returned to the supply voltage not only through discrete components D_3 R_2 and D_4 R_3, respectively, but also through an integrated resistor inside the Micrologic element. By taking the output across this integrated resistor, the usual degradation of rise time due to charging current from the coupling capacitor (C_2 or C_3) is avoided. This is because the charging current flows through the discrete-component resistor and is isolated from the output by the diode (D_3 or D_4). Although only one output is needed, the external path to the supply voltage is added to both collectors to help maintain symmetry of output.

Operational integrator—The basic operational integrator circuit consists of a third inverter in the µL 927 element with C_6 and R_5 in the feedback loop. Forward-biased diodes D_5 and D_6 provide self-regulating Class-A bias similar to the normal zener biasing method. But, it is more suited to this circuit because of the low voltage bias requirement. Emitter-resistor bias could not be used in view of the low supply voltage (3 vdc). Base bias current is obtained from the collector circuit through the bias diodes and R_7 and R_8. A dc collector voltage of about 1.5 v is fixed primarily by the V_{BE} of the µL 927 transistor and the two diode drops, the voltage dropped across R_7 and R_8 being small. C_7 and R_8 form a low-pass filter that couples the dc component of the collector voltage to the bias diodes. Since the integrator operates only on an ac basis, integrating a symmetrical square wave, C_4 sim-

Fig. 5: A single driver circuit is shown here.



T1

PRIMARY: 2 100T #28
SECONDARY: H_1 10T #26
H_2 25T #26
CORE: FERRITE GC-02

OUT: CROSS SECTIONAL AREA = 1 cm^2

$C_{12,14}$ 1µf/15V
C_{13} 100µf/50V

D_{12-14} FR107
D_{15} 18V 1W ZENER
$R_{16,17,18,20,21,23,24,25}$ 3.3KΩ

$R_{19,22}$ 47KΩ
$Q_{1,2,5,6}$ SE2002
$Q_{3,4}$ SE8002

plifies coupling between the square-wave generator and the integrator by blocking dc voltage.

Differentiator—The differentiator circuit consists of C_5, R_6 and R_9. Since the output of the integrator is introduced at one end of R_9, current summing of the integrated and differentiated waves produces the triangular peaked waveform at the junction of R_6 and R_9. This waveform is directly coupled into one input of the level comparator. The controlling error voltage is introduced into the other.

Level Comparator—The level comparator is a μA 702A analog integrated element operating without feedback. Effect of the dc component of the direct-coupled triangular wave is offset by biasing the operational amplifier in the following manner: pin 4 of the μA 702A, which is normally connected to a negative supply, is grounded; pin 1, the common amplifier input terminal, is operated at +3 vdc, and the positive-supply input terminal (pin 8) at +9 v. Thus, the effective positive and negative supply voltages are +6v and −3v, respectively. A single output, a square wave of controlled duration, is taken from pin 7.

Trigger and inverter—A μL 914 dual 2-input gate connected as a cascaded pair of saturating amplifiers between the comparator and the frequency dividers serves two functions: (1) it insures reliable triggering of the dividers by improving the rise and fall times of the square wave; and (2) it provides complementary inputs to the dividers.

Frequency dividers—Two μL 923 J-K Flip-Flop elements divide the input trigger pulses by two. This provides complementary, symmetrical outputs displaced from each other in time by the width of the input pulse. Suitable negative-going pulses for the trigger (pin 2) input of each divider are obtained by coupling and differentiating the complementary square wave outputs from the μL 914 gates through networks C_8 R_{12} and C_9 R_{13}, respectively. The ambiguity elimination set line goes from pin 5 of the lower binary to pin 1 of the upper. Complementary outputs are obtained from pins 5 and 7 of each binary.

Supply voltage—Needed supply potentials are obtained from the combination resistor-diode divider network consisting of R_{14} and R_{15} and D_7 through D_{11}. Appropriate points are bypassed by C_{10} and C_{11}.

Driver Circuitry

The drivers operate push pull, each device conducting a full 180°. A single driver circuit "H" is shown in Fig. 5. The driver power-output transistors Q_3 and Q_4 are predriven by Q_2 and Q_5. Since the 1v level of the drive voltage signals (H and $\overline{H}$) from the control binaries is insufficient to control predrivers Q_2 and Q_5 directly, voltage-gain stages Q_1 and Q_6 are

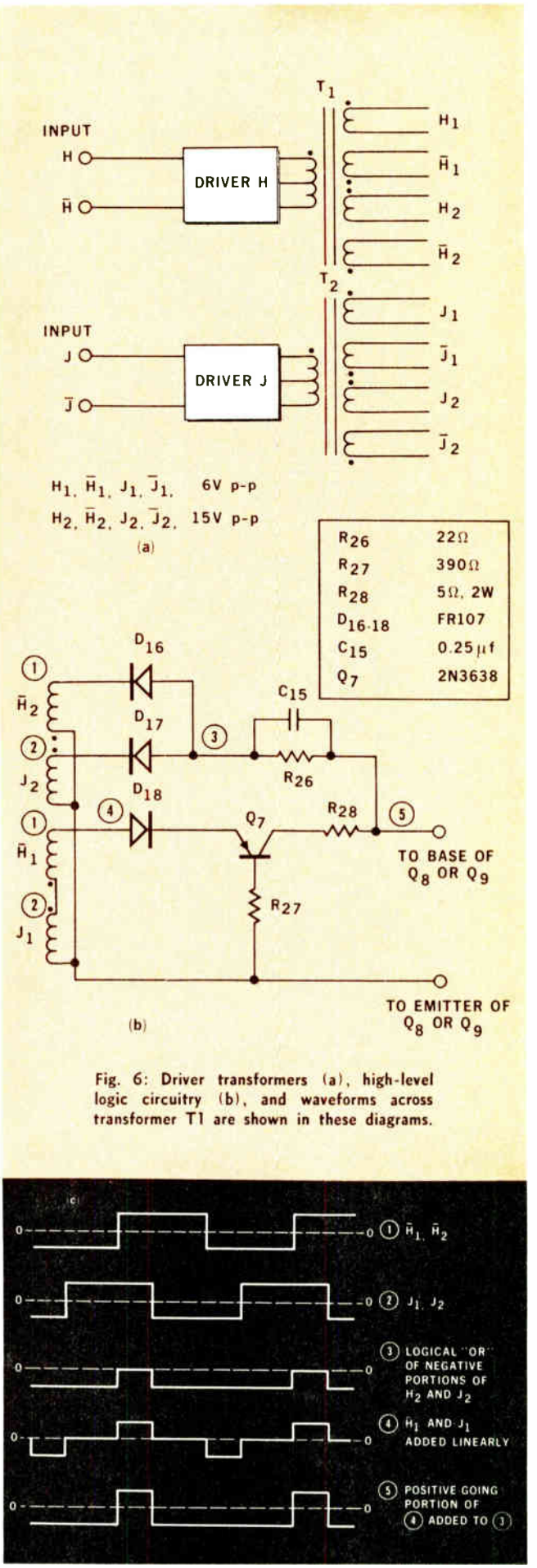


Fig. 6: Driver transformers (a), high-level logic circuitry (b), and waveforms across transformer T1 are shown in these diagrams.

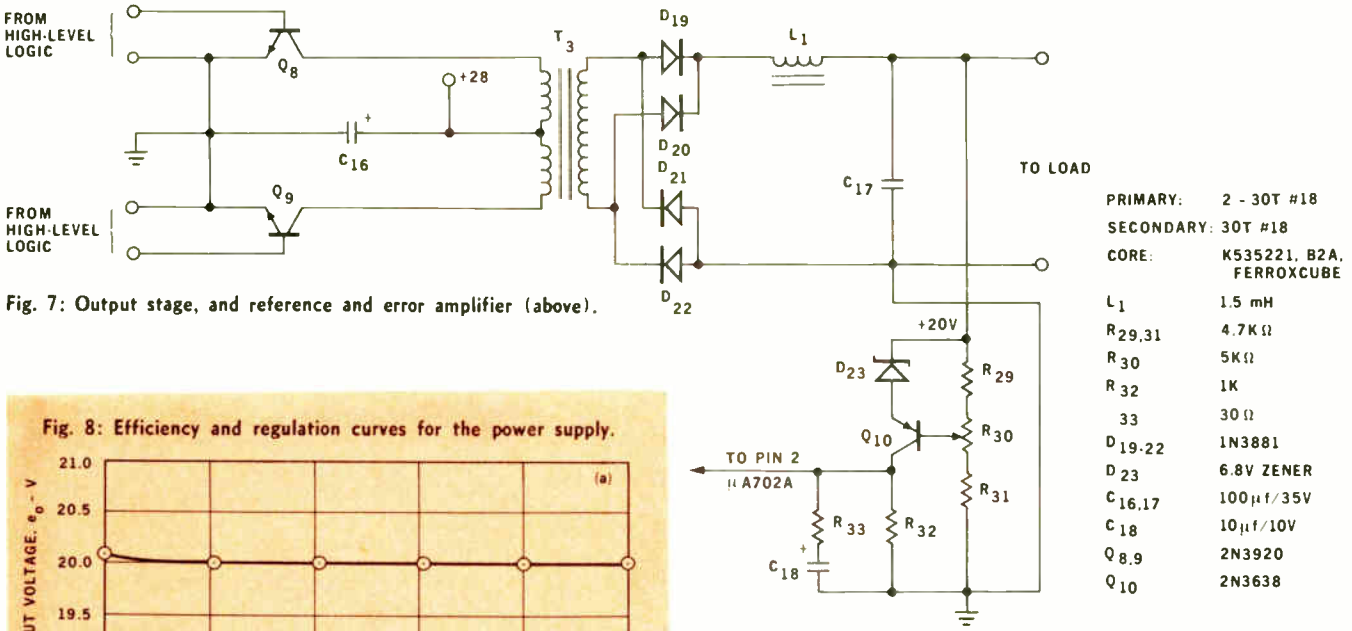
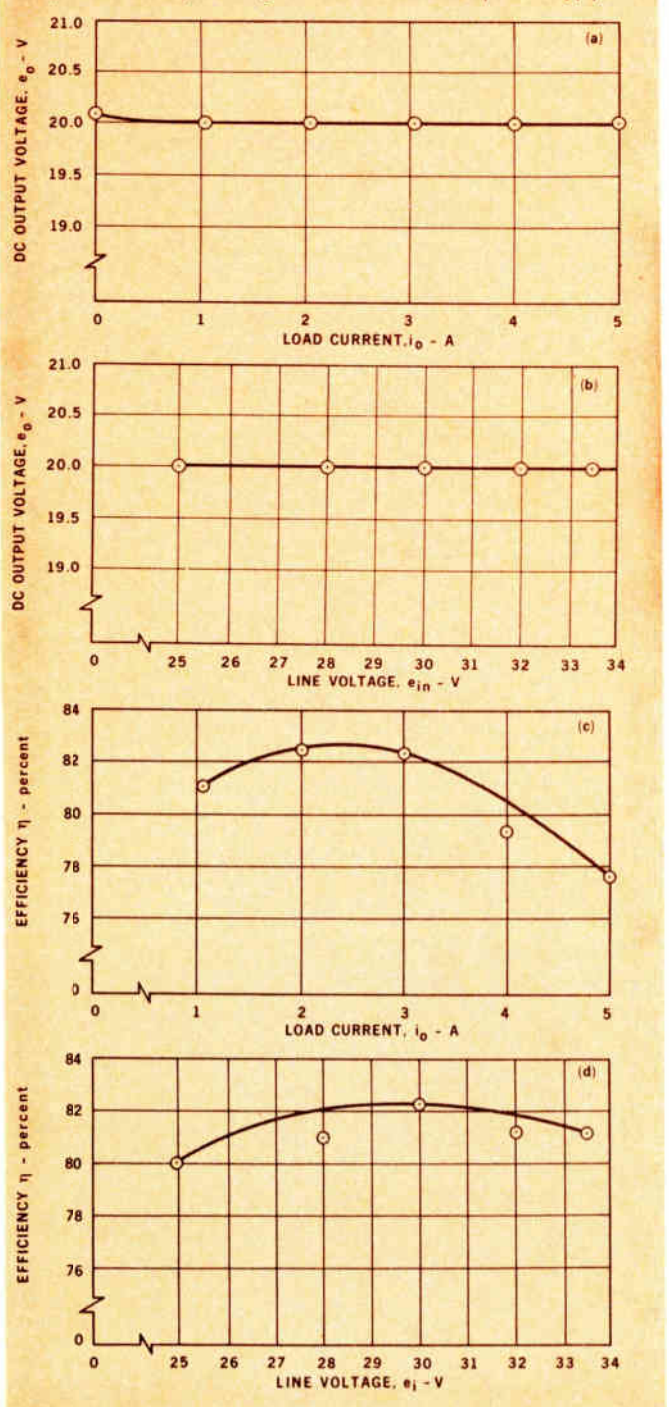


Fig. 7: Output stage, and reference and error amplifier (above).

Fig. 8: Efficiency and regulation curves for the power supply.



MICROLOGIC POWER SUPPLY (Continued)

added. Capacitive coupling is used between the collectors of the voltage-gain stages and the bases of the predrivers. This is done so that, in the absence of drive signals, Q_2 and Q_5, being unbiased, will not conduct. The danger of overdissipation of the output transistors Q_3 and Q_4 is thus eliminated. To provide further assurance of turn-off in the absence of drive, D_{13} is placed in the common-emitter path of both output devices. Direct coupling may be used between the control binaries and the voltage-gain stages to minimize components.

The predriver stages are in the common-collector setup, directly coupled into the bases of Q_3 and Q_4. The predriver collectors are supplied with +10 vdc through D_{15}. The output-transistor bases are referenced to ground by R_{20} and R_{21}. Diodes D_{12} and D_{14} are used for transient damping. They return the energy stored in the leakage inductance of the driver output transformer T_1 to the power supply. C_{13} is a supply bypass.

High-Level Logic Circuitry

Two secondary windings of each driver transformer supply 6 v peak to peak, and two supply 15 v peak to peak, Fig. 6a. The secondary windings are connected

Table 1 TRANSISTOR COMPLEMENT

Device	T_{max} (oper.)	P_{max}	Characteristics h_{FE}	$V_{CE\ (sat)}$	BV_{CBO}	T_S	General Remarks
SE2002 (2N916)	125°C	0.3w at 65°C case	100 – 400 I_C = 10 ma V_{CE} = 1v	0.7v I_C = 10 ma I_B = 1 ma	35v I_C = 0.1 ma I_E = 0	—	General-purpose NPN with low $V_{CE\ (sat)}$
SE8002 (2N3110)	200°C	2.8w at 100°C case	40 – 120 I_C = 150 ma V_{CE} = 1v	1.2v I_C = 1.0a I_B = 0.1a	80v I_C = 100μa I_E = 0	—	Medium-power NPN with low $V_{CE\ (sat)}$
2N3638	125°C	0.42w at 65°C case	30 – 67 I_C = 50 ma V_{CE} = – 1v	– 0.25v I_C = 50 ma I_B = 2.5 ma	– 25v I_C = 100μa I_E = 0	—	Medium-high-current PNP switch
2N3920	150°C	15w at 75°C case	100 – 300 I_C = 2a V_{CE} = 2v	1.2v I_C = 10a I_B = 1a	12.0v I_C = 5 ma I_E = 0	0.5μs turn-on 1μs turn-off I_C = 10a	High-Current NPN switch

Table 2 DIODE COMPLEMENT

Device	BV	I_R	V_F	Characteristics t_{rr}	P_D	Package	Remarks
FD-100 (IN3064)	≥ 75v I_R = 5μa	≤ 100 na V_R = 50v	≤ 1v I_F = 10 ma	≤ 4.0 nsec I_F = I_R = 10 ma, rec. to 1.0 ma	≥ 250 mw	DO – 7 glass*	High-speed switch
FR – 107	≥ 250v I_R = 500μa	≤ 500 na V_R = 150v	≤ 1v I_F = 1.0a	≤ 100 nsec I_F = 1.0a V_R = 30v	≥ 1.0w	1W glass	High-speed rectifier

*FDM1000 low-cost epoxy unit can be used in commercial/industrial applications (T_A < 125°C)

to the high-level logic circuits (Fig. 6b). These supply symmetrical, positive-going pulses (waveform 5, Fig. 6c) to the output switching devices.

Turn-off Waveform—Waveform 3 in Fig. 6c is generated by combining $\overline{H}_2$ and J_2 in an OR gate. When either $\overline{H}_2$ or J_2 is negative, 3 is negative; otherwise it is zero. D_{16} and D_{17} (Fig. 6b) assure that only a negative-going output will appear at 3. Capacitor C_{15} determines the charge initially removed from the output transistor base to effect turn-off. R_{26} serves two functions: (1) it provides a direct path to the output transistor base to maintain cutoff; and (2) it supplies a discharge path for C_{15} so that C_{15} will be ready to absorb charge on its next operating cycle. Note that Waveform 5 at the output transistor base is alternately negative for turn-off and positive for turn-on.

Turn-on Waveform—When $\overline{H}_1$ and J_1 are of the same polarity, Waveform 4 is of this polarity, but when $\overline{H}_1$ and J_1 are of opposite polarity, no voltage appears at 4. The magnitude of 4 is the linear sum of $\overline{H}_1$ and J_1. During the turn-on interval D_{18} is forward-biased and the base drive applied to Q_7 through R_{27} is negative, so that Q_7 is driven into saturation. Thus a path exists to the output transistor base (5) for a turn-on current whose magnitude is limited by R_{28}.

Isolation—Isolation between the turn-on and turn-off circuits is provided as follows: during the turn-off interval when $\overline{H}$ and J are negative, D_{18} is reverse-biased and Q_7 is held off by the positive signal on its base. Thus no path for current flow from point 3 to point 4 exists. During the turn-on interval, when $\overline{H}$ and J are positive, $\overline{H}_2$ and J_2 are of larger amplitude than $\overline{H}_1$ and J_1. Current flow is therefore prevented by reverse bias on D_{16} and D_{17}.

Switching Amplifiers, Bridge Rectifier, and Filter

As shown in Fig. 7, the output stage consists of two switching power amplifiers, Q_8 and Q_9, transformer-coupled to the rectifier and filter circuitry. This circuitry supplies a constant dc voltage to the load and to a reference amplifier (Q_{10}) use for voltage regulation. Transistors Q_8 and Q_9 are arranged in push-pull and held alternately on and off by positive- and negative-going signals from the high-level logic circuitry. C_{16} bypasses the power input terminal, providing a low-impedance path to ground for the load current. Coupling transformer T_3 operates as a linear transformer. A bridge (D_{19}, D_{20}, D_{21}, and D_{22}) is used to rectify the output. Alternatively, a full-wave

(*Continued on page 134*)

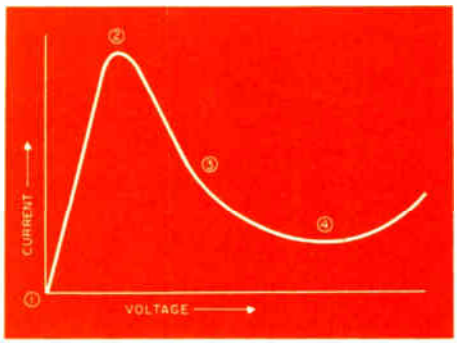


Fig. 1: Here is a typical tunnel diode characteristic curve.

Interest in tunnel diodes has gone up and down

Some of this fluctuation is due to a lack of under-

Understanding the TUNNELLING PHENOMENON

By CHARLES K. ADAMS

THE OBJECT HERE is to present a simplified explanation of why the tunnel current exists. This involves the use of quantum physics. The basic groundwork for the understanding of quantum physics is given. If you wish to look deeper into quantum physics, then check the references given at the end.

The tunnel diode is a two terminal, PN junction device, showing negative resistance characteristics for certain values of bias voltage. Fig. 1 is a normal tunnel diode curve. The region in which the current decreases as the voltage increases is the negative resistance region. It is in this region that the diode must operate. The name, tunnel diode, arises from the fact that electrons *appear* to "tunnel" through the PN junction when working in the negative resistance region.

Quantum Physics

When one delves into the sub-atomic world, i. e., a world that is not apparent, classical physics has reached its limits. It is more concerned with the overall effects, such as the diffraction of a beam of light. And as such, it must give way to quantum physics, which is concerned with the sub-atomic world, a world made up of particles.

The deBroglie equation; $\lambda = h/mv$; is the assumption upon which deBroglie based his work in quantum physics. This equation gives the relationship between the electron wavelength and the electron energy, where:

λ is the deBroglie wavelength of the particle.

h is Plancks' constant, a universal constant of nature.

m is the mass of the particle in question.

v is the velocity of the particle.

This equation says that if the electron is allowed to have an infinite number of wavelengths, there would be an infinite number of energy levels for the electron. But an electron must occupy an orbit of an atom. And, for an electron to occupy an orbit, the deBroglie half-wavelength must fit an integral number of times into the length of the orbit. An electron orbit cannot support any other wavelengths because of wave attenuation.

Bohrs' model of the atom gives a finite number of allowable orbits for an electron. Hence, there are a finite number of energy bands available for an electron. We say bands, because there are several energy levels within each band. The electrons in the same orbit interact to make several energy levels within the band. Each electron within a shell will occupy a different energy level within the energy band for that shell.

These bands are wide apart, with the region between the bands called the forbidden region. For in this region no energy levels can exist. This is because the deBroglie equation does not allow any energy levels there.

There are several of these bands. But, we are interested in the uppermost forbidden band, the band below this, (the valence band), and the band above this, (the conduction band).

For an electron to become a current carrier, it must occupy an energy level in the conduction band. Also there must be a hole, or absence of an electron, at the same energy level for the electron to move to.

The width of the forbidden band is zero for a conductor. Therefore, many electrons are available for conduction. For the insulator and semiconductor, the forbidden band will prevent most electron movement.

since the discovery of the tunnelling phenomena. Interest is again on the up cycle.

standing of the basics. Here is a chance to get up-to-date with this concise explanation.

Dept. 411, McDonnell Aircraft Corp.
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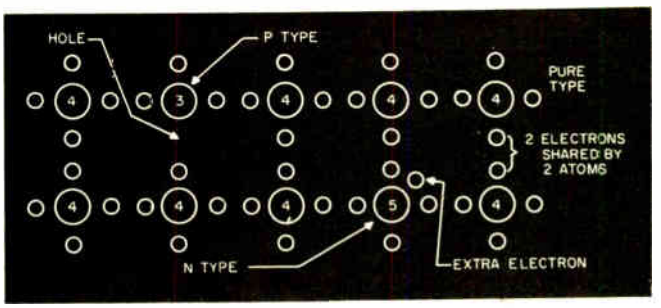


Fig. 2: The atomic diagram is illustrating a pure P, and N type of semiconductors.

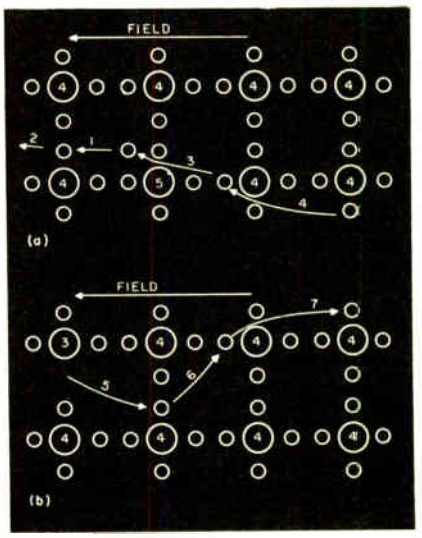
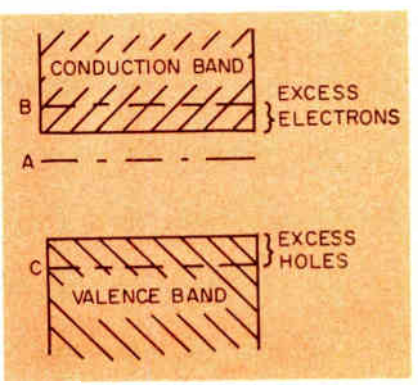


Fig. 3: An atomic diagram for a N (3a) and a P (3b) type semiconductor showing the electron and hole movement in the material.

Fig. 4: Energy diagram showing the Fermi levels for doping levels of: A, N type of 10^{15} atoms per cc; B, N type, and; C, P type, both of 10^{19} atoms per cc.



The Atomic Diagram

A semiconductor has 4 valence electrons. These are the electrons in the outer orbit of the atom. The 4 electrons combine with 4 other atoms, as shown in Fig. 2, to form a neutral crystal. Now, if an atom with the valence of 5 is added, there will be an extra electron that does not fit into the normal pattern of the crystal. This atom has an electron that is not shared by 2 atoms, as shown in Fig. 2. Because this electron is bonded to only one atom, the energy required to free it is less than one shared by 2 atoms.

Once this electron is released from its parent atom, it floats around the crystal until it is trapped by a hole. This is a N type impurity because of the extra electron, or negative charge.

If an atom with the valence of 3 is added, there will be an absence of an electron, or a hole in the normal crystal structure. The result is a positive charge, which can trap free electrons. This is a P type impurity because of the extra hole, or positive charge.

Now let us apply a field to the crystal in the direction shown in Fig. 3. For the N type impurity, the field will supply enough added energy to elevate the extra electron to the conduction band and release it from its parent atom. This is shown by arrow 1 of Fig. 3a. This electron collides with another electron, and releases it (arrow 2). Meanwhile the hole will attract an electron from a neighboring atom, (arrow 3). Then another electron will be released from its parent atom to fill the hole created by 3 (arrow 4). The result is that an electron has moved to the left side and a hole to the right side. *(Continued on following page)*

For the P type impurity, the field will supply the energy required to move the hole to the right, as shown in Fig. 3b. In this sketch the arrows represent hole movement. The original hole will move to a neighboring atom, which gives up an electron to the hole (arrow 5). This hole will, in turn, migrate toward the right side (arrows 6 and 7), as electrons move toward the left. The net result is that an electron is on the left, trapped by the original hole, and a hole is on the right side.

Fermi Level

The fermi level is defined as the energy level at which the probability of finding an electron 'n' energy units above it is the same as that for finding a hole 'n' energy units below it.

For a pure semiconductor, the fermi level is in the center of the forbidden band. The reason is that there are no electrons in the conduction band, and no holes in the valence band.

If some N type impurity is added, the fermi level will shift upwards. Because the energy level of the added electrons is greater than the electrons of the semiconductor. The more impurity atoms that are added, the more the fermi level will shift, as shown in Fig. 4. If some P type impurity is added, the fermi level will shift down.

If the impurity content is high enough, the fermi level will fall in the valence or conduction band, as for tunnel diodes.

When a PN junction is formed, the crystal is one continuous atomic structure. Therefore the fermi level for the P and N sides of the junction will be at the same energy level.

When the fermi levels line up, the energy bands stay in the same relative position with respect to the fermi levels. This means that electrons have to shift from the N to the P region, and holes have to shift in the opposite direction. Therefore the P region has a net negative charge, and the N region has a net positive charge. This gives a potential barrier at the junction that opposes current flow. The results are shown in Fig. 5, which is the energy diagram for an unbiased tunnel diode.

If a potential barrier (such as the junction) is placed in the path of electron flow, classical physics states that all electrons will be reflected from it. This is assuming that the energy of the electrons is not great enough to go over the top of the barrier.

But quantum theory states that there is a possibility that some electrons will 'tunnel' through the barrier, as though it never existed. What actually happens to the electron while tunnelling is not fully understood. It is similar to electron flow in a wire. It is upon this fact that the tunnel diode was conceived.

As the barrier width decreases (or the transition from the N to the P region becomes narrower) the probability that an electron will tunnel increases. Also, as the energy of the electron increases, the tunnelling probability increases.

Fig. 5: This is the energy diagram for point 1 of the curve in Figure 1.

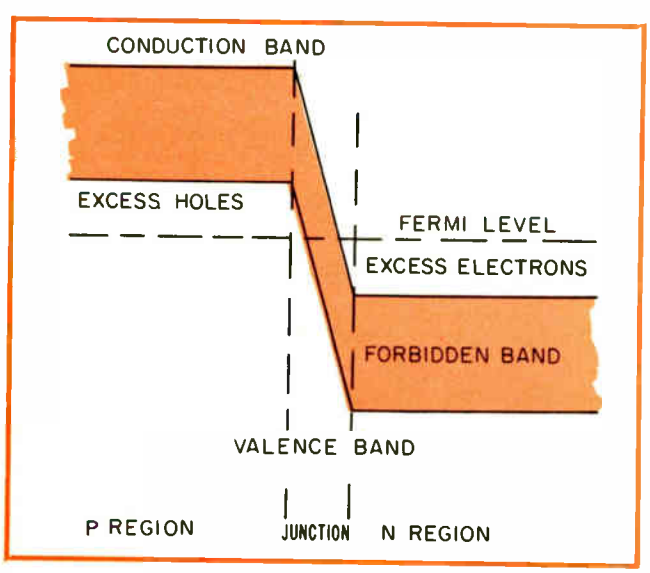
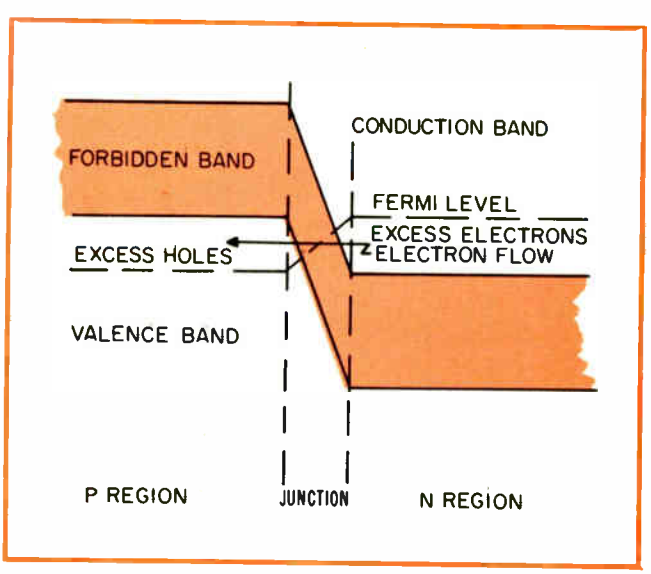


Fig. 6: Referring to Fig. 1, this is the energy diagram for point 2, the peak.



Tunnel Current

For tunnel current to flow, 3 conditions must be met. These are:

1, the junction must be very narrow;

2, several electrons must be available for tunnelling;

3, a hole must exist on the opposite side of the junction, at the same energy level.

The physical and atomic construction of the diode takes care of the first two items, while biasing takes care of the third.

Fig. 5 shows the energy diagram with no bias applied. This corresponds to point 1 on the curve of Fig. 1. The excess electrons are at the same energy level as the electrons on the other side of the junction, so no current flows.

As the bias is increased, the energy level of the excess electrons will increase with respect to the energy level of the excess holes. This will cause some overlap between the excess electrons and the excess holes. There will be some current flow, represented by a horizontal transition across the forbidden gap. Fig. 6, corresponding to point 2 of Fig. 1, shows the condition for peak current. At this point the added electrons and the excess holes are at the same energy level, so maximum tunnel current flows.

If the bias is increased still more, the electron energy will increase. Therefore the added electrons and holes will be offset from each other, with the electrons at the higher energy level. This will reduce the tunnelling current. This is shown in Fig. 7, which corresponds to point 3 on the curve.

At about point 3, a small amount of 'excess' current begins to flow. This current cannot be explained by tunnel theory, and is not easily explained by normal diode current. This excess current can be looked at as electrons obtaining enough energy to climb the barrier. This is shown by the dashed arrow of Fig. 7. It is this excess current which causes the non-linearity in the lower region of the negative resistance part of the curve.

If the bias is increased still more, the excess electrons will become more offset from the excess holes. This is shown by Fig. 8, which corresponds to point 4 of Fig. 1. The added electrons are at a higher energy level than the excess holes, so no tunnel current flows. The current at this point is excess current, as shown by the arrows.

As the bias is increased still more, normal diode current will flow, and the curve follows a normal diode curve.

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Fig. 7: Again, looking at Fig. 1, this is the energy diagram for point 3.

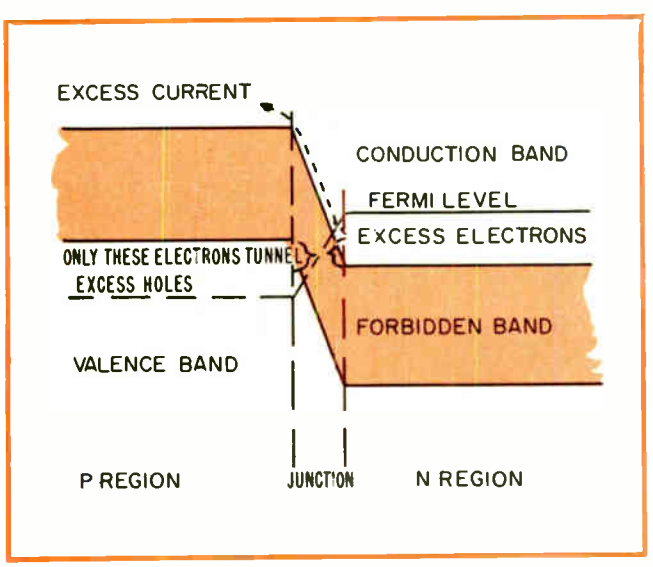
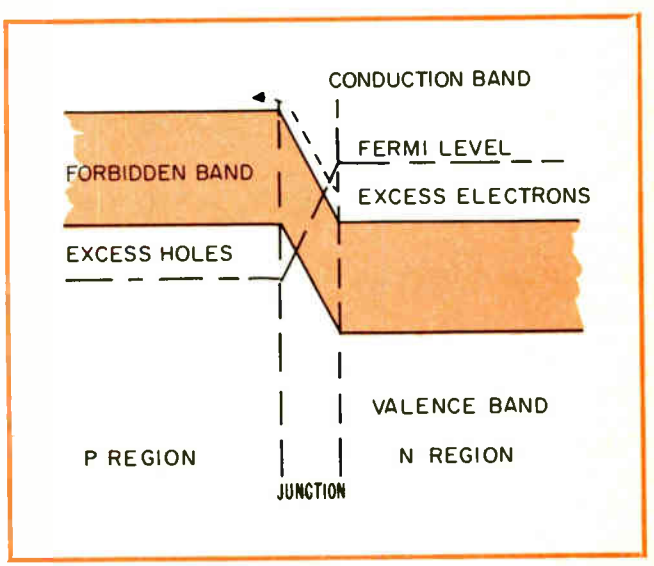


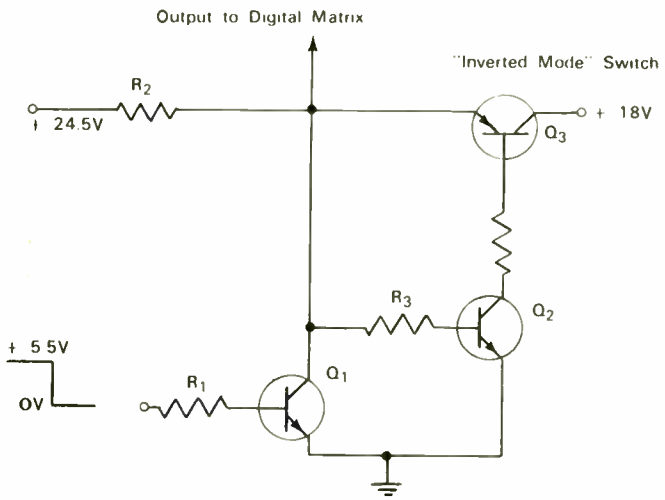
Fig. 8: And last, the energy diagram for the valley of the curve in Fig. 1.



CIRCUIT WISE

Circuit Clamps Voltage Within 0.1%

WE NEEDED TO APPLY two accurately clamped voltage levels (+ 18 or 0 volts) to the input of a digital-to-analog resistive matrix that binarily develops a deflection staircase. A transistorized clamping circuit that clamps either of two voltage levels (+ 18 or 0 volts) with less than 0.1% voltage offset did the job.



When a positive 5.5v level is applied to the base of transistor Q_1 through resistor R_1, transistor Q_1 is driven into saturation. In this state, the collector-emitter voltage of transistor Q_1 is about 30mv and is relatively independent of temperature. The output of transistor Q_1 is applied directly to the digital matrix and to the base of transistor Q_2 through resistor R_3. This holds transistor Q_2 at cutoff, which in turn keeps transistor Q_3 (operating as an "inverted-mode" switch) biased off.

When a zero-volt level is applied to the base of transistor Q_1 through resistor R_1, transistor Q_1 is biased off. Transistor Q_2 is driven into saturation by current from the 24.5v supply through resistors R_2 and R_3. The output of transistor Q_2 turns transistor Q_3 on and allows the 18v supply to be applied through transistor Q_3 to the digital matrix. The collector-emitter voltage in transistor Q_3 is about 5mv.

Whereas ideal output levels are 18.0v and 0.0v, actual performance obtainable is 18.005v ± 5mv, and 0.030v ± 15mv. Although the speed of operation of this clamping circuit technique is limited by the charge storage in transistor Q_1, it may be useful for analog, digital, and hybrid circuit applications.

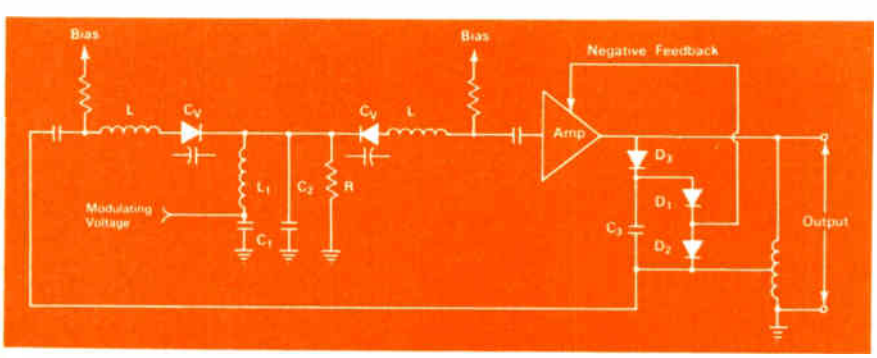
For further information contact: Technology Utilization Officer, Goddard Space Flight Ctr., Greenbelt, Md., 20771. Ref. B65-10118.

VOLTAGE VARIABLE OSCILLATOR

ALTHOUGH FREQUENCY-MODULATED OSCILLATORS are available, their uses are restricted by certain operating limitations. In LC or reactance-tube oscillators, relatively low levels of phase stability are normal, and in piezoelectric crystal oscillators, modulation is limited to a fraction of a percent of the center frequency.

A voltage variable oscillator using a low noise, phase stable amplifier with negative feed-back, plus two (or more) series resonant LC circuits for high phase stability and optimum frequency deviation was used.

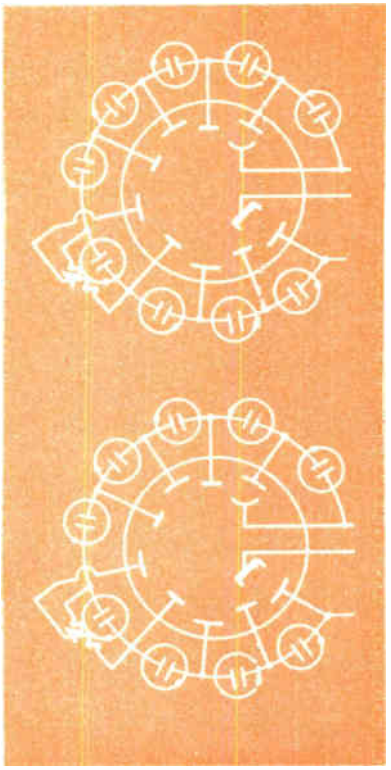
The resonant part of the oscillator consists of two identical series resonant circuits, each consisting of an inductor (L) and a voltage variable capacitance (C_v) loosely coupled by capacitor C_2. Since C_v is a voltage variable capacitance, the oscillator frequency can be varied by applying a modulating voltage.



A low-pass filter section, consisting of C_1, L_1 and C_2 is used to isolate the r-f oscillator signal from the modulating signal. The filter load resistor R has a resistance much greater than the capacitance reactance of C_2 at the oscillation frequency.

Amplifier negative feedback is done by the network consisting of C_3, D_1, D_2 and D_3. A dc voltage proportional to the oscillator output voltage is developed across D_3 and C_3 and applied to the h-f point contact diodes D_1 and D_2. If the amplifier output tends to increase, the higher output signal reduces the dynamic resistance of D_1 and D_2 and negative feedback to the amplifier increases to maintain a constant output signal level.

For further information contact Technology Utilization Officer, Langley Research Ctr., Langley Sta., Hampton, Va. 23365. Ref.: B65-10204.



ELECTRONIC INDUSTRIES
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Precise Voltage Regulation for Photomultipliers

The product of the previous dynode stages is multiplied at each dynode stage of a photomultiplier tube. To preserve any semblance of accuracy or predictability, the voltage at each stage must be precisely controlled. A method of providing this close control is provided here.

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THE MODERN CONCEPT OF PHOTOELECTRICITY stems from Einstein's genius and the development of the quantum theory. His classic equation, $E = \frac{mv^2}{2} = h\nu - \phi$, tells us that the maximum energy of the emitted photoelectron, $\frac{mv^2}{2}$, is proportional to the energy of the light quanta $h\nu$ less the energy of the work function ϕ which must be given to an electron to allow it to escape the surface of the photocathode. The real progress that has been made in photosensitive cathodes, however, has paralleled the development of semiconductors and solid state technology.

The use of semiconductor materials instead of metals as the photoemitter cathode has an important advan-

PHOTOMULTIPLIERS (Continued)

tage. The advantage is that their quantum efficiency in the visible spectrum exceeds that of the metals by a much higher ratio. It is up to 30% for semiconductors versus up to 0.1% for metals. These semiconductor materials have made possible special amplification methods which are used in the photomultiplier tubes.

Secondary Emission

Photoelectric emission is a relatively efficient process on a per quantum basis. But, the primary photocurrent for low light levels is so small that secondary electron emission is needed to provide enough current amplification to be useful. In the photomultiplier tube, photon energy impinging on a photocathode causes electron emission. These electrons are directed to a secondary emitting surface called a dynode. Impingement of the primary electron on the dynode causes 3 to 6 secondary electrons to be emitted per primary electron. These secondary electrons are directed to a second dynode where the process is repeated. Photomultiplier tubes may have as many as 14 dynodes. The last dynode is followed by an anode which collects the electrons and provides the output signal.

Coupling and focusing of multiple secondary-emission stages (dynodes) so that the secondary electrons from one become the primary electrons of the next results in a total gain which is an exponential function of the number of stages. This gain is described as a function of the voltage applied to the dynodes.

Need for a Regulated Supply

This indicates the need of providing a well regulated voltage supply for each of the dynode stages. A photomultiplier can be operated so that each stage is at the voltage needed for maximum secondary emission. But, such a condition would require about 500 v. per stage. The more normal and practical approach is to operate each dynode at the voltage which produces the maximum gain per volt. While this voltage varies from tube to tube, it is generally about 70 to 100 v. Thus, again we see the need for closely regulated voltage supplies.

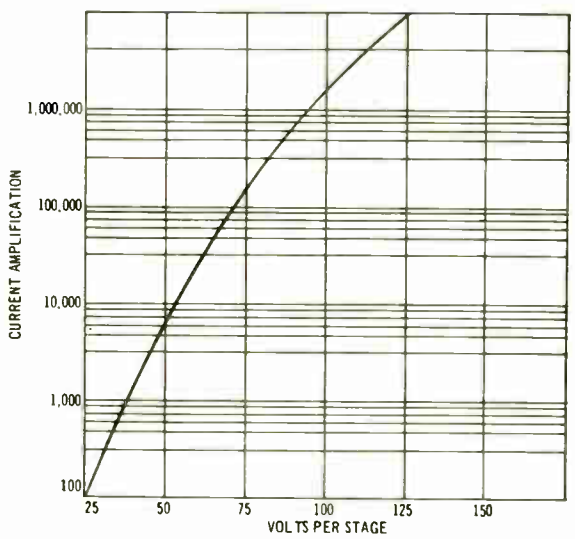

Fig. 1: Average amplification of Type 931-A photomultiplier.

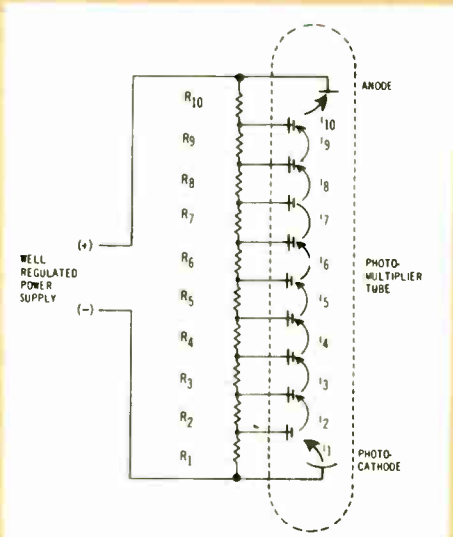

Fig. 2: Simple voltage divider net for a multiplier phototube.

Photomultiplier Classifications

The method by which electrons are directed from dynode to dynode determines photomultiplier classification. They may be classified as unfocused, electrostatically focused and electromagnetically focused. In unfocused structures such as the grid, Venetian-blind and box types, electrons are simply accelerated from dynode to dynode by means of grids. In electrostatically focused types a portion of each dynode serves to shape the electric field between dynodes so that secondary emission from one dynode is focused upon the optimum area of the following dynode. Mutually perpendicular electric and magnetic fields provide similar focusing of secondary electrons in electromagnetically focused photomultipliers.

An electrostatically focused type with nine dynode stages before the collector anode may result in an overall gain of about one million at 100 v. per dynode stage. Variation of the amplification factor with the voltage per stage is shown in Fig. 1 for a typical 931-A tube. It can be seen that the gain is affected

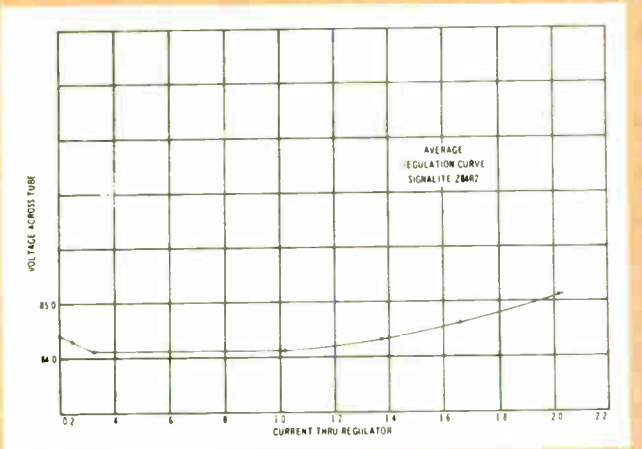

Fig. 3: Average regulation curve for Signalite Z84R2.

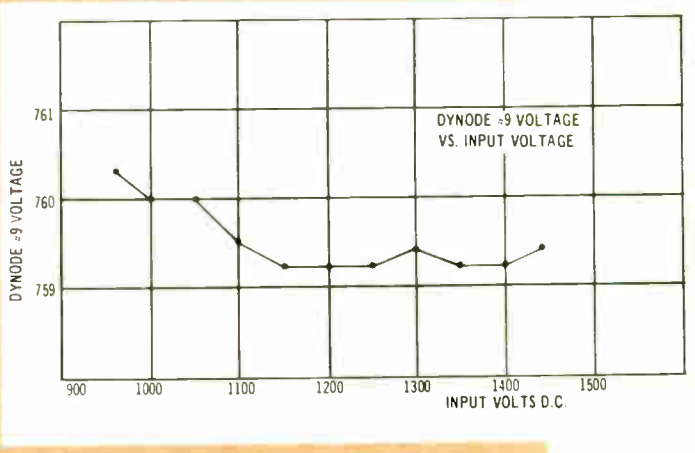

Fig. 5: Dynode number 9 voltage vs. input voltage.

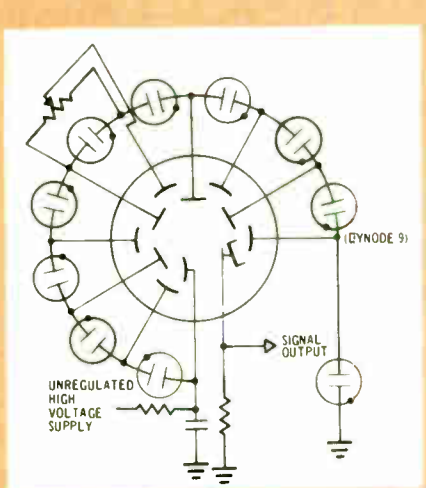

Fig. 4: Voltage regulation of dynodes of a photomultiplier tube using cold cathode voltage regulators (Signalite Z84R2).

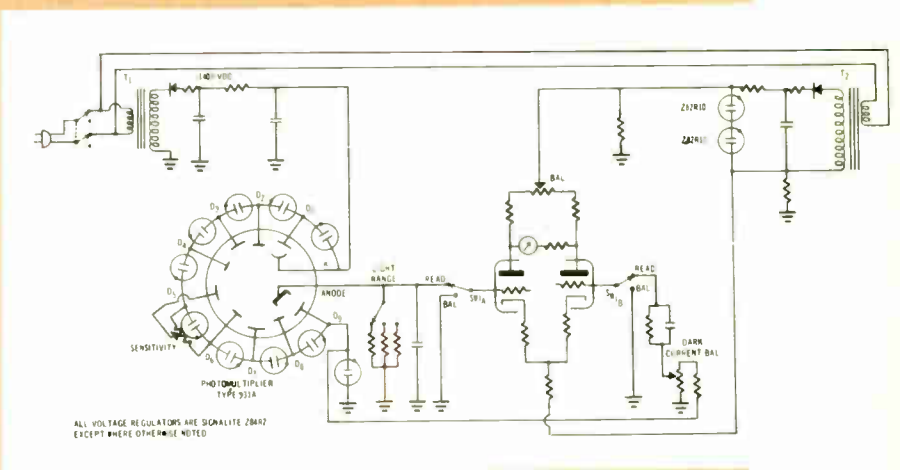

Fig. 6: Typical photometer circuit.

either by variations in the stage voltage of all the dynodes, or in the voltage of just one dynode. Thus, the photomultiplier amplification depends on the characteristics of the circuit supplying the needed interelectrode operating voltages. When this circuit is a simple resistive voltage divider, interstage currents of the tube may alter distribution of the dynode voltages. This may be done in a manner which causes limiting of the output current and loss of gain due to electrostatic defocusing and electron skipping of dynode stages.

Most common type of voltage divider used for the tube is a series of resistors which divide the applied voltage equally or unequally among the various dynode stages as needed by the tube's electrostatic focusing system. Fig. 2. In some uses the interstage currents are negligible compared with the divider current. Also, the relation between output current and light flux is linear. When there are large variations in light level, these interstage currents are not negligible. This reduction in current produces the greatest loss between the last dynode and the anode. If the total applied voltage is kept constant, the voltage lost in the output stages is redistributed among the preceding stages in a nonuniform manner. This causes unequal changes in the gain of the affected stages. It may cause electro-

(*Continued on page* 136.)

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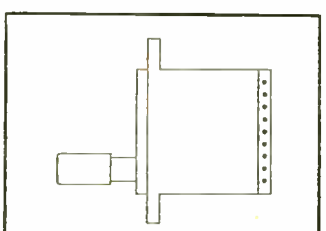

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Part 2: Pushbutton Switches

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PART 2 highlights hand-operated mechanical pushbutton switches for computers, video switching systems, intercoms, radios, audio, light-duty machinery, amusement equipment, lighting, medical apparatus, signaling, test equipment and other DC, AC, audio and high-frequency control and communications applications. The charts identify each supplier with the types and classes of switches he offers, and list the basic electrical and physical data under appropriate headings. AC and DC current ratings are nominal values for resistive loads at the voltages given. An "X" in a column indicates that the product conforms to all the categories listed under the heading.

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Adolet Mfg. Co. 4801 W. 150th St. Cleveland, Ohio 44135	*	C	1	X			1,2	DT	to 2	to 10	to 600	B	SC		0.7 dia.
*Explosion proof types only	*	R	2	X			1,2	DT	to 2	to 10	to 600	B	SC		
Alcoswitch Lowrence, Mass.	MSP	C	1	C	S	SN	1,2	DT		5	115	B	T	0.7	0.5
	MSP-205N	C	1	C	L	SN	2	DT		5	115	B	T		
Allen-Bradley Co. Milwaukee, Wisc.	800/800T*	C	1		X			DB		6	120		SC		
	—	C	1		X			DB		3	240		SC		
	—	C	1		X			DB		1.5	480		SC		
	—	C	1		X			DB		1.2	600		SC		
	—	C	1		X			DB	0.2		550		SC		
	—	C	1		X			DB	0.5		235		SC		
	—	C	1		X			DB	1.1		115		SC		
*Oil tight															
Ark-Les Switch Corp. 51 Water St. Watertown 72, Mass.	2900	R	to 8	C		L		to 7-ckts		25	120		X	1.3	0.5*
	—	R	to 8	C		L		to 12-ckts		25	120		X	1.5	0.7*
*Button spacing, centers															
Arrow-Hart & Hegeman Electric Co. Hartford, Conn. 06106	80511-3	C	1		S		1	ST		3	120	B	X	0.5	
	82931-3	C	1		S		2-ckt			3	120	B	X	0.5	
	82791-3	C	1		S		1	ST		3	250	B	X	0.6	
	—	C	1		S		2	DT	3	3	125	B	X	0.6	
	—	C	1		S		1,2	DT	1	1	125	B	X		
	—	C	1	C	L		1,2	DT	3	3	125	B	X		
	82383	C	1		S		1		8	8	125	B	X		
	82546	C	1		S		1		10	10	125	B	X		
	80938	C	1		S		1,2	ST	15	15	125	B	X	0.9	
	80710	C	1		L		1,2	DT	3	3	250	B	X	0.5	
	82403	C	1		L		1,2	DT	6	6	125	B	X	0.6	
	81105	C	1		L		1,2	DT	6	6	125	B	X	0.7	
	81946-51	C	1		L		1,2	DT	15	15	125	B	X	0.9	
	PM	C	1	C	C		1-3	DT	2		29	B	T	0.3	0.5
	PMQ	C	1		L	SN	1	DT	5		29	B	T	0.3	0.5
Capitol Machine & Switch Co. 36 Balmforth Ave. Danbury, Conn. 06813	HP	C	1	I	S	S	2	C		3	110	B	T		
	PSB	R	1	I	S	S	2	C		3	110	SC	T		
	S	X	to 20	X	X	S	2	C		3	110	SC	T		
Corling Electric, Inc. West Hartford, Conn. 06110	110	C	1		X		1	ST	6	6	125	B	X	0.5	
	160	C	1		X		1	ST	10	10	125	B	X		
	316	C	1		X		2	DT	3	3	125	B	T/L		
	FA761	C	1	C	S		1	ST		6	250	B	X		
	FA751	C	1	C	S		1	ST		10	250	B	X		
	90	C	1		S					2	250	SC			
	D	C	1		X		1,2	ST	16	16	125	B	SC	0.7	1.8
	E	C			X		1,2	ST	20	20	125	B	SC	0.8	2.1
Carter Precision Electric Co. 3401 W. Madison St., Skokie, Ill. 60078	S6	C	1	C	S	SN	1	A-C		2	115	B	T	1	0.7 dia.
Chicago Dynamic Industries 1725 Diversey Blvd. Chicago, Ill. 60614	PB-DN	C	1	I	L		10(Decimal switch)			3	115	SC		2.7	2.5
	—	C	1	I	L		10(Binary switch)			2	115	SC		2.7	2.5
Chicago Switch Div., F & F Enterprises 1733 Milwaukee Ave. Chicago, Ill. 60647	203-016	C	1	C	L	SN	4	C				B			
	203-029	S	1	C	L	SN	6	C				S			

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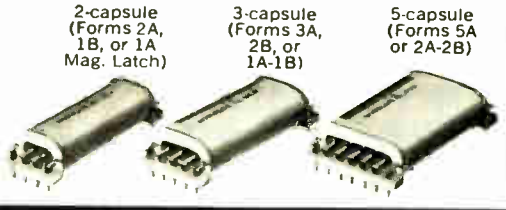
That's because PC CORREEDS* are specifically designed for direct insertion into standardized grids. Terminals are located on multiples of 0.200-inch centers. And all terminals are designed to fit standard 0.062-inch holes; permit the use of small wiring pads. Standardized terminal size and spacing also allow for greater packaging density.

In addition to this feature, PC Correeds have separate terminals to eliminate strain on the glass capsule. These terminals are "ribbed" for added strength and rigidity, and are welded . . . not soldered . . . to the capsule leads. Individual capsules can be removed without having to remove the entire package. The bobbins are made of glass-filled plastic for greater strength and to eliminate breakdown due to moisture absorption.

For the full facts on how these new AE Printed-Circuit Correeds meet the requirements of modern electronic circuitry, write to the Director, Electronic Control Equipment Sales, Automatic Electric, Northlake, Illinois 60164.



*Patent applied for.

AUTOMATIC ELECTRIC

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PUSHBUTTON SWITCHES	Type No. or Series	Round Button(C); Square(S); Bar(R)	Buttons Per Switch Assembly	Illuminated(I); Colors(C)	Momentary Action(S); Latching(L)	Snap Switch(SN); Leaf(S); Slide(SL)	No. of Poles Per Station	Contact Form	Nom. DC Amps.	Nom. AC Amps.	Nom. Volts	Bush.Mtg.(B); Screws(SC); Snap-In(S)	Lug Terms.(T); Screws(SC); Leads(L)	Body Depth Behind Panel (In.)	Body Length (In.)
Controls Co. of America, Control Switch Div. 1420 Delmar Dr. Folcroft, Pa.	W9623	C	1		L	SN	2-ckt	10		28	B	SC/T		
	W403P6	C	1				2-ckt	10		28	B	T		
	W1501	C	1				4-ckt	4		28	B	T		
	J334PT	C	1		L		DT	1		28	B	T		
	B2000	C	1	C	S	SN	DB	3		28	B	T		0.6 dio.
	B7070/80	C	1	C	S	SN	2-ckt		3	115	B	T		0.5 dio.
	B5000	C	1	C	S	S	2-ckt	3		28	B	T		0.6 dio.
	WC1500	C	1	C	S	SN	4-ckt	2		28	B	T	1	
	A4-5103	C	1		S	SN	DT		5	120	B	T	0.6	0.8
	A4-18-103	C	1		S	SN	DT		5	120	B	T	0.7	0.8
	A4-6-103	C	1		S	SN	DT		5	120	B	T	0.6	0.8
	A4-86-103	C	1		S	SN	DT		5	125	B	T	0.9	0.8
	A4-14-103	C	1		S	SN	DT		5	125	B	T	0.8	0.8
	A4-332-103	C	1	C	S	SN	DT		5	125	B	T	0.9	1.2
	J4010	C	1	C	L	SN	DB		4	115	B	T		
	A4-87-103	C	1	C	L	SN	DT		5	115	B	T		
	B7000	C	1	C	S	SN	NO/NC		5	125	B	T		0.3 dio.
	C100	C	1	C	S	SN	NO		10	125	B	T		
	J4004	C	1	C	L	SN	DT		10	125	B	T		0.5 dia.
	A4-2/K3-4	C	1		S	SN	6-ckt		15	125	B	T		
	D200	C	1		S	SN	NO	35		28	B	T	0.8	
	A4-50/G3-8	C	1		S	SN	2-ckt	40		30	B	T	0.9	
Cutler-Hammer Inc. 436 W. 12th St. Milwaukee, Wisc.	8455	R	1	I	X		2	DT	5	5	125	S	T	1.5	0.5
	8452	R	1	I	X		1	ST		6	125	B	T	0.9	0.6
	8096	C	1		S		1	ST	5	5	12	SC	SC	0.8	0.7
	8406	R	1		S		1	ST	0.7	0.7	125	SC	T/SC	1	1.8
	8410	C	1		S		1	ST	0.7	0.7	125	SC	T/SC	1	1
	7106	C	1		L		1	ST	5	5	125	B	SC	0.8	1.5
	8440	C	1		L		1	ST		3	125	B	T/SC	0.7	0.6
	8446	C	1		L		1	DT		15	125	B	T/SC		1
	8448	C	1		L		2	ST		15	125	B	T		1.3
Dialight Corp. 60 Stewart Ave., Brooklyn, N.Y. 11237	—	C/S	1	X	S		1	A-F		3	125	B	T		
Donald P. Massmon, Inc. P.O. Box 265 Brewster, N.Y. 10509	7600	C	to 12	X	L	S	20**	A-D		3	110	SC	T	2.6	9
	7700	C	to 12	X	L	S	20**	A-D		3	110	SC	T	4.3	10.3
	5900	C	to 12		L	S	20**	A-C		3	110	SC	T	2.6	10.2
	536*	C	1	X	X	S	14**	A-E		3	110	SC	T	3.5	
	5600*	C	1		X	S		A-E		5	110	SC	T		
	4400*	C	1		X	S				5	110	B	T		
	5500	C	1		S	S	20**	A-D		3	110	B	T	2.4	
	L7600	R	to 6	X	L								T	3.7	
	5400	R	1	X	X	S	12**	A-D		3	110	SC	T		
	761	C	1		X	S	12**	A-D		3	110	SC	T	2.6	
*Push/Turn Switch; **Springs															
Eagle Electric Mfg. Co. 23-10 Bridge Plaza South L.I., N.Y. 11101	—	C	1		S	S	1	ST			28	SC	SC		
	—	C	1	I	S	S	1	ST			28	SC	SC		
	—	C	2		S	S	1	ST			28	SC	SC		
	—	C	1		S	S	1	ST				SC	SC	0.5	
Electronic Controls, Inc. Wilton, Conn.	803	C	1		S	S	to 36	DT		2	125	B	T	0.5	to 1.7
GC Electronics Co. 400 S. Wymon St. Rockford, Ill. 61101	34-000	C	1	C	S	S	1-3	DT		3	110	B	T		
General Control Co. 1200 Soldiers Field Rd. Boston 34, Mass.	MPB	C	to 16	C	X	S	to 5	A-H		5	125	SC	T	4.4	0.7*
	SPS	C	to 16	C	X	S	to 7	A-H		1	125	SC	T	2.6	0.6*
	LPS	C	to 16	I	X	S	to 7	A-H		1	125	SC	T	4.2	0.6*
*Standard button spacing															
General Electric Co. 95 Hathoway St. Providence, R.I. 02907	RFS	R	1	I	S		1	DT		3	25	S	L	0.5	1.2
	5491	R	1	I	L	SN	1	ST		15	125	SC	SC	1.4	1.7
George Risk Industries, Inc. P.O. Box 907 Columbus, Nebr. 68601	R	C	1	C	L	SN	1	DT		3	250	B	T	0.4	0.4 dio.
	D	C	1	C	L	SN	1	A-C	0.5		28	B	T	0.9	0.3 dia.
	G	C	1	C	L	SN	1-4	A-C	0.5		28	B	T	1	0.6 dio.
	T	C	1	C	L	SN	1-4	A-C		3	250	B	T	1.7	0.9 dia.
	W	C	1	C	L	SN	1	DT		3	250	B	T	1.7	0.6 dia.
Grayhill, Inc. P.O. Box 373 La Grange, Ill. 60526	46	C	1		L	SN	1,2	DT		0.2	115	B	T	0.7	
	2000	C	1	C	S	SN	1	ST		10	115	B	T	1.2	
	4000	C	1	C	S		1	ST		0.5	115	B	T	1	
	35	C	1	C	S		2	ST		0.5	115	B	T	0.5	
	23	C	1	C			1	ST		0.2	115	B	T	0.5	0.5 dio.
	30	C	1	C			1	ST		1	115	B	T	0.4	0.4 dia.
	30-16	C	1	C	L		1	ST		1	115	B	T		
	30-17	C	1	C	S		1	ST		1	115	B	T		
	39	C	1	C	L		1	ST		0.5	115	B	T	0.2	0.2 dio.
	40	C	1	X	S		1	ST		1	115	B	T	1	
Guardion Electric Mfg. Co. 1550 W. Carroll Ave., Chicago 7, Ill.	CXA-3430	C	1	C	X	SN/S	3	DT		10	115	B	T		
Harvey Hubbell, Inc. Bridgeport, Conn. 06602	—	R	1		L		1,2	3-way,4-way		20	277	SC	SC		
	—	R	1	I	L		1	3-way,4-way		20	120	SC	SC		
	—	R	1	X	L		1			20	120	SC	SC		
	—	R	1		S					20	277	SC	SC		
International Electro Exchange Box 8360, Minneapolis, Minn. 55426	D	C	to 10		X	SL	to 8	DT		1	250	SC	T		
Jay-El Prods. 1859 W. 168th St., Gardena, Calif.	4	R	1	I	X		2	DT	7		28	S	T		
Joseph Pollak Corp. 179-195 Freeport St. Boston, Mass. 02122	A-43-5A	R		I	L		3	DT	5		28	SC		4.4	
Lincon, Div. Illinois Tool Works, Inc. 6615 W. Irving Park Rd. Chicago, Ill. 60634	01-800	R	1	X	X	SN		SPSTNO,NC		10	250	S	T	to 2	1.2
	44	C	1	X				SPDT							
Litton Industries, Useco Div. 9370 Santa Monica Blvd. Beverly Hills, Calif. 90213	6P	X	1	X	X		to 6	DT					T		
Machinery Electrification, Inc. Northboro, Mass.	MEK-02PB	C	1	X	L	SN	2-ckt,4-ckt			6	125	B	T		
	—	C	1	X	L	SN	2-ckt,4-ckt			1.5	to 600	B	T		
	—	C	1	X	L	SN	2-ckt,4-ckt		2.2		125	B	T		
	—	C	1	X	L	SN	2-ckt,4-ckt		0.2		to 600	B	T		

PUSHBUTTON SWITCHES

	Type No. or Series	Round Button(C); Square(S); Bar(R)	Buttons Per Switch Assembly	Illuminated(I); Colors(C)	Momentary Action(S); Latching(L)	Snap Switch(SN); Leaf(S); Slide(SL)	No. of Poles Per Station	Contact Form	Nom. DC Amps.	Nom. AC Amps.	Nom. Volts	Bush.Mtg.(B); Screws(SC); Snap-In(S)	Lug Terms.(T); Screws(SC); Leads(L)	Body Depth Behind Panel (In.)	Body Length (In.)
Marco-Oak Industries P.O. Box 4011, Anaheim, Calif. 92803	—	C	1	I	X	SN	1,2	DT		to 15		B	T		
Master Specialties Co. 15020 Figueroa St., Gordena, Calif. * = Momentary Action 1 = 2 lamps, 2 = 4 lamps	12	R	1	X	X	SN	2/4	DT		5	250	S	T	1.7*	0.6
	14	C	1		X	SN	2/4	DT		5	250	B	T	1*	
	90E	R	1	X[1]	X	SN	2/4	DT		5	250	S	T	2.2*	
	10E	R	1	X[2]	X	SN	2/4	DT		5	250	S	T	2.8*	
	2100	R	1	X[2]	X	SN	2/4	DT		5	250		T		
Micro Switch, Div. of Honeywell Freeport, Ill. 61033	2N	R	1	X	X	SN	1,2	DT		to 20	125				
	6	C	1	C	S	SN	1,2	DT		to 20	125	B	T	2.2	
	S	C	1		X	SN	1,2	DT		to 20	125	B	T		
	PB	C	1	C	X	SN	2-4	B		5	125	B			
	DM	C	1	C	S	SN	1,2	DT		10	122	S			
	2PB11	C	1	C	S	SN	2	DT		5	250	B	T	1	0.6
	3PB11	C	1	C	S	SN	3	DT		5	250	B	T	1	0.9
	4PB11	C	1	C	S	SN	4	DT		5	250	B	T	1	1.2
	82PB	C	1	C	L	SN	2	DT		5	250	B	T	1.3	0.7
	84PB	C	1	C	L	SN	4	DT		5	250	B	T	1.3	1.2
	1PB5	C	1				1	DT				B	T	0.6	0.2 dio.
Midland International Corp. 1519-21 Atlantic St. North Kansas City, Mo.	25-457	C	1		S		2	DT				B	T		0.4 dia.
	25-445	C	1	I	L	SN	1	ST		10	125	B	T		
Milli-Switch Corp. 1400 Mill Creek Rd. Gladwyne, Pa.	B-PB1	C	1		S		1-3	DT				B	T	0.7	0.8
	B-PB2	C	1		S		1-3	DT				B	T	0.7	0.8
	B-PB3	C	1		S	SN	2-4	DT				B	T	0.9	0.8
	B-PB4	C	1		L	SN	2-4	ST				B	T	1	0.8
Muter Co. 1255 S. Michigan Ave. Chicato, Ill. 60605	4649	R	1		S	S	2	ST	0.5	0.5	125	SC	T	0.3	1.4
Novigotion Computer Corp. Volley Forge Industrial Park Norristown, Po.	1050	S	1		S	SN			0.05					1.5	0.7 dia.
Oak Mfg. Co. Crystol Lake, Ill. 60014 *Spacing between buttons	130	S	to 12	I	L	S	to 10	DT		0.5	110	SC	T	3.6	0.7*
	80	S	5	I	L	S				0.5	110	SC	T		0.7*
	131	S	to 12	I	L	S	to 10	DT		0.5	110	SC	T		0.6*
Pyle-Notional Co. 1334 N. Kostner Ave. Chicago, Ill. 60651 *Weatherproof, vapor tight	XBP/ERC*		2(Start-stop station)				1-ckt, 2-ckt								
Rils Industries 1 Henry St., Bloomfield, N.J.	101	C	1		L		1	DT			250	B	T	1.7	
Rowon Controller Co. P.O. Box 306 Bethel Rd. Westminster, Md. *Oil Immersed	675*	C			L					6	125	SC			
	675	C			L					1.2	600	SC			
	6175	C			L					5	600	SC			
Sloter Electric, Inc. 45 Sea Cliff Ave., Glen Cove, N.Y. 11542	190	C	2	C	S		2	DT		15	125		L	2	
	191	C	2	C	L	SN	2	DT		15	125		L	2	
Stromberg-Carlson Corp. 100 Carlson Rd. Rochester, N.Y. 14603	200	C	4	C	L	S									
	325-326	C	6	C	L	S									
	—	C	7	C	L	S	2	A-D		0.5	110	SC	T	2.6	4.6
	—	C	10	C	L	S	2	A-D		0.5	110	SC	T	2.6	6.5
	—	C	12	C	L	S	2	A-D		0.5	110	SC	T	2.6	9.5
	—	C	20	C	L	S	to 4	A-D		0.5	110	SC	T	2.6	14
	14673	C	24	C	L	S	2	A		0.5	110	SC	T	1.5	6.6
	14671	C	20	C	L	S	2	A		0.5	110	SC	T		
	14622	C	16	C	L	S	2	A		0.5	110	SC	T		
	310/312	C	1		S	S		A-D				SC			
Superior Electric Co. Bristol, Conn. 06012	SPF	C	1	X	L	SN	1	A		10	125	B	T	2.2	1.2 dia.
Steorns-Lyman Corp 12 Cass St. Springfield, Moss. 01101	—	C	1	C	L		1,2	A,C		to 3	500	SC	T	2.8	1 dia.
	—	C	1	C	L		1-4	A,C		0.5	250	B	T	2.1	1.3 dio.
	—	C	1	C	L		1,2	A,C		to 3	500	B	T	3.3	1.2 dia.
	—	C	1	C	L		1-4	A,C		0.5	250	SC	T	1.6	0.9 dia.
Switchcroft, Inc. 5555 N. Elston Ave. Chicago, Ill. 60630 *Push/Turn Switch	32000	C		I	S	S	to 4	C		3		B	T	3.4	
	32000TL*			I	X	S	to 4	C		3		B	T		
	35000	X	to 18		L	S	to 6	DT		3		SC	T	2.3	
	37000	R	to 18	X	L	S	to 6	DT		3		SC	T	2.3	
	—	C	1	X	S	S	1-3	DT		3		B	T	1	
	17000	C	to 37	X	L					3					
	15000	R	1	X	L	S	to 4	A-F		3		SC	T	2.9	
Tower Mfg. Co. 158 Pine St., Providence, R.I.	5500	C	1		L	S	1	ST	to 25		12	B	SC/T	0.6	1.0 dia.
	100	C	1		L	S	1	NO				S	SC/T	0.7	0.6 dio.
Ucinite Co. 459 Watertown St. Newtonville, Mass. 02160	MS25089	C	1	C	L	SN	1,2	DM,SPSTNO,NC	10		28	B/S	T		
	MS24318	C	1	C	L	SN	1	DM	10		27	S	T	0.9	0.7
	B8100	C	1	C	S	SN	1	DM,SPSTNO,NC	20		28	B/S	T		
	SR	C	1	C	S	SN	1,2	DM,SPSTNO,NC	17		28	B/S	T		
Unimax Switch Div., Moxson Electronics Ives Rd., Wallingford, Conn.	LAI-TIR	C	1	X	L	SN	1	C		5	125	B	T	1.9	0.5 dio.
Vemaline Prods. Co. Fronklin Lakes, N.J.	200	C	to 10	I	X	X								2.2	to 10
	400	C	to 10		X	X									to 10
	380	C	to 10	I	C										to 10
	110	C	1		C	S		A-E		3	110				
	120	C	1		L	S		A-E		3	110				
Vitramon, Inc. P.O. Box 544, Bridgeport, Conn. 06601	—	C	1	C			1	A	0.25		28	B	T	0.5	
Ward Leonard Electric Co. Mount Vernon, N.Y.	2901	C	1		S		1	DB	1	6	125	SC	SC	1.1	1.3
	—	C	2		S		2	DB	1	6	125	SC	SC	0.9	1.8
Zoron, Inc. 612 W. Monroe St. Chicago, Ill.	6000	C	1	C		S	1	DT		3	115	B	T	0.6	1

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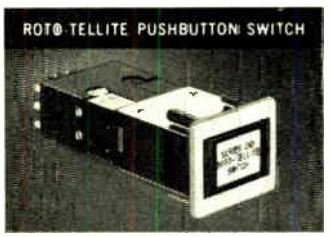
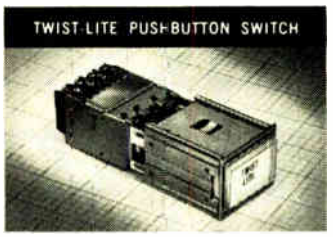
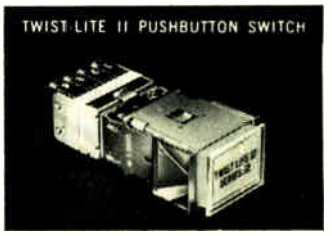
Flush-mounted, 2-lamp units. Rotating lamp/legend capsule for front relamping without tools. Mounted in stacks, rows or matrices. Removable control capsules for Master Dimming, Master Test. Modular channel configurations yield complete units ready to install. CATALOG 2002



Flush-mount, 4-lamp pushbutton switches. Relamp without tools. Full to 4-way split, 4-color display. 2PDT and 4PDT mom. and alt. action plus holding coil units. Mounted in rows, stacks, matrices in channel configurations ready to install, including legends. CATALOG 2009

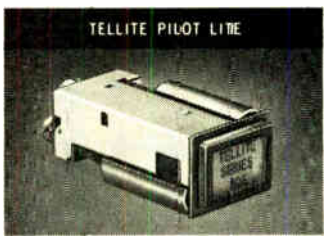


Series 10E, four-lamp, flush-mount, units. Twist/pull to relamp from front without tools. Up to 4-way split, 4-color display. 2PDT/4PDT mom. or alt. action switches. Positive hard mount in rows, stacks and matrices. Removable lamp filters for individual color control. CATALOG 2000



Series 12, 4-lamp, spring clip or barrier mount. Relamp without tools. Six mounting styles, up to 4-way, 4-color display. Internally bussed lamp circuits. 2PDT or 4PDT mom. or alt. action or holding coils. Engravings included. Individual lamp color control. CATALOG 2001

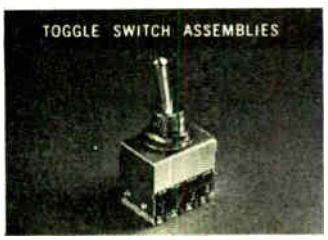
Series 70E. Includes 2-lamp and standard fuse. Both replaced from panel front without tools. Resistance limiter or isolated lamp circuits. Unlimited mtg. arrangements. Positive hard mount with integrated mtg. sleeves. Easy legend/filter change. Projected color. CATALOG 2005



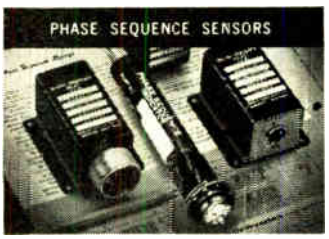
Series 80E, miniature, 2-lamp flush mount units. Full, vert. or horiz. split display or 2-lamp reliability 2 color display. Engraved, 3-line legends. Integrated mounting sleeves - no brackets. Combination screw/solder terminals at rear. Needs no tools for relamp. CATALOG 2006

Series 90E miniature, 2-lamp units. Front relamp without tools. Horiz. and vert. split, 2 color full display, or 2-lamp reliability in full display. All terminals at rear. Easy legend change. 2PDT, 4PDT mom. or alt. action. Occupies half the volume of standard units. CATALOG 2008

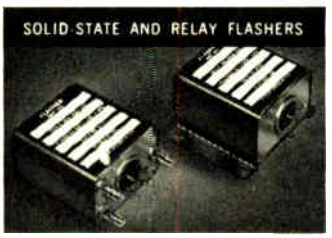
Series 14, unlighted, precision units. Instant "no-tease" contact transfer. Mil-Quality. 2PDT or 4PDT alt. or mom. action. Gold or silver contacts rated to 5 amps. Concave finger-fit buttons, plated, double turret terminals. Universal anti-rotation hardware included. DATA 3020



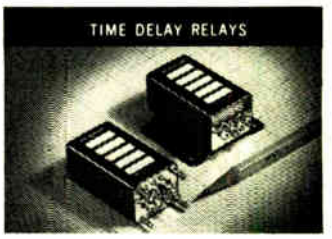
Alternate action, precision switches. Simultaneous transfer of all switch contacts within 1° of toggle lever 34° travel arc. Full travel lever action prohibits "tease" operation. 2PDT or 4PDT types. Plated double turret terminals for two wire connection. Series 16. DATA 3021



Relays: Automatically monitor three-phase power, block current of wrong sequence to protect circuits. SPST, SPDT, DPDT contacts. Rated to 10 amps.
Indicators: Panel-mount monitors to warn of incorrect phase sequence. Six standard ratings. CATALOG 2020



Series 500 miniaturized flashers feature transistorized circuitry, numerous configuraitons. Flashing rates of 60, 90, 120 cycles per minute. Series 600 features solid state flasher circuit to operate relay, in the same can. Various output ratings, on-off ratios. CATALOG 2019



Solid-state timing network actuates relay with ±10% or ±5% accuracy and ±2% repeat accuracy. Delay time can be pre-set or can be adjusted. Mil quality for airborne or ground support use in extremes of environment. Various mountings and headers. CATALOG 2021

Send for Short Form Catalog No. 2007a

MSC **Master Specialties Company**

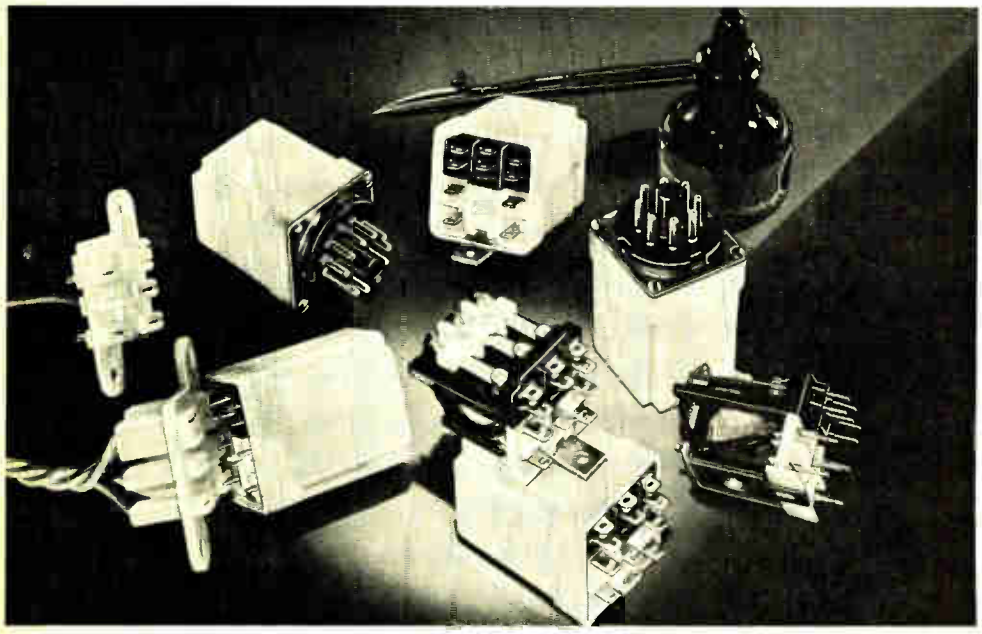
1640 MONROVIA, COSTA MESA, CALIFORNIA 92627 ▪ TELEPHONE 714-642-2427

Regional Offices and Telephone:
Huntsville, Alabama, 205-536-7415 ▪ Costa Mesa, California, 714-642-0114 ▪ Sunnyvale, California, 408-245-9292 ▪ Winter Park, Florida, 305-647-0100
Chicago, Illinois, 312-282-7112 ▪ Syracuse, New York, 315-479-9191 ▪ Valley Stream, L.I., New York, 516-561-2334 ▪ Dallas, Texas, 214-357-9459

RBM CONTROLS NEWS

Serving Major Markets Since 1921

RELAY EDITION: 93



New 3PDT Switching Relays are Most "Versatile" and "Real Cost Savers"!

AC AND DC MINIATURE RELAY users have been presented with new cost-saving opportunities with the introduction of the RBM CONTROLS line of 3 pole double-throw switching relays.

The new Type 93 line includes both open and enclosed types, and is characterized by their rugged construction features, conservative ratings, versatility, and, above all, by several important cost-reducing features.

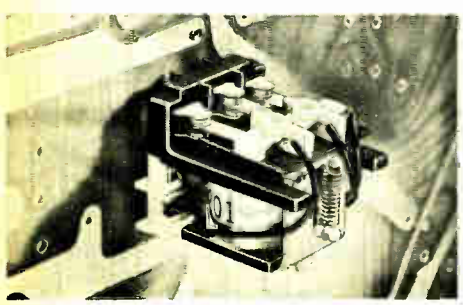
FRONT WIRING—All terminals, both coil and contacts, are out the front of the terminal block surface. This "everything out the front" construction makes it easier to wire, with resulting reductions in assembly costs.

Another cost-reducing feature is the one-screw, single-hole front mounting standard, which cuts both mounting and assembly time.

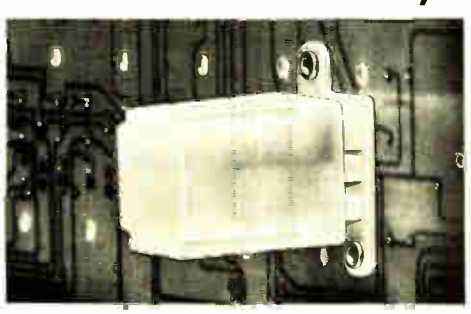
CONTACT FLEXIBILITY—Both open and enclosed types are available in three terminations — **3/16" quick connects, solder type, or printed circuit.** Continuing with the versatility of the new line, RBM CONTROLS has also provided contact flexibility. Button type power contacts can be provided on the relays with highest quality crossbar heavy duty contacts for reliable circuit operation on multiple switching operations.

MOUNTINGS—Numerous types of mountings are available. For the open type relay they include: (1) 6-32 Stud With Lug, (2) Single Hole With Lug, (3) Front Mounting, (4) Printed Circuit. The enclosed type relay includes: (1) Printed Circuit, (2) 8 & 11 Pin Octal Plug-In, (3) Quick Connect Plug-In, (4) Solder Terminal—Front Mounting, (5) Quick Connect—Front Mounting.

Open and Enclosed Printed Circuit Relays



Open type relays are available with printed circuit terminals for easy, low cost assembly to printed circuit board.

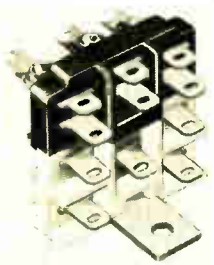


Enclosed type relay plugs into receptacle that is mounted directly to printed circuit board.

Special Construction Offers Many Advantages

MOLDED PLUG

For 3/16" quick connect plug-in enclosed relay provides protection in handling and servicing.



WIRING FLEXIBILITY

Both coil and contact terminals are out front for ease of wiring and low cost assembly.

CONTACT FLEXIBILITY

Button type (a) and crossbar (b) power contacts available on same relay for multiple switching operations.

LOW COST MOUNTING

One screw, single hole standard **front** mounting reduces assembly time.

General Specifications

CONTACTS—To 3PDT. Button—power. Crossbar—low energy loads.

COIL—DC to 110 Volts, AC to 240 Volts.

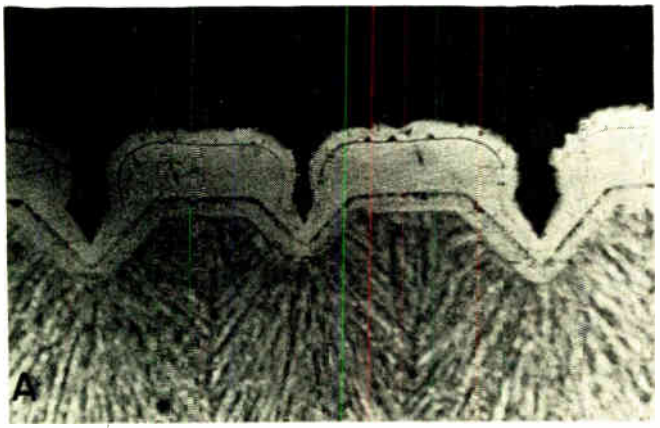
LIFE—Mechanical—10,000,000 Minimum; Electrical—10,000,000 Dry Circuit.

UL & CSA—Recognized under U/L Component Recognition Program and CSA with variety of contact ratings, coil voltages, and terminations.

Standard controls available from your authorized distributor.

For complete technical data, please write to RBM CONTROLS, Division Essex Wire Corporation, Department 93; Logansport, Indiana.

Circle 35 on Inquiry Card



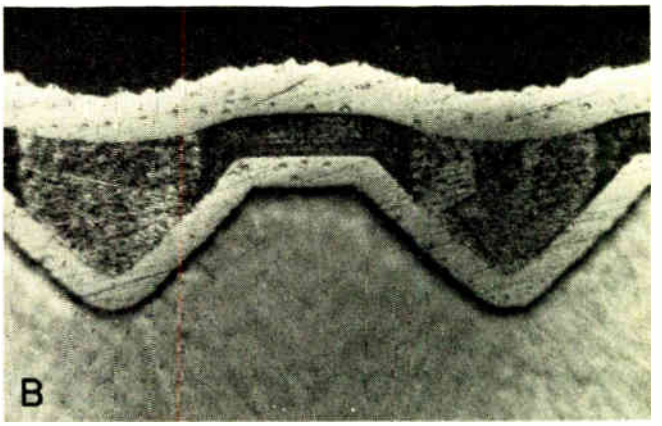


Fig. 1: Comparison photographs of plated phonographic record stampers illustrate the leveling ability of the BDT process. Photograph A, shown at approximately 500X, illustrates the "dog-boning" edge build-up and nodulization effects that are characteristic of many common gold electroplating processes. Photograph B, pictured at approximately 900X, illustrates the leveling characteristics of one of the BDT processes. The record stampers are first given a nickel coating. The gold is then applied, followed by a nickel overlay.

GOLD PLATE LEVELS ROUGH SURFACES

We had an opportunity recently to view first hand a relatively new gold electroplating process. It is common in plating to have difficulty plating in valleys and to overplate on mountain areas. The "BDT" process at Sel-Rex Corporation appears to reverse this tendency. The build-up in the valleys is greater than on the peaks so that with continual plating, a smoothing of the surface results. (See Fig. 1.)

Key to the development is a new generation of non-cyanide electrolytes. Sel-Rex, however, will not divulge the formula. Their main interest is in selling the plating baths and consulting on plating problems.

Advantages of the Process

BDT exhibits unusual uniformity of metal distribution. Where other electrolytes will vary in the build-up of the plate by as much as 30% depending on the contour of the parts being plated, tests show BDT deposits that vary no more than 8% in deposited coatings measured from edge or corner to side. This holds for thicknesses of 0.05 in. and greater.

The BDT process also builds surface brightness as the deposition increases. Nickel has been considered the best leveling (ability of an electroplated deposit to smooth out a surface) electroplated coating with a ratio of 2.5:1. BDT is able to level at the rate of 4 to 5:1. Also, BDT apparently has greater throwing power than other electrolytes—the ability of a system to deposit metal in recesses or crevices.

Comparison with Standard Baths

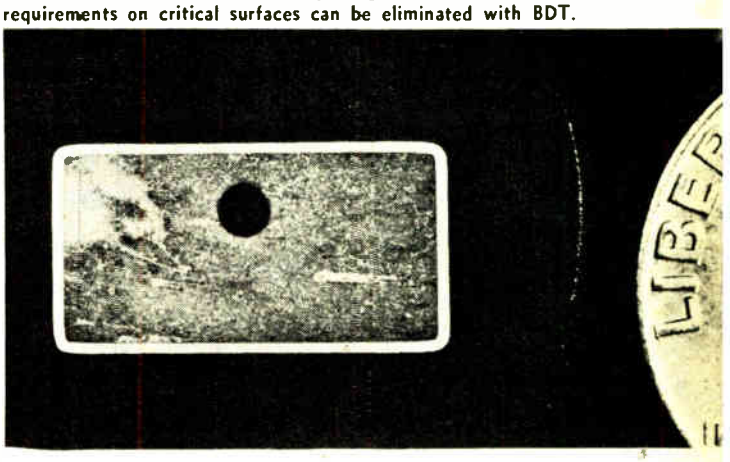
BDT baths range in purity from 98.0 to 99.9+ percent and in hardness from 110 to 240 Knoop. There are several BDT formulations. Although they are similar in basic characteristics, each has certain applications for which they are best suited. Compared to present high purity, ductile deposits which have a matte finish, the high purity BDT formulations are equally ductile, as resistant to oxidation at high temperatures; yet they are also mirror bright and harder. Actually, high purity, ductile matte deposits test only 70 to 110 on the Knoop scale. Like all high purity golds, BDT permits soldering, welding, die attachment and whisker wire bonding. Because BDT when deposited, does not build up on edges or projections (dog-boning), (see Fig. 2), a characteristic of other gold processes, the need for overplating to meet thickness specifications can be eliminated with a significant economic advantage to the user. Also, when exposed to high temperatures as high as its melting point, bright BDT deposits of gold do not discolor.

Applications

On connectors, where a stamping operation may have left a bad surface, the BDT plating process can help smooth out the surface depending upon thickness of plate.

On printed-circuit boards, on wearing surfaces such as finger tabs, BDT's anti-galling or anti-coldwelding characteristics can prevent tabs or contacts from sticking while providing a harder wear surface.

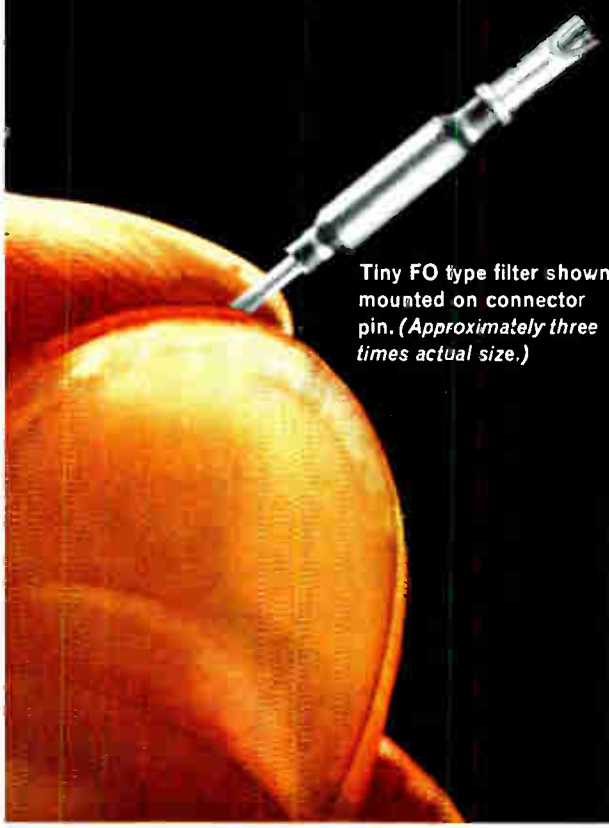
Fig. 2: Cross-section of a gold plated copper bar demonstrating the uniformity of the deposits achieved with the BDT plating process. Magnified 8X, the bar has been plated to an extra heavy thickness of 0.013 in. to demonstrate how overplating to meet minimum thickness requirements on critical surfaces can be eliminated with BDT.



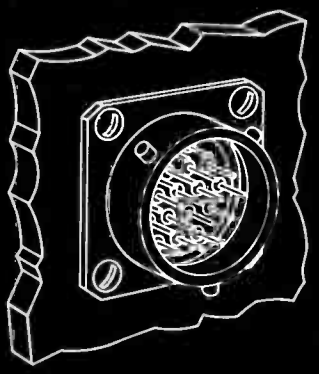
new

Allen-Bradley line of subminiature low pass filters provide...

HIGHER PACKAGING DENSITIES AND EFFECTIVE FILTERING TO 10 GHz



Tiny FO type filter shown mounted on connector pin. *(Approximately three times actual size.)*

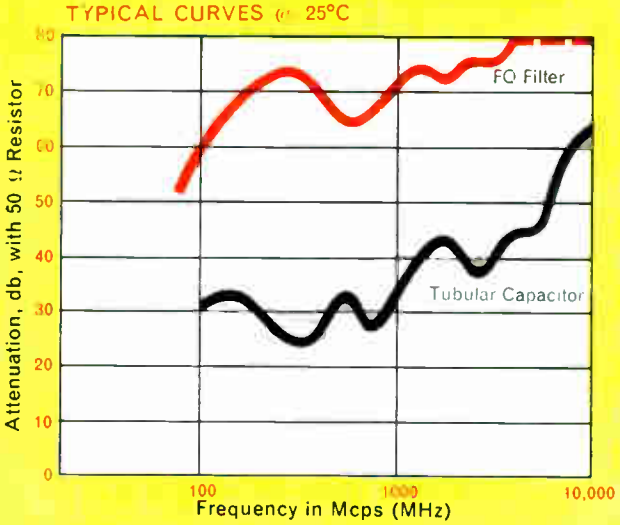


especially designed for use in cable connectors

TYPICAL SPECIFICATIONS

	A	B	C
	 ACTUAL SIZE	 ACTUAL SIZE	 ACTUAL SIZE
Pin Size	16 (0.062" dia.)	20 (0.040" dia.)	24 (0.030" dia.)
Max. O.D.	0.160"	0.100"	0.075"
Approx. Length	0.625"	0.450"	0.350"
Voltage Rating (V.D.C. max.)	500 v	200 v	100 v
Feed-thru current rating	25 amp	10 amp	5 amp
Attenuation, min. (at max. operating temp.)	50 DB	50 DB	50 DB
Temp. Range	−55°C to +125°C	−55°C to +125°C	−55°C to +85°C

TYPICAL CURVES @ 25°C



■ This new line of FO type subminiature low pass filters is designed to provide maximum reduction of RFI *in a minimum of space*—attenuation is greater than 50DB over the frequency range from 100 MHz to 10 GHz.

The exclusive Allen-Bradley design allows unusually close spacing. The filters can be introduced into connectors with no reduction in the number of terminals, still providing the possibility of individual replacement of filters if desired.

With these filters mounted through a ground plane in the connector, there's complete shielding to prevent the possibility of rf coupling between input and output.

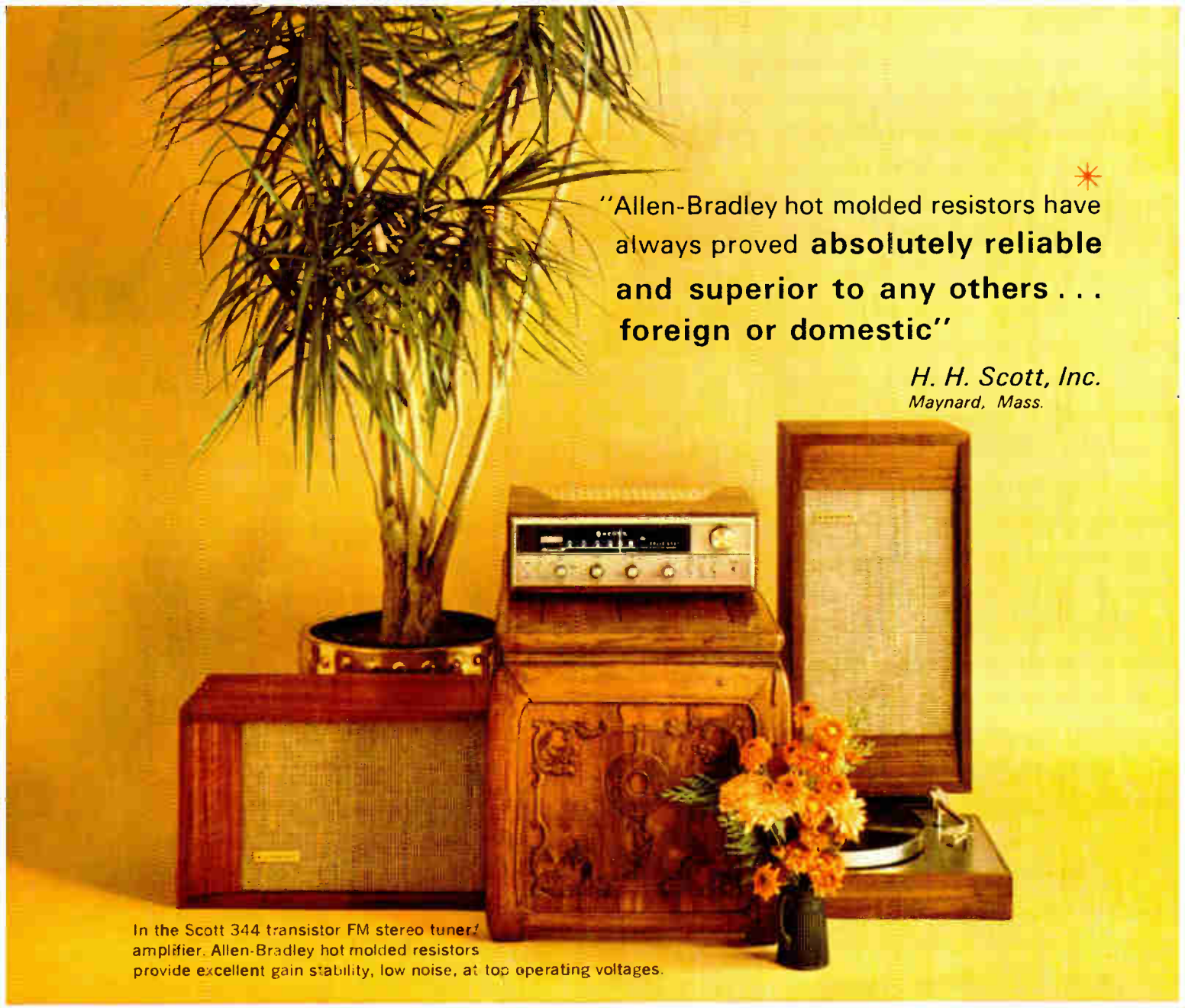
A-B engineers will be pleased to cooperate with you in the application of these new subminiature filters. For more details, please write: Allen-Bradley Co., 222 West Greenfield Avenue, Milwaukee, Wisconsin 53204.

Export Office: 630 Third Ave., N.Y., N.Y., U.S.A. 10017.

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

50-07-5E



"Allen-Bradley hot molded resistors have always proved **absolutely reliable and superior to any others . . . foreign or domestic"**

H. H. Scott, Inc.
Maynard, Mass.

In the Scott 344 transistor FM stereo tuner/amplifier, Allen-Bradley hot molded resistors provide excellent gain stability, low noise, at top operating voltages.

"Based on our use of more than 30,000,000 Allen-Bradley hot molded resistors over the past 18 years, under a continuous re-evaluation program for all component parts."

The known reputation of Scott hi-fi equipment is based on their unquestioned engineering excellence and their rigid quality standards. And Allen-Bradley hot molded resistors have played an important role in this achievement.

The consistently high quality of Allen-Bradley resistors —year after year, and million after million—is the result of an *exclusive* hot molding process developed and used only by Allen-Bradley. It produces such uniformity that the long term performance of Allen-Bradley resistors can be accurately predicted . . . and catastrophic failures *never* occur.

You can be certain of this same "built-in" resistor reliability and superlative performance *only* when standardizing on Allen-Bradley hot molded resistors. For more complete specifications, please send for Technical Bulletin 5050: Allen-Bradley Co., 222 West Greenfield Avenue, Milwaukee, Wisconsin 53204. Export Office: 630 Third Avenue, New York, New York, U.S.A. 10017.

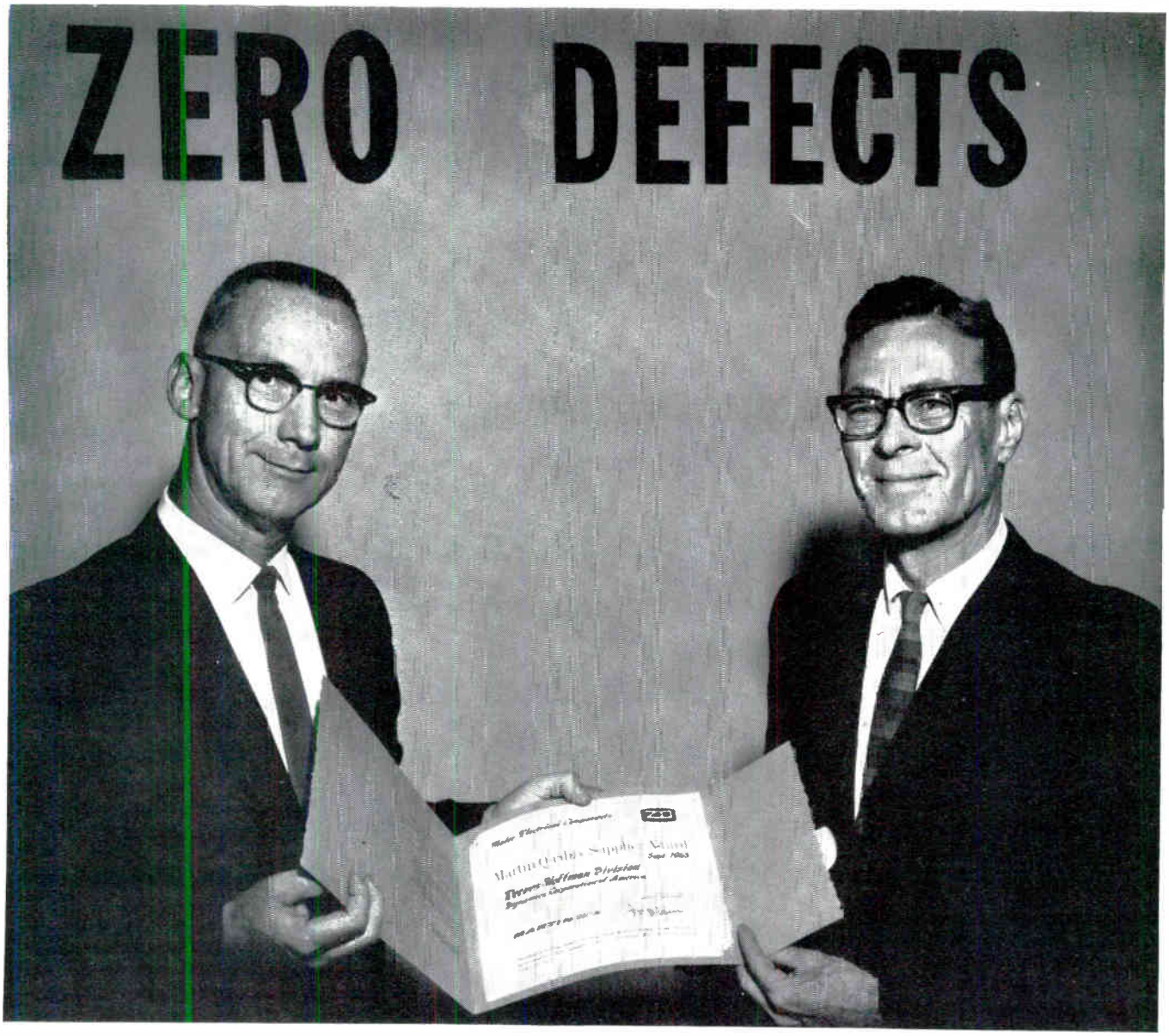
HOT MOLDED FIXED RESISTORS are available in all standard EIA and MIL-R-11 resistance values and tolerances, plus values above and below standard limits. Shown actual size.

A-B QUALITY

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

51-07-5E



Albert Canning (left) presents Martin's Quality Supplier Award to Horace Potter, president of Reeves-Hoffman.

Reeves-Hoffman is the first crystal manufacturer to earn Martin's coveted "Zero Defects" award!

With delivery of over 1,000 defect-free crystal-controlled filters for the highly reliable Bullpup missile, Reeves-Hoffman becomes the first and only crystal manufacturer to earn Martin-Orlando's Zero Defects Award.

The product that won the award was a complex miniature network package, which consists of crystals, glass-to-metal seals, temperature controlling and other circuitry.

In making the presentation, Mr. Albert J. Canning, technical requirements chief, quality, of Martin-Orlando, said in part: "This award from the Martin Company for Zero Defects is intended to reflect the thousands of systems components that Reeves-Hoffman has previously delivered. . . . It represents excellence in performance."

We think it is important to note that the award is also based on management cooperation and the meeting of scheduled delivery dates. Shipping defect-free products merely qualifies a supplier for the award, but does not guarantee it.

Whether our products are for outer space, undersea or "down-to-earth" applications, we do our utmost to deliver "zero defects" shipments on time. We invite your inquiries.

REEVES-HOFFMAN
DIVISION OF **DCA**

400 WEST NORTH STREET, CARLISLE, PENNSYLVANIA 17013

Circle 38 on Inquiry Card

← Circle 110 on Inquiry Card

VACUUM THERMOCOUPLES

Used in true RMS *voltmeters or converts DVMs to measure* RMS.

The MP1S.7 vacuum thermocouples are used in true RMS voltmeters or they can convert digital voltmeters to measure true RMS. Matching for temp. and tracking effects is better than 0.5% over a 50°C range, accurate for freqs. from a few CPS to 10MC. When used with a suitable amplifier, the true RMS of the input ac current will be proportional to the dc output current within 0.25%. Characteristics include: heater current, 5ma; heater resistance, 90Ω (±10%); couple output, 7mv (±12%), and couple resistance, 8Ω (±10%). Price is $24.95. Best Electrics Div., Harry Levinson Co., 1211 E. Denny Way, Seattle, Wash. 98122.

Circle 140 on Inquiry Card

BINARY ENCODER

The Binary C encoder has a revolution life of 7.5 million. Revolutions for a full count is 64, and accuracy is 1 part in 8,192. Load current/digit is 20v. (max.). The units max. speed (continuous interrogation) is 200 RPM, while max. slew speed is 1500 RPM. The operating temp. range is −54°C to 105°C; storage is allowed up to 125°C. Norden div. of United Aircraft Corp., Norwalk, Conn. 06852.

Circle 141 on Inquiry Card

VOLT STANDARD

Voltage includes 1mv to 1111.110vdc. Accuracy 0.01%.

Model VS 1000NR is a portable voltage standard/source. It allows 10ma of current to be drawn at all voltages. Short-term stability is 0.001%, and the instrument is completely short-circuit and overload proof. It needs no zeroing or calibrating. This makes it ideal for production-line quality control or laboratory uses. An added feature is a built-in nullmeter which provides potentiometric measurements. Price $995. Electronic Development Corp., 423 W. Broadway, Boston, Mass. 02127. Phone Robert Ross 617 268-9696.

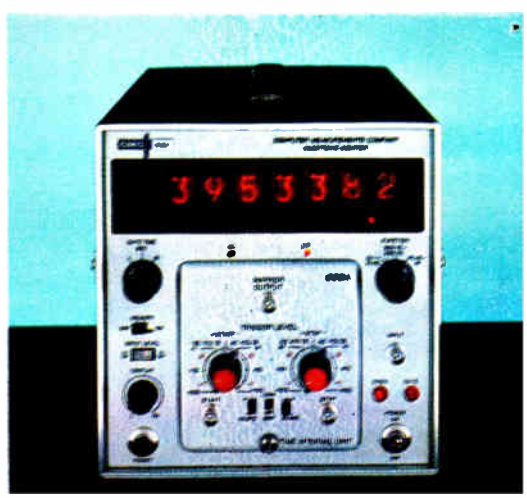
Circle 142 on Inquiry Card

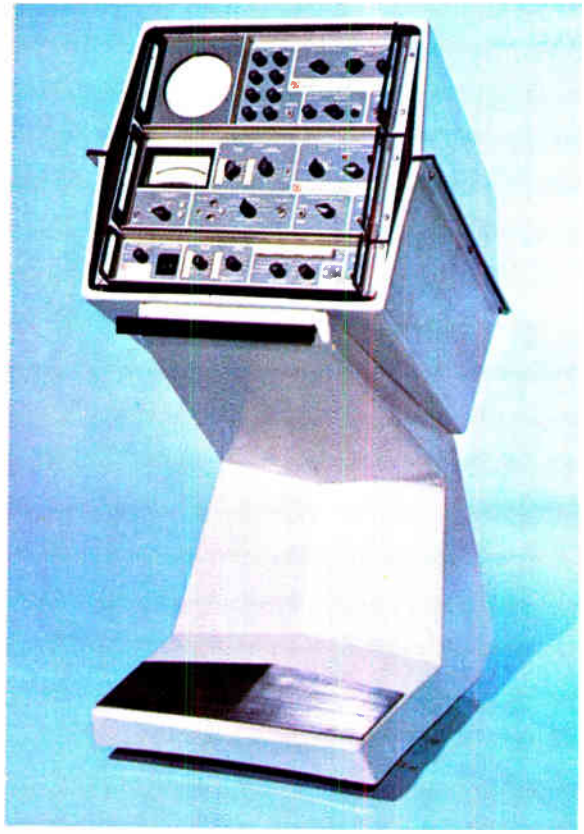
TIME INTERVAL METER

Measures time intervals with a range from 1μsec. to 10 sec.

The Model 633A time interval meter plugs in the center compartment of the CMC Model 616A freq. meter. The combined instrument will then measure the time interval between 2 points on the same or different waveforms, with measurement results displayed in μsec. Marker waveforms are available at a front-panel receptacle so that the trigger points can be observed on an oscilloscope. Price is $325. CMC, 12970 Bradley Ave., San Fernando, Calif.

Circle 143 on Inquiry Card





DATA ANALYZER

12 operating speeds ranging from 10 to 10,000 bauds. Distortion accuracy ±2%.

The DAS-10 is a stop-pulse length telegraph Data Analyzer System. It has a floating input for higher common-mode voltages. Internal slide switch programming allows precision control of stop-pulse length. This feature enables operators to adjust stop-pulse widths from 1 to 2 units in 0.01 bit increments. Additional flexibility is provided by an integral time base which produces a 128-character message, including both standard alphanumeric and ASCII formats. Testing is simplified by an A-scope which shows the actual signal as it appears on the line being measured. Radiation Inc., Products Div., Melbourne, Fla.

Circle 144 on Inquiry Card

ELECTROMETER

Has 1mv, 0.01pa, and $10^{14}\Omega$ full-scale sensitivity.

The Model 610B electrometer has all of the features of conventional VTVM plus $10^{14}\Omega$ input resistance. This permits measurements in circuits where a conventional VTVM causes undesirable circuit loading. The unit offers 79 ranges for dc measurements: 11 voltage ranges from 1mv full scale to 100v.; 28 current ranges from 10^{-11}a. full scale to 0.3a.; 25 resistance ranges from 100Ω full scale to $10^{14}\Omega$.; 15 coulomb ranges from 10^{-12} coulomb full scale to 10^{-6} coulomb; unity-gain output and recorder outputs. Keithley Instruments, 12415 Euclid Ave., Cleveland 6, Ohio. Phone 216 795-2666.

Circle 145 on Inquiry Card

AUDIO AMPLIFIER

Has 300mw output with less than 5% total harmonic distortion.

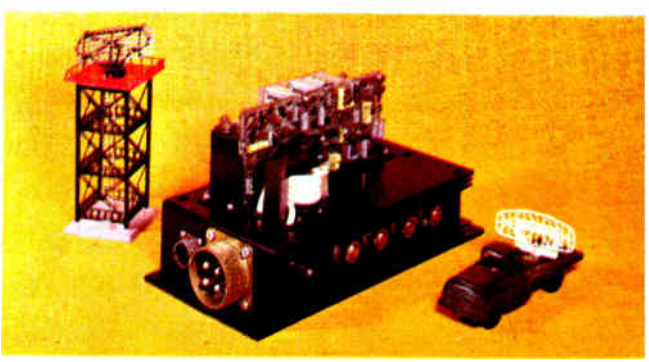
The freq. response of Model A-300 is ±2db from 200 to 5000 CPS and ± 5db from 200 to 10,000 CPS. The amplifier consists of a volume control, 5 transistors, 1 thermistor, a shielded input transformer with 2 primary windings for 50Ω high impedance, and an output transformer with 2 secondary windings (8Ω for speakers, 500Ω for modulation and high impedance loads). Gain at the 100K input is 40db; at the Ω input, it is 80db. Noise level is −70db. Price is $7.95. Birnbach Radio Co., Inc., 435 Hudson St., New York, N. Y.

Circle 146 on Inquiry Card

SERVO AMPLIFIER

The Model A480, 17kw power output servo amplifier will drive 1 to 8 HP dc motors. The amplifier output gives smooth, full-wave, bi-directional control with linear operation through null. Adjustable current limiting and 3 signal inputs with 100K input impedance are standard features. Westamp, Inc., 1542-15th St., Santa Monica, Calif. 90404.

Circle 147 on Inquiry Card

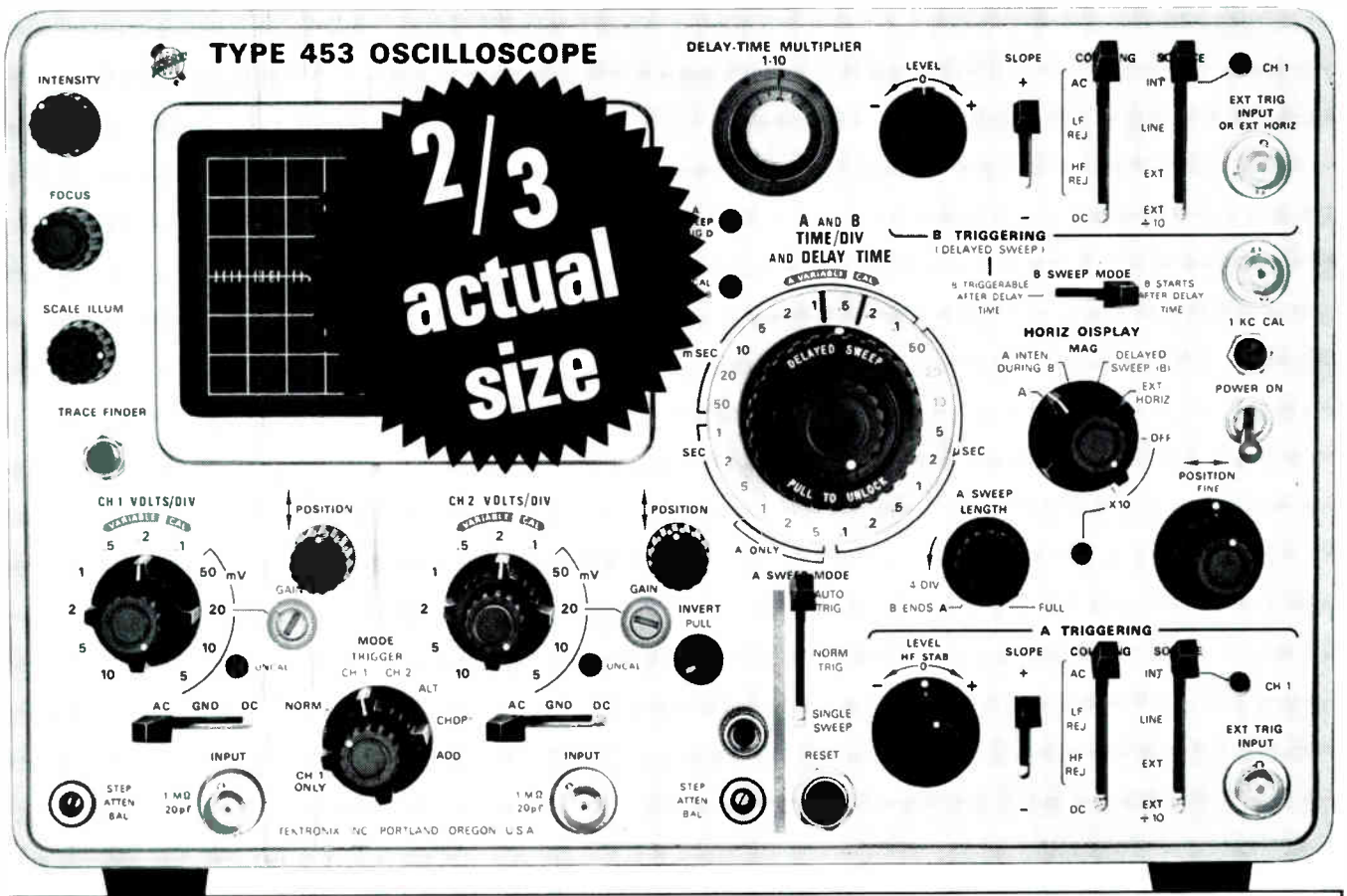


new portable 50 MHz oscilloscope

TEKTRONIX

- **DUAL-TRACE DISPLAYS**
  20 mV/div through 10 V/div, dc-to- > 50 MHz.
  10 mV/div, dc-to- > 45 MHz.
  5 mV/div, dc-to- > 40 MHz.
- **SINGLE-TRACE DISPLAYS**
  1 mV/div, dc-to- > 25 MHz (channels cascaded).
- **X-Y OPERATION**
  5 mV/div through 10 V/div, dc-to- > 5 MHz.
- **OPERATING MODES**
  Channel 1 only; Channel 2 only (normal or inverted); Added Algebraically (≥ 20:1 CMRR up to 20 MHz, linear dynamic range ≥ 20X indicated sensitivity); Alternate; Chopped (500 kHz ±20% chopping rate).
- **SWEEP RATES**
  5 sec/div to 0.1 μsec/div (Time Base A), 0.5 sec/div to 0.1 μsec/div (Time Base B), with 10X magnifier extending fastest sweep rates to 10 nsec/div.
- **SINGLE SWEEP**
  Time Base A.
- **PRECISION SWEEP DELAY**
  50 sec to 1 μsec.
- **DISPLAY FEATURES**
  4-inch rectangular tube; 6 x 10 div display area (1 div/0.8 cm); internal, illuminated graticule; 10 kV accelerating potential; P31 phosphor.
- **TRIGGER SYSTEM**
  To 50 MHz, from Channel 1 or combined signals (both sweeps). Trigger modes include AC, AC LF REJ, AC HF REJ, DC, AUTO. Trigger sources include INT, LINE, EXT, EXT ÷ 10.
- **POWER REQUIREMENTS**
  96-127, 103-137, 192-254, or 206-274 V ac (≈100 W) 45 to 440 Hz.
- **MECHANICAL FEATURES**
  Net weight is ≈28 lbs. including panel cover; shipping weight is ≈36 lbs. Overall height including feet is 7¼"; overall width including handle is 12½"; overall length including rear feet and front cover is 20½", including rear feet and extended carrying handle is 22⅗". Carrying handle may be set in any one of a number of positions for viewing convenience. Feet on rear provide for vertical operation.
- **ENVIRONMENTAL FEATURES**
  Ruggedly designed to operate reliably under environmental conditions encountered in portable use.

Type 453 Oscilloscope . . . $1950
Rack Mount Type R453 . . . $2035
U.S. Sales Prices f.o.b. Beaverton, Oregon

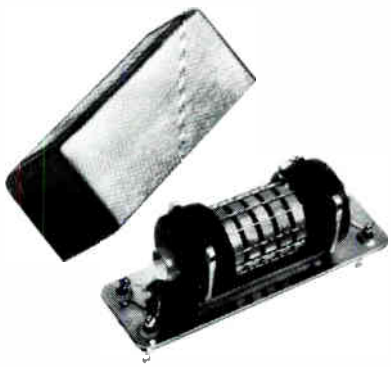


A compact, high-performance oscilloscope, the Type 453 operates almost anywhere, and under severe environmental conditions—giving sharp bright displays. The Type 453 offers dual-trace and sweep-delay for accurate and reliable measurements over the dc-to-50 MHz range.

For a demonstration, call your Tektronix field engineer.

Tektronix, Inc.

What is it ?



Clue No. 1: Its development made application of single sideband practical.

Clue No. 2: Its applications range from Citizens Band radios to such highly complex telemetry systems as that of the Saturn Rocket.

Clue No. 3: It offers the greatest combination of selectivity, simplicity, compactness and reliability ever developed in a component designed for its particular purpose.

Clue No. 4: It resists aging to such a remarkable degree in accelerated tests that aging need not be a consideration.

Clue No. 5: It's a classic circuit component associated universally with the Collins name.

Answer: It's the Collins Mechanical Filter. It's used in single sideband applications. High performance transmission and receiving equipment. Missile guidance systems. Multiplexing equipment. Frequency synthesizers. Doppler radar. Data transmission systems. Precision navigation equipment. Spectrum analyzers. FM communication receivers and Citizens Band transceivers.

It's available in frequencies from 60 KC to 600 KC, and in bandwidths of .1% to 10%.

If you build any of this equipment and have a selectivity/reliability requirement, call Collins Radio Company, Components Sales Department, 19700 Jamboree Road, Newport Beach, Calif. Phone: (714) 833-0600. Or call your authorized Collins components sales representative.

COLLINS

COMMUNICATION / COMPUTATION / CONTROL • COLLINS RADIO COMPANY / WORLD HEADQUARTERS / DALLAS, TEXAS

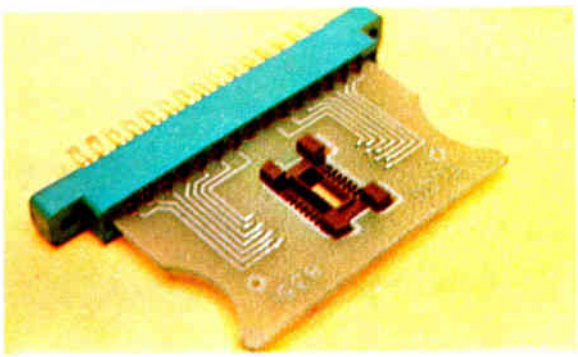
New products

PRECISION POTENTIOMETER

Resistance range 100Ω to 100KΩ (±5% max.) Linearity ±1%.

Model 3707 is a 10-turn, ½ in. dia. potentiometer for industrial uses. Power rating is 1w. at 40°C, and operating temp. is −55° to 105°C. The units resolution is 0.09 to 0.02%. A special rotor design assures excellent wiper stability under 50G shock and 10G vibration. Price is $10 in 100 quantities. Bourns, Inc., Trimpot Div., 1200 Columbia Ave., Riverside, Calif.

Circle 148 on Inquiry Card



IC CARRIER

For testing and shipping of ¼ x ⅛ in., 14-lead, IC packages.

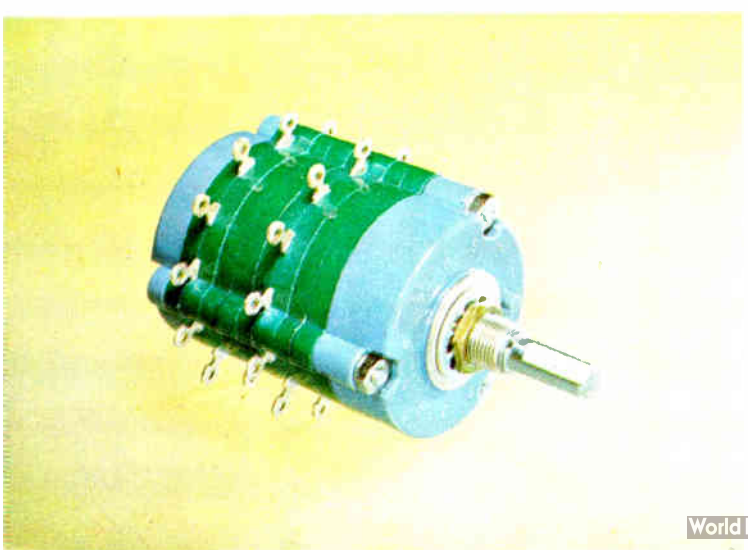
Series 8351 integrated-circuit carrier has a spring-action lock for easy loading and quick assembly. The IC package fits into a 2-piece thermoplastic holder which can be heat sealed by the manufacturer for warranty purposes. This holder snaps into a glass-epoxy board, where spring-wiping contacts of beryllium copper make electrical contact with the integrated-circuit package leads. The carrier plugs into a standard 14-contact, card-edge connector with 0.156 in. center-to-center spacing for testing. Elco Corp., Willow Grove. Pa. 19090.

Circle 149 on Inquiry Card

SINE-COSINE GENERATOR

Model 530 is a 2-channel function generator for analog computation of sines and cosines. Max. static error is less than 25mv, and zero signal error is below 2mv. Accuracy better than 0.025% (±100v) output. Sine capability is ±270° and cosine +180 to −270°. Zeltex, Inc., 2350 Willow Pass Rd., Concord, Calif.

Circle 150 on Inquiry Card

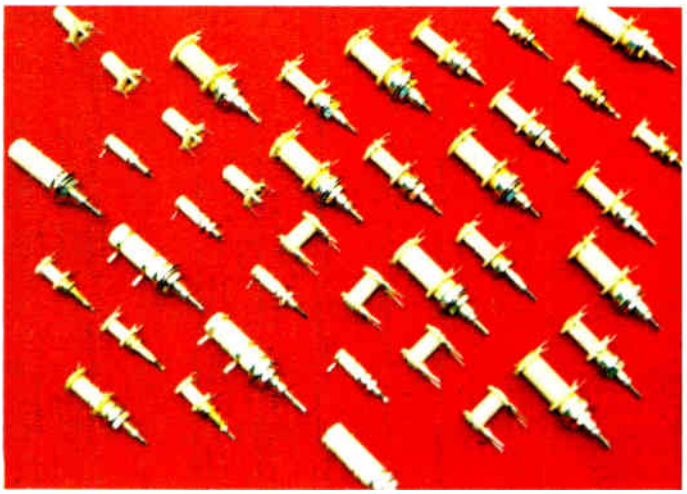


ROTARY INSTRUMENT SWITCH

Life of this 12-position switch exceeds 1 million cycles.

Series 2000 is a 12-position, 1 to 6 pole switch. Primary uses include precision bridges and decades, laboratory test equipment and thermocouple switching. The switch has silver contacts and external, adjustable stops. Contact resistance is less than 1 milliohm and varies less than ½ milliohm after 1 million cycles. Industrial Devices, Inc., Edgewater, N. J. Phone 201 WH 3-4084.

Circle 151 on Inquiry Card



CERAMIC COIL FORMS

Ceramic coil forms come in 4 diameters: 0.205, 0.260, 0.375, and 0.500 in. The ceramic material conforms to Mil-I-10 Grade 523 specs. Brass cores and 6 grades of powdered iron permit use in freq. ranges between 50KC and 300MC. Bushing-mounted forms with fiberglas collars for high-Q/low-loss uses are available in 2-terminal and 4-terminal configurations. J. W. Miller Co., 5917 S. Main St., Los Angeles, Calif. Contact L. G. Crawford.

Circle 152 on Inquiry Card

STEREO MIXING CONSOLE

Seven mixing inputs are normalled via push-button to 17 sources.

Model AF-37A solid-state mixing console allows 7 mixing inputs to be normalled to 17 programs sources, 6 of which are dual stereo sources. In addition to its stereo design, the console contains facilities for simultaneous SCA operation from a separate program source by assigning a third output channel for this purpose. Melcor Electronics Corp., 1750 New Highway, Farmingdale, L. I., N. Y. 11735. Phone: 516 MY 4-5570.

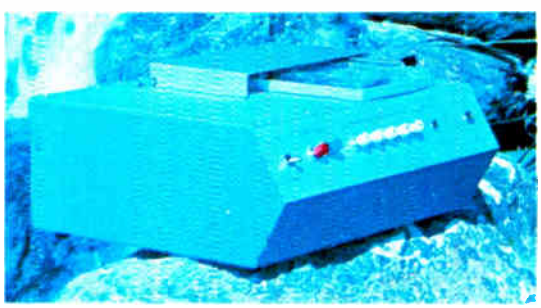
Circle 153 on Inquiry Card

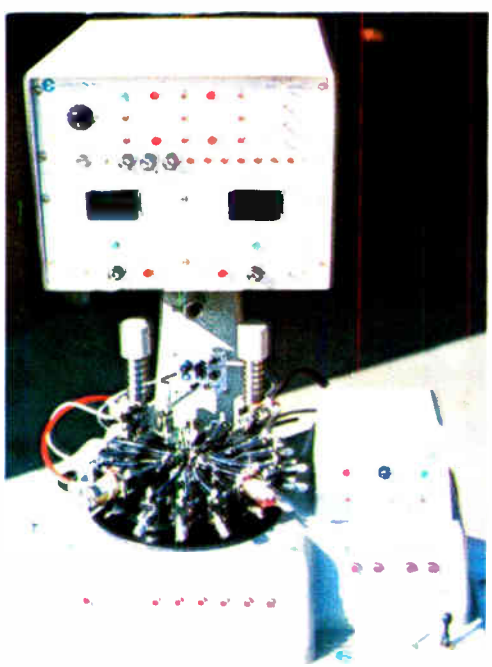
TAPE RECORDER

No tape threading, no reels to install, no arms, guides or levers.

The D/C-1 portable instrumentation cartridge tape recorder uses standard ¼ in. Mylar-base magnetic tape contained in Fidelipac tape cartridges. This 25 lb. recorder can be loaded or unloaded in less than 2 sec. Just slip the cartridge in place, release the idler-control, and start. You can even leave it unattended—the tape can't run out. The D/C-1 operates at 1⅞, 3¾, 7½ and 15 ips with the desired speed electronically selected through the front panel controls. Data/Cartridge Inc., Dept. 3P, 161 Constitution Dr., Menlo Park, Calif. 94025. Phone: 415-323-9880.

Circle 154 on Inquiry Card





WAFER-DIE SORTER

Tests and classifies microcircuit devices at 2000 units/hr.

With the Model 920, wafer die-sorting is fully automated. The unattended operation eliminates costly and tedious methods previously used. Once probe points are positioned to the pattern configuration, the operator is free and the 920 takes over. The probe steps across, down, reverses its path and then indexes until the wafer is completed. The tester then returns to a start position and is ready for reloading. Just one technician without extensive training or skills can operate up to 4 units. Electroglas, Inc., 150 Constitution Dr., Menlo Park, Calif. Phone 415-325-1536.

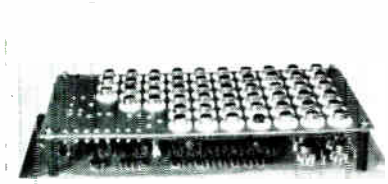
Circle 155 on Inquiry Card

ELECTRONIC INDUSTRIES

NEW PRODUCTS

A-TO-D CONVERTER

Features 10-bit conversion (Unipolar) and 50,000 conversions/sec.

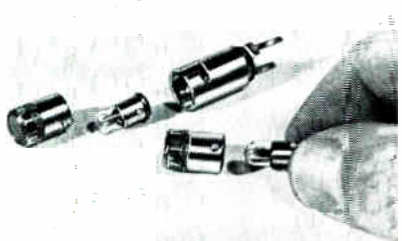


Model AS-2 is a solid-state, high-speed analog-to-digital converter using integrated circuits. It has a basic accuracy of 0.05% (±½ LSB) and completes decisions at a rate of 2μsec./bit. Output is approx. 45,000 samples/sec for a 10-bit word including sign (without input amplifier). The AS-2 is also available as a 3 decimal digit machine. Price is less than $2060 in quantities of 1-9. Epsco, Inc., 411 Providence Hwy., Westwood, Mass. 02090. Phone 617 329-1500.

Circle 130 on Inquiry Card

LAMP ADAPTOR

Lets T-1¾ lamps be used in low cost T-3¼ bayonet type.



The Adaptor-Lens uses a bayonet sleeve with inserts to retain the T-1¾ lamp and plastic lens. The lamp is inserted at the rear of the assembly and is retained under spring tension. The unit is then received by the standard T-3¼ socket. Electrical connections are made to the center post of the lamp and to the shell of the adaptor-lens. As the adaptors are not wired directly into the circuit, they can be readily removed and replaced, facilitating the change of lens colors. Display Devices, Inc., 2117 Sepulveda Blvd., Los Angeles, Calif. 90025.

Circle 131 on Inquiry Card

DELAY SET

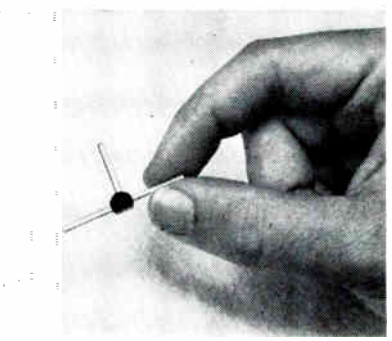
Accuracy is ±5μsec. Total delay is measured unambiguously for 4msec.

The Model 460 transmitter and receiver units can be stacked together for local input-output, or separated for remote inputs and outputs. Each contains its own power supply for plug-in operation on 115vac. Its carrier frequencies are variable from 500cps to 50kc. It is capable of both absolute and relative measurements. Readings are in msec., and the set is adaptable to closed or open loop measurements. Acton Laboratories, Inc., 531 Main St., Acton, Mass.

Circle 132 on Inquiry Card

NPN TRANSISTOR

Provides 5w. at 500mc with a max junction dissipation of 11w.

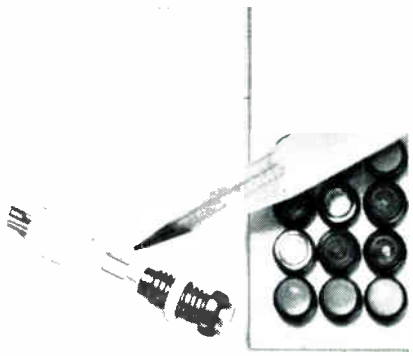


This epitaxial device has low induction ribbon leads, low parasitic capacitance, low junction-to-case thermal resistance and a beryllium oxide base readily solderable to a dissipator. In a lumped-element test circuit the transistor delivered 6db gain at 500mc, yielding a 5w. output at 53% efficiency. This unit has operated in coax circuits with outputs greater than 100mw at 2gc. It comes in flat pack. Price is $60 ea. in quantities of 100. Vector Solid State Laboratories, Vector Div. of United Aircraft Corp., Southampton, Pa. Phone 215 EL 7-7600.

Circle 133 on Inquiry Card

DISPLAY LIGHT

Ideal for indicating toggle switch positions and for verifying relay settings.

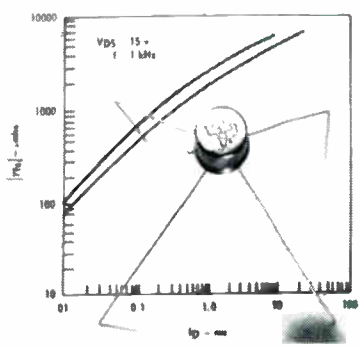


The SDL Series indicator lights are 0.240 in. in dia. and mount on ¼ in. centers horizontally and vertically. They are designed for use where panel space is limited, or where small indications such as decimal points are wanted. A choice of connector hook-up (SDL-A Series) or wire lead (SDL-B Series) is available. The SDL Series uses 100K hr. T-1 incandescent lamp and 13 lens colors. TEC-LITE, Transistor Electronics Corp., Box 6191, Minneapolis, Minn. 55424.

Circle 134 on Inquiry Card

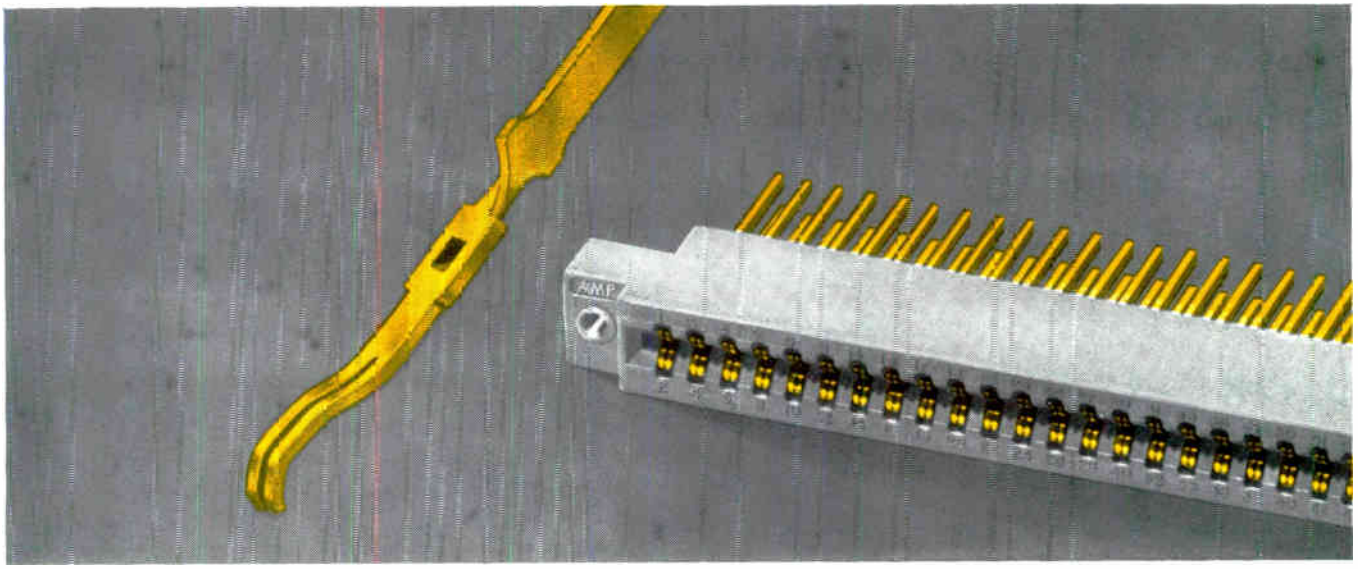
TETRODE FET

Said to offer 2-to-1 improvement in freq. transconductance.

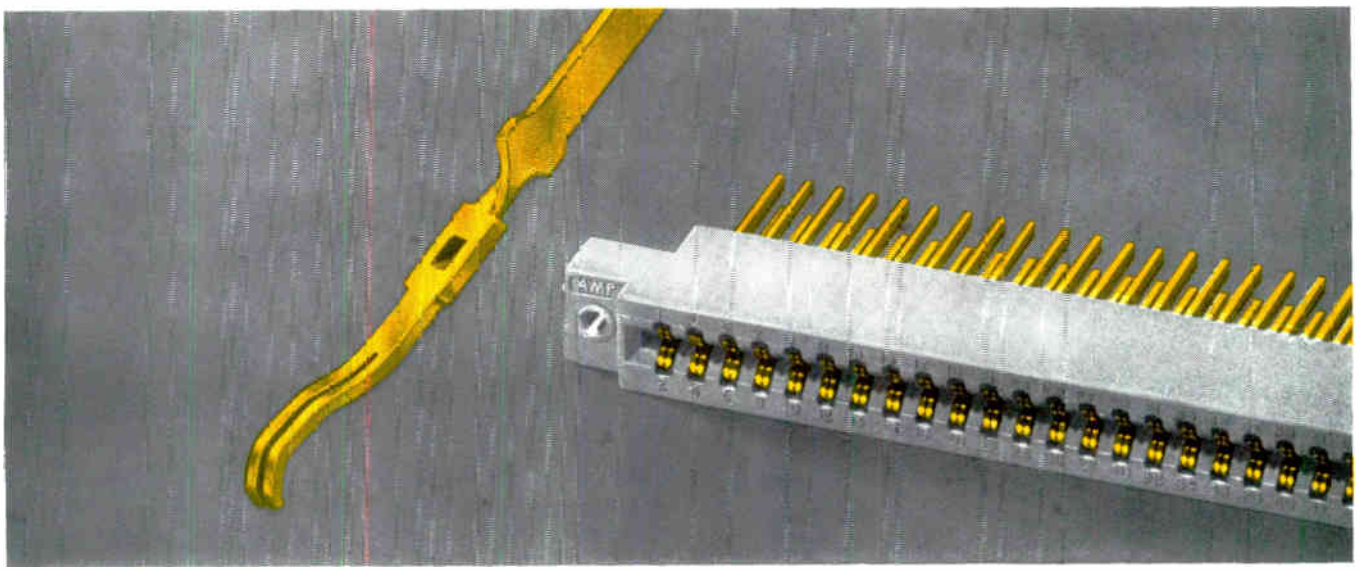


The TIXS35 is an N-channel double-gate TO-12 device. Transconductance of the front gate with the substrate gate connected to source is typically 8000 micromhos. With the front and substrate gates connected together, Y_{fs} is 10K micromhos min. The unit allows the use of FETs in autodyne mixer circuits where it can function as both mixer and local oscillator, thus eliminating 1 transistor and associated oscillator circuitry. Texas Instruments Incorporated, P. O. Box 5012, Dallas, Tex. 75222. Phone Jack Miller 214 AD 5-3111, Ext. 1206.

Circle 135 on Inquiry Card



Pardon our redundance, but you asked for it!



We're referring to the contacts in our new TERMI-TWIST★ Printed Circuit Connector. In addition to all their other advantages, they're bifurcated for redundancy.

Now, with TERMI-TWIST contacts, you may use automated point-to-point wiring techniques and have the benefits of AMP's gold-over-nickel plating—plus contact redundancy. Yet, they're designed for cost savings from the front bifurcated contact through the center twist locking section right back to the rear post which accommodates AMP's new TERMI-POINT★ clip wiring devices.

For reliability, the phosphor-bronze contacts are plated with gold over nickel, including a .000030" gold plating on the critical contact areas. Thanks to their 90° twist and square shoulder design, the contacts are positively aligned and firmly locked in the housing. Contact removal, however, is easily accomplished with ordinary long nose pliers.

These low-cost TERMI-TWIST Connectors are available in either diallyl phthalate or phenolic housings in sizes which include 15, 22, 31, or 43 contact positions, with contacts loaded on one or both sides. They are designed with a contact density of .156" for convenient replacement of existing panel mounted connectors.

Take a look at these TERMI-TWIST Connector features:

- Economy—low initial and per-line cost
- Wiring compatibility—use TERMI-POINT clips; or solder, weld, or wrap
- Flexibility—accepts printed circuit boards from .054" to .071" thick
- Quality—meets mechanical and electrical requirements of MIL-C-21097
- Reliability—Gold-over-nickel plating and high contact force
- Versatility—optional automatic machine or hand tooling

If you've been asking around for an economical and reliable board edge connector that's compatible with automated application, don't overlook this TERMI-TWIST Connector. Write for complete details today.

★Trademark of AMP Incorporated

AMP INCORPORATED
Harrisburg, Pennsylvania

INDUSTRIAL SALES DIVISION

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

Circle 67 on Inquiry Card

WHAT'S NEW

NEW MOUNTING FOR MICROCIRCUITS

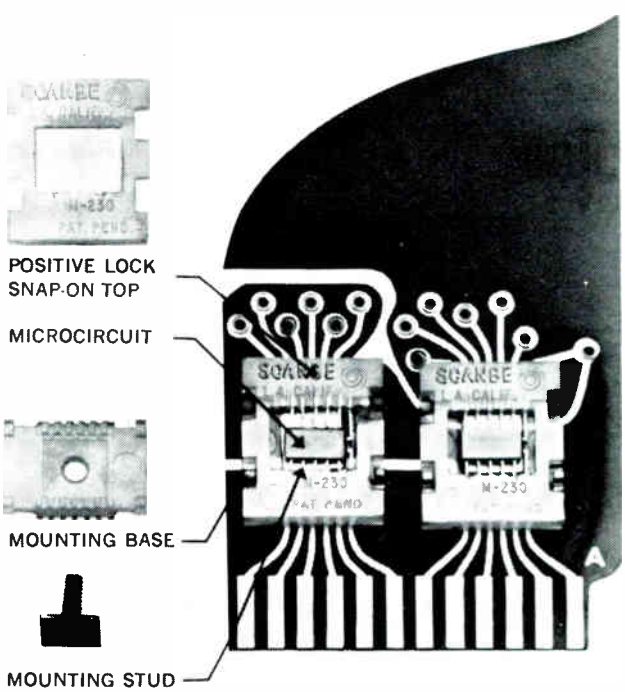
A NEW MOUNTING CONCEPT, which allows easy handling of microcircuits and provides solderless pressure-contact mounting of circuit chips, has been developed by Scanbe Mfg. Co., 1161 Monterey Pass Road, Monterey Park, Calif.

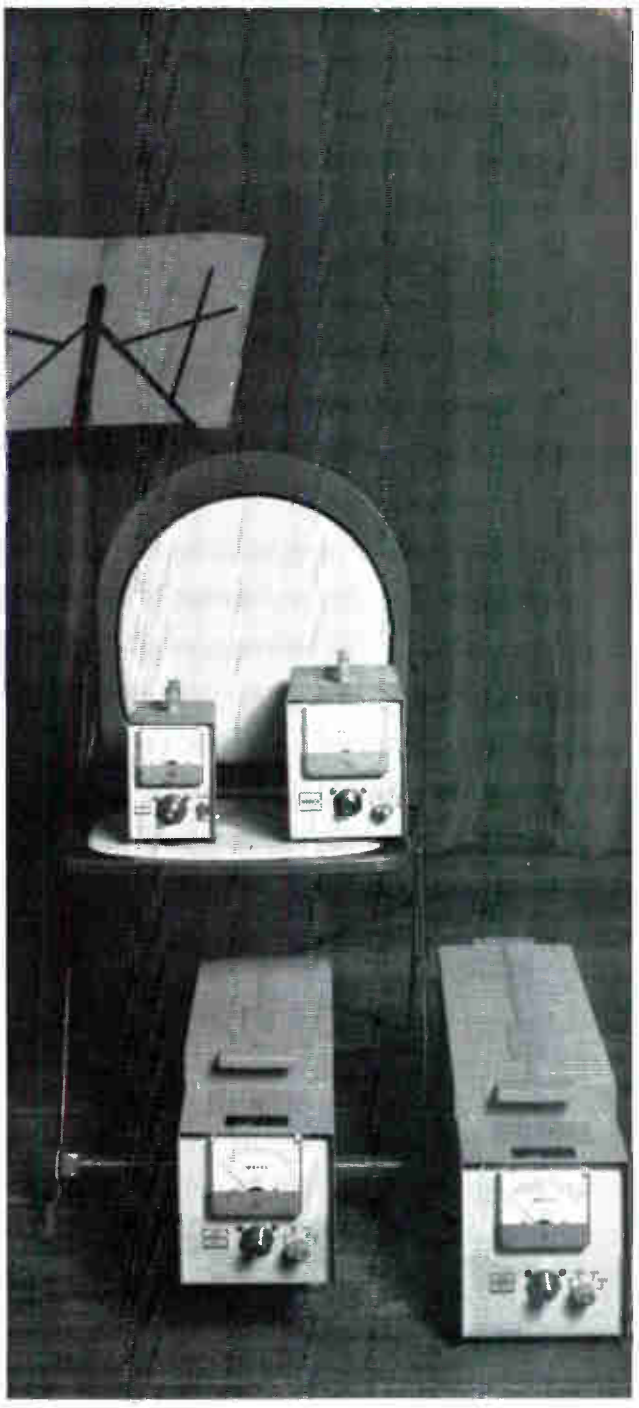
The package consists of three pieces: a base in which the chip is set with no fastening necessary; a positive lock snap-on top which holds the chip securely in place; and a mounting stud which becomes part of the base. The mounting stud extends through the mother board and a nut is applied on the opposite side. Since the mounting stud and nut are metal, they also act as a heat sink.

The chip leads are brought out of the package in individual channels. This assures constant lead separation and spacing, yet allows the leads maximum contact area with the mating leads on the mounting board. Tightening the nut pulls the assembly down tight against the board, creating a pressure contact. The package also has a boss molded into it for orientation in an indexing hole on the board.

The new packaging concept proves to be economical. With it the chip and its mounting can be installed, removed, tested, or replaced without damage to the mother board and its circuits, or to the chip itself. The package also serves as a test fixture, and can be used for shipping container. Circle 196 on Inquiry Card

Package allows pressure-contact mounting of circuit chips. It needs no heat sink, and can be used as a shipping container.





One way to check for power loss

Visual inspection may sometimes reveal the source of a power loss. Most transmitters, however, require more sophisticated test equipment. Fortunately, the cost of wide-range power meters like Sierra's new Series 401A r-f termination wattmeters need not sound a sour note in your budget.

At prices you can appreciate (see below), Series 401A wattmeters make precise measurements of power on four selectable ranges up to 1,000 watts, with frequency coverage of 2 to 1000 Mc. Single-knob switching lets you read down to two watts on the 1,000-watt model. Sierra's "Twist-Off" connectors permit quick field changes of eight connector types. Permanent sealing eliminates coolant leakage.

You can bring on a full range of data concerning Sierra Series 401A r-f wattmeters with a note to Sierra/Philco, 3885 Bohannon Drive, Menlo Park, California 94025.

Sierra 401A R-F Termination Wattmeters

401A (120 w)	**$195.00**	401A (500 w)	**$275.00**
401A (250 w)	**$225.00**	401A (1,000 w)	**$365.00**

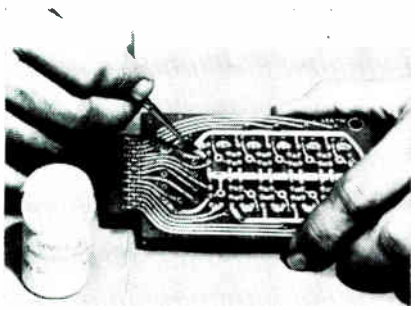
A better way from Sierra

SIERRA ELECTRONIC DIV.
OF
PHILCO
A SUBSIDIARY OF Ford Motor Company

NEW PRODUCTS

SILVER-FILLED PAINT

High electrical conductivity plus adhesive and film-forming properties of acrylics.

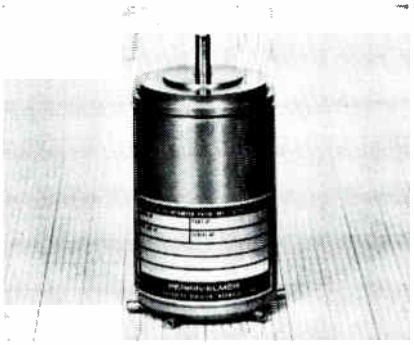


Dynaloy 340 adheres to any surface—metal, plastic, glass, rubber, or ceramic. Uses include electrostatic shielding, repair and prototype production of printed circuits, dielectric test patterns, component lead terminations, etc. Volume resistivity is 0.001Ω-cm. This silver-filled conductive paint requires no formulating, and can be applied directly from the can by dipping, brushing, roller coating, or silk screening. Trial quantities available at $10.00 for 3 oz. cans. Dynaloy, Inc., 408 Adams St., Newark, N. J. 07114.

Circle 136 on Inquiry Card

A-C POTENTIOMETER

Nominal input impedance is 40kΩ and max. output impedance is 20Ω.

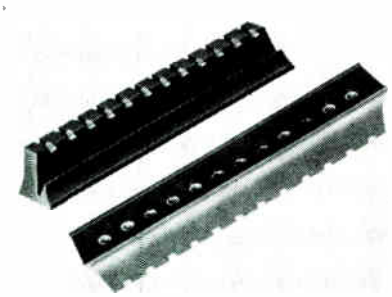


The Model 3C Vernistat® potentiometer has an absolute linearity of 0.005%. The unit has no end-trimming. High mutual coupling provides a ratio of 10^3 or better between input and output impedances, assuring relative immunity to loading errors. Specs. include: theoretical resolution (100/N) of 0.002%; max. output current of 25ma; and electrical rotation 30 turns, 10,800°. Electronic Products Div., Perkin-Elmer Corp., Main Ave., Norwalk, Conn. Phone Henning Nielsen, 203 847-0411.

Circle 138 on Inquiry Card

PRINTED-CIRCUIT CHECKER

Test point strip/handle provides convenient access to test and alignment voltages.

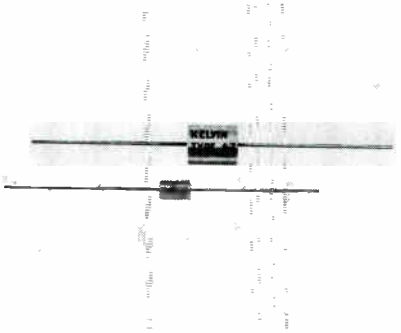


With this test point strip/handle, test points on the front of the unit are numbered for individual circuit identification, and an area is provided at either end of the strip board identification. This allows PC boards to be checked in the circuit without using a board extender, jumper cables, or substitution. The test point strip/handle mounts on PC boards by manual positioning and is permanently secured by wave soldering. The new component is designed for both single and multiple layer PC boards. E. F. Johnson Co., Waseca, Minn. 56093.

Circle 137 on Inquiry Card

WIREWOUND RESISTORS

Offer 0.0025% absolute tolerance @ 25°C with 0.0025% stability for 3 years.



Series "A" precision resistors are rated at 0.12 to 1w. based on a max. amb. temp. of 125°C, derated to 0w. @ +145°C. Resistance ranges from 1K to 1 meg. Tolerences of 1% through 0.0025% are available on most types and resistance values. Temp. coefficient is ±10 ppm/°C standard from +10°C to +85°C. Sizes range from ¼ x ½ in. to ½ x 2 in. The resistors are ideal for A-to-D converters, analog computers, differential voltmeters and guidance computers. Kelvin, 5907 Noble Ave., Van Nuys, Calif. Phone Roger Featherston 213 782-6662.

Circle 139 on Inquiry Card

Delco Radio's new 400V silicon power transistors will change your thinking about high voltage circuitry. You can reduce current, operate directly from rectified line voltage, and use fewer components. Our standard TO-3 package stays cool (junction to heat sink 1.0°C per watt). And price is low—less than 3c a volt even in sample quantities—for wide ranging applications. Vertical and horizontal wide-screen TV outputs, high voltage, high efficiency regulators and converters. Your Delco Radio Semiconductor distributor keeps them on ice. Call him today for data sheets, prices and delivery.

The heat's off high energy circuits

RATINGS	DTS 413	DTS 423
VOLTAGE		
V_{CEO}	400 V	400 V
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)

FIELD SALES OFFICES

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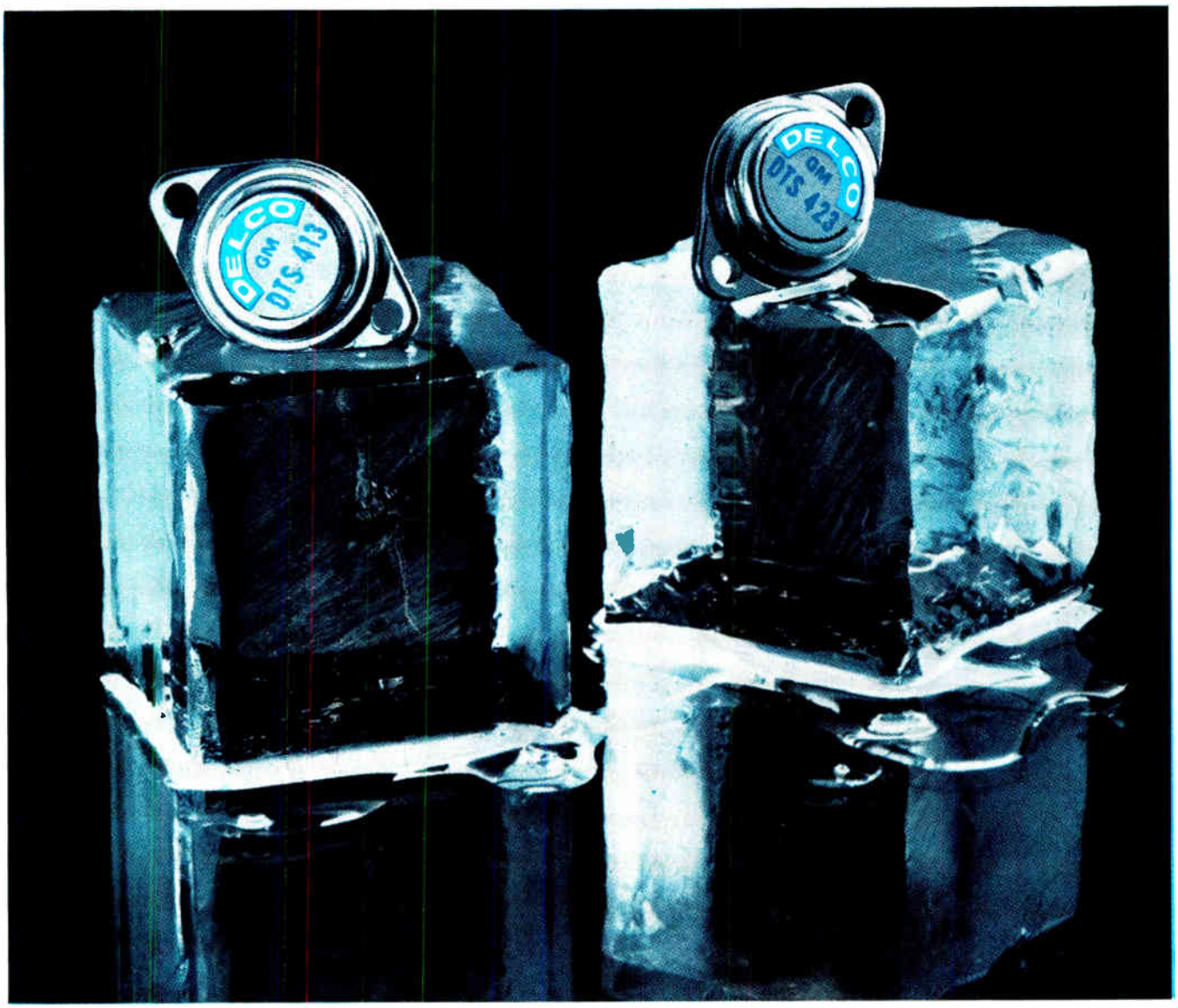
726 Santa Monica Blvd.
(213) 870-8807

General Sales Office:
700 E. Firmin, Kokomo, Ind.
(317) 457-8461—Ext. 500

*Office includes field lab and resident engineer for application assistance.

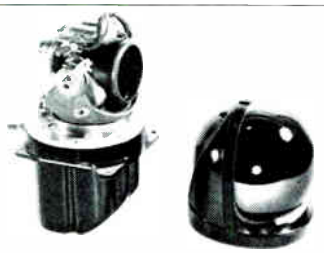
DELCO RADIO
Division of General Motors, Kokomo, Indiana



INFRARED ENGINEERS AND SCIENTISTS:

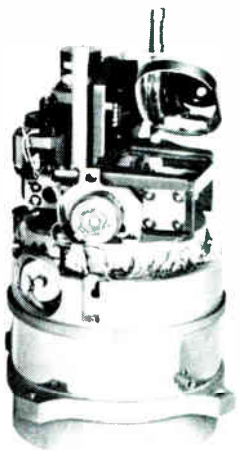
Can you contribute to the development of products like these?

Homing guided missile seeker head.

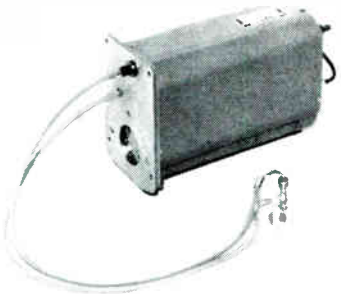


Interceptor IR search/track set

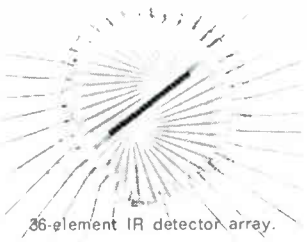
Anti-tank missile controller.



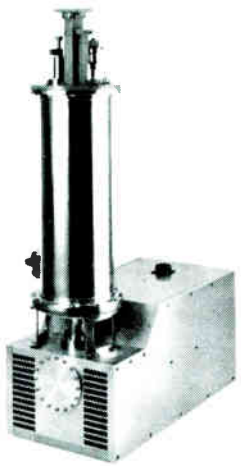
Star tracker for SURVEYOR spacecraft.



Miniature closed-cycle cryogenic refrigerator.



36-element IR detector array.



Cryogenically cooled parametric amplifier.

Radiometer for NIMBUS weather satellite.

Multi-element cooled IR detector.

Cast silicon IR optical components.

Rapid growth of Hughes infrared activities in the Aerospace Divisions and the Santa Barbara Research Center has created many responsible positions for qualified engineers and scientists in all phases of IR systems development from conception through production engineering.

Immediately available assignments include openings in such diverse technologies as optical design, semiconductor physics, cryogenics, mechanical engineering, precision electro-mechanisms, electronic circuit design, servo systems . . . and many other areas.

Current Hughes IR contracts include advanced systems for: space exploration, weather satellites, anti-ballistic missile defense, night reconnaissance, aircraft and space vehicle defense, and tactical weapon guidance and fire control.

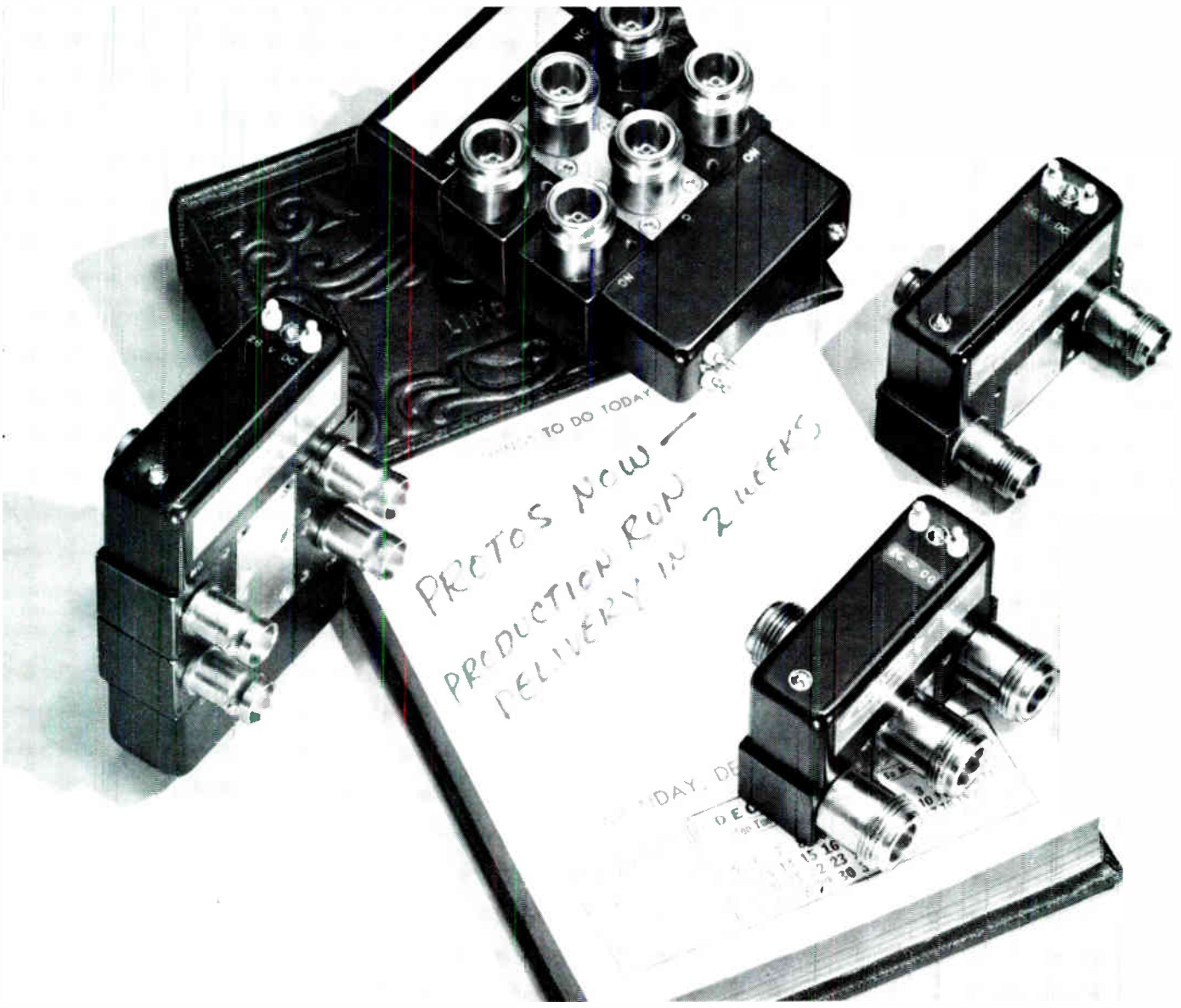
Professional experience, an accredited degree and U.S. citizenship required.

For immediate consideration, please airmail your resume to:

Mr. Robert A. Martin
Head of Employment
Hughes Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City 2, California

HUGHES
HUGHES AIRCRAFT COMPANY
AEROSPACE DIVISIONS

An equal opportunity employer



New Amphenol design cuts RF switch delivery to 14 days

Modular construction of Dynaform* switches puts prototypes or production quantities in your hands as quickly as they can be assembled and shipped.

OVER 300 VARIATIONS. Amphenol Dynaform switches are built from 23 standard modules. From these come over 300 switch variations: SPDT, DPDT, and Transfer. Shorting, non-shorting or resistor terminations can be provided. A variety of coil voltages are available.

Connectors are BNC, TNC or type N positioned for through-panel or above-chassis mounting.

LIGHTER WEIGHT. New aluminum construction cuts weight to less than one-half that of comparable RF switches.

Completely enclosed design makes Amphenol Dynaform switches dust-proof, too.

FREQUENCY RANGE EXTENDED. Electrical performance of the new Dynaform switch is better than any other blade-type RF switch. Usable frequency range has been extended to 6 Gc. Crosstalk remains consistently low in all frequency ranges.

Designed and tested to exceed the requirements of classes B2b and B3b coaxial switches per Military Specification MIL-S-3928B

DELIVERY IN 2 WEEKS. Order today and be prepared to install your custom design Dynaform in 14 days Call your Amphenol Sales Engineer. Or write Amphenol RF Division, 33 E. Franklin St., Danbury, Connecticut.

*Dynaform is a trademark of Amphenol Corporation.

AMPHENOL RF DIVISION
AMPHENOL CORPORATION

Specify Amphenol . . . the leading name in cable, connectors, assemblies, RF switches, potentiometers, motors, microelectronics

Circle 45 on Inquiry Card

Which ELECTRONIC INDUSTRIES Article was the MOST USEFUL in 1965?

You can win a cash prize by telling us how one of the articles listed on the opposite page was useful to you in 1965. Just write the name of the article and a description of how it helped you on the attached card. Mail to us before April 15th, 1966. Winners will be determined by the best comments on the use of an article.

1st prize	**$100.**
2nd "	**$ 50.**
3rd "	**$ 25.**
4th "	**$ 25.**
5th "	**$ 25.**

In addition, a reprint of the article receiving the most votes will be mailed to all participants.

The winners will be announced in our June issue. Mail your entry today. Only one per person.

IF CARD HAS BEEN USED SEND YOUR ENTRY ON A COMPANY LETTERHEAD

To The EDITOR, ELECTRONIC INDUSTRIES, 5611 Chestnut Street, Philadelphia, Pa. 19139

1965 FEATURE ARTICLES IN ELECTRONIC INDUSTRIES

January 1965

1965 Review and Forecast for the Electronic Industries
The 1965 Electromagnetic Spectrum Chart
Guide to Connector Specifications: Part 1—P-C Connectors
Manufacturers of Printed-Circuit Connectors
Materials for Packaging Microelectronic Devices
Comparing the Backplane Wiring Techniques
Designing the RFI-Shielded Package
Selecting Epoxies for High-Z Circuits
A Microwave Beamfield Plotter
New Market Looms in Electronic Toys

February 1965

State-of-the-Art in Electrical Energy Sources
Specifying Connectors for Coaxial Cable
The Evolution of Semiconductor Electronics
How to Specify High Voltage Silicon Diode Stacks
Practical Design of All-Pass Networks
Shift Register Design Using Tunnel Diodes
Parallel Tuned Circuit Calculations
Making Meaningful Measurements
Laboratory Accuracy in a Portable Dual-Trace Oscilloscope
Writing Persuasive Proposals
Solid State Circuits Conference

March 1965

1965 Survey of Relay Specifications (Part 1)
What Engineers Should Know About Plasma
The Navy's Approach to Telemetry
Optimum Performance from Silicon Reference Elements
Applying Poles and Zeros to Nonlinear Networks
Choosing the Right Solder Alloy
Checking the Quality of Integrated Circuits
Making Meaningful Measurements—Part II
Profile of Today's Electronic Engineer

April 1965

1965 Connector Specifications Guide . . . Part 3 Multi-Pin Connectors
The impact of Integrated Circuits on Industry Roles
Mating the Thin Film and Semi-conductor Technologies
Measuring DC Relay Coil Transients
Suppressing Relay Coil Transients
A Semiconductor Servo for DC Control
Solid State Relay for Data Communications
Design Guide-Lines for Space Thermal Environments
The Probably Reliability of a Measurement
Many Technical Films Available for Engineers
Needed: Better Technical Papers

May 1965

Engineer's Guide to Antenna Selection
- Considerations in Selecting Antennas
- Linear Antennas
- Long-Wire Antennas
- Aperture Antennas
- Log-Periodic Antennas

1965 Relay Specifications—Stepping Relays & High Voltage Relays
Using Field Effect Transistors for Digital Circuits
Thermal Probe Speeds Environmental Testing
Oceanography—New Challenge for Equipment Designers

June 1965

The Status of Monolithic and Thin-Film Circuits
Thin-Film Hybrid Approach to Integrated Circuits
A Close Look at Measurement Standards
Low Level High-Frequency R-F Voltage Standards
Measuring Frequency Deviation
Selecting the Right Meter
Improved Circuits for Testing SCR's
Oscilloscope Sampling Techniques
Laminates for Multi-Layer P-C Boards
Late Developments in Capacitor Design
Design for a Simple Voltage Regulator
Engineer's Notebook: Rise-Time Calculations
Color Photomicrographs of Electronic Devices
How EIA Faces the Challenge of Change

July 1965

The Broad Aspects of EMC
New Developments in EMC
Evaluating DC Testers for Integrated Circuits
Survey of Integrated Circuit Testers
1965 Survey of Commercial Semiconductor Photosensitive Devices—Part 1: Photoconductors
1965 Connector Specifications Guide, Part 4: Plugs, Jacks, Cords and Terminals
Reliability Through Redundancy
A Simple Approach to Operational Amplifier Design
Electromagnetic Compatibility Measurements

August 1965

1965 Survey of Relay Specifications, Part 3: Power Relays
Profile of Electronic Engineers—1965
1965 Survey of Commercial Semiconductor Photosensitive Devices
Designing Varactor-Tuned Circuits
Applications for Collector Logic
The Electronic Correlator
Growing Crystals for Electronic Devices
Testing Silicon Rectifiers
Don't Overlook the Competition

September 1965

1965 Survey of Commercial Semiconductor Photosensitive Devices, Part 3: Phototransistors & PNPN Light Activated Devices
1965 Survey of Relay Specifications, Part 4: General Purpose Relays
A Look at Linear Integrated Circuits
Digital Integrated Circuits and Their Limiting Factors
Report on the Transistor Industry
Semiconductor Diodes—Past, Present, and Future
Wire & Cable Reference Chart
A Miniature R-F Switch for Space Applications
Nomograph for the Parabolic Surface Area
Curve Tracer for Field-Effect Transistors

October 1965

1965 Survey of Potentiometer Specifications, Part 1: Precision Potentiometers
The Broad Aspects of Testing Integrated Circuits
Integrated Circuits Commercially Available
Using SCR's in Power Control Systems
Potentiometer Linearity Considerations
Applying Directional RF Wattmeters
How to Avoid Engineering Obsolescence

November 1965

A Practical Component Packaging System
Microwaves—Past, Present & Future
1965 Survey of Microwave Semiconductors
Understanding Plasma Diodes and Amplifiers
Design Technique for Wideband Microwave Links
1965 Survey of Potentiometer Specifications, Part II: Special Purpose Potentiometers
Photoconductive Detectors for Infrared Measurements
Market for Microwave Components Turns Upward

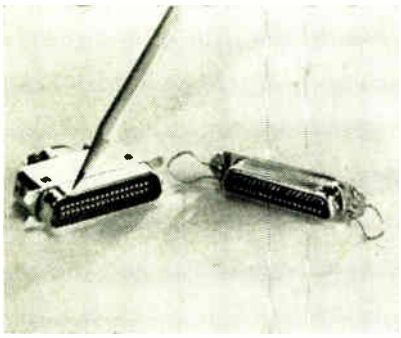
December 1965

More Computing Power Per Dollar
A Survey of Optical Character Recognition
OCR Equipment Manufacturers Listing
Memory Devices for Modern Computer Memories
Basic Considerations in Time-Sharing
Looking at Integrated Circuit Costs and Failures
1966 Survey of Switches, Part 1: Toggle, Rocker, Slide and Lever Types
Notes on the Measurement of SNR
Legal Protection for Computer Software

NEW PRODUCTS

RACK & PANEL CONNECTORS

Has 50 contacts in a mating face area approx. 2.4 x 0.61 in.

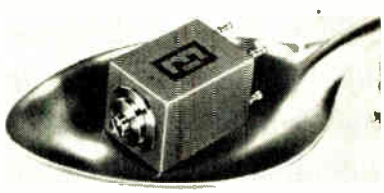


The Micro-Ribbon 57 series allows mounting many identical units on a single frame without danger of mismating with new keyed shell miniature connectors. Four different keying positions are possible on each connector in the line. Combinations of these basic keying positions further increase the number of like connectors that can be used on the same panel. Three types are available: cable to chassis units; cable to cable units; and right-angle shell units. Contacts are rated at 5a., 700vdc. Amphenol Connector Div., 1830 S. 54th Ave., Chicago, Ill. 60650.

Circle 156 on Inquiry Card

MULTI-TURN POT

Resistance ranges from 25Ω to 100KΩ with a tolerance of 1% standard.



With this multi-turn potentiometer, the wiper rotates around the periphery of the resistance wire helix, and follows each turn as does a nut on a screw. Since the contact essentially travels with the axis of the resistance wire, instead of across the turns as with conventional potentiometers, high resolution is achieved with a low noise level. Linearity is 0.01% and temp. coefficient is 10 PPM/°C to 125°C. A ½° of shaft rotation provides a typical resolution of 0.17Ω in the 25KΩ unit. Elliott Industries, 23987 Craftsman Rd., Calabasas, Calif.

Circle 158 on Inquiry Card

PHOTOCHOPPERS

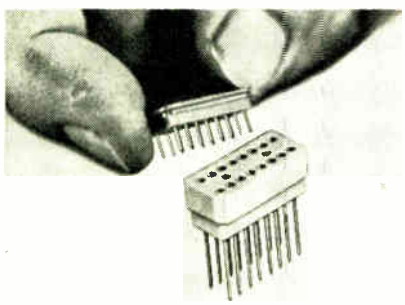
Operate at chopping freq. to 1KC and modulates dc signals in sub-μv level.

The hpa-4503 and 4504 are DPDT externally-driven photochoppers. The 4503 features a high impedance modulator for use with high input impedance amplifiers; the 4504 features a low impedance modulator for use with low amplifiers. The demodulator of both types is used with a low output impedance amplifier and provides an output impedance of 50KΩ. Prices are $37.50 in quantities of 1-99 and $26.50 in quantities 100-999. HP Associates, 620 Page Mill Rd., Palo Alto, Calif. 94304. Phone Dan Scheel 415 321-8510.

Circle 160 on Inquiry Card

PLUG-IN CONNECTOR

Allows interconnection of plug-in IC flat packs for testing.



Model MPC4 Pin Pack Connector allows interconnection of in-line or plug-in flatpack types of integrated circuits for testing, prototype design, and production packaging. The device accepts 16-lead flatpacks. Spring-loaded connector has 16 positions consisting of 2 rows of 8 lead sockets spaced 0.200 in. apart on 0.100 in. centers. Socket locations are numbered both on the top and on the bottom of the connector and 1 corner is chamfered for easy indexing of devices. Texas Instruments Incorporated, Metals & Controls Inc. Div., Attleboro, Mass. Phone Bob Rowe, Ext. 7203.

Circle 157 on Inquiry Card

MICROWAVE POWER METER

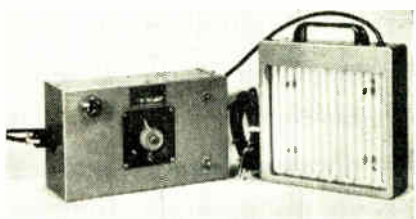
Uses 60 cycle line voltage for calibration; no bridges or amplifiers needed.

Model 540 power meter is used in conjunction with a thermal-converter mount to indicate microwave power. The meter provides a full scale indication for 10mw of r-f. The microwave thermal converter mount has a VSWR of less than 1.5:1 from 8.2-12.4gc, and the mount efficiency is better than 98%. The thermal converter mount is capable of meeting Mil shock and vibration and shows less than ±5% variation in output from 0° to 70°C. The response time is approx. 3 sec. MSI Electronics Inc., 116-06 Myrtle Ave., Richmond Hill, N. Y. 11418. Phone A. Lederman, 212 HI 1-6420.

Circle 159 on Inquiry Card

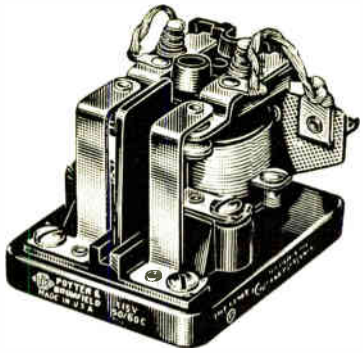
LIGHT SOURCE

Provides the high speeds needed to expose photo resist materials.



Series B3642 emits approx. 85% of its energy in the 365MU and 420MU region. These peaks match the sensitivity response of most photo resist emulsions, resulting in exposures that are said to be 3 to 10 times faster than those produced by conventional brute-force sources. The source offers cool and uniform light coverage, cleanliness, automatically timed exposures, and almost inexhaustible lamp life. All units are thermostatically controlled, insuring peak intensity at each start. Designed for intermittent operation only. Aristo Grid Product, 65-B Harbor Rd., Port Washington, L. I.

Circle 161 on Inquiry Card

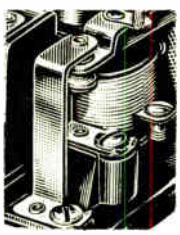


Here's why engineers have specified this heavy duty 25 amp relay by P&B for over 30 years

This is the granddaddy of all P&B relays. Our very first design. Many millions are in use throughout the world . . . starting motors, controlling elevators, switching high current and voltage loads, doing a multitude of heavy duty jobs, reliably. Year after year, the PR Series remains high on our best-seller list. Here are some reasons why.

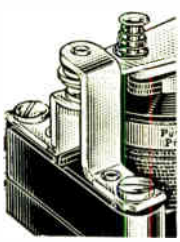
EXCELLENT CONTACT WIPE ACHIEVED WITH FLOATING CONTACT CARRIER

PR relays are designed with a full floating carrier for the movable contacts. Beside providing sufficient contact pressures, the floating carrier builds-in an abundance of wipe to keep the contacts scrubbed on every operation. Large, 5/16" diameter contacts switch 25 ampere non-inductive loads or 1 HP at 115/230 VAC, single phase. A phenolic barrier between the contacts of multipole relays prevent flash-over between contacts.



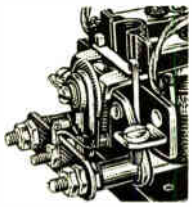
SELECT FROM A VARIETY OF CONTACT ARRANGEMENTS

PR reliability is available in relays having the following contact arrangements: SPST-NO, SPST-NC, SPST-NO-DB, SPST-NC-DB, SPDT, DPST-NO, DPST-NC, and DPDT. Coil voltages range from 6 to 440 volts A.C., and 6 to 110 volts D.C. A vast number of special variations of these standard parameters have been engineered over the years.



AUXILIARY CONTACTS ADD TO VERSATILITY OF PR RELAYS

A single set of auxiliary contacts (Form A, B or C) can be supplied when the application demands. They are rated at 5 amperes at 115 VAC, 60 cycle resistive. Standard models of PR relays with auxiliary contacts are available from leading electronic parts distributors.



MANY STANDARD RELAYS ARE LISTED BY U/L AND CSA

A wide range of standard PR relays is listed by Underwriters' Laboratories (File E22575) and Canadian Standards Association (File 15734). CSA listing covers AC relays only. These listings can often save you time and extra expense when obtaining UL or CSA qualification for your products.

MAGNETIC ARC-QUENCHERS FURNISHED ON SOME MODELS

For DC loads over 28 VDC, PR relays with normally open contacts can be furnished with permanent magnets to quench arcs. These magnets increase the DC voltage rating to 220 volts resistive . . . and often increase the life of contacts handling DC inductive loads.

PR SERIES SPECIFICATIONS

GENERAL:

Mechanical Life: Single-pole, 1,000,000 (cycles); double-pole 10,000,000 (cycles).

Contacts: 100,000 cycles at rated load. Contact life increases at smaller loads or with appropriate arc suppression.

Breakdown Voltage: 1,500 volts rms minimum between all elements and ground.

Ambient Temperature Range:
DC: −55 to +80° C.
AC: −55 to +45° C.

Weight: Approximately 10 ozs.

Pull-In
DC: 75% of nominal voltage (approx.)
AC: 78% of nominal voltage (approx.)

Terminals: Heavy-duty screw type terminals are standard for coil and contacts. Available with printed circuit, plug-in, ¼" quick connect and terminals for rear panel wiring.

Enclosure: PR dust cover.

CONTACTS:

Arrangements: Up to 2 Form C (DPDT.)

Material: ⅛" dia. silver standard. Other materials available for special applications.

Load: 25 amps non-inductive or 1 HP @ 115/230 volts AC, single phase. Special version—30 amp. non-inductive at 115/230 VAC; single phase available. (Consult factory)

COIL:

Voltage: AC: 6 to 440 volts.
DC: 6 to 110 volts.

Power: DC: 2.0 watts nominal.
AC: 9.8 volt-amps.

Resistance: 63,800 ohms maximum.

Duty: Continuous, AC or DC (DC coils will withstand 8 watts @ +25° C.

Mounting: Two ⅜" diameter holes on 1⅞" centers.

LEADING ELECTRONIC PARTS DISTRIBUTORS STOCK 44 DIFFERENT PR RELAYS

Immediate delivery at factory prices.

Ask your distributor for a copy of Stock Catalog 100

POTTER & BRUMFIELD

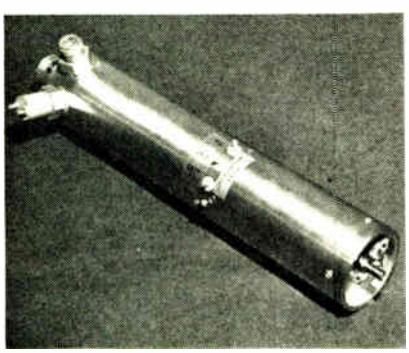
Division of American Machine & Foundry Company, Princeton, Indiana
Export: AMF International, 261 Madison Avenue, New York, N.Y.

BUSS: The Complete Line of Fuses and . . . .

NEW PRODUCTS

TRIODE OSCILLATOR

Provides a high-power signal source continuously tunable from 2GC to 4.0GC.



The Model 2423 oscillator uses a triode mounted in a multi-axial cavity. Average power output is 1.5W.; min. is 1.0. Tuning resolution is 40KC or better with overall residual FM less than 10KC. Varactor element incremental freq. control is provided over the entire octave band with a tuning range of ±0.4MC at 2GC to ±0.8MC at 4GC. It may be used in phase-locking applications. Price is $1,750. Scientific-Atlanta, Inc., Box 13654, Atlanta, Ga. 30324.

Circle 162 on Inquiry Card

COMPUTER TAPE

For phase modulation recording. Packing density of 1600 cpi.

Ampex 836 computer tape is fully compatible with the IBM 2400 tape transport. It is suitable for present standard NRZI digital recording, 7-track or 9-track, at packing densities up to 800 cpi. The 836 tape carries a 3-yr. computer tape warranty. Ampex Corp., 401 Broadway, Redwood City, Calif. Phone Gregg Perry 415 367-4151.

Circle 163 on Inquiry Card

TRANSISTOR SOCKET

Solders to PC board and accepts TO-60 outline package.

The EX-736 mounts 3/32 in. above the board. Dia. is 0.370 in. max. Insulator is G-10 glass epoxy laminate with individual contacts securely staked into it; pull-out force is 25 lbs. min. Operating temp. range of insulator is 150°C continuous. This socket is particularly suitable for airborne or severe service applications. Robinson Nugent Inc., 802 E. 8th St., New Albany, Ind. 47150.

Circle 164 on Inquiry Card

ROTARY SWITCH

PC board switch eliminates soldering, all wiring and mounting hardware.

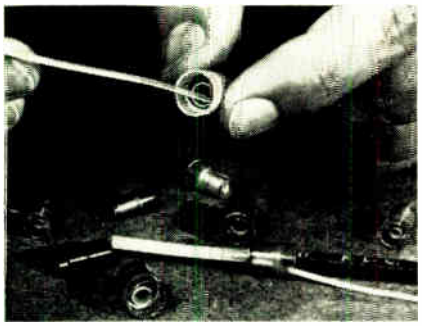
This switch has a printed stator pattern incorporated directly to the PC board. To assemble, just drill or punch a hole in the center of the stator pattern and snap the switch in place. Switch can be assembled, ready for use in less than a min. The contacts lift off the stator as they are turned to a new position, reducing wear due to normal wiping action. Lateur Engineering Co., 5537 Satsuma Ave., N. Hollywood, Calif.

Circle 165 on Inquiry Card

NEW PRODUCTS

ONE-PIECE CONNECTOR

For solderless terminating and grounding braids on shielded or coaxial cable.



This connector has a floating inner sleeve which facilitates insertion of the braid and grounding lead for faster installation. Two large inspection windows are provided in the end of the connector. These windows allow #20 stranded ground wire to be inserted from the front. Available in 9 sizes, the connectors accommodate a dielectric or insulation range from 0.053 to 0.202 in. The Thomas & Betts Co., 36 Butler St., Elizabeth 1, N. J.

Circle 166 on Inquiry Card

CRYSTAL OSCILLATOR

Stability better than 5 parts in 10^{10}/day and 1 part 10^{8}/month.

The FFO-160 provides a 1MC output. Proportionally controlled oven permits stable operation from −40°C to +60°C. A low jitter crystal oscillator circuit, with an AGC system to maintain constant crystal current, gives a short-term stability better than 1 part in 10^{10}/sec. Price is approx. $750. Manson Laboratories 77 Danbury Rd., Wilton, Conn.

Circle 167 on Inquiry Card

RECTIFIER BRIDGE ASSEMBLY

Available in single or 3-phase configurations with outputs up to 140a.

This hybrid SCR bridge assembly is designed for max. cooling and optimum performance under conditions such as heat and dust. It features simplified terminal attachment, accessible gate terminal blocks, and insulated rail mounting for the utmost flexibility. International Rectifier, 233 Kansas St., El Segundo, Calif. 90246. Phone Kenneth O. All, 213 678-6281.

Circle 168 on Inquiry Card

A-TO-D CONVERTER

Features 15 bit (±0.01%) accuracy at high conversion rates.

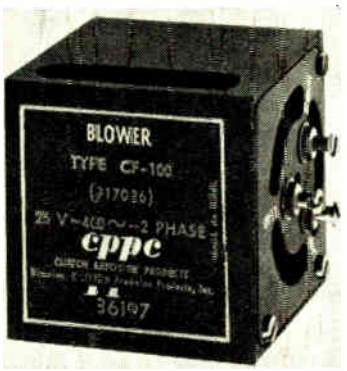
Model 633 analog-to-digital converter converts input voltage levels to digital form for subsequent recording or processing. Using integrated circuit techniques, it provides resolutions up to 15 bits of binary data or 17 bits of BCD data at a conversion rate of 1.5μsec./bit. Any of 8 different output signal levels are available at the user's option. Redcor Corp., 7800 Deering Ave., P. O. Box 1031, Canoga Park, Calif. 91304.

Circle 169 on Inquiry Card

NEW PRODUCTS

MINIATURE BLOWER

Generates 2G maximum vibration; has 1000 hr. minimum life.

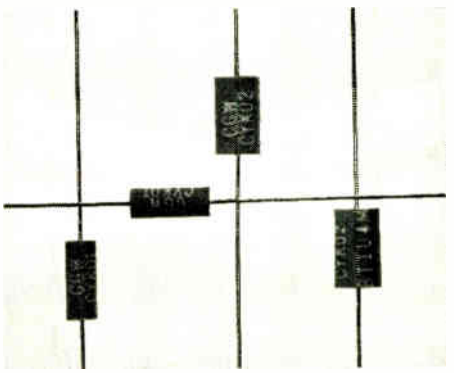


The CF-100 miniature blower (1 in. cube) delivers 2 cfm. The unit is a radial bladed, centrifugal type which weighs less than 37 grams. It contains a 2-phase 2-pole hysteresis motor that operates at 26v, 400 cycles. The motor consumes less than 2.5w./phase. Operating temp. range is −55°C to 125°C. The blower has a 20°C heat rise. Power factor is 0.87. Clifton Precision Products, Div. of Litton Industries, 5050 State Rd., Drexel Hill, Pa. Phone George Galvin, 215 622-1000.

Circle 170 on Inquiry Card

MINIATURE CAPACITOR

Uses new dielectric material. Packs a max. of 1μf in a 0.25 x 0.14 in. package.

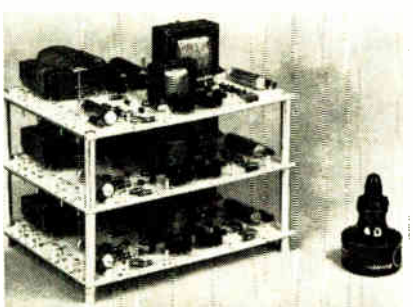


The Glass-K capacitors use a dielectric of glass composition containing interspersed microcrystals. Working voltage is 50vdc for an operating temp. range of −55°C to +125°C. In addition to the 0.25 x 0.14 in. package, a 0.25 x 0.1 in. unit is available which is rated at 0.051μfd. The smaller case size has a capacitance range of 0.001 to 0.051μfd. The other case size has a capacitance range of 0.012 to 0.100μfd. Corning Electronics, Corning Glass Works, Raleigh, N. C.

Circle 172 on Inquiry Card

GATE DRIVERS

Prevents failures caused by the di/dt effect, and provides increased gate power.



Series VS6532 and VS6732 are Silicontrol® packaged SCR gate drives. They are fast-pulse rise-time stacked open-card assemblies and provide increased gate power for pulsing SCRs having high-current ratings. Ideally suited for completely balanced, reliable SCR firing in 3-phase ac or dc power control, they require no bias for pulse reset. They are fail-safe—load and control circuits are fully isolated. Each gate-signal output is a pulse of substantially constant amplitude which is 180° wide at full SCR conduction. Sprague Electric Co., North Adams, Mass. Phone Sidney Chertok, 413-664-4411.

Circle 171 on Inquiry Card

PULSE GENERATOR

Offers a min. rise time of 4.5nsec. and external triggering from 1v.

The repetition rate of Model 110A is variable from 4cps to 40mc. Linear transition times are separately variable. Simultaneous positive or negative outputs are available to 10v. into 50Ω with up to 70db attenuation in either single or double pulse modes. Pulse width is variable from 10nsec. to 5msec.; pulse delay is variable from 10nsec. advance to 50msec. delay. Duty cycle is 50% at 40mc. Variable dc baseline control allows selection of complement output pulses at any level between ±10v. Datapulse Inc., 509 Hindry Ave., Inglewood, Calif. 90306. Phone M. B. Cox, 213 671-4334.

Circle 173 on Inquiry Card

SELECTED for MAJOR AEROSPACE SYSTEMS because of DRAMATIC SIZE REDUCTION and INHERENT RELIABILITY...

ERIE SUBMINIATURE BROAD BAND RFI FILTERS

Actual Size

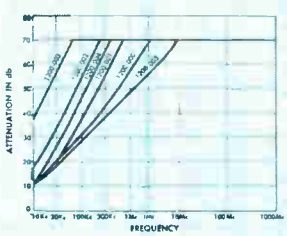
Exclusive! **High Attenuation • Hermetically Sealed Subminiature • Reliable**

Only one-fourth the size of conventional filters, Erie subminiature Broad Band RFI Filters provide excellent attenuation performance in the 10KC to 10KMC frequency range as shown in the attenuation curves below.

The problem of Electro-Magnetic Interference caused by switches, relays, motor commutators, SCR and transistor switching is efficiently eliminated by the use of Erie's hermetically sealed Broad Band EMI Filters. No longer is it necessary to use bulky paper capacitor-coil combinations . . . or large conventional filters. Erie filters provide better attenuation *in a fraction of the space.*

These reliable Broad Band Filters are selected for major aerospace systems as well as for use in industrial and commercial communication circuitry because of their small size (.375 dia. x .720 long) and high performance. Mounting arrangements and hardware to suit the application.

Consider the advantages of Erie Broad Band EMI Filters in your equipment. Write TODAY for literature and samples . . . Erie Technological Products, Inc., Erie, Pennsylvania.



TYPICAL ATTENUATION CURVE

Another series of components in Erie's Project "ACTIVE." Advanced Components Through Increased Volumetric Efficiency.

ERIE TECHNOLOGICAL PRODUCTS, INC.

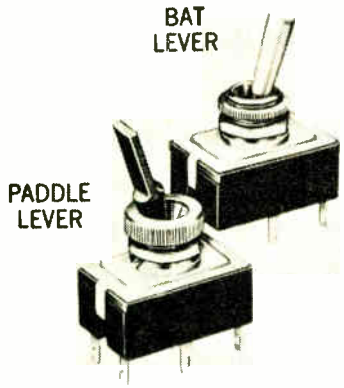
Formerly Erie Resistor Corporation

644 West 12th Street
Erie, Pennsylvania

NEW PRODUCTS

SWITCHES

AC rated at 5a., 125v. and 2a. 250v.; dc at 4a., 125v. and 1a. 250v.

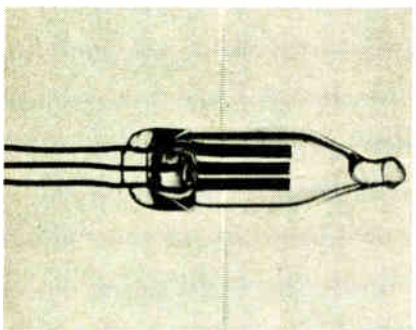


Series 84000 are snap-sliding, wedge-action switches. This new line offers ac and dc ratings; quick make, quick break with wiping contact action; 2 or 3 lever positions: maintained or momentary action—on 1 or both sides of center: choice of 3 contact materials; and compact physical dimensions. The 85000 series is offered in all circuits SPST through DPDT. Specialty Switch Div., The Arrow-Hart & Hegeman Electric Co., 103 Hawthorn St., Hartford, Conn.

Circle 174 on Inquiry Card

NEON TRIGGER TUBE

For switching circuits. Standoff voltage rating is 190 to 210vdc.

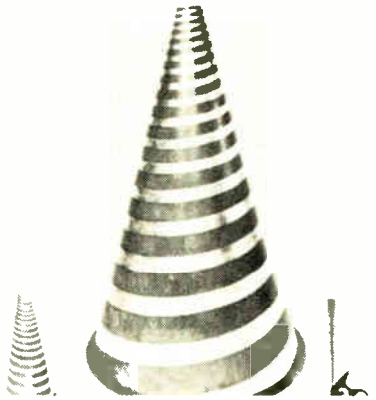


The TRQ250 trigger tube can be used in switching circuits such as timers, ring counters, shift registers, memory cells, X-Y matrices, computer readouts, machine control, etc. Its high light output allows it to be used with photo resistors. The tube is ionized by 106 (±4)vdc. Its maintaining voltage is 100 (±2)vdc. Operating current range is 1 to 6ma. Maintaining voltage is 2ma. Turn-on current is 1μa. max. Life expectancy is greater than 25,000 hrs. Signalite Inc., 1933 Heck Ave., Neptune, N. J. Phone Robert Mayer, 201 HU 7-7477.

Circle 175 on Inquiry Card

LOG SPIRAL ANTENNAS

Three individual models span the freq. range from 130 to 8500MC.



The Series 324 conical Log-Spiral antennas may be used as low-power primary feeds for paraboloidal reflectors in applications requiring min. boresight shift and good circular-polarization performance. To meet these requirements, the balanced excitations are derived from a series of inherently balanced balum configurations which provide a bandwidth ratio of 4:1. Jasik Laboratories, Inc., 100 Shames Dr., Westbury, L. I., N. Y. Phone Dr. A. D. Bresler, 516 ED 3-4010.

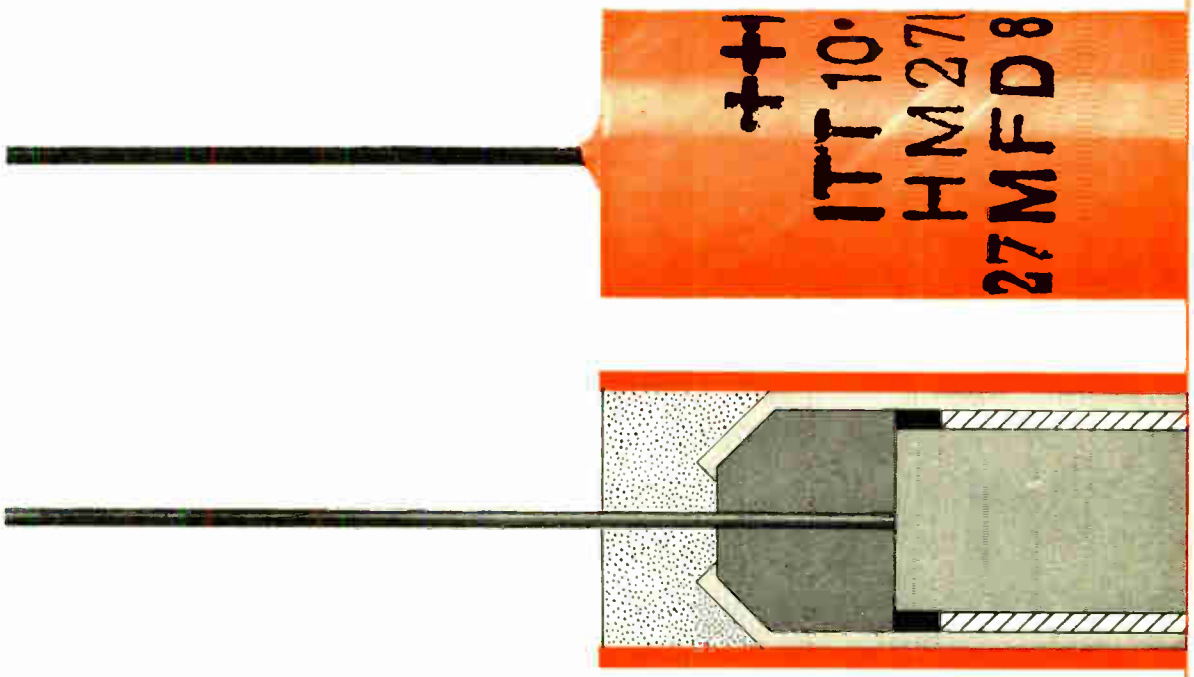
Circle 176 on Inquiry Card

MERCURY-WETTED RELAYS

Operates at speeds as high as 1msec. and on power as low as 1.2msec.

The Series BW5 mercury-wetted relays can be used on printed-circuit boards. The relay meets the high-speed switching needs of computer, control and data processing systems, and operates from −37°C to +107°C. They have life expectancy of over 1 billion cycles, and will withstand non-operating shock up to 30G's and vibration of 100G's. Other specs. include: max. power dissipation (35°C) from 1.5w., and a contact resistance (max.) of 40 milliohms. Babcock Relays, Div. of Babcock Electronics Corp., 3501 Harbor Blvd., Costa Mesa, Calif.

Circle 177 on Inquiry Card



Why ITT wet tantalum capacitors can't leak

Every ITT Red Cap® wet tantalum capacitor gets a "total stress" seal that, unlike the ordinary single-crimp seal, positively prevents electrolyte leakage. To accomplish this, ITT inserts a teflon end seal, then spins down the open end of the can until end seal, anode and insulating washer are under a predetermined compressive force.

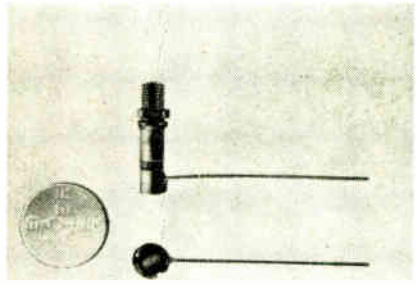
Seal integrity is further insured by the addition of an epoxy end fill. Since the epoxy's expansion coefficient is less than that of the can, temperature cycling cannot relax the spun seal.

If you're tired of electrolyte leaks and the problems that go with them, here's an easy solution. Order the ones that can't leak — the Red Caps® — from your ITT Capacitor distributor or from ITT Semiconductors, 3301 Electronics Way, West Palm Beach, Florida.

ITT

PISTON TRIMMER

⅛ in. dia. unit permits new latitude in package miniaturization.

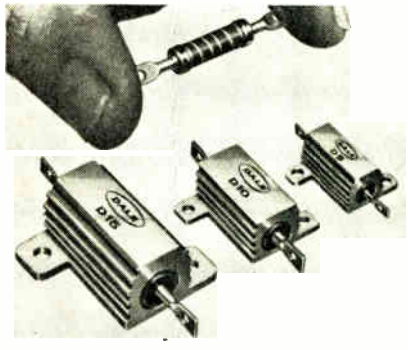


MH-13 is a tiny precision glass-piston trimmer capacitor which extends only ⅜ in. behind panel. The Q at 1 MC is 300min., and Q at 250 MC is 200min. Solid metal electrode bands on glass dielectric permit soldering directly to electrodes without damaging the capacitor. Samples available from Roanwell Corp., Roanwell Bldg., 180 Varick St., New York, N.Y. Phone Marvin Payne (212) 989-1090.

Circle 178 on Inquiry Card

POWER FILM RESISTORS

Resistance range is 50Ω to 5 megohms. Tolerances are 1/10, ¼, ½, 1, and 2%.



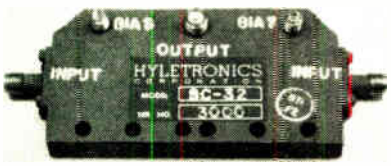
The D resistor comes in 3 models rated from 4 to 12w. The D5 is rated at 4w.; the D10 at 8w. and the D15 rated at 12w. Resistance range is from 50Ω to 5 megohms. Two standard temp. coefficients, ±25 ppm/°C and ±50 ppm/°C, are available in an operating range from −55°C to +175°C. Functionally, the D series meets the physical specs. of Mil-R-18546C for housed resistors and the electrical specs. of Mil-R-10509E for film resistors. Approx. $1.25/unit, depending on quantity, tolerance and T.C. Dale Electronics, Inc., P. O. Box 488, Columbus, Nebr.

Circle 179 on Inquiry Card

NEW PRODUCTS

SUBNANOSECOND SWITCH

Uses Gallium Arsenide and exhibits switching times less than 1nsec.

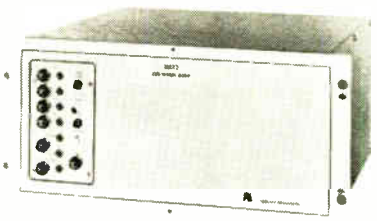


Model SC-32 is a SPDT switch. It exhibits insertion loss of approx. 0.7db in the transmitting state, and isolation greater than 30db when biased "off." The freq. bandwidth of operation is greater than 10% at C-band. This unit is designed for small size and min. bias. These min. bias conditions enable a simple high-speed driver to be used. Hyletronics Corp., 185 Cambridge St., Burlington, Mass.

Circle 180 on Inquiry Card

IC MEMORY SYSTEM

Integrated-circuit, core-memory system has full-cycle time of 2μsec.

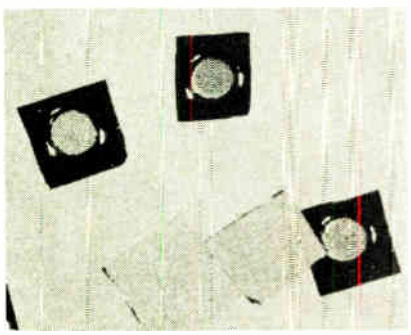


Series MUA comes in any of 4 access modes: random, sequential, random / sequential, and sequential-interlaced. In addition, the user can select from a variety of interface circuits and optional features such as address register, power supply, and self-test. Half-cycle time is 1.25μsec., and access time is 950nsec. Word capacities range from 64 to 4096 with 2 to 30 bits/word. Fabri-Tek, Inc., Amery, Wisc. Contact Mrs. Ruth Gordon.

Circle 182 on Inquiry Card

PASSIVATED DICE

Encompass computer, zener, and general purpose silicon diode specs.

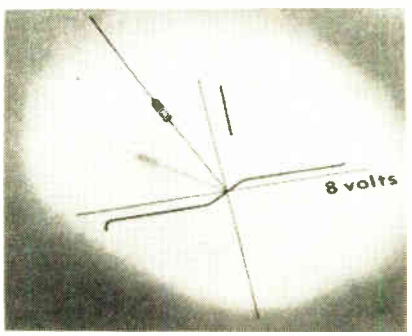


These silicon mesa passivated dice have recovery and capacitance of less than 2nsec. and 2pf. Specific, substrate, thin-film and matrices configurations can be custom engineered. Dice surfaces can be metalized. Termination temps. greater than 350°F can be used without degrading the device characteristics or the passivated surface. The dice meet or exceed Mil-S-19500 and Mil-STD 202 specs. without further encapsulation. Units are priced at $1.50 each at the 100 unit quantity level; less than $.50 at over 1000 unit quantity level. MicroSemiconductor Corp., 11250 Playa Court, Culver City, Calif. Phone James Whitehead 213 391-8271.

Circle 181 on Inquiry Card

4-LAYER DIODES

Simplifies circuitry by reducing the number of components needed.



These 2-terminal, bistable switches change from the high resistance off state to a low resistance on state when the applied voltage exceeds the device's forward breakover voltage. The 4-layer diode remains in this high-conductivity state as long as the current through the device exceeds its specified holding current. The diode simplifies circuitry. Whenever the applied power and the control signal are the same or are on the same line, the diode eliminates the pulse-steering circuits which isolate or derive the control signal and deliver it to the control terminal of a 3-terminal device. Motorola Semiconductor Products Inc., Box 955, Phoenix, Ariz.

Circle 183 on Inquiry Card

NEW PRODUCTS

BANDWIDTH AMPLIFIERS

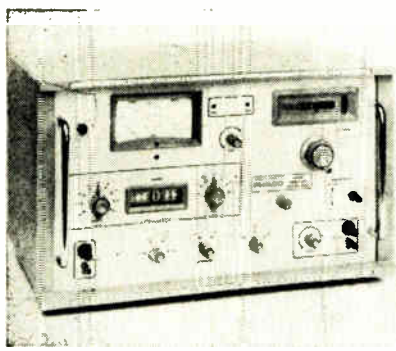
Solid-state amplifiers deliver output powers comparable to vacuum-tube types.

The AP series are low-noise, octave-bandwidth amplifiers. Standard freq. coverage is provided by the following models: AP-10, 100 to 200 MHz; AP-20, 200 to 400 MHz. These amplifiers provide between +20 and +23dbm of power at the 1db gain compression point. The MTBF is 250,000 hrs. @ 71°C. Max. dc input is +15vdc @ 3.75w. They use 50Ω impedance OSM miniature r-f connectors, and the complete unit weighs less than 8 oz. Price is approx. $1000. For additional data write to Larry Thielen, Avantek, Inc., 3001 Copper Rd., Santa Clara, Calif.

Circle 184 on Inquiry Card

WAVE ANALYZER

Examines fundamental freqs., harmonics, and components from 20cps to 100kc.

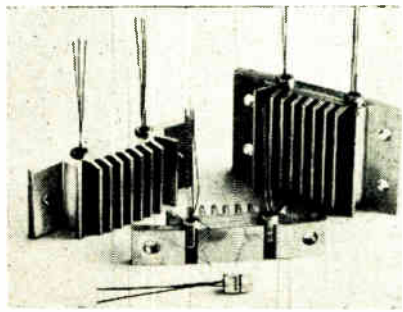


Model 301A is a solid-state, wide-range wave analyzer with digital readout that is direct-reading in kc. The 5-digit readout provides numerical values in 10cps increments, with 2cps interpolation marks. Freq. resolution is specified as ±1% +10cps from 20cps to 10kc, and ±100cps from 10kc to 100kc. Model 301A can be used as a tracking signal generator or as a selective voltmeter with restored signal output. In the signal generator mode, the output freq. is the same as that to which the voltmeter is tuned. Price is $1,995. Sierra/Philco, 3885 Bohannon Dr., Menlo Park, Calif. 94025. Phone 415 322-7222.

Circle 185 on Inquiry Card

HEAT SINK

Low-cost heat sinks are for TO-1 case transistors.

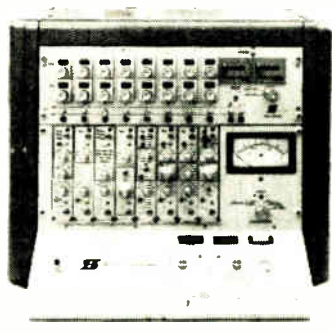


The 1-piece construction of the 2N-2431MP heat sink eliminates clamping nuts and bolts, and saves the time spent in aligning the 2-piece types. Thermal resistance from case to amb. is reduced by a factor of almost 2:1. Three types are available: HS-3 is used in amplifiers up to 10w.; HS-2 is adequate for a 5w. amplifier in free air; HS-1 provides heat sinking for 2 output pairs (4 transistors for stereo), for up to 10w./channel, when mounted on a chassis. Amperex Electronic Corp., Semiconductor & Receiving Tube Div., Slatersville, R. I. 02876.

Circle 186 on Inquiry Card

FET/TRANSISTOR TESTER

Tests characteristics of p- and n-channel junction MOS FET.

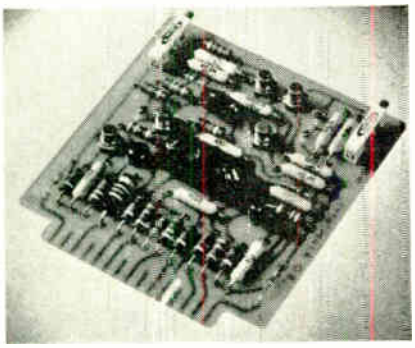


Monitor II is a general-purpose, easily programmed test set. In addition to FETs, it tests most small-signal and medium-power bipolar transistors and semiconductor diodes by adding program modules. Some features include: 10 pico-amp leakage current resolution; modular construction; test time programmable from 100msec. to 1 sec./parameter. Any transistor or diode within parametric limits of the equipment may be tested by changing test modules. Price varies from $7,900 to $15,000; 90 day delivery ARO. Silconix Inc., 1140 W. Evelyn Ave., Sunnyvale, Calif. 94086. Phone Harriet St. John 408-245-1000.

Circle 187 on Inquiry Card

VOLTAGE FOLLOWER

Features 4000 megohms input and unity gain to an accuracy of 20 ppm.

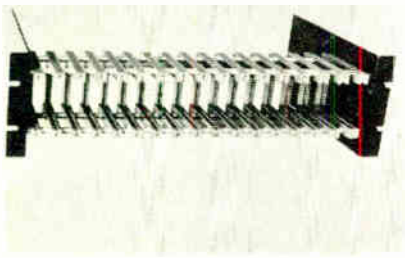


Model 933 is a differential amplifier specifically optimized for follower uses. Applications include: impedance transformation, measurement from very high-impedance sources, unloading of precision voltage dividers, sample and hold circuits, shield capacity drivers, and precision active low-pass filters. Output is 20ma @ 10v.; drift is 5μv/°C and 120pa/°C. Voltage and current offsets are adjustable to 0. The output impedance is less than 0.01Ω. RO Associates, Inc., 917 Terminal Way, San Carlos, Calif. 94070. Phone Jerry Haegle, 415-593-7570.

Circle 188 on Inquiry Card

CARD HOLDER

Accepts any size card within the limitations of the end plates used.

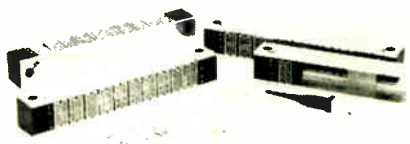


The Verorack printed circuit card holder comes in sizes of 5¼, 7, and 8¾ in. high x 11 in. deep for standard 19 in. wide mounting. Furnished normally unassembled, it consists of end plates, tie rods, plastic guides and spacers. Any desired card spacing can be achieved down to 0.6 in. by using the appropriate spacer size. Various length guides are available to suit the card length. Connectors are mounted either directly on the card guides or on connector mounting rails. Price depending on size and number of guides required. Vero Electronics, Inc., 48 Allen Blvd., Farmingdale, N. Y. Phone Walter O'Donnell, 516 MY 4-6550.

Circle 189 on Inquiry Card

TERMINAL JUNCTIONS

Replaces bulky terminal strips and reduces wiring steps and weight.

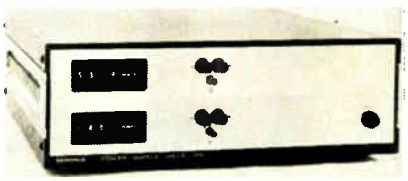


The TJ Series are high-density, environmental terminal junctions with rear release, insertable/removable, crimp-type contacts. They feature a modular design which, together with associated hardware, allow junctions of varying lengths. The junctions use crimp-type pin contacts in sizes 20, 16, 12, and 8 designed to geometry similar to NAS 1600. The contacts are inserted and removed from the rear by a single insertion/removal tool; they are crimped by a standard MS 3191 tool. The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif. Contact Henry Comeau.

Circle 190 on Inquiry Card

POWER SUPPLY

Output can be accurately controlled by standard digital control systems.



Model 3100 is a programmable, wide-range dual-output power supply. Remote programming is accomplished by contact closures in 1248 BCD code. Two independent supplies are included; each supply provides either constant voltage or constant current. The constant voltage range is 0 to 99.99v. in 0.01v. steps, and the constant current range is 0 to 99.99ma in 0.01ma steps. Both outputs are floating and can be operated in parallel in the constant-current mode or in series in the constant-voltage mode. Accuracy of voltage or current output is 0.01% (±1 digit). Fairchild Instrumentation, 844 Charleston Rd., Palo Alto, Calif. Phone Robert G. Merrick 415 962-2451.

Circle 191 on Inquiry Card

NEW PRODUCTS

CROSSBAR SELECTOR SWITCH

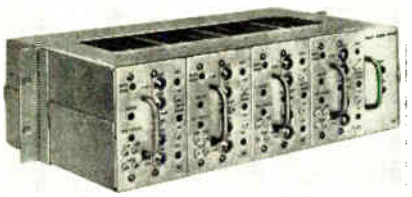
Simplifies circuit selection and permits rapid program changes.

The C10-44A provides 400 crossover points. It is intended for use in multiple-circuit situations, and provides interconnection of all common circuits by the printed-circuit strips. The working contacts are wiping and in parallel with forces averaging 200 grams, effecting a contact resistance of 0.050Ω max. Electrical capacity: current-carrying only (no make or break) 3a.—125vac or vdc. Make or break 1a.—15vdc., 150ma—125vac. List is $55.00 each. Cherry Electrical Products Corp., P. O. Box 438, Highland Park, Ill. Phone H. I. Anderson, 312 432-8182.

Circle 192 on Inquiry Card

MULTIPLEX EQUIPMENT

Solid-state, 48-channel FM voice multiplex equipment for microwave relay.

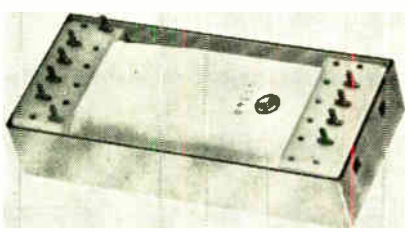


The MC-30 features toll quality performance, modular construction, battery operation, and is ideally suited for transmission of voice, VHF base station control, telemetering, data and facsimile. A channel module contains transmitter, receiver, termination and dc regulator. Each channel is totally independent, and only a 120vac power module, if used, is common to a 4-channel group. Power options permit operation from 24vdc, 48vdc, or 120vac. Motorola Inc., Military Electronics Div., Chicago Ctr., 1450 N. Cicero Ave., Chicago, Ill. 60651.

Circle 194 on Inquiry Card

DRY REED RELAYS LINE

Operate time is less than 3msec. at nominal coil voltage and 25°C.

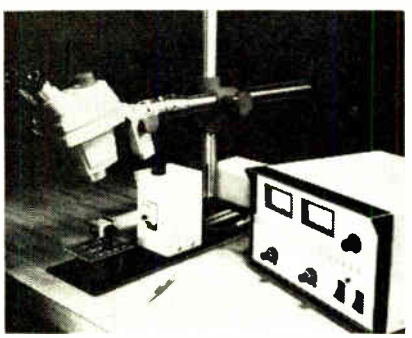


The JR series come in a wide selection of operational configurations. Two types of glass dry-reed switches are used singly or in groups. Either reed switch may be magnetically biased. Release time is 0.5-msec. at 25°C. Temp. range is −50°C to +85°C. Contact life is 20 million operations at rated load. Contact arrangements are Form A (SPST-NO); Form B (SPST-NC); Form C (SPDT) combining Forms A and B, and true Form C (SPDT) in 1 capsule rated 20w. The ratings of Forms A, B and combination C are 15 or 50w. Potter & Brumfield, Princeton, Ind. Phone W. A. Huser, 812 385-5251.

Circle 193 on Inquiry Card

MULTI-PURPOSE WELDING

Enables precision welds for a wide range of uses including flatpacks.



The Unibond allows welding of flatpacks to PC boards, fine wire to thin-film conductors, potentiometer interconnects, and heat-stripping/reflow soldering of insulated wire. Dual-sensing circuits in the power supply allows simultaneous control of voltage amplitude and pulse duration during the weld cycle. The system provides instant selection of fixed or modulated pulse duration. Pulse duration ranges are 0-10, 2-20, and 4-40msec. Compliant tip electrodes conform to uneven weld surfaces. Operating speeds are 60 welds/min. Weldmatic Div./Unitek, 950 Royal Oaks Dr., Monrovia, Calif. Phone Fred E. Benoit 213 EL 9-8361.

Circle 195 on Inquiry Card

STANDARDS FOR MICROCIRCUIT PACKAGES AND SUBSTRATES

The Philadelphia Electronic Connector Study Group is urging industry standards for the substrates and packages used with thin-film and monolithic ICs.

To determine the optimum size for substrates and packages, the Connector Group held a meeting in Philadelphia on Jan. 12. Manufacturers represented were American Lava, Bendix Scintilla Div., Coors, and Glass-Tite. Users were Burroughs, General Electric, Philco, RCA, the Army Signal Corps, and Vector.

The users complained that while substrates can be ordered in any size, the packages available are inadequate, for various reasons.

In spite of this, designers use the packages available because it is cheaper to buy off-the-shelf than pay for the tooling needed for a custom package. The manufacturers, on the other hand, claim the packages available were developed by customer needs.

To solve this substrate-package problem, the participants agreed that standards were needed in the following areas: Form Factor, Substrate Size, Lead Size, Lead Spacing, Number of Leads, and Package Size. After lengthy discussion the group developed the following tentative standards: Form Factor—rectangular with leads on long edge; Usable Substrate Size—0.65, 0.35, and 0.15 sq. in.; Lead Size and Type—25 mil grid system or increments thereof. The two most common will be 0.50 or 0.10 mil. Leads will be axial types (as opposed to ribbon) and the diameter will be 0.0017 in.; Number of Leads—optional.

These tentative standards will become firm unless the manufacturers are told differently. The Group wants to know if these specifications meet your needs; if they don't, let them know. The Group would also like your views on the type of connection preferred (should it be between substrate and package) and the number of usable leads needed. Send your recommendations to Glenn R. Heidler, General Electric, P. O. Box 8661, CCF-1, Room 1727, Phila., Pa.

HULL ASSUMES EIA POST

David R. Hull, former Raytheon Co. executive and two-term past president of the Electronic Industries Association, has joined EIA as director of the association's Engineering Dept.

FILING BY TELEVISION

Southern Pacific Co. will convert paper files for freight waybills to video tape using new Ampex Videofile document filing and retrieval system, which will store more than 20 million documents, permit faster filing and retrieval and take up only one/eighth space.

NEW SILICON PHOTOSENSORS FEATURE PLANAR PASSIVITY

Two miniature silicon photosensors have been developed by Fairchild Semiconductor for use in tape and card readers, optically-coupled circuits, encoder-decoders, character recognition devices and process control applications. Both units feature planar passivation.

The FMP-100 phototransistor responds from 0.4 to 1.1μ and has a maximum dark value of 0.1μa to typical values in the range 1.5 to 2.5ma upon illumination. Typical rise time is 3μsec.

By using a flat window, Fairchild engineers have managed a divergence angle of 70°. Avoiding optical magnification eliminates the possibility of a hot spot developing to introduce random errors. An array of units may be placed in physical contact with a moving tape without abrading the tape. Cross-talk is eliminated by this feature.

IR INSPECTION SYSTEM IS NON-DESTRUCTIVE

Following almost three years of R&D, the Research Div. of Automation Industries, Boulder, Colo., has announced the completion of an Infrared Non-destructive Testing System.

The infrared System "has proved to yield inspection of superior quality" in several types of materials and structures, according to automation engineers. One of the more important materials inspected was honeycomb sandwich structures, used extensively in aircraft, missiles and space vehicles.

INTERNATIONAL NEWS

Ilford—Plessey Company Ltd. and The Bissett-Berman Corp., Santa Monica, Calif., announces a distribution and manufacturing cross licensing agreement in oceanographic and meteorological instruments and sensors.

Reading — New 3-stage ultrasonic cleaning system, developed by the Sonics Division of Elliott-Automation, cleans, rinses and dries mechanical and electromechanical components and assemblies.

Jutphaas, The Netherlands—FOM Institute will soon have a brand new 20kw microwave power source supplied by Sperry Rand Corp. for plasma research. Heart of the package is Sperry's cw klystron type SAX 418.

Ulm, West Germany — Telefunken has entered a license agreement to manufacture and sell in Europe, air traffic control radar systems designed by Whittaker Corp. of Los Angeles.

Copenhagen—Eastern Air Devices, Inc., Dover, N. H., has acquired Peerless Fabrikkerne A/S, one of Europe's oldest and largest manufacturers of speakers, speaker cones, and magnets.

Gothenberg, Sweden — A 4000-line intercom system, believed largest in the world, is being installed in the Volvo auto plant, here by Standard Radio & Telefon, AB (ITT).

Malmo, Sweden—Radio AB Peerless, a distributor of electronic components, has joined expanding Eastern Air Devices, Inc., Dover, N. H., maker of electromechanical devices.

Rio de Janeiro—Air navigation aids, about $2.4 million worth will be installed by U. S. Federal Aviation Agency at five Brazilian airports. Equipment: surveillance radars, instrument lading systems, and light systems.

Monterrey, Mexico — A substantial interest in Acumuladores Mexicanos S. A. of Monterrey, Mexican battery manufacturing firm, has been purchased by Gould-National Batteries, Inc., St. Paul, Minn.

Tokyo — Nippon Electric Company Ltd. (NEC) has completed the first PCM (pulse code modulation) communications system for commercial use in Japan.

New CORNING® C Style Resistors give you precision stability, reliability, 1, 2 and 5% tolerances, 100 ppm T.C.

All of which boils down to this. Only one component to specify, buy and stock. One component you can use for general-purpose, semi-precision and precision use alike. One component that satisfies two military specs, as a look at the table quickly reveals. And you still get all the performance advantages of CORNING Glass-Tin-Oxide film resistor construction. Now for your tests. At our expense. Return coupon for samples.

PERFORMANCE CHARACTERISTICS

Characteristics	New CORNING C-Style Resistors			Mil-R-22684B	Mil-R-10509E Chorocteristic D*
Temperature Roting	70°C	70°C	125°C	70°C	70°C
Wattage C 4 (RL07S) Resistors, 51 ohms to 150K	¼	⅛	1/10	¼	⅛
Wattage C 5 (RL20S) Resistors, 10 ohms to 499K	½	¼	⅛	½	¼
Load Life △ R	1.0%	0.5%	0.5%	2%	1%
Design Tolerance △ R	−2 to +4%	−1 to +2.5%	−1.5 to +3%		
Temperature Coefficient from −55°C to +175°C	±100 ppm			±200 ppm	+200 −500 ppm
Dielectric Withstanding Voltage △ R	±0.10%			±0.50%	±0.5%
Moisture Resistance △ R	±0.50%			±1.50%	±1.5%
Short Time Overload △ R	±0.25%			±0.50%	±0.5%
Temperature Cycling △ R	±0.25%			±1.00%	±0.5%
Effect of Soldering △ R	±0.10%			±0.50%	±0.5%
Low Temperature Operation △ R	±0.50%			±0.50%	±0.5%
Shock △ R	±0.10%			±0.50%	±0.5%
Vibration △ R	±0.10%			±0.50%	±0.5%
Terminal Strength △ R	±0.10%			0.50%	
Voltage Coefficient	±0.001%/Volt				
Shelf Life △ R	+0.10%/Year				±1.0%

*For Type-marked, military lead Mil-R-10509 E Chorocteristic D Resistors, specify CORNING NA Style Resistors

CORNING GLASS WORKS, 3909 Electronics Dr., Raleigh, N. C. 27604.
Send complete data, test samples of new CORNING® C Style Resistors.

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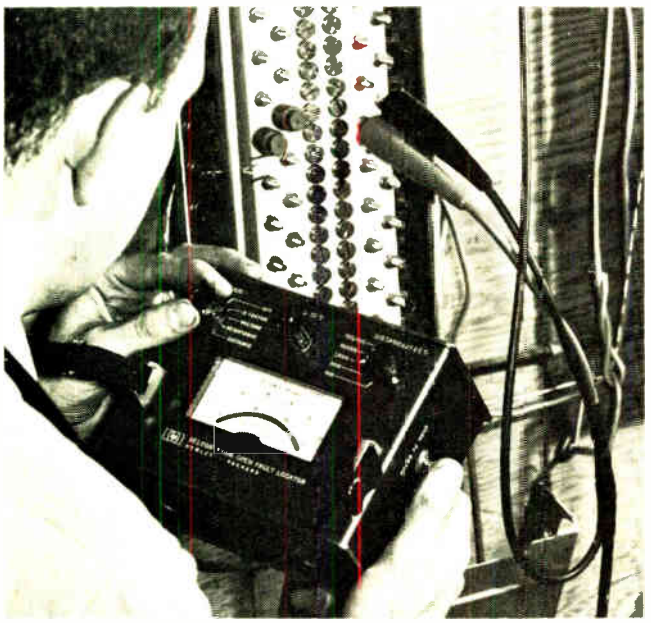
CORNING ELECTRONICS

CABLE FAULT LOCATOR

Open Fault locator (Model 4910A) self-calibrates for variations in conductor capacity to give precise readings in feet to location of open in communications cable. Solid-state instrument, made by Delcon Divisions of Hewlett-Packard, uses automatic charge sampling.



Equipped for many functions, new, compact portable MultiMite, introduced by Thermo-Electric Co., Inc., Saddle Brook, N. J., calibrates moving-coil pyromillivoltmeters and potentiometer-type pyrometers; it measures up to 5 thermocouple or millivolt inputs. Accurate to ¼ of 1% of millivolt scale, the MultiMite has direct reading, dual scales calibrated in F or C degrees, in millivolts, or both.

A new device developed by Radiation Inc. enables users to combine standard test equipment to automatically record semiconductor and integrated circuit dynamic test data on punch cards. The instrument, an automatic tester interface, when combined with Tektronix 567 oscilloscope and 262 Programmer, plus IBM 526 card summary punch, permits up to eight test parameters to be recorded. Two or more programmers can be cascaded for more complex measurements.

Bench-mounted convenience centers for laboratories, quality control, and engineering or production test areas are offered by X-Cel Controls Inc., South Bend, Ind. Placing the test units conveniently throughout the plant eliminates much handling of instruments and saves time in making test setups. All models have ac outlets. Some have instrumentation, while others have a built-in variable dc supply.

A new series of 3 Dimensional Directional Probes for measuring yaw and pitch angle, and total and static pressure as well as total temperature, have been developed by United Sensor & Control Corp., East Hartford, Conn. A wide variety of standard or custom designed types are suitable for almost any industrial, aircraft, missile and special purpose applications. The probes are usable up to velocities of Mach 0.7. They are furnished with individual calibration curves up to pitch angles of 40°.

A problem has existed in measuring the intensity of cavitation—formation followed by a rapid collapse of small cavities into a liquid phase. Macrosonics Corp., Carteret, N. J., suggests a new Cavitation Meter (Model CVM-3a) which indicates instantly the true amount of energy released during cavitation of liquid media.

The Instrument Division of Bourns Inc. is now using a random/sine vibration system, that produces continuous random vibrations over 10 to 4,000 CPS. Transducers can be accurately tested under exact environments met in missile launches, sonic barrier breakthroughs, and spacecraft stage separations.

"An extremely sensitive and highly accurate" frequency meter has been announced by Data Instruments Division, Pennsauken, N. J. The unit—331C—operates as a frequency meter and as a signal generator up 3,000 MC with accuracy of ± 5 parts in 10^{10} and drift of 1 part in 10^{9} per day.

Measurements of either long or short delays with accuracy on order of 0.1 nsec are now possible with Accu-Time, new solid-state test instrument developed by WMA Anderson Co., Inc., Pleasant Valley, Conn. This accuracy is assured by a 1-MC oven-controlled crystal oscillator and a passive phase shifting device. A digital readout is provided for incremental delays of less than one μsec.

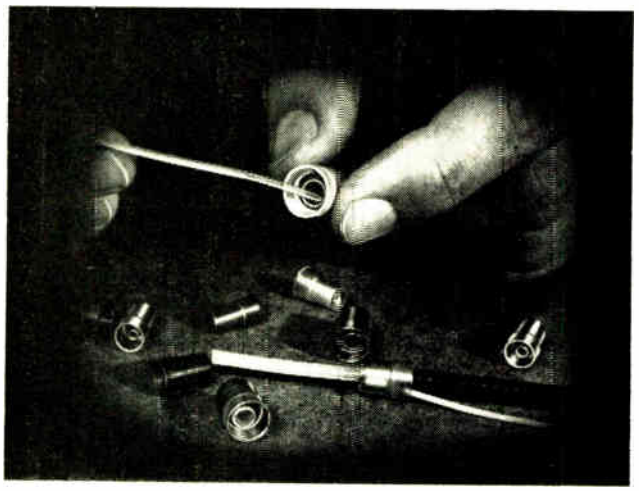
For testing highly precise components under simulated g-forces, Model 444 Precision Dual Range Centrifuge recently introduced, has many suitable design features, reports developer The Gyrex Corp., Santa Monica, Calif. The 444 is dual-range with Range I infinitely variable from 5 to 100 g's, and Range II infinitely variable from 10 to 600 g's. Accuracy: Range I, 0.005%; Range II, 0.25%.

FLOW METER CALIBRATOR

Portable console calibrates flow meters using nitrogen or deionized water as medium. In closed circuit, the medium is monitored for cleanliness by particle counter. Continuous counts are provided ranging from 10 to 175μ and more. The console, developed by Royco Instruments Inc. for the Apollo program, has adjustable pressures up to 150 psi for nitrogen, 80 psi for deionized water.

T&B ENGINEERED GROUNDING TECHNIQUES

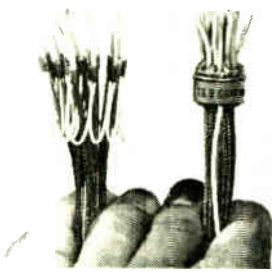
NEW ONE PIECE SHIELDED CABLE CONNECTOR HAS "WOBBLE ACTION" FOR QUICK INSTALLATION



T&B's new Shield-Kon® connectors for Shielded and coaxial cables provide better quality connections and reduced costs. The "wobble-action" of the hard inner sleeve allows it to move when the shielded cable is inserted. The soft outer sleeve provides an excellent compression material. One squeeze of the T&B Shure-Stake™ hand tool and a noise-free, high quality connection which meets the performance specifications of MIL-F-21608B is completed. The connectors can also be installed by any Class I, MS-25312 tool. All Connectors accommodate one or two #22 or #20 stranded ground wires from back or through front inspection hole. Nine sizes cover the conductor insulation range from .030 to .202.

For complete information write for Bulletin S-7

NEW CONNECTOR GROUNDS ALL CONDUCTORS OF SHIELDED CABLE SIMULTANEOUSLY

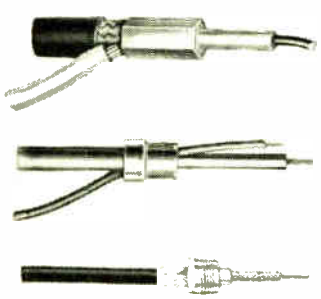


T&B's new Shield-Kon® connectors offer users an easy, quick and reliable system for grounding multiple-conductor shielded cable. One compression grounds all wires — eliminates individual connections and daisy chained jumpers. Reduces installed costs — less installation and inspection time. The system utilizes a hard brass inner ring and a soft copper outer ring. Ground wire or wires and shielded braids are positioned between the two rings. One stroke of the tool and a 360° compression uniformly grounds all wires in a noise-free connection. These Shield-Kon connectors are also available with a rugged nylon insulator ring which protects conductor insulation from abrasion.

For complete information write for Bulletin T60

SOLDERLESS COAXIAL GROUNDING CONNECTORS & R. F. ADAPTERS

NEW COMPRESSION TECHNIQUE REDUCES NOISE



A permanent hex-compression method for reliable grounding termination and insulation of shielded and coaxial cable at lower installed costs. Provides a noise-free, solderless, secure connection without damage to insulation or measurable change in impedance. Mechanically, the bond is stronger than the braid.

T & B has designed a line of R. F. Adapters which are pre-matched to fit widely used coaxial cables to specified R. F. Connectors. They provide a complete, secure, threaded joint in addition to the advantages of the hex-compression. These adapters lower inventory and tool requirements which make them particularly attractive to users of coaxial cable.

A wide selection of sizes in several connector styles are available for the complete range of shielded cable. Standard and special types for every need — non-insulated, flared, self-insulated, half-length and special high temperature, to 500°F, inner and outer sleeves. T & B flag type for special applications is also available. Hand and power tools are available.

Write for technical bulletin T60.

The Thomas & Betts Co., Incorporated • Elizabeth 1, New Jersey
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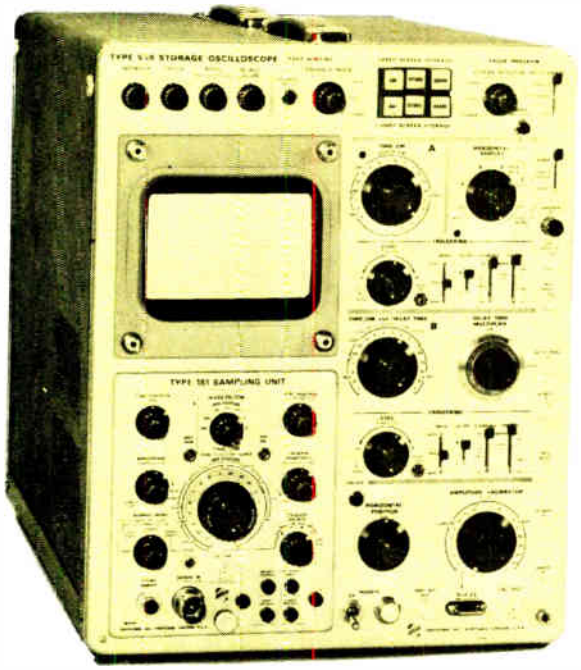
Product samples available on letterhead request.

T&B ENGINEERED **THOMAS & BETTS**



By DONALD C. CALNON, Project Engineer,
Instrument Engineering, Tektronix, Inc., Beaverton, Ore.

Advances in Storage Oscilloscopes

More versatile oscilloscopes are possible because of improved storage cathode-ray tubes. State-of-the-art storage tubes are discussed, terminology defined, and trade-offs considered.

A STORAGE OSCILLOSCOPE has an ability to store a CRT display in order that it may be observed for any required time. This stored display may be instantly erased to make way for storage of a later event. By the flick of a switch, the instrument is converted to a normal display oscilloscope.

Historically, a limiting factor in adapting storage CRT's to oscilloscopes was the slowness of the storing mechanism in relation to the sweep velocities of general purpose scopes. New, faster responding storage CRT's are now available and, coupled with circuit methods which increase their speed of response, these obstacles have been overcome.

Mechanics of the Bistable Storage CRT

The Anderson bistable storage tube has two electron sources: a normal "writing gun" which provides the oscilloscope beam for writing, and a pair of "flood guns"* which provide the broad flood of electrons that bombard the whole target uniformly. This flood of electrons directed to the target holds it in one of two stable modes or levels. They are the "written level" and the "ready to write" level.

Target behavior is explained in the storage CRT by referring to secondary emission phenomena as it occurs in certain materials. The curve of Fig. 1 shows how electrons emitted by secondary emission usually respond to the bombardment by primary electrons.

When the flood of view electrons arrives at a voltage below the first crossover, the target charges toward the first stable point where it then rests in the ready-to-write, or rest level condition. Target appearance is dark, and the light level associated with this condition is termed the background light level or simply, background. The target is made ready to write by the erase pulse, which is applied to the target terminals to move the storage element into the ready-to-write level.

When the writing gun is turned on, electrons arrive with very high energy and move the bombarded target

*Similar to view guns.

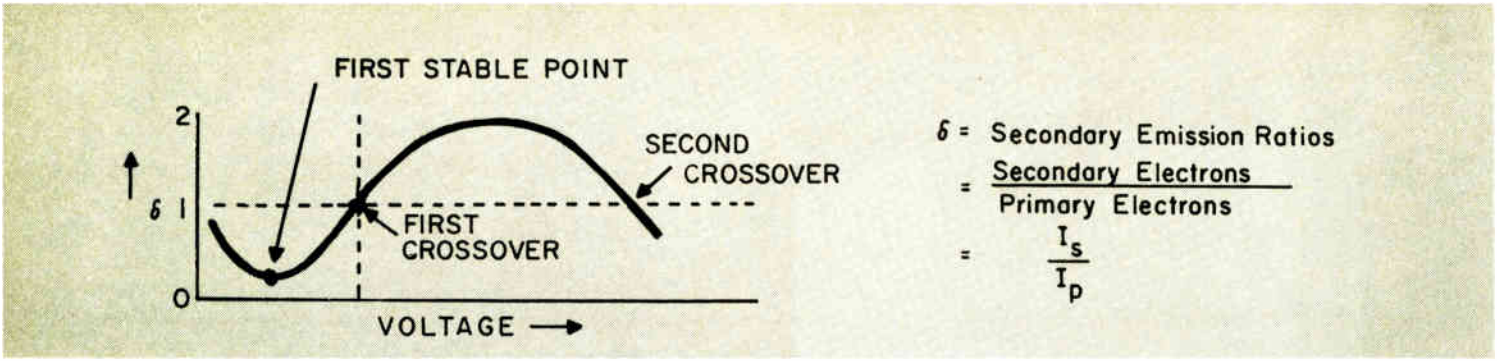


Fig. 1: Curve of secondary emission ratio.

STORAGE OSCILLOSCOPES (Continued)

element quickly beyond the first crossover point where it becomes written. Secondary emission maintains this level, while flood gun electron current to this segment results in still higher brightness. The light level of the written area is thus the written brightness for the storage CRT.

Quality of the stored display is often measured by the ratio of written brightness to the background light level. This is the *contrast ratio.*

The target terminal (or terminals) in the split-screen-type tube is connected to a control circuit which maintains a constant terminal voltage relative to that of the flood gun cathode. This voltage is termed the *target operating level.* When this level is advanced positively so that flood electrons arrive at energy levels above the first crossover, the target tends to shift to the higher stable point. This action or condition is termed *fade positive.*

Moving the target voltage level lower, while observing a written trace, permits voltage measurement where the written area begins to fade or drop back to background light level. This voltage is called the *retention threshold.*

The voltage range between *fade positive* and *retention threshold* is called the *stable range.* Often bistable storage tubes are operated at the mid-point of the *stable range,* the *operating level* in this case.

The Anderson storage CRT can be erased by applying a voltage to the target terminal having first a positive portion followed by a negative step and ramp return as shown in Fig. 2.

The first portion of the waveform causes the target to have a uniformly written appearance, and the second portion moves the target from the written state back to the the ready-to-write state where it is held by the action of the flood electrons. Time needed for pulse completion and for the target to get ready to write is about ¼ sec.

Writing Speeds of Storage Targets

Because of its bistable nature, the storage target displays a uniformly bright trace as the writing beam travels across it. At some faster sweep rates, the writing beam runs "out of gas," and the target fails to write. This lineal speed or rate of writing (including vertical components), where the target will just store a display, is the *maximum writing speed* of the system.

Measurement of maximum writing speed is done by first finding the maximum intensity setting where the beam is well focused. Then successive sweeps are used and erased, while changing sweep rates, until the maximum storing speed is found.

Another often-used method of measurement is to apply a sine wave to the vertical system with about 3 to 5 Hz per horizontal screen division. If the vertical amplitude of the waveform takes more than 3 divisions, the horizontal component of velocity can be ignored and the following relationship used to calculate writing speed:

$$\textit{Stored writing speed} = \pi h f \text{ div/sec}$$
$$h = \text{amplitude of the display}$$

Maximum stored writing speed is then the maximum speed at which the sine waves will appear fully written in a single traverse of the sweep.

A shortcut method often used on storage scopes is to adjust the vertical display amplitude to 3.2 cm so that *writing speed* is read directly. Thus:

$$\textit{writing speed} = (\pi)\ (h)\ f$$
$$\text{" "} = (3.14)\ (3.2 \text{ cm})\ f$$
$$\text{" "} = 10 \times f \text{ cm/}\mu\text{sec}$$
$$\text{where } f = \text{frequency in MHz}$$

Caution is required so that the written sine waves are well separated on the target. Specifications on writing speeds of storage targets include a permissible gap dimension of 0.025," the writing beam current, and, in some cases, a defined quality area of the target.

Enhancement for Faster Writing

A method for faster writing in storage scopes uses a pulse technique to briefly shift target operation to

Table 1

Characteristics of Anderson storage tubes used in oscilloscopes

	Standard Target	Mosaic Target
Stored Writing Speed	25 cm/msec	500 cm/msec
Writing Speed Enhanced	250 cm/msec	5x10³ cm/msec
Contrast Ratio (typical)	2 to 1	5 to 1
Written Brightness (typical)	6 ft L	3 ft L

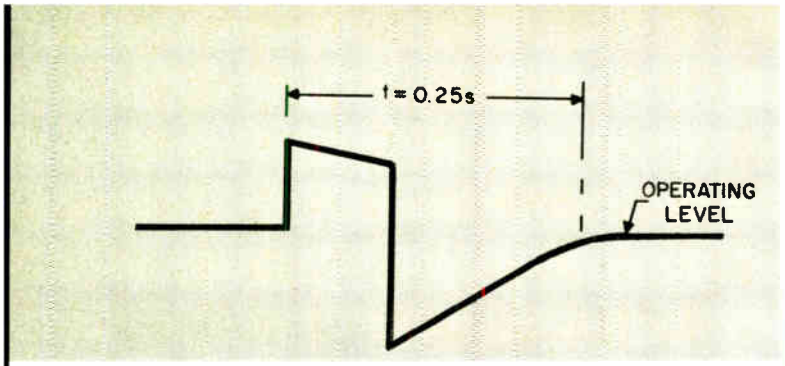


Fig. 2: Typical erase waveform.

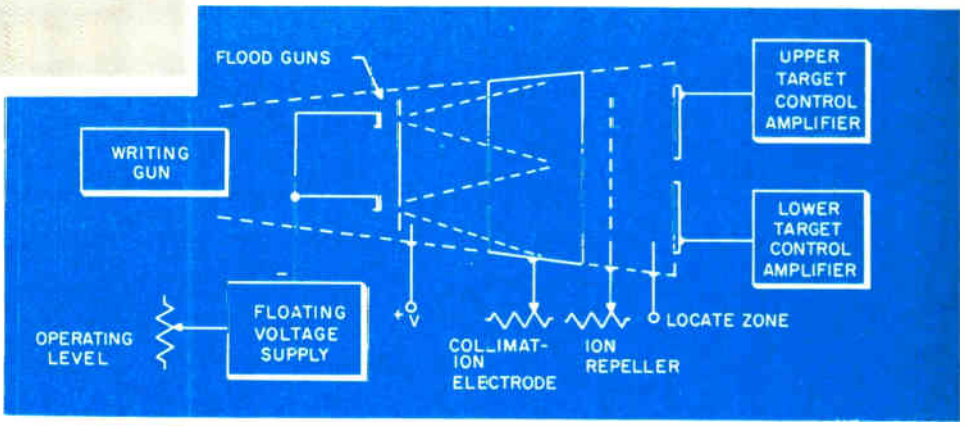


Fig. 3: Simplified flood-gun/collimation system.

favor faster writing with a return to normal before deterioration of the display can occur. This method is called *writing speed enhancement*, or simply, *enhancement*.

The circuitry provided for this purpose is a simple multivibrator which generates a rectangular waveform of variable width or height. This waveform is applied to the *flood gun* cathode or to the *target* itself. The circuit is initiated by the sweep system and applies one pulse for each sweep. The scope is provided with a front panel control to adjust either amplitude or width to a level at which optimum writing is obtained with the least deterioration of the background. Increase in the response speed of the different types of storage targets varies from 5 to 20 times. Typical pulse durations used are from 1 to 5 usec., with amplitudes of 40 to 60 v.

The Mosaic Target Storage Tube

The Mosaic target storage tube is the newest of the Anderson storage CRT's for oscilloscope use. This tube is different in physical appearance but employs a similar storage principle based upon target secondary emission behavior.

The Mosaic target tube, represented in Fig. 3, is readily identified by its gold surface, which is the metallic terminal for making electrical connection to the two halves of the target and to the locate zone. The gold extends into the target in a honeycomb pattern and permits the control voltage changes to be relayed to the target for establishing the stable conditions needed to store a display. The erase and enhance pulses are applied to this terminal.

Mosaic targets offer stored writing speeds from 2 to 100 times that available in previous scopes. Performance with enhancement is the area of high-speed stored writing where the Mosaic target has offered the most significant advances. See Table 1.

Collimation System of the Mosaic Storage CRT

The Mosaic target CRT uses a simplified flood gun assembly with two highly efficient electron guns mounted in front of the writing gun deflection system (see Fig. 3). These guns supply the high density flood of electrons needed at the storage target to hold those written areas and ready-to-write areas stable. These efficient electron sources contribute to the more positive nature in which the Mosaic target functions, permit higher brightness and more uniform target response.

A regulated-voltage power supply must be used to control the *flood gun* cathode potential so that storage target backplate-to-cathode voltage is at the proper *operating level*. Power supply stability is critical because of the dependence of target characteristics on the *operating level* voltage, particularly important in *split-screen storage systems*.

Collimation of the electron flooding is done with one electrode terminal, to which a variable voltage adjustment is connected. Thus, the storage system operates with nearly uniform potentials throughout.

To minimize damage to the storage target, an ion repeller should be mounted near the targets, to be operated at a potential slightly above that of the target backplate. A locate zone to the left of the storage target does not store. This allows the operator to select a proper vertical position setting without writing on the target. This operator aid has been found very helpful when storing a group of traces on the display area.

Storage Oscilloscopes Add a New Dimension

The freezing of a waveform in time by recording it on the storage oscilloscope screen until observed, or until a second event can be stored for direct comparison, has added unparalleled capability to oscilloscope instrumentation. The normal phosphor display is no longer acceptable when compared to a storage system at sweep rates below 0.5 sec/div. In all probability the new storage scopes will ultimately replace most instrumentation which depends upon long persistence phosphors, except where halftones are necessary.

AUTOMATIC SOLDERING

ICICLES, BRIDGING, AND BOARD WARPING are a few problems minimized by an automatic soldering line system for processing circuit boards through the soldering operation. The new system consists of 4 integrated process units: (1) full-wave flux applicator, (2) preheater, (3) adjustable-wave soldering station, and (4) an enclosed washing and drying station. The circuit boards are carried through these stations on a chain-driven conveyor at speeds from 0-96 in./min.

The flux applicator has a 12-in. useable wave width with height adjustment to ½ in. The flux is forced into terminal holes and against hairline circuits, insuring proper wetting.

The system uses a preheating cycle which aids in the fluxing action and evaporates excess solvent. It also thermally conditions both the circuit board and component leads. When the solder wave touches the underside of the board, the molten solder flows into every terminal joint. As the board leaves the solder contact, the exit slope of the wave reduces board temperature slowly, permitting excess solder to remain free-flowing long enough to drop back into the pot. By avoiding sudden cooling, bridging and icicling of excess solder are minimized. There is no abrupt heating or cooling of the boards to cause warping.

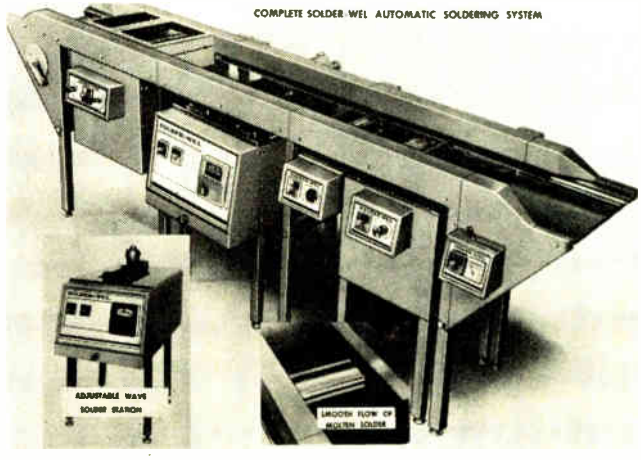
The 12-in. wide solder wave is adjustable 3 ways. Both the entrance and exit angles can be adjusted individually, and the wave height can be preset at any height to ½ in. This is said to give the operator complete control and is particularly important for boards with critical soldering requirements, such as extremely thin or extremely heavy component leads, hairline circuits and wire wrapped terminals. The solder temperature range is adjustable up to 900°F.

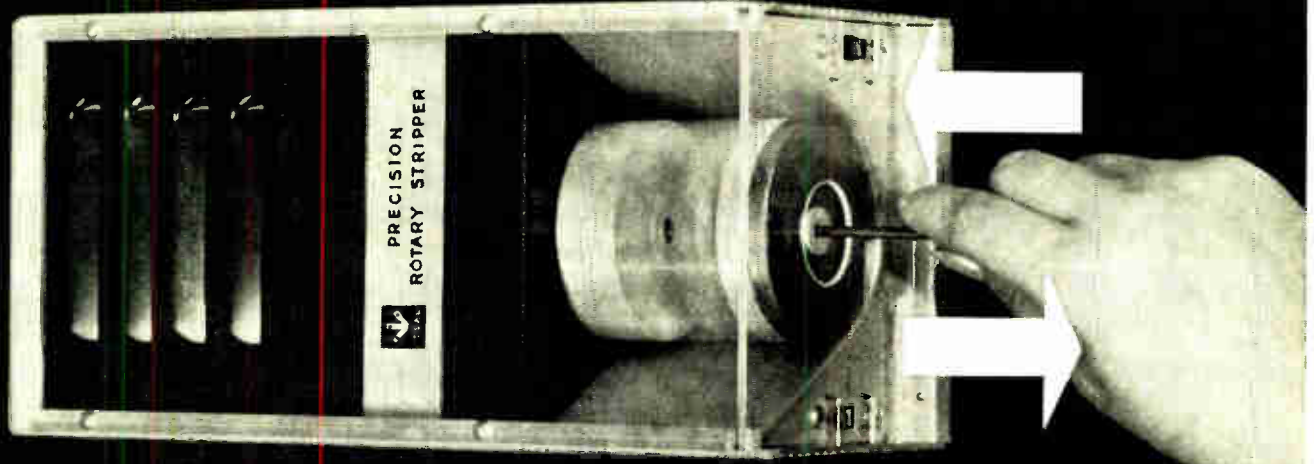
The washing and drying station is enclosed and cleans excess flux from both sides of the board simultaneously.

The Solder-Wel Automatic Soldering System, a product of Dimensional Control Machinery Co., Salem, Ohio, is constructed in 30 in. modular sections.

Circle 197 on Inquiry Card

Soldering system allows operator total control of operation.





That's all the operator does with the new Ideal Precision Wire Stripper. Insert the wire, pull it out, and it's automatically precision stripped without nicking, or scraping.

The secret is a unique stripping blade design, a carbide blade mounted on a leaf spring and installed on a rotating head. The blade partially cuts insulation, then rotational force twists the slug, severing the remaining web of insulation. Since the blade never touches the conductor, stripping is nick-free. Blade adjusts in increments of .0004".

For single-conductor wire, either solid or stranded, in sizes AWG #16 to #26 with single-layer insulation including Teflon and PVC. Write for specifications.

IDEAL MAKES NICK-FREE STRIPPING AT PRODUCTION RATES AS EASY AS *PUSH-PULL*

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3600	1/375			
CFC 1200	1/600		4:1 to	
1800	1/275	to 1000 oz. in.	46,656:1	1 19/32"
3600	1/225			
CLC 1800	1/25	to 200 lb. in.	12:1 to	3 3/8"
3600	1/20		1800:1	

Start with 115 v.a.c., 60 cycle hysteresis synchronous motors or gearmotors small enough to meet your space and weight requirements, big enough to meet your torque needs, and meet your price objectives. Check Globe first for fast delivery of standard units, prototypes, and specials; many available in 24-hrs. Request Bulletin CAC. **Globe Industries, Inc., 2275 Stanley Ave., Dayton, Ohio 45404, U.S.A., Tel: 513 222-3741.**

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ELECTRONIC INDUSTRIES

Learn Integrated Circuit Technology!

Dear Reader:

Through the years, as editors, we have seen a number of evolutionary changes take place in this industry. As examples we cite: the shift from vacuum tubes to solid state devices, the transition in equipment design from manned aircraft to guided missiles, the development of an important market for high fidelity audio equipment, and the current expansion from black-and-white TV to color-TV.

We are now on the threshold of another great change . . . but this one promises to be revolutionary rather than evolutionary. We are facing the time when practical low-cost integrated circuits are becoming available. These new devices will find application in all types of electronic equipment . . . military, industrial, and consumer.

The development of these new circuits involves "functional design techniques." Most electronic engineers now working in industry have never received any formal training in this new technology. To fill this need, ELECTRONIC INDUSTRIES is happy to announce an exclusive series of educational articles covering every aspect of this new technology. These articles, starting in April, will be prepared by the Integrated Circuit Engineering Corporation of Phoenix, Arizona, leading consultants to the industry.

The content of this series will parallel the highly successful five-day seminars conducted by this organization throughout the United States. Tuition for these seminars has been set at $500.00 per person. The lecturers are prominent engineers with years of practical experience with the major IC producer organizations.

A detailed outline of this course will be published next month. Reprints will be available to interested readers as each article is published.

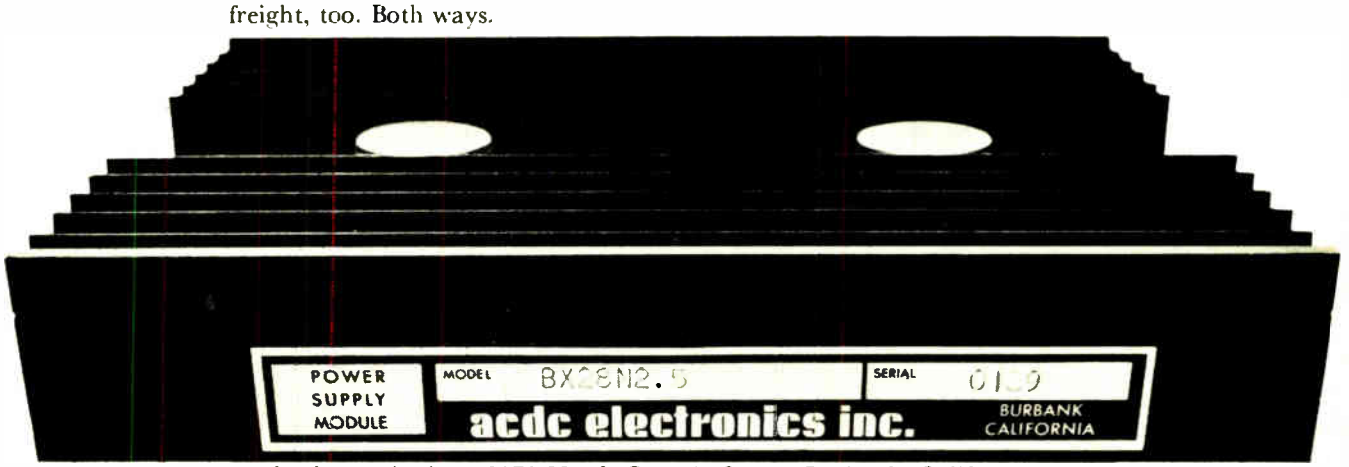
We are proud to be the first publication to present such a series as a service to the industry. We invite your comments and suggestions as the course progresses.

Sincerely,
The Editors

ACDC POWER SUPPLIES ARE GUARANTEED FOREVER.

WE SHOULD CLARIFY THIS:

Your catalog ACDC silicon power supply is guaranteed forever. Against power surges, spikes, breakage, abuse, civil disobedience, anything. If it is in need of service or calibration at any time, return it directly to the factory and we'll adjust it to meet its original specifications, free of charge. And that means we'll pay the freight, too. Both ways.



acdc electronics inc., 2979 North Ontario Street, Burbank, California 91504

Is EIA/JEDEC Device Registration Useful?

As in most other systems for coding, cataloging or registering, the EIA/JEDEC system for registering tubes, semiconductors, and microcircuits has both advantages and disadvantages. Despite obvious drawbacks, the system offers significant advantages.

By Sidney Feldman, Associate Editor ELECTRONIC INDUSTRIES

Interview with G. F. Hohn, former manager of EIA's engineering office.

THE EIA/JEDEC SYSTEM of registering electron tubes, semiconductor devices and microelectronic circuits has been and is being criticized. Despite some shortcomings, however, the system still provides industry with an effective tool for marketing and standardization.

The subject is especially pertinent because of the recent assignment of the 6N100 series of numbers to microelectronic circuits and devices. By way of a full discussion of the usefulness of the system, Mr. Hohn offers answers to 16 questions on the EIA/JEDEC system and the series 6N100.

Q.—What does the number 6N100 mean?

A.—This kind of number has been assigned by the Electronic Industries Association (EIA) to microelectronic devices. For many years type-designations, assigned to electron tubes and semiconductors, were known as EIA and JEDEC-type numbers. However, microelectronic devices will be identified by EIA type-numbers.

Q.—Is there any significance to the letters and figures in this type-numbering system?

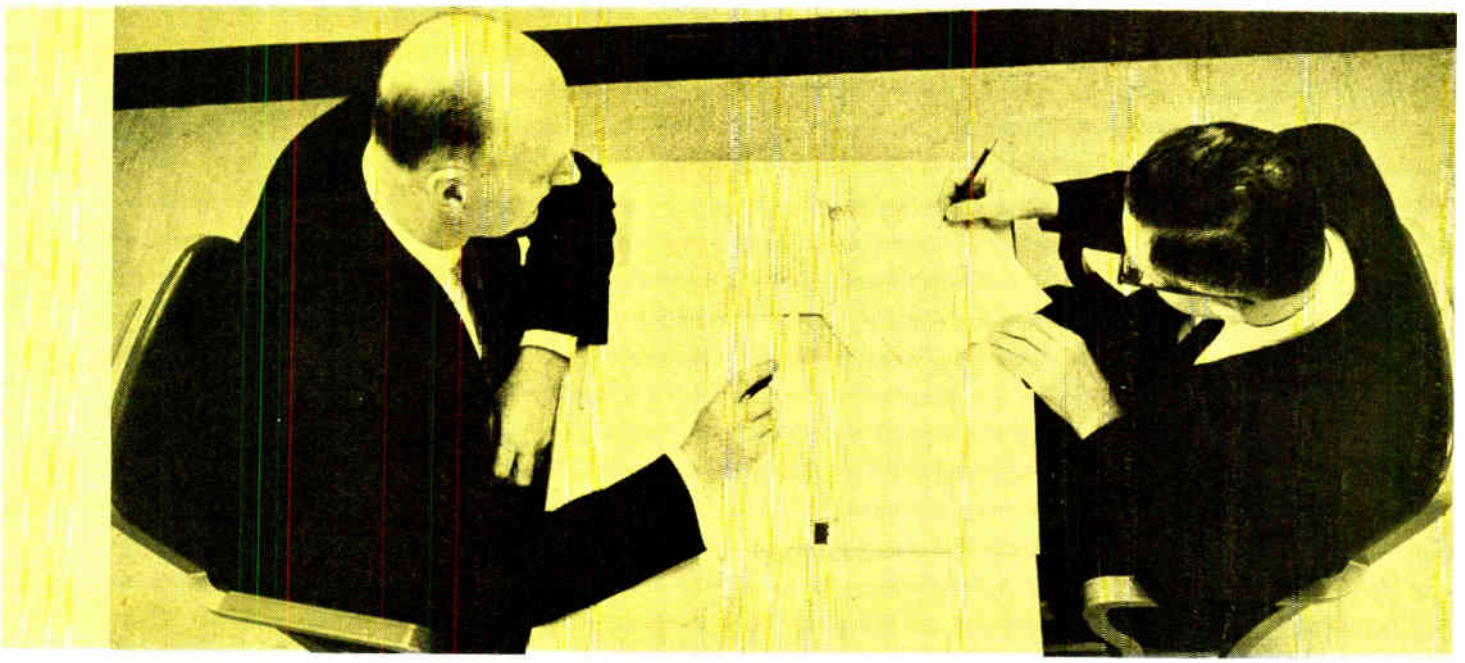
A.—No. The number is similar in nature to the 1N, 2N, 3N and 4N numbers assigned to solid state devices. 6N means simply that it is a microelectronic circuit device and the three, and later four digits following the 6N are assigned sequentially as applications are received.

Recently there was some publicity about consideration of a 5N-numbered series. Since this possibility was reported, EIA has decided to omit the 5N-number series. This was done to avoid potential conflict with a similarly-numbered series used by a well-known semiconductor device manufacturer.

Q.—How is such registration handled?

ADVANTAGES TO ELECTRONIC INDUSTRIES OF EIA-REGISTRATION SYSTEM

1) **A single number replaces multiple house numbers, of various manufacturers, used where two or more manufacturers make a particular device. This advantage particularly benefits the larger customer, such as the government, because it means in most cases the procurement and supply of a single item instead of multiple items. This single number also encourages standardization. A nationally recognized designation encourages other manufacturers to make similar devices, thus increasing and promoting competition.**
2) **EIA/JEDEC-registered types can be compared more easily because their defining characteristics must be registered with standard formats, under standard test conditions.**
3) **Publication of registration information, through trade channels, helps cus-**



"The EIA/JEDEC system, used for more than 30 years, has proved quite effective as a standardizing tool for tubes and semiconductors."

A.—In the registration process a manufacturer requests from EIA a type-designation number. He supplies data to insure that the type is so well-defined that another manufacturer using these data will make an interchangeable product. Interchangeability is required to protect the user who will purchase the device by type-number from all manufacturers marketing a device with that particular type-number.

This system also functions as a standardizing tool offering advantages for the electronic industries. (Advantages are listed in the box below.)

After a type-number is assigned, the whole industry is informed and is given registration data. EIA and manufacturers also issue publications summarizing the characteristics of registered designations.

Q.—Why do manufacturers use their own house numbers when the EIA/JEDEC registration system is available?

A.—As you can see from the list of advantages, the registration system is especially useful where two or more manufacturers make a given type. Yet in many cases users buy custom-made or specially-marked products from a particular manufacturer. Here a house number is preferable, particularly if there may be no replacement problem or no likely need of second sources of supply.

Even for house-number types, the EIA/JEDEC number plays a role because the user often, for example, will specify, "Just like the EIA/JEDEC type XXX, except . . ." While there are hundreds of house numbers for every EIA-type number, we know EIA/JEDEC-numbered devices represent a significant portion of each manufacturer's production.

Q.—One frequently hears criticism that there

tomers obtain second sources of supply.

4) **Characteristics of registered devices cannot be changed at will by the first or any subsequent manufacturer, except through a standard re-registration procedure. Standardization and interchangeability also are promoted.**
5) **Relatively non-technical personnel of user procurement, stock, and maintenance operations, often are aided in obtaining proper replacement parts.**
6) **This system provides a permanent record for future procurement where the original manufacturers no longer exist or make a given type.**
7) **The standardization and identification features of the EIA/JEDEC registration program also enable electronic parts distributors to reduce the number of parts required in inventories to serve customer requirements.**

"EIA has no responsibility for policing how its data or numbers are used by manufacturers, but EIA is vitally interested. This system depends upon voluntary compliance by both manufacturers and users.

REGISTRATION (Continued)

are too many type-numbers in the EIA/JEDEC system. People say several types can be substituted for a given type, which may not be available from the manufacturer. How is this possible if, in registration, the manufacturer's application for a number is reviewed to make certain it differs from a type already registered?

A.—A review of all EIA/JEDEC registered types shows that some are old types no longer designed in new equipment, but must be maintained on the registration book for replacement needs. Registration is a permanent record. Several types often can be substituted for a given type, provided one is willing to make certain compromises.

For example, if available space were not a problem in a particular application, then it might be possible to find four or five different application types with similar electrical characteristics but different mechanical dimensions. Different numbers were assigned to these similar devices because their physical dimensions were dissimilar.

In many cases a particular electrical characteristic may not be important to a given application or there may be two or more types whose other characteristics are quite similar. If it were not for standards prepared by EIA/JEDEC engineering committees, the number of registered types would be still more numerous. These committees have recommended dimensions, voltages, currents, test circuits, and rating methods which help minimize variants in product design.

Q.—What happens in cases where types, made by two different manufacturers, bear the same EIA/JEDEC-type numbers that are not interchangeable in a given application?

A.—Assuming manufacturers comply with EIA/JEDEC defining data, these cases will continue to arise because the industry learns as it progresses. For example, a registered-type may be made at a later time by some manufacturer using a newer manufacturing or processing technique and still meet the original registration characteristics. The new technique also may alter some characteristics of the device which formerly were unspecified and hence uncontrolled.

When the need for specifying these parameters comes to light in certain sensitive applications, the engineering committees will require that the characteristics be specified in future data. As the industry advances, the need for data to completely define a device also increases.

Q.—What is EIA's responsibility in observing that manufacturers conform to EIA/JEDEC registration data of their devices?

A.—The marketing and sale of any device is a contract matter between buyer and seller. EIA has no responsibility for policing how its data or numbers are used by manufacturers, but EIA is vitally intertested. This system depends upon voluntary compliance by both manufacturers and users.

Q.—Is this registration system limited to members of EIA?

A.—No. Any manufacturer, domestic or foreign, may register types with EIA.

Q.—Do foreign manufacturers make much use of the registration system?

A.—Limited use only. Types have been registered by electron device manufacturers throughout the world, but the number of these registrations has been small. In Europe, for example, manufacturers have available a registration office similar to EIA's operation.

Q.—Does the European registration office use the same standards and format as the EIA office?

A.—They do, where international standards exist. But their requirements and procedures differ somewhat from EIA. They assign their own series of type-numbers for their devices. Their numbering system is highly coded, compared with our numeric system. This practice was quickly called to our attention by those in our country who advocate changing EIA/JEDEC-type numbers to a coded system.

EIA PUBLICATIONS

EIA's new microelectronics program operation is described in EIA Type Assignment Bulletin No. 3, "EIA Type Assignment Procedure for Microelectronic Devices." Also published is the new data registration format for logic gating circuit devices. Both publications are available from the Type Administration Section, EIA Engineering Office, Electronic Industries Association, 2001 "I" Street, N.W., Washington, D.C.

Q.—Then why don't we change to a coded system?

A.—We don't believe this system offers too many advantages. And in the case of tubes and semiconductors, it is impractical at this late stage to change to a new system of type-designation.

Q.—Now that the process of assignments for microelectronic devices has been started, why don't we introduce a coded system?

A.—For precisely the same reason that we did not start assigning coded numbers to electron tubes and to semiconductor devices at the inception of those numbering programs! We lack a "crystal ball" that allows us to see what kinds of products manufacturers will make in the distant future.

It is easy to look back and devise a coding system *after* a product area has been developed and stabilized. That is why the European registration office comparatively recently adopted a registration system for tubes and semiconductors by taking advantage of U. S. and European marketing experience. Significantly, we have no knowledge that the Europeans have been able to devise a coded system for microelectronic devices.

EIA engineering committees have spent much time examining possibilities of a coded system, particularly for newer products such as semiconductors and microelectronic circuit devices.

For example, well over a year ago semiconductor device manufacturers actively were designing types in which the operating portion of a JEDEC-numbered device was placed in a smaller "TO" package. This might have offered a good opportunity to use coding to show the electrical relationship between types having different outline dimensions. But, after careful study, the JEDEC Council and its committees found that changing the device packaging altered one or more electrical characteristics. A coded system then would have had to limit any variation in the so-called "identical characteristics" to be eligible for one of these coded designations.

Q.—Despite the Council's action, didn't some manufacturers use JEDEC registrations with added numbers and symbols to indicate the kind of coding mentioned here?

A.—Yes, but they were asked to discontinue this practice. The altered JEDEC designation misled users into believing that these devices were registered regularly. Registration procedures do not allow for the alteration of JEDEC numbers, except by the U. S. armed services.

There, the practice has been to assign a prefix, such as Mil (Military) or Jan (Joint Army/Navy), to indicate a device for which a military specification has been prepared, based upon EIA or JEDEC registration. The military specification usually adds quality or reliability requirements which are not part of the JEDEC registration.

Q.—Then, the JEDEC registration system is useful to the armed services?

(Continued on following page)

REGISTRATION (Concluded)

A.—Yes, in several ways. First, as mentioned, the armed services use the registration data in preparing a procurement specification. Second, in isolated cases there are small urgent procurements for types not yet covered by military specifications.

Here, the procurement agency uses registration data as a basis for buying the type. Third, and most important, the armed services look for the standardization benefits and advantages to be derived from the basic registration program.

Q.—Has anybody come up with a good plan for coding microelectronic devices?

A.—No. Occasionally we receive proposals on how to code tubes and semiconductors, varying from the mildest to the most extreme degree. Experience shows that the more information that is coded into a type-designation, the more diffcult it is for users to remember the guide lines.

A larger number of systems also must be devised to encompass the many kinds of products covered by type designations. The more complicated the coding, the faster it will break down and require a revision as new product variations are produced.

We all would like to know of a coded system, devised at the inception of a type numbering program, that would: (a) result in type-numbers short enough to be memorized easily, (b) give a maximum amount of information on ratings and characteristics, and (c) be useful for all current and future products without need for any revision in the coding structure. But we lack the wisdom to devise such a system.

Q.—Do you feel that the EIA/JEDEC number system is less useful because it is uncoded?

A.—Certainly not. The construction of a number is only a minor aspect of the type-designation. This system, in use for well over 30 years, has proved quite effective as a standardization tool. It also has resulted in what the armed services call "item simplification." Both the small consumer who buys a single component and the large systems user have benefited from this program.

Inconvenience of an uncoded-type number system is offset largely by publications which list types by product category and summarize characteristics of EIA/JEDEC types.

EIA expects to publish information that will cross-index thoroughly all EIA/JEDEC-registered types. This method of handling data is better than assigning coded-type numbers because, as category needs change, new lists are issued to revise assignments of individual types.

G. F. HOHN, former manager of Electronic Industries Association's engineering office (recently in Newark, N. J.), served as JEDEC administrator from 1958 to 1965. His experience is drawn upon in this exclusive interview with Sidney Feldman, associate editor, ELECTRONIC INDUSTRIES. As of December 31, EIA's Newark office was moved to EIA's new headquarters building in Washington, D. C. Mr. Hohn resigned and was succeeded by C. Everett Coon as EIA/JEDEC administrator.

MICROELECTRONIC DEVELOPMENTS . . .

KMC Semiconductor Corp., Long Valley, N. J., announces a new type of transistor designed for thin-film and other microcircuit packaging techniques. Designated K2857C, the double-diffused NPN silicon device is intended for UHF and VHF amplifier applications. Typical performance at 450MC is 14 db gain with a noise figure of less than 4 db.

Fairchild Semiconductor has established a new memory products department to design, manufacture and market components and systems for memory sections of computers. First products of the new department, located in Mountain View, Calif., will be monolithic semiconductor "scratch-pad" assemblies, ferrite memory cores, wired memory core planes and "stacks" of core planes.

A compact multi-purpose microcircuit bonding system capable of welding, brazing, parallel-gap soldering and thin-film diffusion bonding has been introduced by Hughes Aircraft Vacuum Tube Products Division. Occupying only 20 inches of bench space, the system includes a power supply, two types of bonding heads, micropositioning apparatus and accessories, and a Bausch & Lomb stereozoom microscope.

Four microminiature data processing systems—constructed entirely of microelectronic circuits, and operating on a fraction of a watt of power—are being built by General Instrument Corp., under contract from NASA for use in the OGO-E (Orbiting Geophysical Laboratory) research satellite. Two of the data processors weigh less than 16.5 ounces each and two less than 5 ounces. They will be used in cosmic ray experiments to collect data on space conditions.

A new family of linear integrated circuits for use in industrial environments has been announced by Texas Instruments Incorporated. Designated Series 72, the new family of monolithic silicon circuits initially includes the SN723 general-purpose differential amplifier and the SN724 general-purpose operational amplifier. Operating temperature range of the SN723 and SN724 is 0° to + 70°C. The SN723 features differential inputs and differential emitter-follower outputs. The SN724 features an unusually high input impedance.

NEW TECH DATA

Instruments Catalog

A new catalog contains photographs, descriptions, and complete specs. for this line of electronic instruments, including voltmeters, null detectors, current and voltage amplifiers, calibration sources and resistance measuring devices. The catalog also has definitions, check lists, applications, and charts. Keithley Instruments, 12415 Euclid Ave., Cleveland 6, Ohio.

Circle 201 on Inquiry Card

MOS Microelectronic Circuits

A technical bulletin on designing with MOS microelectronic circuits offers data on MOS applications, fabrication, high input impedance, operation of RST flip-flop, MOS integrated circuits, and resistor problems in integrated circuits. The bulletin contains drawings and schematics. General Instrument Corp., Microelectronics Div., 600 W. John St., Hicksville, L.I., N.Y. 11801.

Circle 202 on Inquiry Card

Memory System Catalog

This catalog (Bulletin 6536) describes an entire line of memory systems and stacks. Ten system descriptions are tabulated in a concise, foldout chart. The chart is designed to let users quickly compare access speeds, word and bit capacities, logic levels, power requirements, operating parameters, accessory equipment, and physical dimensions. Basic data on 2000 possible plane and stack configurations are included. Fabri-Tek, Inc., Amery, Wisc.

Circle 203 on Inquiry Card

Power Sources—Medical

A new illustrated booklet entitled, "One Hundred Million Heartbeats," describes the use of high reliability power sources in medical electronics. Special applications areas are: cardiac situations in the Stokes-Adams syndrome, electrical control of the bladder and urinary tract, stimulation of the eighth nerve in certain hearing defects, and stimulation of the phrenic nerve to promote breathing in paralytic patients. The booklet is illustrated with charts and graphs. Mallory Battery Co., So. Broadway, Tarrytown, N. Y. 10591.

Circle 204 on Inquiry Card

Ni-Alloy Magnetic Cores

Tech Data 53-1 describes familiar nickel-alloy tapewound or cased cores repackaged for lower cost as new standardized line of bobbin cores. Direct size interchange to 1½ in. OD plus new narrow widths to 1/32 in., even in Supermalloy. Change alloys freely for best freq. response: for mag-amps, dc inverters, SCR firing circuits, pulse and saturating transformers and inductors, shift registers, core-rope computer memories and digital circuitry. Infinetics Inc., 1601 Jessup St., Wilmington, Del.

Circle 205 on Inquiry Card

Component Catalog

This new catalog contains 53 pages of listings for capacitors and resistors designed for industrial uses. Capacitor types included are electrolytics, paper, film, metallized film, subminiatures, Mil types, ceramics, and micas. Decade boxes, filters, and resistors are also shown. Catalogs are available at Aerovox distributors or on company letterhead to Aerovox Corp., Distributor Div., New Bedford, Mass.

Stepper Relays

A 34-page stepper relay catalog presents new developments in steppers with a concentrated "short course" for designers of multiple circuitry. Included are photographs, working drawings, specifications and operating data. Special sections include application guides, stepper terminology, a guide to stepper selection and ordering information. Catalog No. 5-32, Guardian Electric Mfg. Co., 1550 W. Carroll Ave., Chicago, Ill. 60607.

Circle 207 on Inquiry Card

Component Selector

New 1965/66 Component Selector "reflects a new philosophy in the component business—one that now offers unprecedented benefits." This 129-page catalog includes application charts, type selector charts, and standard rating selector tables to guide the user, or designer, to the proper selection of a standardized stock design. Cornell-Dubilier Electronics, 50 Paris St., Newark, N. J. 07101.

Circle 208 on Inquiry Card

Strip-Printer Bulletin

Strip printers for use in weapon and aerospace systems are described in this bulletin. It discusses various uses and develops the general concept of strip printer theory and operation. It concludes with a detailed description of 2 typical printers presently used by the military. Franklin Electronics, Inc., Bridgeport, Pa. 19405.

Circle 209 on Inquiry Card

Slip-Ring Assemblies

Bulletin SR-65 shows slip-ring assemblies in drum and pancake styles, from tiny units of less than a cu. in. to assemblies nearly 6 ft. high, carrying more than 150 power, instrument, and signal circuits, plus specs. Electro Switch Corp., 167 King Ave., Weymouth, Mass. 02188.

Circle 210 on Inquiry Card

BUWEPS Synchros

A data sheet on size 11 BUWEPS Synchros is available for designers who need a device that transduces shaft angle to electrical signals and vice versa. The data sheet presents full specs. on a family of synchros. Three types, CT, CX and CDX (Control Transform, Control Transmitter, and Control Differential Transmitter respectively) comprise the family. IMC Magnetics Corp., 570 Main St., Westbury, N. Y. 11591.

Circle 211 on Inquiry Card

NEW TECH DATA

Transducer Catalog

This catalog, in a series of 8, contains a simplified chart for an orderly customized selection of exact configurations to meet most transducer requirements. Manufacturing techniques of the length, stroke, windings within a given category, may be varied in reasonable increments to provide a large variety of configurations. G. L. Collins Corp., 5875 Obispo Ave., Long Beach, Calif.
Circle 212 on Inquiry Card

Micro Switch Bulletin

Full color illustrated Bulletin 70 offers control panel builders quick and easy-to-assemble "plug-in" lighted pushbutton switches and matching indicators. Charts and diagrams cover: mounting and wiring hardware; mechanical interlock "add-on" devices; mounting dimensions; circuitry, component listings; and replacement parts. Micro Switch, a div. of Honeywell Inc., Freeport, Ill. 61033.
Circle 213 on Inquiry Card

Diode Reliability

A 60-page report summarizing 15,700,000 diode hours of 100°C life test at rated conditions is now available. Tests were conducted for three years; during that time 7,885 units "were life tested without a single failure. At the end of testing, all units continued to meet pre-test specified requirements for all parameters." Included is a discussion of acceleration factors and a curve to apply such factors. Unitrode, 580 Pleasant St., Watertown, Mass.
Circle 214 on Inquiry Card

Militarized Tape Transport

High-performance, ruggedized tape transport, for military environments is described in this brochure, Product Data 1-215M. The transport, Model SC-1150M, is a single-capstan digital tape transport which operates at bidirectional tape speeds to 150 ips without program restrictions. Documentation and logistics programs, recommended preventive maintenance, and field support are included. Potter Instrument Co., Inc., 151 Sunnyside Blvd., Plainview, N. Y. 11803.
Circle 215 on Inquiry Card

Photocom Switch

This data sheet (IF-5186) provides specs. for solid-state photocom switch, SPST Series. Driven by a neon lamp that activates a photo-resistive cell, the unit is designed for low level switching. The switch has a life rated at billions of operations and has application as a series or shunt modulator in operational dc amplifiers, PH meters, electrometers and servo controls. Fact sheet contains specs., schematics, and description. James Electronics, Inc., 4050 N. Rickwell St., Chicago, Ill. 60618.
Circle 216 on Inquiry Card

NEW TECH DATA

Potentiometer Catalog

Precision Potentiometer Short Form Catalog No. 3 gives specs. on Bourns entire precision potentiometer line, 25 types, including bushing mount, servo mount, and KNOBPOT® and LAB-POT™ potentiometer styles. Bourns, Inc., Trimpot Div., 1200 Columbia Ave., Riverside, Calif. 92507.

Circle 217 on Inquiry Card

Power Supply Catalog

A 12-page illustrated catalog describing EECO transistorized, 12v and 6v dc power supplies is available. The units are primarily for use with equipment rather than for general laboratory use. Data includes specs., graphs and sales offices. Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif.

Circle 218 on Inquiry Card

Vacuum Relay

A new 16-page catalog (No. 102) describes characteristics, construction and appliances of vacuum transfer relays. The catalog includes a useful section for engineers devoted to constructive suggestions on the proper application of vacuum relays. The section contains schematics and data tables. Jennings Radio Mfg. Corp., P. O. Box 1278, San Jose, Calif. 95108

Circle 219 on Inquiry Card

Miniature Capacitors

Steps in manufacture of miniature electrolytic capacitors are illustrated in a new brochure. Detailed from basic materials through final inspection, brochure underscores care taken in producing a product that relies on manual operation and assembly. Nashville Electronics, Inc., 2950 Foster Creighton Dr., Nashville, Tenn. 37204.

Circle 220 on Inquiry Card

Low T.C. Resistors

New Bulletin 109 describes small, axial-lead resistors recently added to a line of silicone-ceramic, conformally coated power resistors. The line features low T.C. (temperature coefficient of resistance), precision tolerances, excellent stability, and ratings to 1000w. Ohmite Mfg. Co., 3664 Howard St., Skokie, Ill. 60076.

Circle 221 on Inquiry Card

Pulse/Digital Generators

Condensed 1965-66 catalog furnishes major specifications, general descriptions and prices for over 25 pulse generators, including programmable models, digital data generators, and plug-in output units. Domestic and overseas representatives and service centers are also listed. Datapulse Inc., 509 Hindry Ave., Inglewood, Calif.

Circle 222 on Inquiry Card

NEW TECH DATA

CERMET Catalog

This 16-page catalog (No. 3003) contains illustrations and technical data on the full line of CERMET potentiometers, trimmers, resistor/capacitor modules, hybrid integrated circuits and microminiature solid pellet fixed resistors. Tables on environmental performance specs, and electrical and mechanical specs, are given. A table of reliability data, based on the equivalent of nearly 24,000 years of testing, on hybrid integrated circuits is included. CTS Corp., Elkhart, Ind.

Circle 223 on Inquiry Card

Microminiature Modules

One of the "most complete documents ever assembled on microminiature electronic modules" is offered in an illustrated, 32 page booklet, which describes design, development, packaging and prototype fabrication. Illustrations highlight point-to-point, matrix, multilayer and parallel gap welding. High Reliability Circuit Systems, Inc., div. of International Electronic Research Corp., 1853 N. Raymond Ave., Anaheim, Calif. 92801.

Circle 224 on Inquiry Card

Connectors and Contacts

Catalog MCTC-1 describes microminiature high-density MICRO/CON rack/panel and strip connectors features TWIST/CON microminiature contacts. TWIST/CON pins and sockets permit high density packaging up to 420 contacts/sq. in. on 0.050 in. centers. MICRO/CON connectors are sold harnessed and assembled, or in bulk. Catalog contains diagrams, drawings and specs. Microdot Inc., 220 Pasadena Ave., So. Pasadena, Calif.

Circle 225 on Inquiry Card

Indicator Lights

This 16-page, fully illustrated catalog (L-1611F) presents a wide array of miniature and large indicator lights for use with neon or incandescent light source. Also included are tamper-proof open type assemblies and lens caps for panel mounting. Lamp charts are provided, giving a complete listing of the appropriate lamps for the series of indicator lights. Dialight Corp., 60 Stewart Ave., Brooklyn, N. Y. 11237.

Circle 226 on Inquiry Card

Voltage Control Devices

New 20-page buyer's guide, (GEC-1064) describes a complete line of regulated dc power supplies, ac voltage stabilizers, and manual, plug-in, motor-operated and automatic Volt-Pac® variable transformers. Illustrated bulletin contains ordering information, dimensions, diagrams, operating characteristics, and a special problem solver to aid in product selection. General Electric Co., Schenectady, N. Y. 12305.

Circle 227 on Inquiry Card

NEW TECH DATA

Solid-State Multiplexers

This brochure provides complete technical information on Series 970 Solid-State Multiplexers. Three models feature high-speed multiplexing, improved FET switching, 8 to 128 channel expandability, and selectable stepping rates from 0 to 20,000 chanels/sec. Input configurations are described for single-ended Model 970, differential Model 975, and the 3-wire Model 976. Control requirements, operating characteristics, and specs. are detailed. Astrodata, Inc., P. O. Box 3003, 240 E. Palais Rd., Anaheim, Calif.

Circle 228 on Inquiry Card

Solenoid Drivers

A new bulletin discusses inductive overshoot caused by long leads between driver modules and the relays or solenoids they are controlling in memory core testing situations. Overshoot can destroy the driving transistors. Solution suggested is using a zener diode to ground inductive transients that exceed harmful potentials. Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754.

Circle 229 on Inquiry Card

Solid-State Modules

Aplication bulletins, CSCD10, 11, 12 and 20) on 4 new solid-state logic modules for controlling automatic machines and processes, explain logic capabilities of each module and provide data on electrical requirements, installation and connectors. Schematic drawings in each bulletin show the diode relay equivalent circuit which can be supplied by the appropriate module. Ault, Inc., 3501 48th Ave. N., Minneapolis, Minn. 55429.

Circle 230 on Inquiry Cord

Potentiometer Catalog

Revised edition of a 20-page catalog on rotary precision film potentiometers describes 3 new lines: Series 150, 17/16 in. dia.; slimline in 1¾, 2 and 3 in. dia.; and low torque-low inertial Series 170 potentiometers. The catalog (No. rp 962/B) contains data and specs. on single and multi-turn potentiometers and potentiometer elements, plus special configurations. Computer Instruments Corp., 92 Madison Ave., Hempstead, L.I., N. Y.

Circle 231 on Inquiry Cord

Microwave Power Measurement

An 80-page Application Note #64 entitled, "Microwave Power Measurement," details recently-developed techniques for higher accuracies with reduced complexity and time. Special emphasis is placed upon accuracy improvement. Modern means of determining effective efficiency and calibration factor are developed. Ways to apply the data simply, to achieve higher accuracy, are given. Available from Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. 94304.

Circle 232 on Inquiry Cord

NEW TECH DATA

Power Supply Bulletin

A new brochure, Bulletin 101C, describes improved specs. and a new available model in compact, high precision power supply series featuring the "duet" twin amplifier which controls voltage or current with automatic crossover to either mode. Deltron, Inc., North Wales, Pa.

Circle 233 on Inquiry Card

Ceramic Packages

A new Bulletin No. 655 on AlSiPak High Alumina Ceramic Packages contains technical data on this subject which has not been published previously. The technical bulletin contains charts, specs. and colorful diagrams of ceramic packages. Steatite Div., American Lava Corp., Chattanooga, Tenn. 37405.

Circle 234 on Inquiry Card

Differential Amplifier

An all solid-state differential amplifier is described in bulletin 6B020. Designated the Model C-44 Amplexer™ amplifier, this low-cost unit provides commutated, filtered or wideband outputs, and choice of gains, bandwidths and filters. Berkeley Div. of Beckman Instruments, Inc., Richmond, Calif.

Circle 235 on Inquiry Card

Power Supply Index

An up-to-date index lists 10 standard transducer excitation power supplies. A 2-page reference chart on the inside pages contains all specs. Six use constant current, one uses constant voltage, and 3 can be switched from constant current to constant voltage merely by switching links. B & F Instruments, Inc., 3644 N. Lawrence St., Phila., Pa.

Circle 236 on Inquiry Card

Coaxial Switches

A new 12-page catalog describes 23 types of hermetically-sealed coaxial switches. Complete mechanical and electrical spec., photographs, and outline drawings are included. The catalog also contains details on variations of voltages, r-f connectors and power terminations available for each type. Electronic Specialty Co., 4561 Colorado Blvd., Los Angeles, Calif. 90039.

Circle 237 on Inquiry Card

Sealing Design Book

This new design handbook is called a must for all designers faced with sensitive sealing problems. Spring-loaded, self-energized teflon seals feature low friction, chemical inertness, temp. range from cryogenic to +400°F, unlimited storage life. Request Tec-Ring® design handbook, TR-100. Tec Seal Corp., 22624 Avalon Blvd., Wilmington, Calif.

Circle 238 on Inquiry Card

VCXO Use Brochure

A new brochure on the use of VCXOs (Voltage Controlled Crystal Oscillators) includes brief graphic and theoretical discussion. Background data describes important characteristics which make the VCXO applicable to specific techniques in military, industrial and commercial projects. Included are block diagrams, schematics and tables. Damon Engineering, Inc., 240 Highland Ave., Needham Heights 94, Mass.

Circle 239 on Inquiry Card

Micro-Miniature Sockets

Complete details on a full line of micro-miniature relay sockets are presented in a new catalog. Included are photos, outline drawings, electrical and mechanical specs., and chassis cutout dimensions. Branson Corp., Vanderhoof Ave., Denville, N. J.

Circle 240 on Inquiry Card

Rigid Line Assembly

Special assemblies fabricated from rigid line are fully described in this catalog. Four pages are devoted to illustrations of terminations, cavities, power dividers, antennas, low-pass filters and reducers, all of which are "unique assemblies" fabricated of rigid coaxial transmission line in copper or aluminum. Bulletin RLA, Issue 1, Phelps Dodge Electronic Products Corp., P. O. Box 187, 60 Dodge Ave., North Haven, Conn.

Circle 241 on Inquiry Card

Ratiometry Data File

Technical Data File on ac ratiometry and automatic test equipment consists of a bound set of 10 technical bulletins in which engineers discuss the state-of-the-art of ac measurement. Papers cover phase angle measurement and phase sensitive conversion. Theory and practical applications are covered. North Atlantic Industries, Inc., 200 Terminal Drv., Plainview, N. Y. 11803.

Circle 242 on Inquiry Card

Potentiometer loading data

Technical Data Bulletin No. TD-113 discusses aspects of the effect on the output voltage ratio of linear and non-linear potentiometers of varying or unexpected loads. Formulae are developed to permit a circuit or system designer to compute output errors. Each use circuit is illustrated with diagrams, and voltage ratio load effect is shown graphically in a series of curves. Markite Corp., 155 Waverly Place, New York, N.Y. 10014.

Circle 243 on Inquiry Card

Power Rectifier Diode

Bulletin B-113 provides engineering data on a new silicon power rectifier, the 70H, suitable for industrial, commercial and military uses. The device has high surge current capacity (up to 1200a), fatigue-free construction, standard or reverse polarity, and low thermal impedance. International Rectifier, 233 Kansas St., El Segundo, Calif. 90246.

Circle 244 on Inquiry Card

Feed-Thru Capacitors

Lug-terminal capacitors have been added to Type 1801D Tantalex Feed-Thru Capacitor family used for RFI suppression. These capacitors are now available in 50 and 75v. ratings. Complete performance characteristics and list of standard ratings are given in Engineering Bulletin No. 3525A. Sprague Electric Co., 233 Marshall St., No. Adams, Mass.

Circle 245 on Inquiry Card

Resolver/Synchro

Newsletter No. 15 describes precision shaft angle to digital and digital to shaft angle conversion systems—using a special solid-state resolver/synchro. The new resolver/synchro can use CX, CT, CDX or any resolver or synchro configuration, and requires no modification of existing equipment. Reeves Instrument Co., Garden City, N. Y.

Circle 246 on Inquiry Card

Vibration Transducer

A velocity vibration transducer that provides an unusual combination of l-f response in a lightweight (2.2 oz.), shock-resistant unit is described in a bulletin 4150. The type 4-150 is a small vibration transducer for l-f velocity or displacement measurements. Available from Consolidated Electrodynamics Corp., subs. of Bell & Howell, 360 Sierra Madre Villa, Pasadena, Calif.

Circle 247 on Inquiry Card

MICROLOGIC POWER SUPPLY (Concluded)

. . . *from page 51*

rectifier could be used with a center-tapped secondary on the transformer, which would be somewhat more difficult to construct.

The rectified square wave from the bridge, filtered by L_1 and C_{17}, supplies a constant dc voltage to the load. Excitation current for L_1 is normally supplied through the load; for operation without external load, therefore, a small (100 Ω) resistor is shunted across the output terminals.

Reference and Error Amplifier

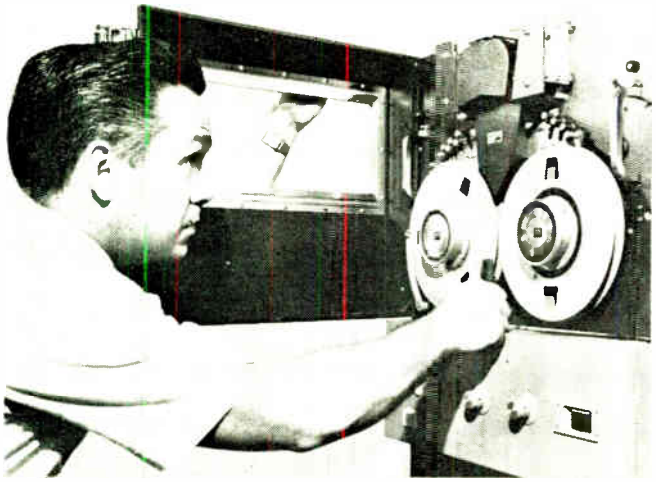
Voltage regulation is provided by the error amplifier and voltage reference consisting of Q_{10} and D_{23}. These feed back an error voltage to the μA 702A comparator to adjust the duty cycle of the output square wave from the control circuitry.

Regulator action is as follows: if, for example, the line voltage or the load voltage increases, the corresponding increase in output voltage appears at the emitter of Q_{10} as well as across the voltage divider network R_{29}, R_{30}, R_{31}. Since less of the increase appears at the base of Q_{10} than at its emitter, Q_{10} conducts more heavily, so that its collector voltage—and therefore the error voltage to the μA 702A comparator—rises. An increase in error voltage causes a decrease in duty cycle of the output square wave and thus a decrease in the rectified dc voltage across filter capacitor C_{17} in the output.

The same mechanism can be used to change the load voltage by adjusting the pot at the base of Q_{10}. Moving it up, for example, causes the base of Q_{10} to go more positive than its emitter. Transistor conduction then decreases and the error voltage also decreases. This increases the duty cycle of the output waveform from the switching amplifiers and thus increases the load voltage.

Performance of supply — Efficiency and regulation curves for the power supply are shown in Fig. 8. The regulation characteristic (a), plotted as a function of load current at a constant 30v input supply level, shows a 1% variation in output voltage from no load up to 1a. From 1 to 5a, the output voltage remains constant. The regulation curve (b) shows that the output remains constant as the input supply voltage changes from 25 to 33.5v. The load current under this condition is a constant 2.1a. The efficiency curve (c) shows a peak efficiency of 82.5% at 3a of output current. The element in the supply which contributes the largest loss is the bridge rectifier. At 5a, a single rectifier drop is 1.5v, so that the total bridge drop, through two series rectifiers, is 3v. If the supply requirement had necessitated a higher dc output voltage, the efficiency would have increased because of the lower diode loss at the reduced current. Curve (d) shows a change in efficiency of only 2% as the input voltage is changed over the extreme range of 25 to 33.5v.

RUGGEDIZED FIELD-TAPE TRANSPORT



New FT-150 Field-Tape® Transport features rugged construction, low 12vdc power and high-speed operation, especially designed for geophysical and military field operations, reports Potter Instrument Co.

PCM BIT SYNCHRONIZER which is fully automatic has been developed by the Bendix Corp., North Hollywood, Calif. Called the Model SC-2000 and using extensive microcircuitry, it covers 10 to 1,000,000 bits/sec., rates continuously. Data is reconstructed with a bit error probability within 1 db. of theoretical curves for both rectangular and prefiltered waveforms.

PHOTOMULTIPLIERS (Concluded)

. . . from page 59

static defocusing, electron skipping of stages, and other effects.

Regulation

The voltage applied to the dynodes may be regulated by either of two methods. One is to have a tightly regulated power supply in the 1000 to 1500 v. class, and to have a high current bleeder so as to supply a low source impedance voltage to each dynode. Disadvantage of this method is that for most uses it is complex, costly and may present a severe maintenance problem.

The second method is to regulate the voltage at each dynode. Several methods have been proposed and used to do this. One is to use zener diodes, which have good regulation. But, they can only be used in applications where they will not be adversely affected by their poor temperature coefficients. Cost is also a factor in their selection because high voltage, close tolerance zeners tend to be too expensive.

Use of large gas tube regulators for each dynode also tends to be costly. Often they do not exhibit a close enough regulation to maintain the dynode voltage within tight limits. Sometimes they exhibit jump voltage characteristics. In some uses, their size prohibits their use.

Newer Method

A newer method for regulating these voltages has recently become available with the development of subminiature cold cathode voltage regulators. These were an outgrowth of the development program to produce neon glow lamps with the same tight tolerances as other circuit components. These new tubes, made by Signalite Inc., are subminiature components whose regulation over the needed current ranges is usually less than 0.1 v. (Fig. 3) and whose temperature coefficient is a few mv/°C. Typical lifetime of 30,000 hrs. allows these tubes to be permanently wired into the circuit. Their low initial cost is well below that of other components designed for the same job. Their physical dimensions and low mass have allowed them to be used with applications of photomultipliers where there are severe space and weight limitations.

A circuit for voltage regulation of a photomultiplier tube using cold cathode voltage regulators is shown in Fig. 4. This circuit was used with a type 931-A tube which is critically dependent on voltage. The voltage at dynode 9 of Fig. 4 is plotted against the input voltage in Fig. 5. Regulation is accomplished by 10 type Z84R12 voltage reference tubes. These tubes have an average temperature coefficient of minus 2 mv/°C and exhibit less than 1 v. change from the 84 v. reference from 0.15 to 2.0 ma. Life expectancy is 30,000 hrs. of continuous operation.

Uses

Photomultipliers are an important tool in detection, measurement and observation where human visual acuity is insufficient. This is particularly true where the light level is low enough to preclude the use of other types of photosensitive devices such as photocells. Because in these uses the effects of noise or transit time can materially affect the needed results, accurate regulation of voltages to the dynodes is of critical importance. These new cold cathode voltage regulators can provide reliable regulation over a long period of time in a small package and at a favorable cost differential. Many photomultiplier uses can benefit from this new development. Some of these are photometry, spectrophometric instrumentation, scintillation counters, gamma ray spectrometers, Cerenkov radiation measurement and particle size measurement. Others are smoke detectors, celestial navigation, star tracking, flying-spot TV pick-up, laser detection and timing measurement.

Typical Photometer

A typical photometer capable of full scale readings in the microlumen range is shown in Fig. 6. It consists of a high voltage power supply for the photometer and a low voltage power supply for the VTVM.

T1 supplies 1,000 vac to a half wave rectifier and a capacitor filter. This produces nominally 1,400 vdc. This negative voltage passes through a dropping resistor. It is then fed through a string of 10 subminiature voltage regulators in series. Each of the dynodes is supplied voltage from a tap in the regulated voltage supply. Hence, the voltage supplied to each dynode is kept constant against variations in line voltage, dynode current or nonlinear current needs.

The anode supplies a current through its load resistor to ground. The amount of anode current is a function of the incident light hitting the cathode. It appears as a voltage drop across the anode load resistor. In the schematic this resistor is actually a selected resistor depending on range. The voltage drop is applied to one grid of a push-pull dc amplifier. This amplifier is very stable due to the negative feedback in its cathode circuit and to its regulated power supply.

In actual operation Switch 1 is turned to the BALANCE position and the BALANCE control is adjusted for a zero reading. Next, with the photomultiplier in an enclosed housing, Switch 1 is turned to the READ position. The dark current BALANCE control is then adjusted until the meter again reads zero. The hood is removed from the photomultiplier and the light range selector switch is turned for the best reading.

BOOKS

13th Annual National Relay Conference and 2nd International Conference on Magnetic Relays Proceedings

Published 1965 by the National Association of Relay Manufacturers, P.O. Box 7765, Phoenix, Ariz. 85011. Price $5.00. Paperback.

Contains copies of the papers presented at the 13th Annual National Relay Conference on Electromagnetic Relays held April 27-29, 1965, at Oklahoma State Univ., Stillwater, Okla.

Systems Engineering Tools

By Harold Chestnut. Published 1965 by John Wiley & Sons, Inc., 605 Third Ave., New York, N.Y. 10016. Price $12.95. 646 pages.

This book develops the mathematics and technical skills needed in the analysis and synthesis of large, complex, one-of-a-kind systems in the utility, industrial, and military fields. The importance of energy, materials, and information in the production of high grade systems is emphasized. Modeling and simulation are highlighted, and computing is presented in terms of both analog and digital methods. Optimization is also treated from many points of view.

Space Communications Systems

By R. F. Filipowsky and E. I. Muehldorf. Published 1965 by Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. Price $14.90. 564 pages.

Divided into two parts, the first four chapters deal with fundamentals, orbital motions, the space environment, propagation, noise, and link design. The final four chapters cover uses in communication satellites, instrumented satellites, deep-space vehicles, and manned spacecraft. The chapters on fundamentals emphasize the systems character of the book by considering the problems of the communications link. Methods used in space communications are explained in enough detail to allow their application to specific problems.

Telemetry Systems

By LeRoy E. Foster. Published 1965 by John Wiley & Sons, Inc., 605 Third Ave., New York, N.Y. 10016. Price $12.75. 308 pages.

This book covers aspects of the field needed to analyze and design airborne telemetry systems. The newest developments in PCM telemetry are stressed and the material presented so that the reader can distinguish between usable theory and actual design. Theoretical and practical aspects are covered first. This is followed by work on sensors. Reduction of telemetry data on the ground is discussed, as is the analysis and design of both airborne TV systems and spacecraft communication systems. Latest work on radar, tracking cameras, CW tracking, and other ground-based devices is included.

Threshold Logic: A Synthesis Approach

By Michael L. Dertouzos. Published 1965 by The M.I.T. Press, Cambridge, Mass. Price $6.00. 256 pages.

Book shows how a basic approach (correlation) can be used in treating the questions of threshold-element synthesis. A number of scattered concepts are unified through this approach under one idea (the characteristic-vector language).

Transmission Lines, Antennas and Waveguides

By R. W. P. King, H. R. Mimno, and A. H. Wing. Published 1965 by Dover Publications, Inc., 180 Varick St., New York 14, N.Y. Price $2.00. 347 pages, paperback.

This Dover edition is a corrected and enlarged version of the work first published by McGraw-Hill Book Co., Inc., in 1945.

Books Received

Microelectronic Circuits and Applications

By J. M. Carroll. Published 1965 by McGraw-Hill Book Co., 330 West 42nd St., New York, N.Y. 10036. Price $9.75. 356 pages.

Symposium on Microelectronics and Large Systems

Edited by S. J. Mathis, Jr., R. E. Wiley and L. M. Spandorfer. Published 1965 by Spartan Books, Inc., 1250 Connecticut Ave., N.W., Washington, D.C. 20036. Price $8.50. 272 pages.

ELECTRONIC INDUSTRIES

Advertisers—February 1966

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ELECTRONIC INDUSTRIES
The STATE-OF-THE-ART Magazine

What Future for Passive Components?

IT MAY SOUND STRANGE TO RAISE THIS QUESTION. Yet, the rapid advances being made in integrated circuits (ICs) make such a question valid.

Recently a group of component manufacturers got together to discuss the subject: "The Future of Passive Components (resistors, capacitors, inductors) in Microelectronics." Authorities from such prominent component companies as Sprague, ITT, General Electric and IRC presented their forecasts for five years ahead.

The consensus was that as experience with functional design techniques grows, the use of integrated circuits will increase in a revolutionary way.

Component producers emphasize present limitations of ICs. They have low power, high cost in small quantities, and limited reliability data. New production facilities are needed and there are few trained engineers in the monolithic art. They believe that advanced manufacturing and processing methods will beget a host of new discrete components that will cost less, be smaller, more precise, and more reliable. The expanding electronic industries are expected to provide many new markets for passive components. Also, they expect some engineering reluctance to change, since the industry is still steeped in the discrete design concept.

What will ultimately happen to the discrete component manufacturer? Progressive companies will move with the trend. An example of this is the wide diversification by Sprague. Short-run ICs are economically feasible now and some discrete component makers may add facilities to specialize in this area. Other manufacturers, slow to switch from tubes to transistors, may have to make the leap directly into integrated circuits.

We do not know just how fast and drastic the drop-off in the use of discrete components will be. We foresee that certain components will be needed indefinitely for special purposes and where they may do a better job at lower cost. But the age of the integrated circuit is at hand. How fast it moves will depend on many factors. We think you—the equipment and systems engineers—remain the big key.

Will you be ready to take advantage of this technology as it unfolds?

ELECTRONIC INDUSTRIES will shortly inaugurate a series of tutorial articles designed to bring you up-to-date on all phases of integrated circuit technology. (See announcement on page 114.)

What's the future for passive components? They'll be replaced by ICs when performance and cost are better served. They'll undergo changes for applications where ICs aren't suitable.

Bernard F. Osbahr

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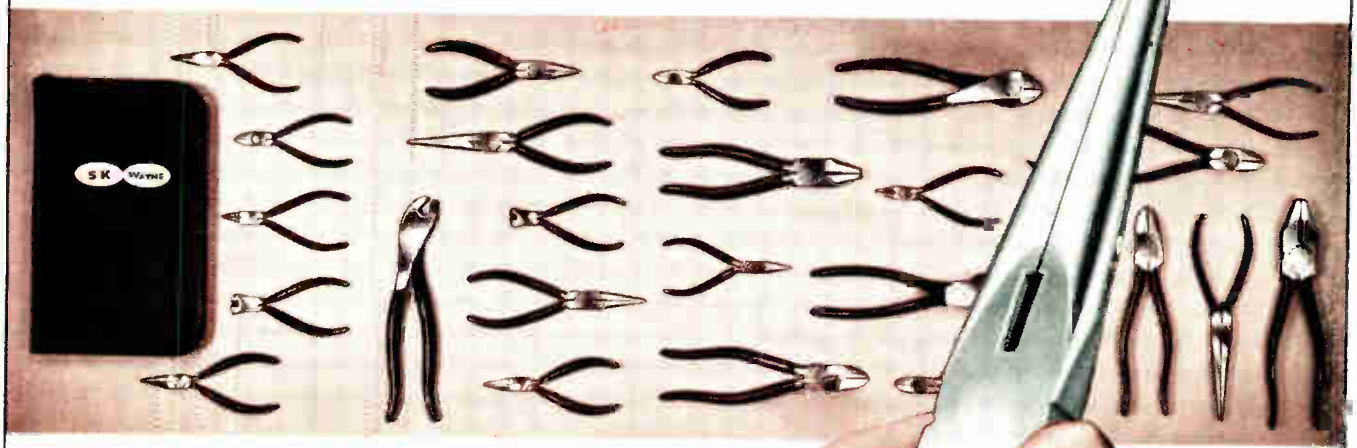

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RCA 40294 low-noise UHF AMPLIFIER—only 4 dB typical noise figure at 450 Mc/s—tested to meet your most exacting high reliability requirements for critical aerospace and military applications.

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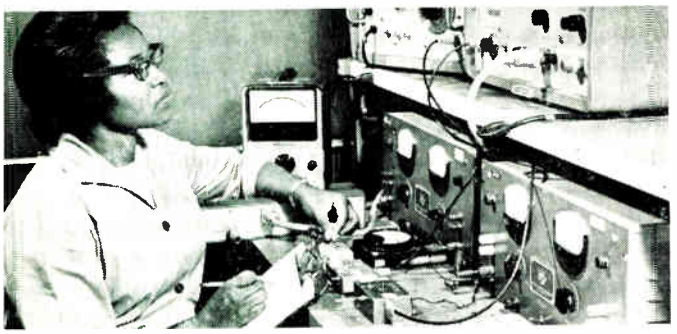

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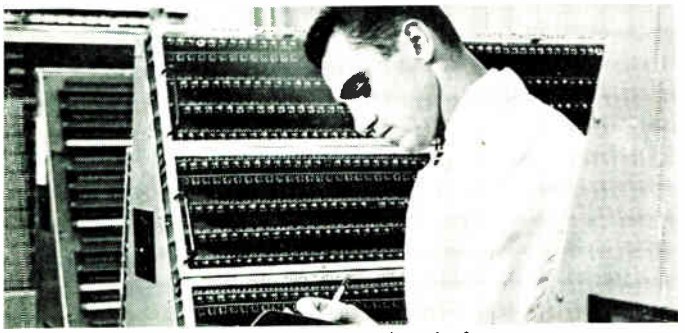

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EMITTER-TO-BASE VOLTAGE, V_{EBO}	2.5 max. volts
COLLECTOR CURRENT, I_C	40 max. mA
TRANSISTOR DISSIPATION, P_T	200 max. mW (25° C T_{FA})
TEMPERATURE RANGE: Storage and Operating (Junction)	−65 to +200° C

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