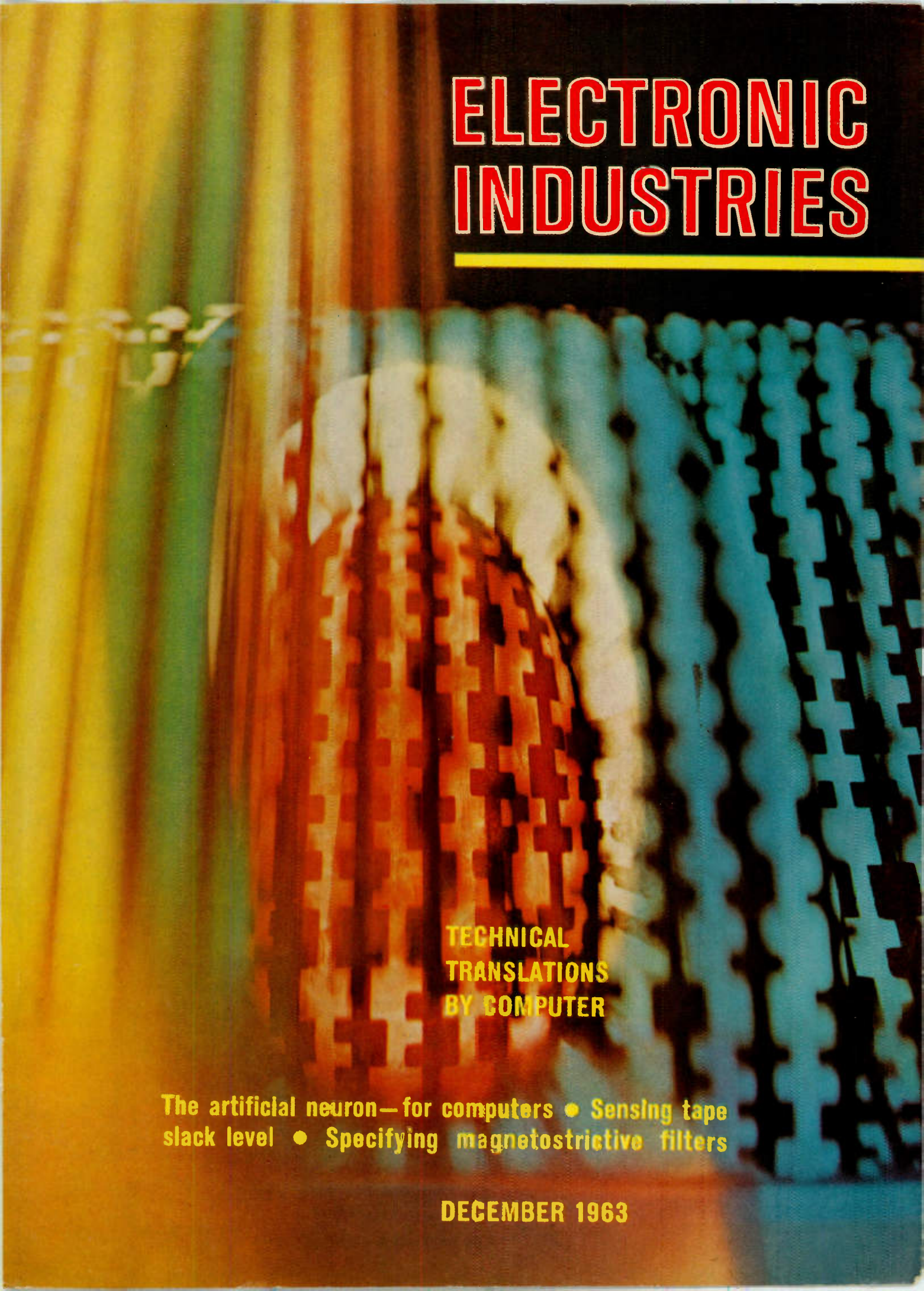
ELECTRONIC INDUSTRIES



TECHNICAL TRANSLATIONS BY COMPUTER

The artificial neuron—for computers • Sensing tape slack level • Specifying magnetostrictive filters

DECEMBER 1963

DALE RELIABILITY

goes into your circuit with

Metal Film Resistors

From lead to lead—from coating to core, the component parts of Dale Metal Film Resistors are integrally matched, one with the other. This is the key to resistor reliability. It is the product of thorough quality monitoring, unstinting quality control and continual product improvement. Dale MF Resistors are specified in applications where high resistive values in miniature size must be combined with a low temperature coefficient and a high degree of stability. The rigid quality control procedures and materials procurement standards used in the production of all Dale resistors have reached new levels of achievement as a result of Dale participation in the **MINUTEMAN** High Reliability Component Development Program. Add reliability to your circuit by specifying Dale MF Resistors. Weldable leads, EIA color banding and reel packaging available.

SPECIFICATIONS

• Meet requirements of MIL-R-10509D, characteristic C • Five physical sizes rated at ⅛, ¼, ½, 1 and 2 watts • Resistance range from 100 to 4 megohms, depending on type and tolerance • Tolerances .25%, .5%, 1% • Operating temperature range –55° to 175° C

Here's how Dale "builds in" reliability

1. SELECTED CERAMIC CORES, formulated to Dale specification are fire cleaned to remove all surface impurities and to assure an intimate bond with resistance film.

2. TERMINATING BANDS are deposited immediately following the deposition of the resistance film while still under vacuum. This assures maximum film-to-lead contact, better load life stability, and reduces possibility of contamination.

3. SPECIAL METAL ALLOY is vacuum deposited to uniform thickness over the entire core. Resistance element then undergoes a normalizing process at elevated temperatures. These procedures assure a stable film with a temperature coefficient as low as 25 p.p.m.

4. COATINGS are matched to provide maximum protection against environmental and mechanical damage. Resistance element receives three coatings of silicone prior to molding of outer jacket. Each coat is cured separately at a temperature higher than maximum operating temperature thus providing automatic normalizing. The first is applied following film deposition; the second and third coats are applied following spiralling to value. Outer jacket utilizes *Dale-perfected molding technique* which precisely centers resistance element in homogeneous, void-free encapsulation.

Write for Dale Resistor Catalog A

DALE

DALE ELECTRONICS, INC.

1304 28th Avenue, Columbus, Nebraska

A subsidiary of THE LIONEL CORPORATION

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

See our specifications in VSMF the microfilm catalog file

Circle 98 on Inquiry Card

SHELBY A. McMILLION,
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ELECTRONIC INDUSTRIES

THE BEST IS YET TO COME, IF.....

THE SELLER'S MARKET for government electronic equipment and services is over. Tighter procurement regulations and increased competition have made it more difficult to do government business at a profit. As taxpayers, we cannot seriously question the desire of the government to get more for our defense dollars.

New procurement regulations were designed to close loop-holes which permitted windfall advantages in the past. Like most government corrective action, perhaps it has gone too far. Zealous administrative and procurement officers have frequently gone beyond the intentions of our Congressional lawmakers.

Too many manufacturers have been lulled to a false sense of security with the rush of defense orders characteristic of the past ten years when our continental defenses needed quick implementation, our missile technology was lagging, and we were building aircraft at a fast pace.

In spite of this changing market, we see no cause for pessimism. Our industry has had the massive support of defense contracts for the past ten years; contracts that have pushed back the frontiers of our knowledge on a wide front. This knowledge should be the basis for a leap forward into many new areas of design and manufacture.

Certainly, better management will be needed in the future for electronic manufacturers to show profitable growth. There has already been some "shaking out" of the less efficient and poorly managed companies of our industry. Manufacturers oriented toward defense business alone must find ways to use their know-how for the development of commercial and consumer products. They will need the traditional virtues of effective management, tight cost control, imaginative product development and astute marketing practices.

Well-managed companies in this industry are making profits and will continue to expand their sales and earnings in the years ahead. Others, which have not been too successful, have a chance to re-examine their operations and direct their efforts toward promising industrial and consumer markets.

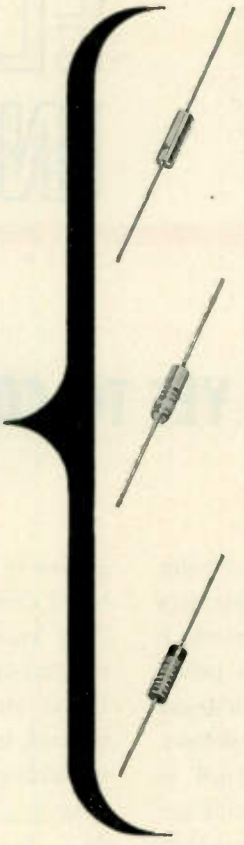
It is significant that 1963 was the first year that industrial electronic sales have exceeded that of the consumer market. This is an area of great potential growth. And newer and better consumer products must be developed and put on the market. We believe this challenge will be accepted by our manufacturers. They will reduce their dependence upon government business and move ahead boldly to capture these new markets.

Keen competition has been the rule in other industries for many years. We are confident that our industry can rise to meet this challenge.

Where will your company be when the chips are down? THE BEST IS YET TO COME, . . . IF WE WORK AT IT!

All from Sprague...for "cordwood" packaging!

ULTRA-MINIATURE SOLID TANTALUM CAPACITORS



Type 172D in glass-to-metal hermetically-sealed cases. Performance characteristics identical to Sprague's famous Type 150D capacitors . . . including superior high frequency performance, lower leakage current values, lower dissipation factor limits, and higher permissible ripple currents as compared to customary industry specifications. **Engineering Bulletin 3523**

Type 154D in molded cases. Another Sprague innovation to cut your costs. Offers nearly all the high performance characteristics of metal-clad capacitors. For selected applications in digital computing equipment and other commercial and industrial electronic gear where you do not need the humidity protection of higher-priced, hermetically-sealed types.
Engineering Bulletin 3530

Type 165D in polyester-film tubes. Sealed with epoxy resin. Because of thin wall of tube casing, Type 165D gives you the highest capacitance of any solid tantalum capacitor anywhere! Recommended for use in encapsulated blocks or hermetically-sealed metal-encased sub-assemblies to assure protection from moisture.
Engineering Bulletin 3535

...PLUS...

TYPE 206P Epoxy-Coated PACER® polyester film CAPACITORS Engineering Bulletin 2067	**TYPE 252C** Molded-Case CERA-MITE® ceramic CAPACITORS Engineering Bulletin 6151	**TYPE 262C, 263C** Molded-Case MONOLYTHIC® layer-built ceramic CAPACITORS Engineering Bulletin 6250	**TYPE 903Z** Epoxy-Coated INDISTOR* induction-resistance DELAY NETWORKS Engineering Bulletin 45,001 *Trademark	**TYPE 416E, 418E** Molded-Case FILMISTOR® metal film RESISTORS Engineering Bulletin 7025B
TYPE 405E, 411E Molded-Case FILMISTOR® deposited-carbon RESISTORS Engineering Bulletin 7000B	**TYPE 239E** Vitreous-Enamel BLUE JACKET® power wirewound RESISTORS Engineering Bulletin 7410D	**TYPE 219E** Silicone-Encapsulated ACRASIL® precision power wirewound RESISTORS Engineering Bulletin 7450	**TYPE 5000Z** CONNECTORS and ISOLATORS ("shorts and opens") Engineering Bulletin 94,000	**TYPE 7000Z** Shielded Radio Frequency INDUCTORS Engineering Bulletin 41,800

The Sprague components shown here are available in the two basic sizes (.090"D. x .250"L. and .138"D. x .390"L.) you need for the accepted high-density technique known as "cordwood" packaging. If you wish, they can be furnished on lead tape for automatic insertion on printed wiring boards. And with standardized sizes, these components can be installed with the same machines, permitting more efficient use of insertion equipment.

For complete technical data, write for Engineering Bulletins listed above. Address: Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

SPRAGUE COMPONENTS

CAPACITORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
TRANSISTORS	PIEZOELECTRIC CERAMICS	PACKAGED COMPONENT ASSEMBLIES
RESISTORS	PULSE-FORMING NETWORKS	BOBBIN and TAPE WOUND MAGNETIC CORES
MICROCIRCUITS	TOROIDAL INDUCTORS	SILICON RECTIFIER GATE CONTROLS
INTERFERENCE FILTERS	ELECTRIC WAVE FILTERS	FUNCTIONAL DIGITAL CIRCUITS

45C-139-63

SPRAGUE®
THE MARK OF RELIABILITY

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ELECTRONIC INDUSTRIES

December 1963
Vol. 22. No. 12

EDITORIAL FEATURES

DEPARTMENTS

BPA NBP

COVER: Artist's conception of an IBM photoscopic disc memory used for translation of Russian into English. Each one of the tiny tracks (magnified here) stores words in coded form. For more on the memory see the article entitled "Technical Translations By Computer" in this month's issue.

Now from Sprague!

SEPT®

SILICON PLANAR EPITAXIAL TRANSISTORS

2N2217 thru 2N2222

TO-5 (P_D=.8W) TO-18 (P_D=.5W)	2N2217 2N2220	2N2218 2N2221	2N2219 2N2222
BV_{CBO}	60 V (min.)	60 V (min.)	60 V (min.)
I_{CBO} @ 50V	10nA(max.)	10nA(max.)	10nA(max.)
h_{FE} @ I_C=150 mA	20-60	40-120	100-300
V_{CE} (SAT) @ I_C =150 mA	.4 V (max.)	.4 V (max.)	.4 V (max.)
C_{ob} @ 10 V	8 pF	8 pF	8 pF
f_T @ V_{CE} = 20 V, I_C = 20 mA	400mc (typ.)	400mc (typ.)	400mc (typ.)

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

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

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

SPRAGUE COMPONENTS

TRANSISTORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
CAPACITORS	PIEZOELECTRIC CERAMICS	PACKAGED COMPONENT ASSEMBLIES
RESISTORS	PULSE-FORMING NETWORKS	BOBBIN and TAPE WOUND MAGNETIC CORES
MICROCIRCUITS	TOROIDAL INDUCTORS	SILICON RECTIFIER GATE CONTROLS
INTERFERENCE FILTERS	ELECTRIC WAVE FILTERS	FUNCTIONAL DIGITAL CIRCUITS

SPRAGUE®
THE MARK OF RELIABILITY

ARTICLE HIGHLIGHTS

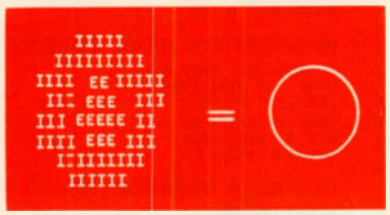
of this issue

"Time Will Sell"
Marketing Industrial Control Computers 32

The computer market is still young. Its offspring, full of "firsts" and growing pains, is industrial process controls. Some firms already depend largely on control computers, while others find their processes are not yet ready. Still others are content to wait and watch for a little. One fact is clear—the market is rising and fast.

The Hybrid Computer . . .
End of an Argument? 38

For years the arguments have continued — which is the better all-around computer, the analog or the digital? Now the hybrid computer composed of both analog and digital elements appears to have answered the question for many uses. Let's see why many people in the computer field are excited about this method of computation.

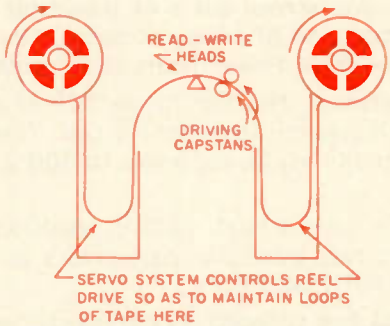


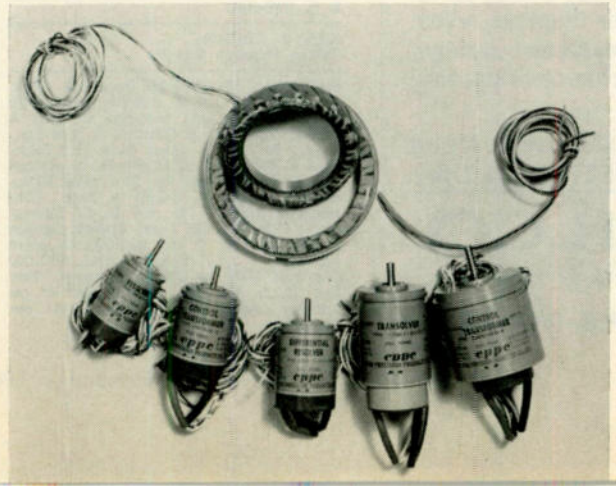
Artificial Neurons—For Machines That Learn 52

The study of neurons is being pushed, not only to learn more about animal behavior, but to enable us to build machines that can "learn" and "think." This article gives a concise description of neurons and how they work, and how these can be duplicated in electronic devices.

Sensing and Control of Tape Slack Level 65

Computer tape is stored between capstans and reels, in columns, for quick take-off. This "slack" allows the reels time to catch up. Generally, the level of tape in these columns is maintained with a bang-bang servomechanism and a sensor. That method is a little crude. The linear sensing method described here will do a better job economically.





Introduction to the Synchro Transolver 69

The transolver has been used as a phase converter and as a synchro transmitter. It has also been used to sum angles, resolve vectors, and to monitor servo instrument systems. As its versatility becomes more widely appreciated, it will be specified more frequently as the pick-off associated with sensitive transducers and central data system.

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New Benelex 100A Is Your "Open Sesame"

Today, there's something new in electrical laminates—a more versatile, more rewarding material for the designer. It's Benelex 100A. This hard, dense, cellulose and lignin laminate has superior dielectric properties. Costs less than phenolic laminates. offers easier workability (cuts and shapes just like wood). And Benelex keeps its advantages through years of use. It will pay you to investigate Benelex 100A—send now for technical brochure.

BENELEX 100A

the electrical laminate

MASONITE CORPORATION

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What's better about Benelex 100A?

- Self-extinguishing with superior arc resistance compared to phenolic laminates
- Physical and electrical properties are constant and dependable
- Benelex 100A is eligible for use up to 105° C as sole support of current-carrying electrical parts where the suitability of the application is determined by Underwriters' Laboratories, Inc.
- Approximately 50¢ per lb. in less than carload lots—much less than phenolic laminates
- Lightweight—high density electrical laminate
- Absolutely grainless, without defects, uniform in hardness
- Machines with ordinary woodworking equipment
- Masonite Fabricator Service delivers Benelex 100A components made to order in any size, shape or quantity.

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Please send me brochure on Benelex 100A

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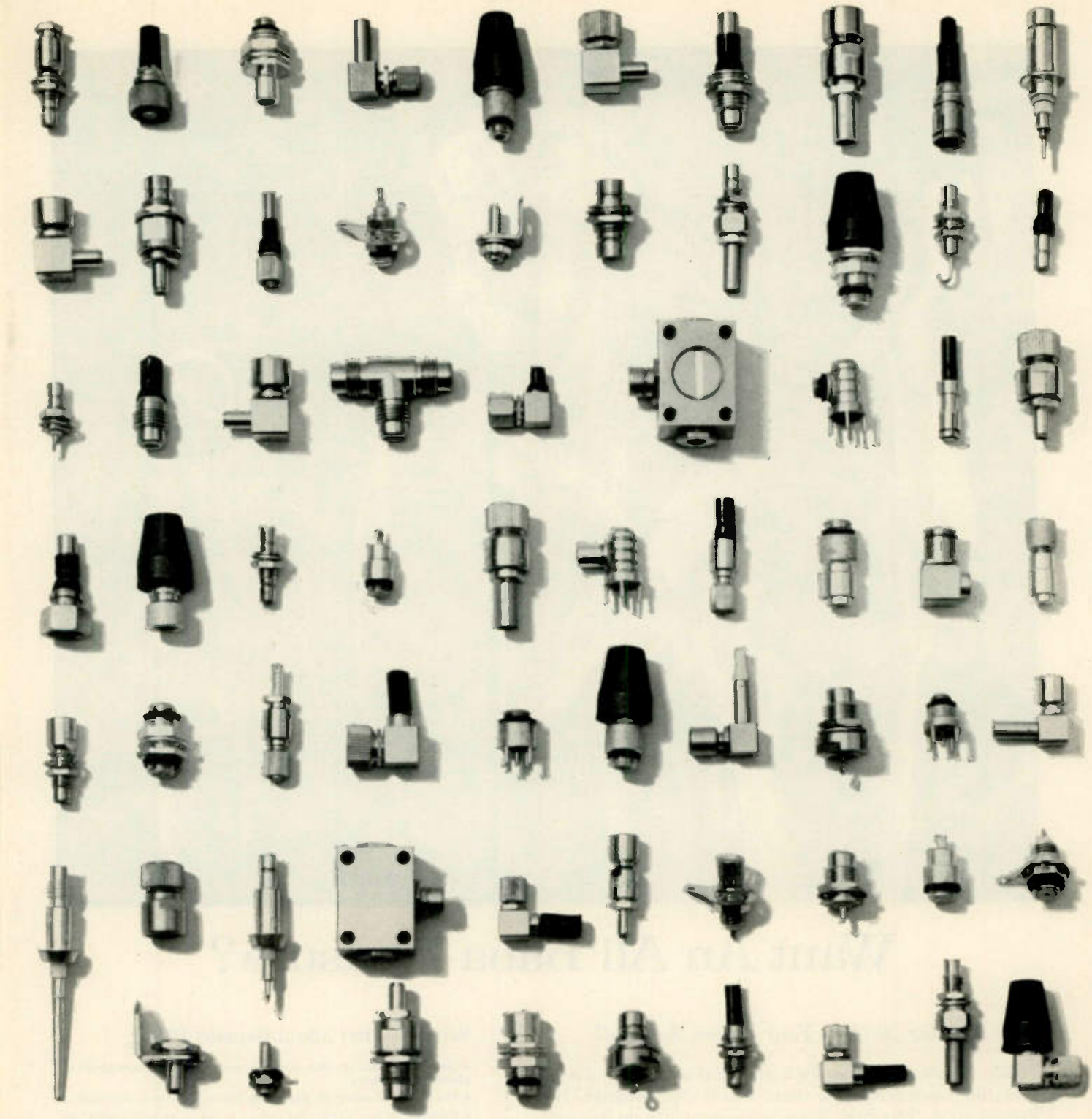

if your subminiature coaxial connector isn't here

Because there's a Subminax® coaxial connector that mates with or is interchangeable with every known subminiature connector on the market today. No matter which connector you are presently using, FXR's complete line of 117 different Subminax connectors includes its mate and its replacement—on the shelf.

Our series 5116 Subminax connectors are quick-crimp for fast assembly. Only three parts, including body assembly. 500 VRMS; impedances of 50, 75, or 90 ohms; with your choice of screw-on or push-on coupling. And priced substantially below competitive "equivalents".

Our series 27 Subminax connectors are available in radial-crimp, braid and compression clamp, and hex-crimp. Same high-level electrical and mechanical performance as our series 5116.

For information, quotations and deliveries, contact Kent Buell, FXR, 33 East Franklin Street, Danbury, Connecticut, or your Amphenol-Borg distributor.

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

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it's nowhere

RADARSCOPE

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

VERSATILE, MORE ACCURATE RADAR

New precision approach radars to monitor high - speed, low - angle approach by small jet craft in 12- 14-mile range with more reliable echo, have been ordered by British Aviation Ministry from ITT's Standard Telephones and Cables, Ltd. Radars, SLA-3C, have clearer display of elevation and azimuth. Consoles can be added.

IT WAS SOMETHING OF A SURPRISE to see the number of universities with exhibit booths at the National Electronics Conference last month in Chicago. The cooperative effort of the uinversities and industry to attract research work to the area is drawing considerable support.

RESEARCH AND DEVELOPMENT PLANS must include thought and discussion on economic, marketing, and sociological influences, according to David C. Minton, vice president of Battelle Memorial Institute. Technology must "become compatible with finance, production, sales and marketing. Technical competence is no longer adequate." A few decades ago research was limited mostly to technical problems, with little or no consideration for their implications in other fields. Now, the national psychology demands constant change in products, and this thinking is important in a research program. Minton said that new products are everybody's business. All phases of corporate activity must work together.

SEMICONDUCTOR DIODE EFFECTIVENESS has been multiplied a thousand times simply because two Purdue engineers redesigned diodes upside down. Yuan Feng Chang and H. W. Thompson had been puzzling over the strange behavior of a group of germanium diodes. They found that the alloy/germanium junction allowed excessive reverse current. By reversing the materials, the Purdue men found that in the alloying process a smoother and more abrupt junction was formed which reduced reverse leakage by 100 times. They tried the same thing on silicon diodes and they turned out 1000 times more effective. According to Purdue, the new diode design is so simple and has so much advantage, it will probably be taken up by the entire industry.

COMMUNICATIONS SYSTEMS DESIGNERS and makers might adopt the technical approach of auto makers, declared Louis A. deRosa, vice president of engineering, ITT Communication Systems, Inc. He said in effect that costly over-specialization in electronics is making a potpourri of components and equipment so specialized that field performance is only vaguely predictable. Auto men may change fins, grilles and other frills, but will seldom mess with costly field maintenance and replacement as a tradeoff for only possibly improved performance. In his plea for more standardization, he offered a solution to the "gadget neurosis" and the "black box" philosophy that has plagued the industry. "Select those applications in which failure to utilize the latest technical advances would endanger national defense." Unless we pinpoint those premium areas, over-specializing will keep on dwindling our defense dollar.

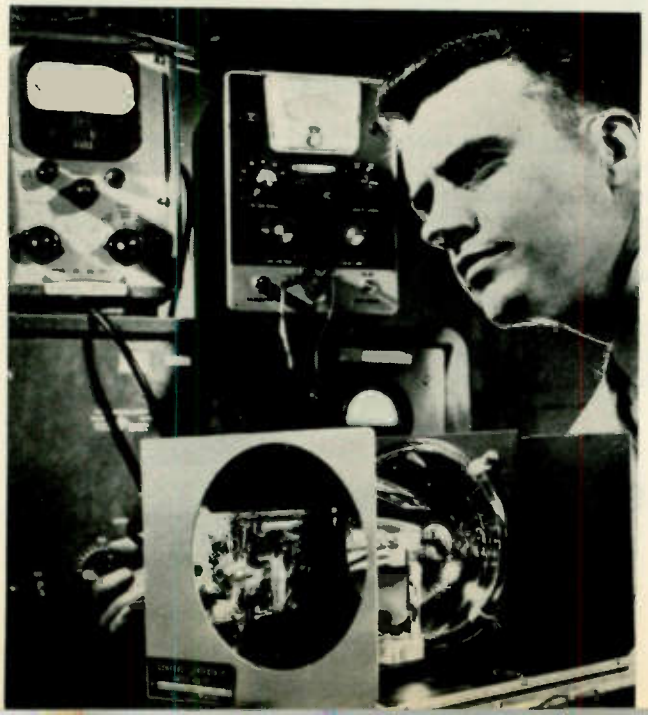
USE OF "FUNCTIONAL ELECTRONICS" promises better electronic operations than are possible now with conventional parts and circuits that depend on resistance and capacitance. Rodney B. Sorkin and Lawrence H. Stember, Jr., of Battelle Memorial Institute say the new field now under study is the direct use of material properties to generate and control electrical and magnetic energy. Functional Electronics will use basic properties such as light emission, heat conductivity, and charged particle motion. Present-day standard systems can contain 200,000 parts and a half-million solder joints. One failure could render the system useless. Functional Electronics could reduce the number of parts by 20 to 100 times or more, reducing size, cost and increasing reliability. The emphasis would be on function and not on configuration.

IMPROVED METAL CONDUCTORS for use in high-temperature studies in the direct conversion of heat to electricity are available to engineers as a result of an extended USAF research project. Researchers reviewed data and theory on conductivity, oxidation resistance, and mechanical aspects of pure metals, alloys, and metal binary compounds. Studies brought up ideas for further study and development, as well as a pile of data in tables and graphs. A report by Melpar, Inc., points out usefulness to design engineers in selecting best conductor to suit specific needs of temperature, oxidation, mechanical environment, and cost. The report is called—Electrical Conductors at Elevated Temperatures. It can be obtained at OTS, Department of Commerce.

ADVANCED TYPE OF "CHILD" CELL in circuit, plug-in module form has been developed by Self-Organizing Systems, Inc., of Dallas. The CHILD (Cognitive Hybrid Intelligent Learning Device) includes all solid-state switching and temperature compensation. The device is a relatively new and promising method of artificial intelligence. First CHILD cells were produced by engineers at the Rome Air Development Center, Griffiss Air Force Base, Rome, N. Y. The first system at RADC has 360 CHILD cells, each using 3 type SE-100 solion tetrodes as memory elements.

GaAs DIODE DATA TRANSMISSION SYSTEM

Compact transmitter is a part of GE's new gallium arsenide data transmission system which has achieved a bandwidth of 12 mc. Much broader bandwidths are predicted. The system will be capable of transmitting large quantities of data. The system sent a good, 800-line video with a 35 db signal-to-noise ratio over a 12-ft. line.



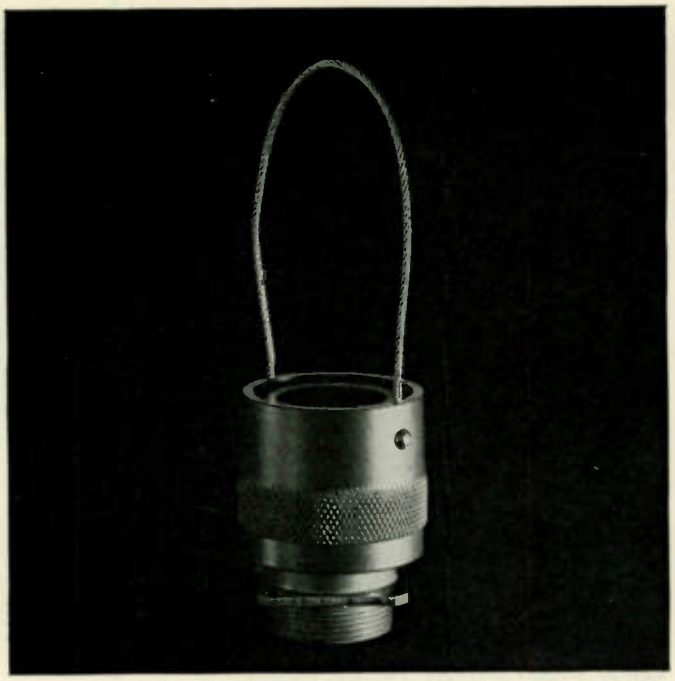
SPLIT CONTROL OF LASER BEAM

Optical circuit component capable of dividing or attenuating coherent laser beam has been produced by Electro-Optical Systems, Inc. Light from helium-neon laser (left) passes into and through interferometric module where it is split and controlled in relation to original beam. Split, controlled beams are at the top.

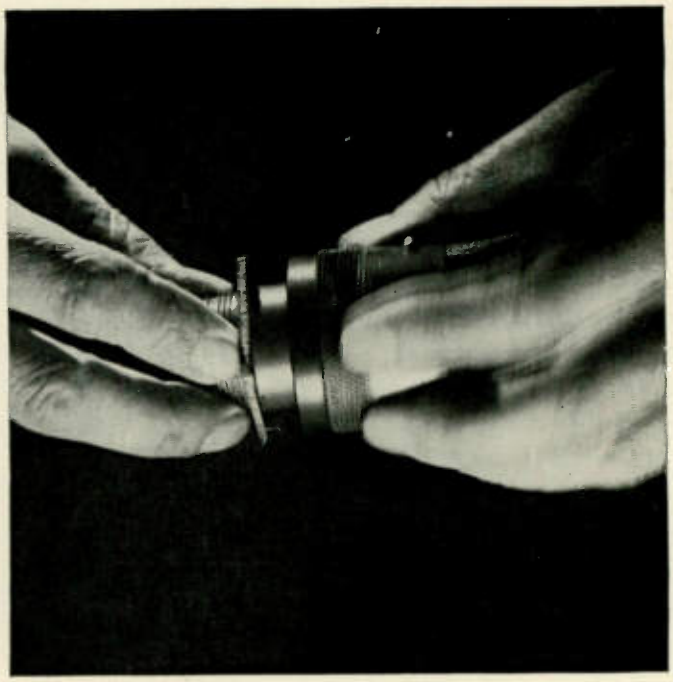
ELECTRON BEAMS AS TOOLS for drilling holes, cutting intricate shapes, and welding sand-grain sized parts are being developed further by Westinghouse. Beams can do these tasks because of intense heat produced when they bombard workpieces with up to 100 million watts per square inch. This is enough power to vaporize most heat-resistant materials. Despite ultra-high temperatures from beams, average power needs only a few watts. Because of the beam's short millionth-of-a-second pulse, the piece being cut or drilled never gets hot. As such results are invisible, a microscope must be used to monitor microminiature making processes.

NEW VHF RADIO CHANNELS crossing the equator are a potential source of long-distance communication. They may help ease problems of a crowded world-wide radio spectrum, according to C. L. Washburn, an ITT engineer at Nutley, N. J. He said there is now proof that the future for VHF paths across the equator is greater than had been known. Good signal-to-noise ratios were constant at 3,000-mile distance during his first tests for the Air Force. Low powers, simple antennas, and standard receivers were used. Signals varied between 30 and 50 MC, and sometimes as high as 75 MC. Signals at times neared the calculated free-space signal strength, suggesting ray focusing. During higher sunspot activity, say in 1970, receiving beyond 100 MC can be expected.

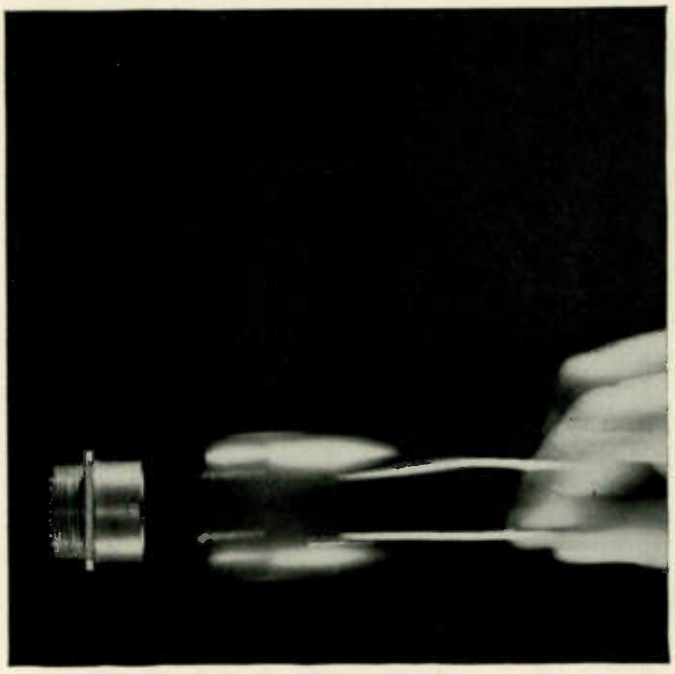
(More RADARSCOPE on Page 13)



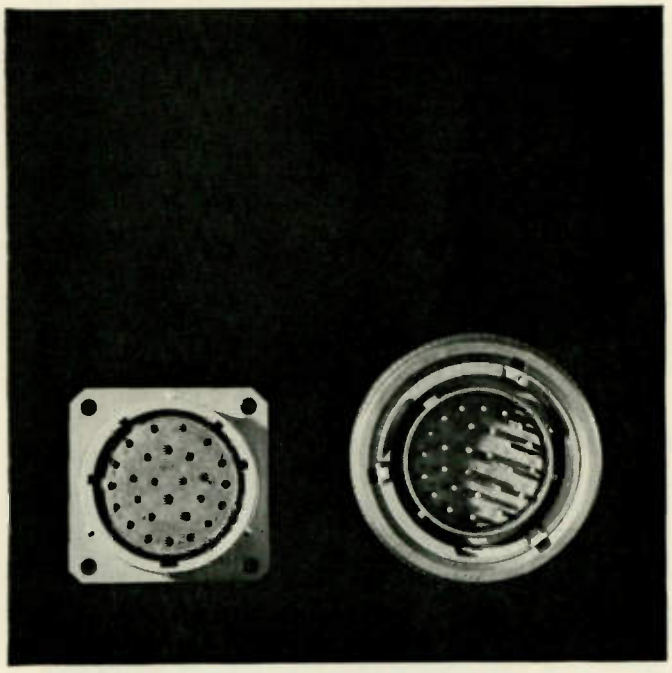
This connector



twists together



and pulls



apart.

This Bendix® Pygmy® Electrical Connector uniquely combines positive coupling and pull-to-disconnect features. It is connected by a twist; disconnected either by hand or remotely by lanyard.

Complete intermateability with PT receptacles is achieved through use of standard Pygmy PT plug shells, five-key polarization, and three-point bayonet lock coupling. The "twist/pull" design assures interfacial sealing and meets applicable requirements of the current issue of MIL-C-26482.

Resilient inserts assure extreme vibration resistance and provide support for size 20 or 16 gold-plated Pygmy contacts of either the solder or removable crimp type. Plating options for the aluminum shell components are: cadmium with an olive drab chromate after treatment, or alumilite hard anodic coating.

Write us today in Sidney, N. Y., for your copy of our informative technical bulletin SL-102, giving complete information on shell sizes and arrangements, as well as helpful design and dimensional data.

Scintilla Division

THE Bendix CORPORATION

RADARSCOPE

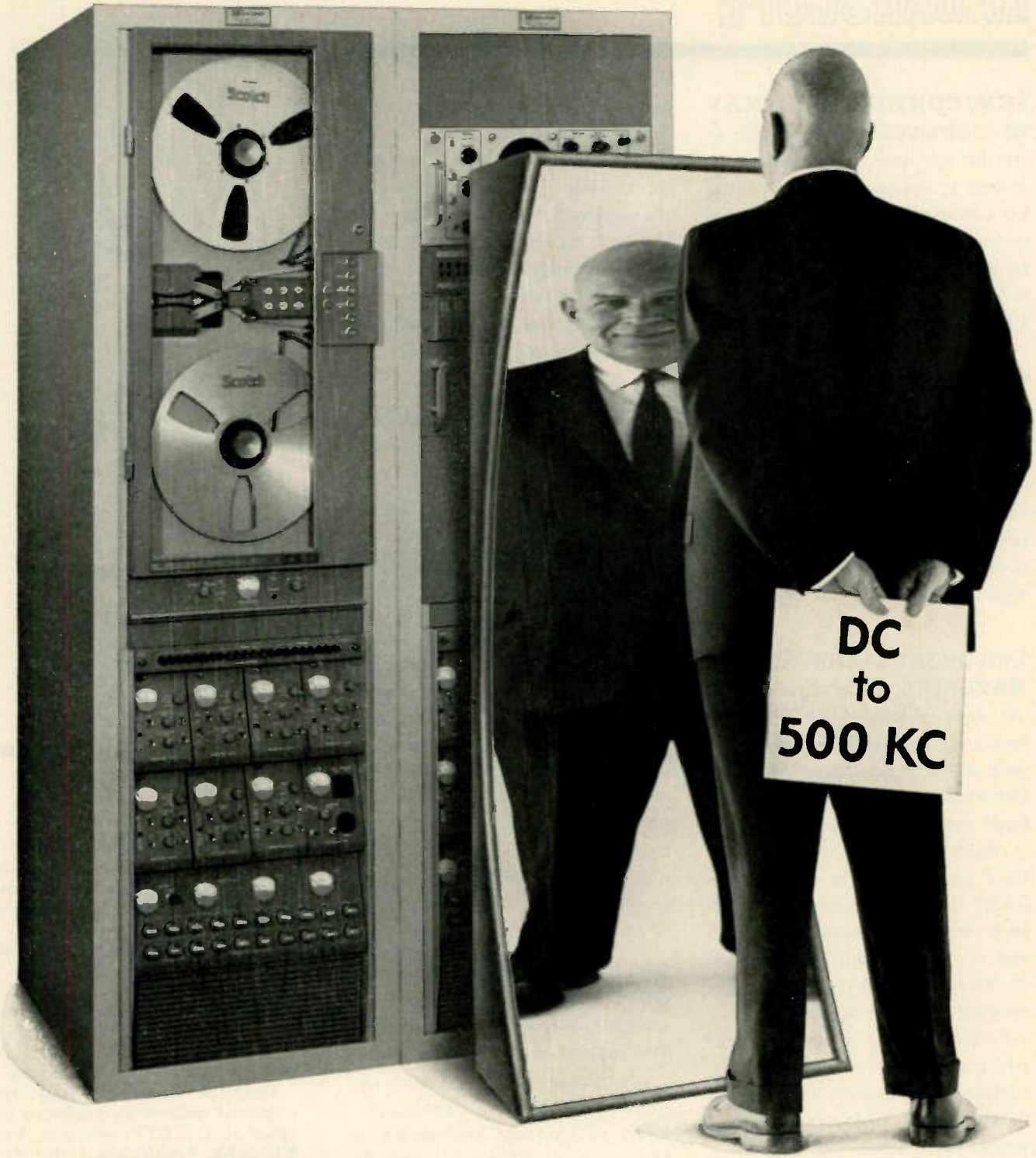
SEMICONDUCTORS MAY BE REPLACED by magnetics in certain computer applications. Engineers at Sperry Rand are looking for a computer that will be immune to neutron radiation as high as 10^{17} to 10^{21} NVT and temperatures up to 900°F. Magnetics, they say, are 100,000 times more resistant to radiation, have 1000 times the life expectancy, and allow about a 10 to 1 reduction in the number of components needed to build a computer. Sperry is now working on a radiation-tolerant computer for the Air Force. The AF believes radiation-tolerant computers would be of particular use in a nuclear powered space vehicle.

1,400-DEGREE INSULATING MATERIAL, lighter than ceramic, has been developed by GE. Dr. James R. Donnalley, general manager of GE's Insulating Materials Department, said the new tough material can be machined or molded. A bonded mica laminate, the material can be made in sheets up to 0.125" thick. It has an electromagnetic wave transmission of 95% and is only two-thirds the weight of ceramic. Dr. Donnalley said the material could be applied to space vehicles, electrical appliances, electronic assemblies, power generating equipment, microwave systems and heavy apparatus. It can withstand surges up to 1,500 volts per mil.

MEDICAL RESEARCH EDP has resulted in progress according to Tulane University and IBM in New Orleans. In a joint study IBM scientists and Tulane medical specialists are looking into using computers for new ways to read x-rays and to analyze brain wave and heart patterns. A technique to process x-rays through digital computers and retrieve them in more readable form has been shown. X-rays are scanned and converted into digital form. With special programming, the computer analyzes the image and shows it on an oscilloscope, which can be photographed. The Tulane-IBM team believes the photo makes it possible to see data or characteristics not clear on the x-ray film.

NEW SOLID-STATE LASER, optically-pumped, has been disclosed by Varian Associates of Palo Alto. Physicists R. Solomon and L. F. Mueller report that the laser works at 5985 Å, in the spectrum's orange range. Coherent beam of the laser is produced by praesodymium ions dissolved in an optically clear crystal of lanthanum trifluoride produced by Varian's crystal group. Varian scientists say crystals with high concentrations of active material, praesodymium, will increase the power output. Also, the spectral position of the output makes the laser useful where radiation is detected photoelectrically, or photographically.

OPTICS IN ELECTRICAL ENGINEERING is growing so rapidly in new basic knowledge and new applications that it has become a whole new field of research and education. George W. Stroke, professor of electrical engineering at University of Michigan, said the "new optics" has had dramatic applications in EDP, communications radar and infrared imaging, and light amplification and control. We have come to recognize "the emergence of a new field, which may be called electro-optical science." Dr. Stroke is head of a new research laboratory set up by the University's Institute of Science and Technology to study modern optics.



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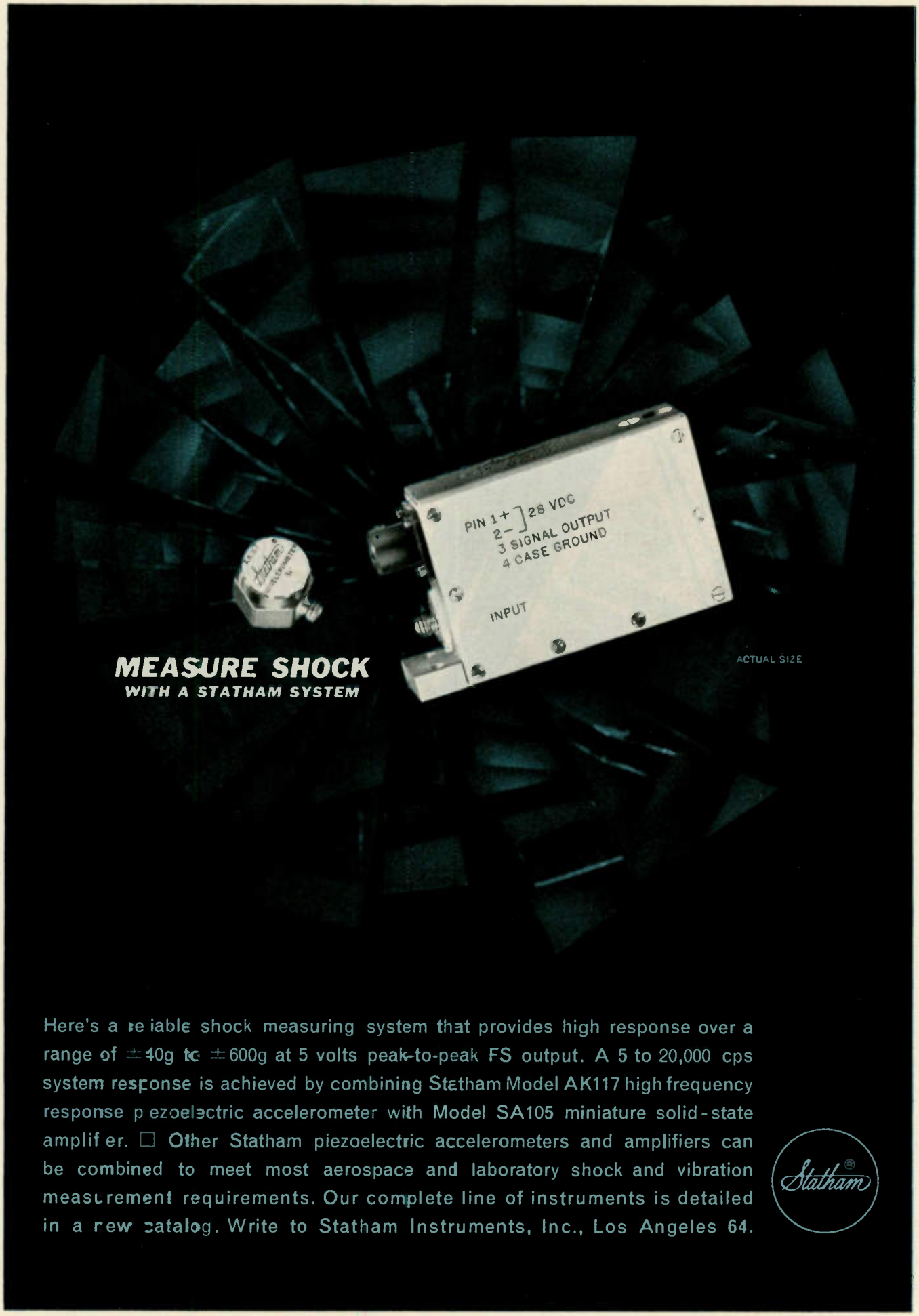

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COMING EVENTS

DECEMBER

Dec. 5-6: 14th Nat'l Conf. on Vehicular Communications, IEEE (PTG - VC); Adolphus Hotel, Dallas, Tex.

Dec. 6: 4th Annual Seminar on Reliability in Space Vehicles, PTG-R, ED, CP; Los Angeles, Calif.

Dec. 9-11: URSI-IEEE Fall Mtg., IEEE, URSI, et al; Seattle, Wash.

Dec. 19-21: APS Mtg., Pasadena, Calif.

Dec. 26-28: Amer. Astronomical Soc. Mtg.; Washington, D. C.

Dec. 26-30: Annual Mtg., Amer. Ass'n for the Advancement of Science; Hotel Cleveland, Ohio.

JANUARY 1964

Jan. 7-9, 1964: 10th Nat'l Symp. on Reliability and Quality Control, IEEE, ASQC; Statler-Hilton Hotel, Washington, D. C.

Jan. 22-24: 19th Annual Instrumentation Symp. for the Process Industries; Texas A & M College, College Sta., Tex.

Jan. 27 - 30: 20th Annual Technical Conf., SPE; Chalfonte - Haddon Hall Hotels, Atlantic City, N. J.

'64 Highlights

IEEE Int'l Conv., Mar. 23-26, Coliseum, New York Hilton, New York, N. Y.

WESCON, Western Electronic Show and Conv., Aug. 25 - 28, IEEE WEMA; Sports Arena, Los Angeles, Calif.

Nat'l Electronics Conf., Oct. 19 - 21, IEEE, et al; McCormick Place, Chicago, Ill.

NEREM, Northeast Research & Eng. Mtg., Nov. 4-6, IEEE; Boston, Mass.

FEBRUARY

Feb. 2-7: IEEE Winter Power Mtg., IEEE; Statler-Hilton Hotel, New York, N. Y.

Feb. 3-7: Int'l Conf. on Materials, ASTM; Sheraton Hotel, Philadelphia, Pa.

Feb. 4-6: 19th Annual Conf. and Exhibit of the Reinforced Plastics Div., SPI; Edgewater Beach Hotel, Chicago, Ill.

Feb. 19 - 21: Int'l Solid-State Circuits Conf., IEEE, Univ. of Pa.; Sheraton Hotel, Philadelphia, Pa.

MARCH

Mar. 2 - 6: 15th Conf. on Analytical Chemistry & Applied Spectroscopy; Penn Sheraton Hotel, Pittsburgh, Pa.

Mar. 16 - 20: Western Metal & Tool Expos. and Conf., American Soc. of Tool & Mfg. Engineers and ASM; Pan Pacific Auditorium, Los Angeles, Calif.

Mar. 23-26: IEEE Int'l Conv.; Coliseum and New York Hilton, New York, N. Y.

Mar. 31-Apr. 2: ASM Gulf Coast Metal-Working Exh. & Conf., ASM; Shamrock-Hilton Hotel, Houston, Tex.

2N2784/5l, only from Sylvania—

Particularly well adapted for use on thin film substrates, the Sylvania 2N2784/51 Micropower Transistor offers you an ideal combination of performance, reliability and size.

These devices are suitable for a variety of applications, and are especially efficient as switches or amplifiers in the microwatt or milliwatt range. Some capabilities: 1 Gc minimum bandwidth. High beta at microamperes, with only gradual falloff beyond 10 milliamperes. High switching speed ($T_{on} + T_{off} = 12$ nanoseconds). Low saturation voltages, typically 0.2 volts.

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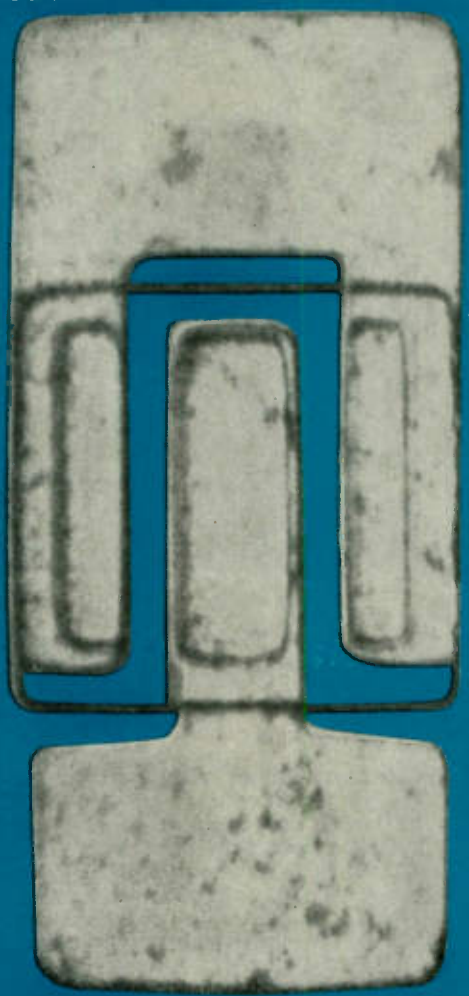
1 Gc min. bandwidth, 12 nsec total switching speed, from Sylvania epitaxial planar 3-stripe construction



SYMBOL	TEST CONDITIONS	2N2784		2N709		2N709A		2N2475	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
h_{FE}	$I_c = 30$ mA $V_{CE} = 1.0$ V	20		15		15			
h_{FE}	$I_c = 10$ mA $V_{CE} = 0.5$ V	40	120	20	120	30	90		
h_{FE}	$I_c = 20$ mA $V_{CE} = 0.4$ V							30	150
C_{ob}	$I_E = 0$ $V_{CB} = 5.0$ V		3.0 pf		3.0 pf		3.0 pf		3.0 pf
V_{CE} (sat)	$I_c = 3.0$ mA $I_B = 0.15$ mA		.26 V		.30 V		.30 V		
V_{CE} (sat)	$I_c = 20$ mA $I_B = 0.66$ mA								.40 V
V_{CEO} (sust)	$I_c = 10$ mA (pulsed) $I_B = 0$	6.0 V		6.0 V		6.0 V		6.0 V	
T_S	$I_c = I_{B1} = I_{B2} = 5.0$ mA		5.0 ns		6.0 ns		6.0 ns		6.0 ns
T_{on}	$I_c = 10$ mA $I_{B1} = 2$ mA $V_{BE(o)} = -1.0$ V		9 ns		15 ns		15 ns		
T_{on}	$I_c = 20$ mA $I_{B1} = 1$ mA $V_{BE(o)} = -1.0$ V								20 ns
T_{off}	$I_c = 10$ mA $I_{B1} = I_{B2} = 1.0$ mA		9 ns		15 ns		15 ns		
T_{off}	$I_c = 20$ mA $I_{B1} = I_{B2} = 1.0$ mA								15 ns
F_T	$I_c = 5$ mA $V_{CE} = 4.0$ V	1000 Mc		600 Mc		800 Mc			
F_T	$I_c = 20$ mA $V_{CE} = 2.0$ V							600 Mc	

This performance stems from Sylvania's advanced photolithographic techniques, making possible the small, highly efficient 3-stripe design, and from a tightly controlled fabrication process.

Package—only Sylvania offers high frequency silicon switches in a TO-51 co-planar welded closure featuring a kovar-hard glass matched seal. Just .060" high and .150" in diameter, these transistors offer the ultimate in space utilization. Package integrity is assured by 100% bubble testing. As an added reliability feature, each production lot is Radiflo tested. All this, plus device stability stemming from the plague-free planar process, gives assurance of high level performance.

Another advantage of the Sylvania TO-51 is the great variety of possible lead arrangements. Attached after the package is sealed, leads can form various patterns to fit the mounting location.

All of the transistors described here are available also in the TO-18 and TO-46 "pancake" package as well as TO-51 co-planar. For complete information, see your Sylvania sales engineer or write to Semiconductor Division, Sylvania Electric Products Inc., Woburn, Massachusetts.

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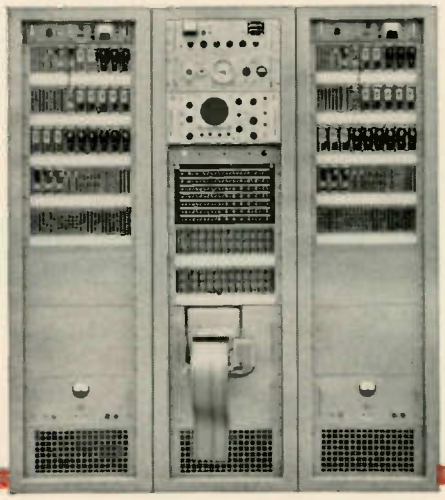
For example, you can select fundamental units from the table below, then designate standard options to obtain exactly the timing functions most suited to your particular requirements. Numerous standard options have been designed and built to provide you with the most versatile—and highly reliable—timing equipment available today.



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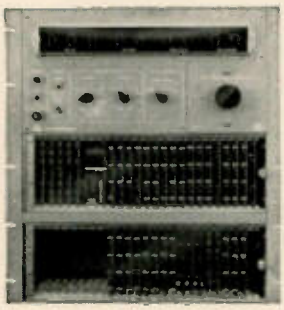
Model 6190 Up to 8 serial time codes simultaneously... standard pulse rates... decimal display ... stability to 1 part in 10^8.

Model 6140 Up to 4 serial time-of-day codes simultaneously... standard pulse rates... decimal display ... stability to 1 part in 10^8.

Model 6100 Up to 4 serial time-of-day codes... standard pulse rates... binary display... stability to 1 part in 10^8.

TIME CODE TRANSLATOR SYSTEMS



Model 6220 UNIVERSAL... translates all serial time codes to decimal display... parallel BCD output. Tape Search and Control Units (Models 6224, 6225, 6226) available for universal automatic tape search.

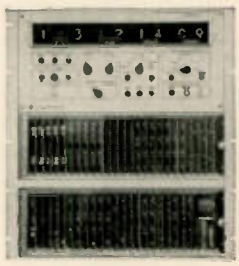
Model 6204 translates serial time code... provides parallel output and display consistent with input code format.

Model 6201 translates time-of-day serial code to parallel output and binary display.

Model 6200 converts input serial time codes to time-of-day display.

TERMINATING SYSTEMS

Model 6420 TIME CODE TRANSLATOR/GENERATOR... operates as Translator and/or generator... synchronizes time code generator to input serial time code... no interruption of output on loss of input signal.



Model 6620 Timing terminal unit... provides basic module for standard terminal function assemblies... can be assembled to provide any necessary terminal, signal conditioning or conversion functions... assemblies available: AGC amplifiers, demodulators, neon drivers, high level amplifiers, balanced line drivers, galvo amplifiers, relay drivers.

A new 48-page handbook of the most commonly used time code formats has been compiled as a handy reference for instrumentation engineers. For your free copy write to

For applications assistance when considering your timing system, contact your nearest Astrodata representative or the Timing Instrumentation Group direct.

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10

WASHINGTON TRENDS

CONGRESS PUSHING EDP STANDARDS—A congressional report on government EDP policies makes a strong pitch for more computer standards. House Post Office and Civil Service Commission, after long study, reports that standardization is vital to efficient use of Federal EDP systems. It suggests that the Commerce Department begin a crash program on machine-to-machine reporting; it suggests a deadline schedule for standardization. The report asks for more competition in government procurement, central reporting of results of various systems, and programming courses in high schools and colleges. There are now 1,248 EDP systems at work in the government. About 63% of them are in DOD. Last year IBM supplied 67% of the new systems. The second ranking vendor, UNIVAC, was a distant second, supplying only 6.3%.

OVERSEAS RIGHTS AN FCC ISSUE—Two communications giants, AT&T and IT&T, are in a bitter squabble before the FCC over non-voice transmission rights to England and Europe. American Cable & Radio, IT&T subsidiary, fingered AT&T as a monopolizer. It says AT&T is trying to control overseas communications by asking clearance to furnish non-voice transmission to Europe for all of its customers. This would include a new deep sea cable to England.

SATELLITE STOCK GOING ON SALE — The U. S. Government is getting ready to supervise the selling of common shares in the Communications Satellite Corp. (COMSAT) in February. The corporation will be owned half and half by communications firms—AT&T and RCA among them—and by the public, and will operate satellite signal relay stations in orbit. The system, channeling both voice and non-voice signals, goes to work later in 1964. Stock offerings will total about $200 million, and the price will be $50 a share.

INCENTIVE CONTRACTS PUSHED — From now on, every major NASA contract will be studied closely. The idea is to find out whether an incentive system will work by rewarding good contractors and by punishing bad ones. The aim: make contractors do better at less cost—and with reliability. Under the untried system, contractors may earn bigger profits for good jobs. For a bad job the contractor may get peanuts, or no profit at all. The system allows contractors to share in cost savings and rewards for superior technical performance. There are penalties for delays in delivering the goods.

ARE RESEARCH DOLLARS BEING WASTED?—Congress is itching to know whether all of the 14-billion-dollar kitty used by the government for research each year is really necessary. There's a growing suspicion among budget experts that this is more than is needed, owing, they say, to duplicated and overlapping research projects. Space and electronic research will get the brunt of any cutback that results from investigations. The House has voted itself $500,000 for nine of its members plus a professional staff to take an official peek.

HOW TO SPREAD THE INFORMATION—A new drive to step up and improve the exchange of scientific data is afoot by the Senate's Government Operations Committee. Sen. Hubert Humphrey (D.-Minn.) has asked scientists and engineers around the country for thoughts on weak links in present data systems and ideas for improving the flow. The Senator offered to treat comments off-the-record if so desired, so as to get candor in responses. He noted that today's stepped-up government efforts to collect and deal out vast scientific information are under heavy criticism.

MORE EDUCATIONAL TV COMING — Requests for a total $5,901,717 have been received from 33 groups filing under a program of Federal assistance to establish or expand ETV facilities. The program is being handled by the Department of Health, Education and Welfare. On October 11th, President Kennedy signed a bill appropriating $6.5 million for the program for the current fiscal year. Congress previously appropriated $1.5 million. New ETV stations will use newly-allotted UHF TV broadcast channels.

ENGINEER PAY SCALE CONFLICT LOOMS—NASA has been accused of luring scientists and engineers from industry and colleges. Washington's biggest wail, though, is that valuable technical men have been switched from other Federal agencies, especially DOD. The argument is NASA built manpower with promises of higher salaries and faster promotions. "Glamorous" NASA is fastest growing U. S. agency, with a fast growing budget. The dispute logically narrows down to the differences in pay rates for technical people from agency to agency. Technical manpower was short, and the government was willing to raise pay scales last year as a come-on. With this shortage apparently satisfied now, Congress may resist efforts to continue wage differential for technical talent.

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MARKETING

Facts and Figures Round-Up

HONEYWELL HEAD URGES SALESMEN TO 'THINK PROFITS!'

To fight the continuing profit squeeze, Honeywell's president says corporate management should include field salesmen in drives to improve operating results.

James H. Binger, head of Honeywell, declared that field salesmen should be made to "think profits." He called them "one of the most neglected areas of business."

In contrast to the good job management has done in cutting producing, engineering and distributing costs in past years, "we haven't yet gotten the word to the field sales force on profits."

"The average field sales force eats, sleeps and talks volume," Binger asserted. He said that too often, if field salesmen think about profit margins at all, they consider the problem as someone else's concern.

RISING JAPANESE IMPORTS CAUSE CONCERN IN SENATE

Ever-growing imports of electronic products are causing new concern in our nation's capital. Some senators, once solid supporters of President Kennedy's free-trade plan, now have misgivings about the wisdom of unrestricted imports.

Sen. Leverett Saltonstall (R.-Mass.) points out that a large part of the cost of U. S. electronic equipment is the labor, and that Japanese wages average only 20% of comparable U. S. wages.

Japanese vendors have captured about 63% of the U. S. transistor radio market. Imported sets are valued at only $6.14 each, while American-made radios have a factory value of $18.70. The Senate views that our existing tariff laws are no barrier to foreign products.

AMPEX'S ROBERTS PUTS 1965 TAPE SALES AT $130 MILLION

As the big magnetic tape market keeps unreeling, a crowded field of competitors is out to share this market. Sales are forecast from a present $60,000,000 to some $130,000,000 by 1964 or 1965.

So predicts William E. Roberts, president of Ampex Corp. He projects Ampex's share as "substantially more than 10% of that larger market."

Industry estimates of the magnetic tape business generally place Minnesota - Mining first, Audio Devices or Reeves Soundcraft second, and Ampex a possible third or fourth.

EDP INDUSTRY PROJECTS MARKET GROWTH TO 1970

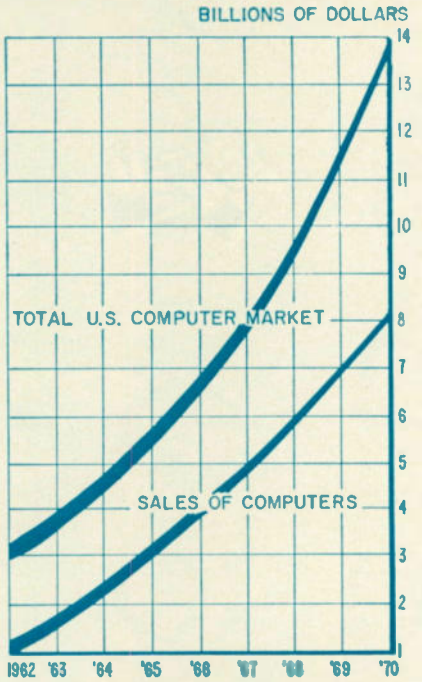
An overworked crystal ball emits both promising and wild projections for the computer market—at least for the firms who will survive the gradual shakeout.

EIA figures show gradual growth from $495 million in 1957 to $1.2 billion in 1962. The association offers no figure beyond 1962.

A spokesman for Honeywell EDP figures the entire hardware, software and services domestic EDP system market at around $3.7 billion at the end of 1963. He sees the market pushing $5 billion by 1965's end. International markets may balloon faster from $1 billion in 1963 to more than $3.5 billion in 1965.

GE's computer people think that more than 50% of all data processors sold by 1970 will use communications equipment. People and equipment will talk to computers, and computers will "talk" to each other. A number of firms, including GE, now make computers that can transmit data, with intermediate hardware attachments, over telephone and telegraph wires, by microwaves and laser systems.

COMPUTER SALES FORECAST



Total U. S. computer market in equipment, installation, services for 1962 has been put at around $3.25 billion. William C. Norris, Control Data Corp., thinks market will rise 20% yearly for next eight years. If forecast holds, market may near $14 billion by 1970. Various guesses in total sales of computers alone average around $8 billion by 1970. Total for 1962 is put at $1.2 billion. Please see chart.

EDP Services Market

The market for data processing services in 1963 may reach $220 million, forecasts J. P. Boyle, manager of EDP services of UNIVAC. He places the market at $500 million within the next five years.

Control Data's William C. Norris predicts that out of 12 major computer makers today, there will be only six in ten years. IBM will probably continue as the goliath of the market. A recent industry study estimates that by 1970 IBM will produce about 60 to 70% of the computers in an $8.5 billion market, compared wtih its 80% of last year's $2 billion sales.

Norris estimated that nearly $5 billion worth of standard computer systems were in operation in the U. S. by the end of 1962, yielding a yearly gross income to computer companies in excess of $2 billion in the same year. The value of installed systems in the U. S., and yearly income, will grow from four to six times over 1962 by 1970, Norris predicted. Yearly sales in the foreign market will approach those of the U. S. market by 1970.

Europe Market

The European market is put at about $400 million now and may go beyond $5 billion in about ten years.

Harold A. Strickland, vice president and general manager of GE's Industrial Electronics Division, said that by the end of 1963 some 6,275 digital computers will be delivered in the U. S. for data processing applications. Their total value, including peripheral gear, will near $2.6 billion. Usage and software will involve another $1.4 billion.

John E. Johnson, vice president of RCA's Automatic Data Processing, said that if computer equipment is used for clerical duties alone, the total computers delivered by 1970 would hit 40,000. He reports that the industry has already delivered some 10,000 systems in the U. S. He believes that the computer population by 1970 could easily reach 75,000 for all applications.

ELECTRONICS TO KEEP LEAD AS A GROWTH INDUSTRY

Electronics will stay on top as a leading growth industry throughout the 1960s. U. S. Department of Labor reports that by 1970 we will be shipping $20 billion or more in electronic products. We will be paying wages to some 1.1 million workers.

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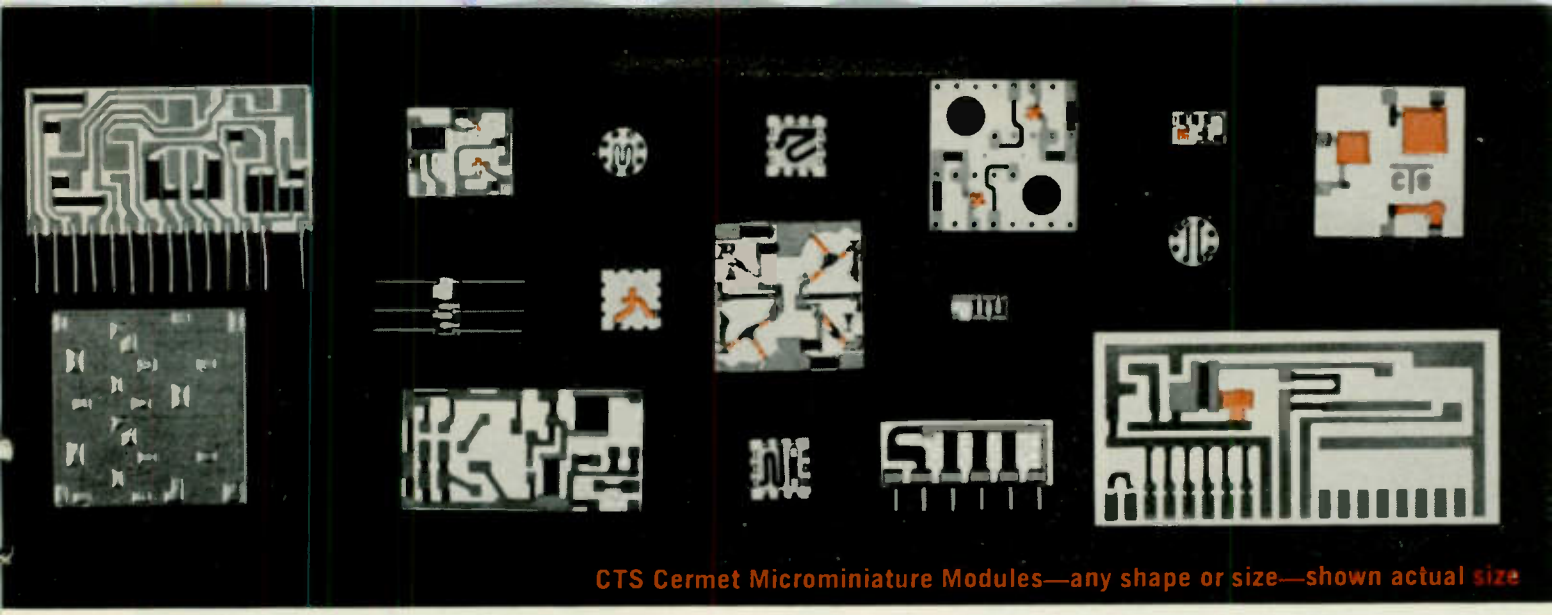

CTS Cermet Microminiature Modules—any shape or size—shown actual size

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- **Unusually stable** and substantially unaffected by the most severe environmental extremes due to the virtually indestructible combination of a matrix of inorganic material and precious metal alloys after firing.
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- **Elements can't separate from substrate** during varying environmental conditions. Cermet resistors and capacitors are thermally bonded.
- **Perfect termination** due to similarity of compositions. Pt-Au conductor composition diffuses with the cermet compositions and becomes part of the substrate after firing.
- **Migration dangers eliminated** because no silver is used.
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- **Extremely tight quality control** in purchased materials inspection, in-process control of production procedures, step-by-step product inspection, and quality assurance program on completed product.
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CTS Cermet Resistors meet MIL-R-10509

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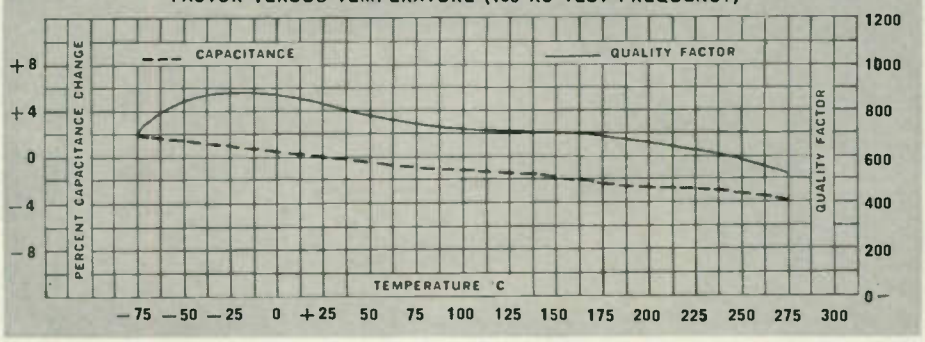

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SNAPSHOTS... OF THE ELECTRONIC INDUSTRIES

'ARTIFICIAL SUN'

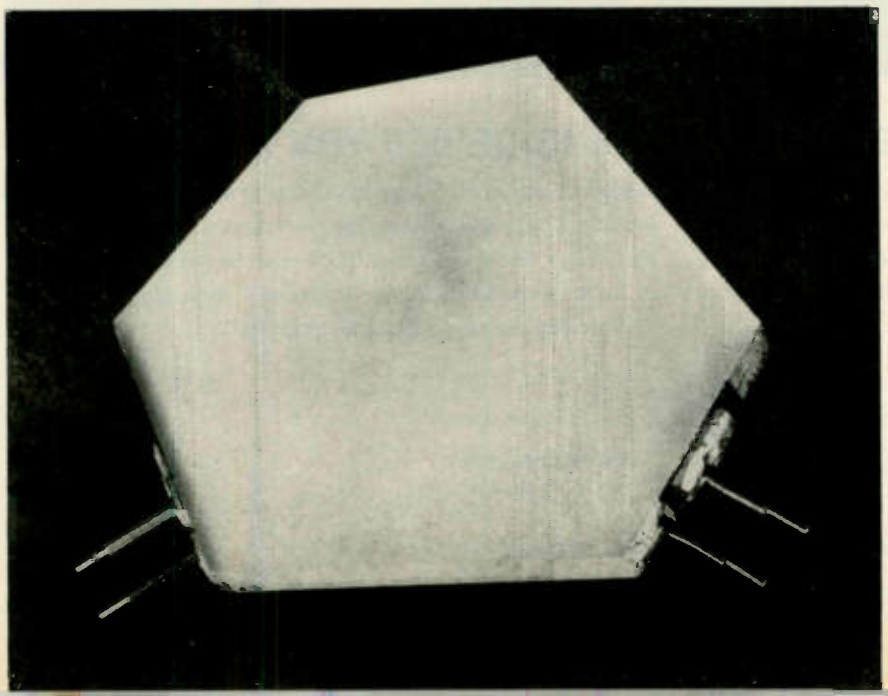
This 3-module solar array was developed for testing space vehicles under conditions simulating the sun's rays found during interplanetary space travel. By means of high intensity lamps and a complex assembly of optical lenses and reflectors, radiation that virtually duplicates solar radiation in space may be produced. Technician Darrell Burnett at the Honeywell California Ordnance Center is shown measuring the intensity and pattern of radiation from the simulator.

'REAL TIME' COMPUTER

Computer operator, Arthur Worsh, operates console of new Honeywell 1400 "real time" computer system that features doubled memory capacity, communications and random access storage capabilities. Computer console also features (l-r) a random access control panel and a communications control panel.

COMPONENT EVALUATION

Reliability engineer L. A. Milton uses a magnifier to examine high-speed x-ray motion pictures of a missile part. The pictures enable reliability engineers at General Dynamics/Astronautics, San Diego, to evaluate parts and part failures under simulated operating conditions. A motion analysis projector is used for closer viewing of the film.



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Glass ultrasonic delay line is used as a high-speed digital memory for computers and data processing equipment. These delay lines are made by Corning Electronic Devices, a department of Corning Glass at Bradford, Pa.

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Delco announces two new silicon power transistors

No.	Vcex Icex=5ma	Vce Sustaining	hFE Ic=5A	hFE Ic=10A	Vce Sat. Ic=5A	Vce Sat. Ic=10A	Vbe Sat. Ic=5A	Vbe Sat. Ic=10A
2N3079	200	200v	10 min. 50 max.		0.7v		1.5v	
2N3080	300	300v	10 min. 50 max.		0.7v		1.5v	
2N2580	400	325v	10 min. 40 max.		0.7v		1.5v	
2N2581	400	325v	25 min. 65 max.	10 min.		1.0v		1.7v
2N2582	500	325v	10 min. 40 max.		0.7v		1.5v	
2N2583	500	325v	25 min. 65 max.	10 min.		1.0v		1.7v

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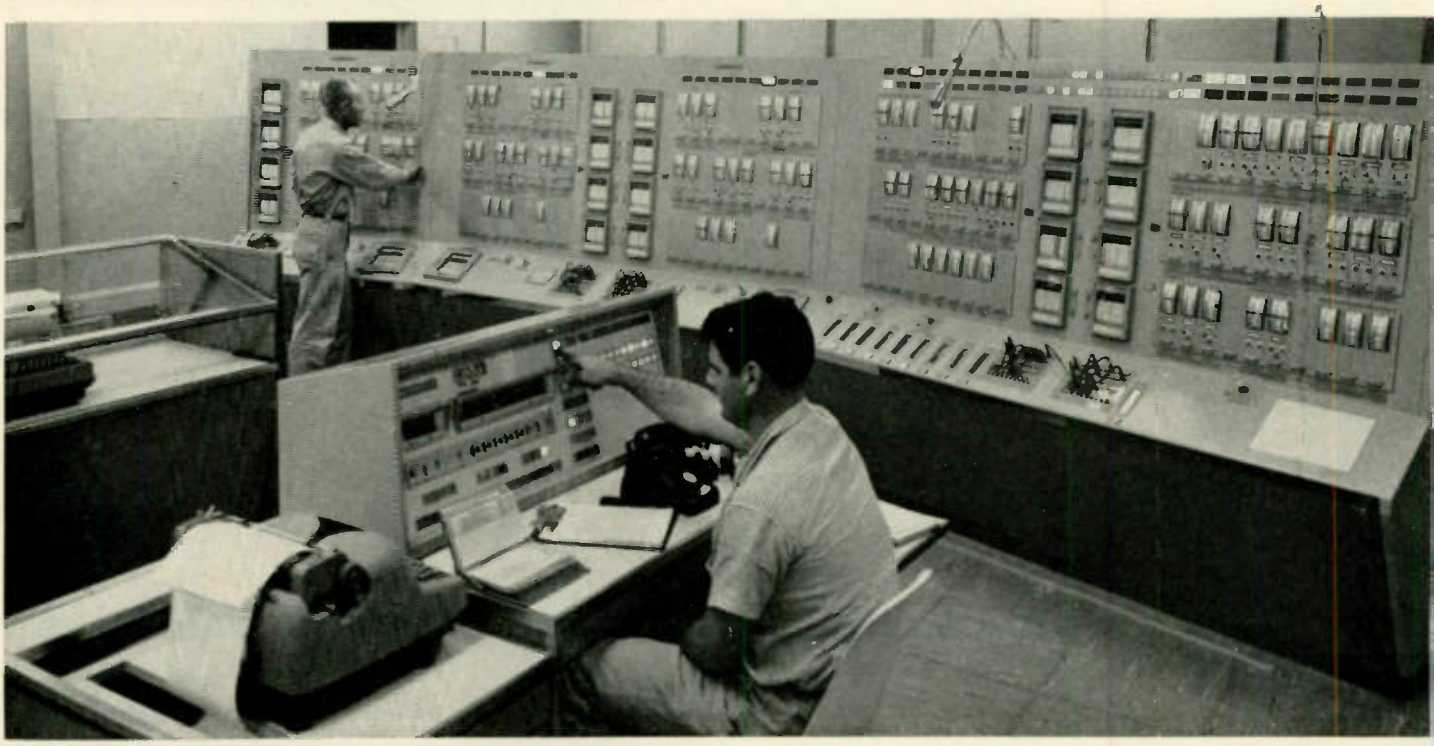
MARKETING INDUSTRIAL CONTROL COMPUTERS

The computer market is still young. Its offspring, full of "firsts" and growing pains, is industrial process controls. Some firms already depend largely on control computers, while others find their processes are not yet ready. Still others are content to wait and watch for a little. One fact is clear—the market is rising and fast.



"Industrial controls may offer the next big computer market in the late 1960s and the 1970s." An IBM 1710 is pacing the Fitchburg Paper Co., Fitchburg, Mass. Engineers (top) work on features to extend 1710's operating range.

Monsanto Chemical Company (center) has equipped Chocolate Bayou hydrocarbons complex near Alvin, Texas, with four Honeywell 290 units.

Three lines at Western Electric's Winston-Salem, N. C., plant (bottom), that makes deposited carbon resistors, are run by General Precision LGP-30s, along with instrumentation by Leeds & Northrup and Varian.

By SIDNEY FELDMAN
Associate Editor
ELECTRONIC INDUSTRIES

COMPUTER CONTROL HAS COME OF AGE in a broadening spectrum of industrial usage. The act of putting computer techniques to work as industrial process controls has spawned new markets for management and new challenges for engineers.

In some fields—electric power, for instance—the digital process computer is becoming commonplace. In others, such as food processing, its potential is only beginning to be realized.

Of an estimated 250 control computer installations in the U. S.—more than two-thirds of the world-wide total—nearly one-half are in the power industry. A recent survey lists about 75 systems in the petroleum and petrochemical industries. Total deliveries up to 1963 are estimated at $62.5 million.

The computer process control systems market now rings up only about $20 million in annual computer sales, programs, rentals and related services. Yet, industrial controls may offer the next big computer market growth during the late 1960's and especially in the 1970's. This is after business and scientific data processing, and information retrieval.

Progress has been slow but there is perceptible acceleration as industry becomes more and more control and automation conscious. This same progress has at times been a bit shaky—and always costly.

Dr. E. M. Grabbe, director of International Computer Operations for Thompson Ramo Wooldridge, Inc., foresees greater progress. He estimates that "today more than 350 computer control systems are on order, or are installed. They are being ordered at the rate of four a week" from several leading vendors.

Dr. Grabbe sees a ten-fold growth by 1970. There should be "about 4,000 process computers controlling an even greater variety of processes than today."

A Little Over-Optimistic

These are world-wide sales estimates for a global market served mainly by U. S. and West European makers. Many firms feel that Dr. Grabbe is a little over-optimistic.

Control systems are part of the much-heralded legacy of commercial fallout or "spin-off" from aerospace/defense R&D. Process control computers budded on the industrial scene less than five years ago. In April 1959, the first closed-loop computer control system was put to use. This pioneer control, for a catalytic polymerization system, was developed for Texaco at Port Arthur, Texas, by TRW.

That event signaled a new field for computers, new markets for firms that make components and computers. There were also new technical and marketing problems to be solved. By 1960 about 25 major process control system suppliers were wondering about their share of this still nebulous market. They saw a way to decrease their heavy dependence on aerospace/defense business. Some makers were in doubt as to whether U. S. firms would help defray R&D of this new technology in the same way the U. S. Government supports R&D in its own activities.

So far, challenge and costs have far out-paced reward. The bigger the system, the most costly the investment. One big, first expense comes in bidding for industry contracts. Many firms may invest as much as $20,000 or more in a mere job proposal.

At this stage of the art, it is considered a minor marketing triumph to sell or lease a computer control system. It is a major triumph when that computer goes on-line, completing closed-loop control.

Best When Designed With Plant

Control computers are best when designed as part of new plants. But when they are hooked onto existing plants, the result more often is merely an experiment and not a marriage. Unsuccessful systems are sent back home. Those only partially successful may be kept on as costly performance monitors and data loggers.

In the control computer market buyer and seller must both be competent in technology and in management. Computer programming, or software, is vital. Systems generally can control most processes. Things get harder when those systems are expected to optimize processing as well. At this point the buyer must tally the rate of payout on his gamble. Then the process must be put down on paper in great detail so the system can be programmed to optimize and control. Programming takes time, costs big money and requires special talent.

A program may take more than a year of effort. A major part of the payoff for a system and its program(s) comes from repeated use of the program. The program can be (and has been) rented to other firms with the same or similar problems.

Though marketing of systems is based simply on matching the art to the needs, much remains to be learned about the dynamics of most industrial processes. Many "modern" processes are akin to magic arts of intuition blended with generations of experience. Most firms balk at having these arts reduced to computer science until systemized competitors force their hand. Only after industrial processing is understood can mathematical pictures be created.

Successful in Chemical Firms

These are some of the growing pains of a new business which has some firsts. A few years ago

Monsanto Chemical Company's ammonia plant at Luling, La., was the first chemical process unit brought completely under computer control. On the whole, many chemical firms have installed control systems that have proved widely successful.

It may take anywhere from days to years for some electric utility plants to be computer-controlled. Perhaps the most unusual record was set recently by Leeds & Northrup Co., of Philadelphia. The firm needed only six days to install and put into service a new digital-directed analog computer closed-loop control. The system serves the Detroit Edison Co., regulating power from 37 generating units to 1,297,188 customers, and to neighboring utilities.

On the other hand, one Far West electric utility may need up to six years to get its more complex control system on-line, owing to a hazardous and high energy operation.

Paradoxically, both success and failure in control systems are usually wrapped in secrecy. Some successes may be kept secret for competitive reasons. Some firms, though, begin trying to increase efficiency and save money, and end up trying to save face.

An advanced IBM 1710 computer control system was put to running a paper mill at Lewiston, Idaho; the firm was using the old Fourdrinier way of making paper. Last summer the computer was withdrawn "for the present." Potlatch Forests, Inc., says the decision does not reflect on the computer equipment. New management felt the computer operation was premature. They felt the entire process and plant had to be analyzed and "tuned up" before a computer could be entered in.

Paper Mills Going into Controls

Yet, an IBM 1710 is pacing the Fitchburg Paper Co., in Fitchburg, Mass., into first stages of automation. This firm increased mill instrumentation, then brought in a digital system to improve output by simple guide control. Plant officials say the system provides greater control over mill operations and provides inputs of machine variables which help operators. Other paper mills are following the same approach.

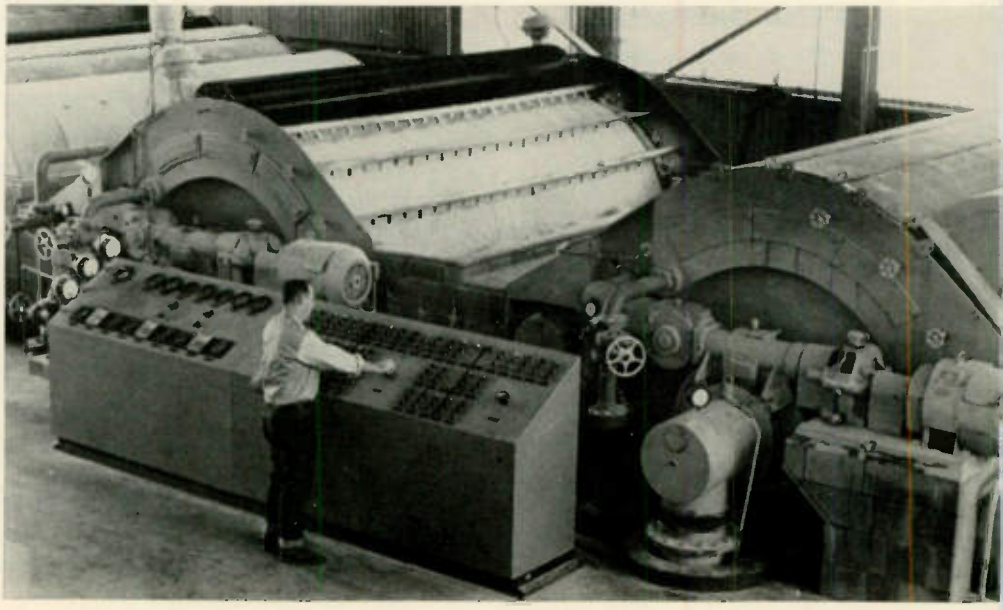
However, Westinghouse has just installed the "first closed-loop, on-line computer control system in the paper industry" at Gulf States Paper Corp.'s Demopolis, Ala., plant. The system is controlling the plant's 350-ton-a-day continuous digester.

Instruments helped upgrade cement output in a closed-loop process control system at California Portland Cement Co., Colton, Calif. There a GE-312 system is aided by a GE X-ray analyzer. The latter unit monitors, examines and adjusts inflow of raw materials to desired blend.

Riverside Cement Co., Riverside, Calif., was so pleased with a 15% increase in output that the firm ordered a second TRW computer. Riverside's president was even featured in a TRW testimonial ad.

Industrial automation may be redefined as "operation bootstrap" at Western Electric's Winston-Salem, N. C., works. There two computer-controlled lines make deposited-carbon resistors. This is the first

"Progress has been slow but there is acceleration as industry becomes more and more control and automation conscious. Westinghouse has installed a closed-loop, on-line computer control system at Gulf States Paper Corp., Demopolis, Ala., plant. The Prodac 580 is controlling plant's 350-ton-a-day continuous digester. It's the 'first' such control in the paper industry."



operation of its kind, and most likely the first to make discrete components automatically. Though economic factors greatly influence this project, product reliability comes first, say WE officials.

In choosing a computer, WE's engineer group thought about buying a system for $1 million as well as renting one for $5,000 a month. They analyzed mathematical capability and high memory capacity per dollar. Then they analyzed access time, type of operation, power needs, and special logical features. They settled on the LGP-30, 1957 vintage, which cost them $40,000. Engineers liked this computer because it could be adapted to black box changes they planned in input and output.

Steel Another Big Market

Another big market is steel. Although European steel makers have always been on the conservative side, they did have to do a bit of rebuilding of bombed-out plants after World War II. As the plants re-grew, process controls were brought in. Now, some European plants may top U. S. firms in steel-making and may soon excel them in rolling.

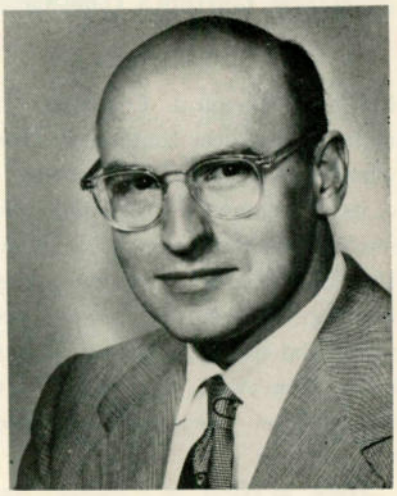
Some observers expect the Common Market nations to spur sales of process control computers in Europe through the late 1960s. As a result, certain continental steel products may prove more competitive than American steel items, both here and abroad. In turn, the state of affairs may stimulate sales of control computers to U. S. steel firms.

Many U. S. steel makers, equally conservative, are waiting for solutions to automated steel making. W. E. Miller, of GE's Systems Sales and Engineering Operation, Schenectady, N. Y., nudged steelmakers last summer. In an address at the International Federation of Automatic Control meeting in Switzerland, he said:

"In the steel industry automation is evolutionary. I know of no steel plant in the world where management considers their plant fully automated."

GE installed the "world's first computer-controlled hot strip mill" at McLouth Steel Co., Trenton, Mich. It next plans to automate several sub-systems of a hot strip mill, from reheating of ingots to the coiling of finished steel.

In certain processes some 50-man-years of engineering are needed to apply computer control to a steel mill or power plant. Such engineering time could run $1.5 million, mostly out of the control maker's pocket. Computer marketing involves long-term financing for engineering, for R&D, and for heavy investment tied up in leased computers. In effect, only the leading firms—the giants in process controls—can thus afford to finance their own learning curves.



Dr. E. M. Grabbe, Director, International Computer Operations at TRW, estimates more than 350 systems are on order, or in place. He sees a ten - fold growth by 1970 and about 4000 process computers in use by that year. Some say he is too optimistic.

No Market Approach Standard

In the new computer market, no single marketing approach is standard. Generally, big computer firms have regional and field offices throughout the nation.

Customers' engineers may deal directly with the manufacturer. Monsanto Chemical's own systems engineering section designs and operates control computers. Some customers may take on a consultant, others will let the computer firm do the whole job.

So successful have been some installations—those in which there has been ample time to evaluate performance—that some firms have two or more computers either in use, or on order. An example of some note is Monsanto, which has equipped its big Chocolate Bayou hydrocarbons complex near Alvin, Tex., with four Honeywell 290 units. Monsanto has two other computer setups, and Honeywell says it was the first big plant to be completely "computerized."

Computer controls are becoming more applicable in industry as seller and user both learn from each other. A somewhat "far-out" use of computer control technology is in the system Honeywell will shortly install at the new $22-million cake plant of the Sara Lee Kitchens in Chicago's suburban Deerfield. The Honeywell 610 system, will direct production and the complex functions of an automated warehouse the size of a football field. Honeywell engineers say that this advanced and sophisticated system will be the first computer application in the food processing industry and also the first in any industry to direct and control warehouse and shipping operations.

Firms Offer 'Package Deal'

At the building of a petrochemical plant for the

Celanese Chemical Company, Honeywell worked with the engineer-contractor. Honeywell supplied a whole deal that included among other things some of its own computer-compatible instruments, checked-out, calibrated and set up. At Honeywell's Pottstown, Pa., EDP Center, Celanese's engineer was trained in programming. He saw the system put together, wired and debugged under 30-day simulated conditions. Honeywell, then, installed the system, tied it into process loops and contracted for continuous maintenance.

Here, in effect, is a package deal offering built-in markets for a single firm as major contractor drawing upon its many divisions for sales and engineering support. Big firms, such as GE, Westinghouse and others, can do likewise.

Smaller firms in the field cooperate in joint relationships, often with larger makers. The Leeds & Northrup LN 3000 all-transistor digital computer for on-line process operation is designed and built by Philco to L&N specifications.

Input-output equipment to complete the computer system is custom-built by L&N to meet customers' needs. Sales and services are handled by L&N.

UNIVAC Division at St. Paul, Minn., makes the general purpose industrial control computer marketed by Westinghouse as a major component of the broader PRODAC process control system. Westinghouse assumes complete responsibility for systems planning, installation, marketing. U. S. and foreign firms may and do enter similar international joint ventures.

Though IBM has the lion's share of the general computer market, it is rated third in the world-wide process control computer market. These statistics come from TRW which rates itself first, and GE second. Elliott-Information Systems Inc. is rated fourth, Westinghouse is fifth, Daystrom sixth.

A company out to make its mark in the world control computer market is Control Data Corp., Minneapolis. It recently acquired Daystrom's Control Systems Division, and earlier acquired the Computer Div. of Bendix Corp. Last May, CDC acquired a controlling interest in Electrofact N.V., Amersfoort, the Netherlands, to broaden its foreign capabilities in automatic industrial process control.

Other Markets Included

In addition to process and production computer control systems, related markets include: air and highway traffic control, baking, engine testing, television program switching and scheduling, university and medical research, weather and data reduction. Some sources foresee related work in structural design, reaction chemistry, metallurgy. Dr. Grabbe of TRW predicts "new technology (resulting) in the development of many new processes designed especially for computer control."

One current project with broad technical and marketing implications concerns the U. S. Bureau of Reclamation which bought a GE-412M computer system. It will be used for load-frequency control, economic dispatching, optimizing water usage in its five-state Colorado River Project. Microwave and land lines will link the computer center to analog and digital telemetering units in Colorado, Utah, Wyoming, New Mexico and Arizona. The computer also will perform energy accounting and billing.

Biggest Market in U. S.

Yet the biggest market is in the U. S. Foreign competition and domestic growth may spur U. S. industries to replace an estimated $90 billion in existing production facilities considered obsolete. Rate of growth of control computer sales may be paced by the rate of new industrial plant construction. However, revitalizing or rebuilding old plants or updating them with modern computer control offers a big market and a big headache. It's easier and better to integrate new plants and computer control concurrently.

Finally, labor's place—or lack of place—in the world of automation remains to be solved. At this stage, automation really is not as prevalent as is generally believed. In part, jobs are shifting. More people are being hired by the computer companies, while automated and semi-automated plants shrink payrolls. Yet the problem of future unemployment somehow must be considered part of marketing's task of closing the loop of the computer control market.

U.S.-CANADA LEAD WORLD IN USE OF INDUSTRIAL CONTROLS

According to figures from the Computer Division of Thompson Ramo Wooldridge, Inc., United States and Canada at present have upwards of 234 industrial process control computers in operation in various industries.

Industry	No. of Control Computers
Petroleum and Gas	26
Chemicals	36
Electric Power	79
Steel	41
Paper making	11
Cement	4
Miscellaneous Industries	37
Total units (as of September, 1963)	234

In contrast, the Soviet Union has four operating process control systems in chemicals and only two, so far, in steel.

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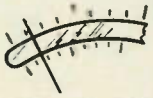

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For years the arguments have continued—which is the better all-around computer, the analog or the digital? Now the hybrid computer composed of both analog and digital elements appears to have answered the question for many uses. Let's see why many people in the computer field are excited about this method of computation.

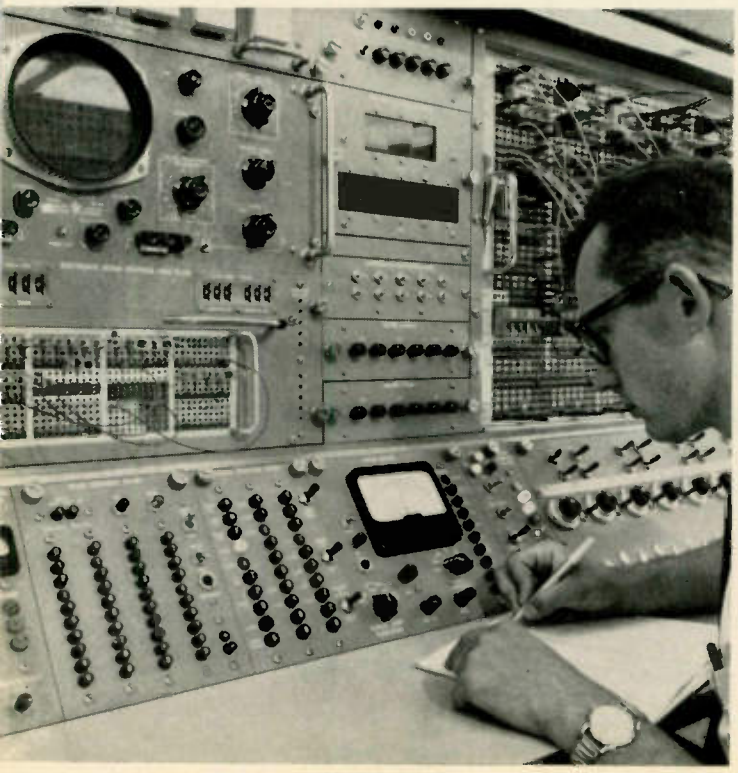
THE HYBRID COMPUTER... END OF AN ARGUMENT?

WHICH IS THE BETTER COMPUTER? Which is more accurate? Which is faster? The digital computer has the ability to make decisions. Programming the analog is easier, while the digital computer is more accurate. Time scale of analog computations may be slowed down or speeded up easily. The arguments go on and on!

Companies which needed computers for their operations were forced to make a decision. This decision often resulted in a sacrifice of some feature. This was necessary to obtain another more desirable quality in the selected unit. Thus, the system chosen was not always as efficient as it could have been. For many uses this decision need no longer be made. The hybrid computer, which combines the capabilities of the individual computers, may be the answer. This article will discuss the relative merits and restrictions of analog and digital computers and the part each plays in the makeup of the hybrid version.

* * *

The analog computer can instantaneously solve an equation containing many variables. This ability makes it a natural choice for simulation uses. Photo is courtesy of Honeywell.



There are two divergent philosophies as to just what constitutes a hybrid computer. The first states that the hybrid computer must perform digital and analog computations which are of equal significance. This generally requires an analog and a digital computer joined by a linkage system. The second philosophy is that an analog computer which contains some digital logic or method of making a decision (or, conversely, a digital computer with some analog capabilities) should be considered a hybrid computer. The first definition may be the better of the two, although the feeling in the industry seems to be that many computers of the future will be "hybridized" and thus adhere to the second definition.

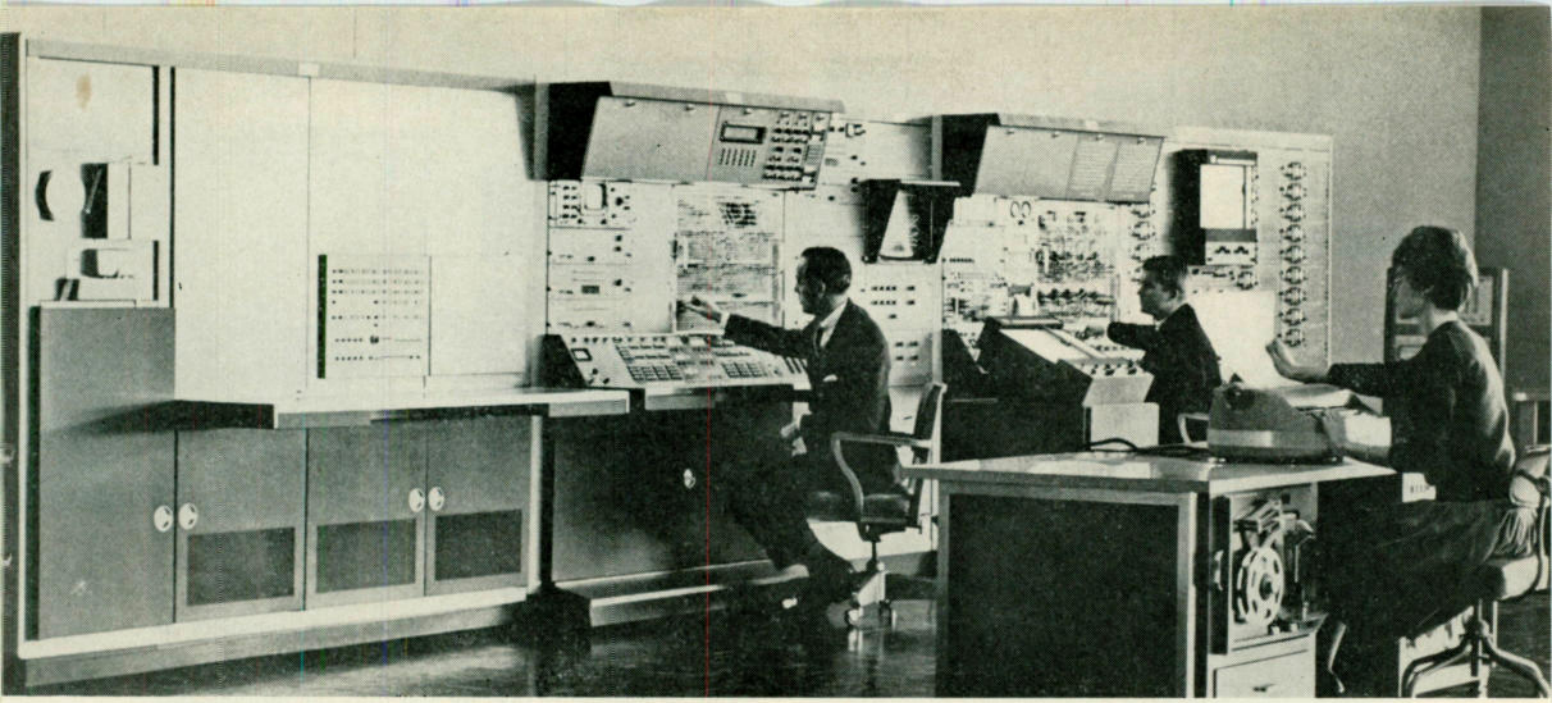
There is some feeling that a system is not a hybrid unless:

1. Both machines compute at the same time, on the same problem.
2. The transfer of data is a two-way proposition; that is, from digital to analog and also from analog to digital.
3. The inputs are connected. Here, the output of one machine would not be put on tape, cards, etc., and then later fed into the other computer.

A true hybrid computer is one that is *made especially* for hybrid use. This line of thought has some merit. In fact, it is emphasized by two cooperative agreements which were recently signed between digital and analog computer companies. These agreements call for the sale of integrated systems.

The first of these was one signed between Electronic Associates, Inc., Long Branch, N. J., and Control Computer Co., Inc., Framingham, Mass. Result of this agreement is a computer termed Hydac 2400 which combines both general purpose analog and digital computers in a single integrated system. The Hydac 2400 system includes two EAI 231R-V PACE Analog Computers, the EAI Series 350 Digital Operation System (DOS) for interface and con-

By SMEDLEY B. RUTH
Associate Editor
ELECTRONIC INDUSTRIES



Hydac 2400 hybrid combines (l to r in background) Computer Control Co.'s DDP 24, general purpose digital computer; EAI's DOS 350, interface and control system; and EAI's 231 RV, general purpose analog computer, in a single integrated system.

trol, and the 3C DDP-24 General Purpose Digital Computer. In addition to its capability as an integrated computer, the system design also provides for independent use of the analog and digital computers.

The second of the two agreements is one which was signed between Packard Bell Computer, Los Angeles, Calif., a digital computer manufacturer, and Computer Products, Inc., South Belmar, N. J., maker of analog computing equipment. These companies have agreed to a joint marketing and systems engineering effort in design, manufacturing and installation of large hybrid computing systems. Equipment proposed under this agreement includes Computer Products Mark III analog computer and the Packard Bell PB440 digital computer. The Mark III was specifically designed for use in hybrid systems with digital control logic and digital computers.

These two agreements make it possible for a customer to contact only one source instead of three different sources as is often the case when the analog computer, the digital computer and the linkage systems tying them together are purchased separately. Also, the engineering involved is done by the companies' engineers. Disadvantage of these systems is that the cost is prohibitive for all but the largest companies. For example, the first of these computers will cost about $550,000. For those companies which find either of these systems to be impractical, there is still the older method of making the hybrid computer. This is to pick and match the analog and digital computers and the linkage system yourself. Many companies have done this.

For us to understand the need and advantage of hybrid computers we should first study the analog and digital characteristics which make them attractive or unattractive for hybrid use.

The Analog Computer

The analog computer operates as both a simulator and a mathematical machine. A wide variety of mathematical operations can be done through use of continuously variable physical quantities. One of its main forte's is its ability to instantaneously solve an equation containing dozens of variables. This ability makes it a natural for simulation work. It can be used to study physical behavior of a system by virtue of analogous characteristics.

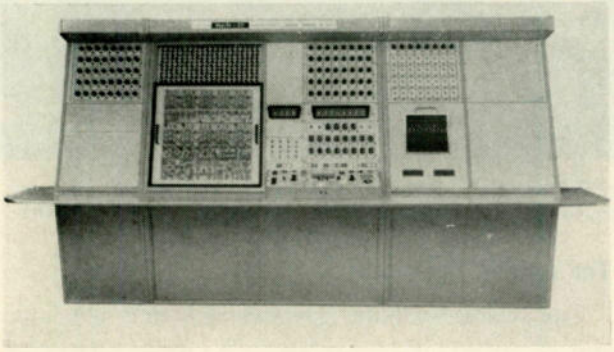
It is a fairly flexible machine due to its building block construction. This makes it able to perform many different simulations or investigations within a short period of time, merely by changing the operational elements that perform the mathematics of a problem.

The building blocks, or modules, normally provide the functions of summation, integration with respect to time, multiplication by a constant, multiplication and division of variables, function generation, generation of trigonometric functions, and representation of system discontinuities. All quantities are represented by continuously varying voltages; outputs from the computer are never absolute numbers. Differential equations may also be solved on the analog. This is done by integrating a suitable number of times to form integral equations and these can be represented on the computer.

The analog, being a parallel machine, is ideally suited to dynamic calculations. All variables are computed simultaneously and continuously, making its speed independent of the size or complexity of the problem. But, as each building block works on one part of the problem, the size of the problem determines the amount of equipment needed. Also, even

HYBRID COMPUTER (Continued)

Photos show hybrid computing system being offered by Packard Bell Computer in conjunction with Computer Products, Inc. System consists of PB440 digital computer and Mark III analog computer below.



though the analog can calculate at any speed, there is, in practice, a maximum time base associated with any particular problem. Thus, if the problem is run at an unrealistic rate, accuracy will be affected.

Analog outputs are generally accurate to within 1%, but seldom better than 0.1%. Accuracy can be improved, but cost is prohibitive.

The analog also has the advantage of continuous readout which does not have to be translated. Some readout devices used are: digital voltmeters, oscilloscopes, strip-chart recorders, X-Y plotters and digital printout.

Speed of the analog helps it to overcome some of its failures (in some instances). For example—even though the analog can't make logical decisions its speed allows it to make a large number of runs in a short time; thus, the best one may be chosen. Its speed permits computing in "real time" or faster. It can keep up with any physical system. It solves certain types of problems in seconds that would take a digital computer hours to solve. Memory capabilities of the analog do not begin to approach those of the digital.

They are more easily programmed than the digital machine. There is little or no "software" available for analog computers, but more attention is now being given to this problem. It is said that a good programmer can, through "tricks," improve the accuracy of the analog computer.

It should be evident why this computer, designed mainly for use in the aircraft industry, has become a valuable tool for research and scientific investigation, various types of simulation, etc.

The Digital Computer

The digital computer operates with numbers as opposed to voltages in the analog. It makes use of a counting method to operate and thus the output takes the form of a set of numbers or letters. It does not work instantaneously—some time is needed for computation. As it must do arithmetic, there is a lag (however short) between the problem and its solution.

Basic operations performed by the digital machine are addition, subtraction, multiplication and division. These basics are, in turn, used to do much more complex calculations. In short, a digital computer can solve any problem that can be written in the form of simple arithmetical operations. Programming is more difficult than in the analog.

The digital machine does only one operation at a time. Thus, problem solving can be very time consuming. This drawback may be somewhat offset as computing speeds increase and multi-programming methods improve. For repetitive calculations it can be very fast. As it works with increments, variables are not calculated continuously. It follows instructions exactly. New programs must be written for any changes.

Three areas in which the digital computer stands out are those of decision making, storage, and accuracy. Its ability to make logical decisions is unquestioned. It's not called the "thinking machine" for nought. It can store large amounts of information, and this capability can be easily expanded. Furthermore, it can store a variety of information—tables, functions of several variables and even whole programs.

It is very accurate. Accuracy can be increased merely by decreasing the calculation increment. Also, there is no drift problem in the digital computer.

Uses of the digital machine are many and still growing. It is particularly useful where much information must be stored, many repetitive operations must be performed, logical decisions must be made, or extreme accuracy is required.

Industrial processes are simulated by analog computers and controlled by a digital computer at Honeywell's systems simulation center in Pottstown, Pa. Hybrid facility consists of two EAI 231R analog computers (foreground) of special design and a Honeywell 290 digital computer (background).

Linkage System

Three major drawbacks are presented by the linkage system. They are:

1. The problem of reconciling the time bases.

2. Discontinuous D-A signals—digital computer supplies information to the analog computer at discrete time intervals. The analog sees this as a stepped function.

3. Unrepresentative A-D signals—if the digital time step is larger than, or even a large portion of, the fundamental frequency of the analog output, the A-D data could actually be a poor representation of the analog outputs.

Much effort has, and continues to be, devoted to these problems. Many equipment claims have been made, but a method of programming may hold the answer. One such method was described just last month in a paper presented at FJCC by R. Gelman. Entitled "Corrected Inputs—A Method for Improving Hybrid Simulation," it describes a programming procedure designed to minimize these three difficulties.

The linkage system for a hybrid computer can be of normal or special design depending on usage. As these systems are a study in themselves, let it suffice here to say that their importance should not be overlooked when making a choice. They can have as much affect on system performance as either the analog or digital computer.

The Hybrid Computer

The hybrid computer is a fairly recent addition to the computer family. It represents an attempt to solve problems which neither the analog nor digital computer can solve alone. Combining the most desirable features of the two computers it achieves an efficiency which is greater than either system alone.

It is finding increasing use in aerospace and process simulation, process control, biomedical research, engineering design and optimization and man machine systems.

Let's look at a hybrid solution to a satellite control problem. Here the digital models itself after the logical system of the satellite control unit. The analog portion simulates the response of the mechanical part of the satellite. Together they serve to simulate flight even before the satellite is designed.

The hybrid can be used to make improvements to a mathematical model by making exploratory changes to it. After each change the analog calculates new results which are then compared with previous results stored in the digital memory. The digital computer then makes changes in the model and starts a new cycle of computation.

When should a hybrid system be considered? This list, taken from notes given at a hybrid computation seminar conducted by EAI early this year, suggests that problems having one or more of the following mathematical features should lead to a consideration of hybrid computation.

1. Simultaneous differential equations with widely different parameters which produce both low and high frequencies in the solution.

2. Differential equations to be solved at high speed, their solutions for different initial conditions or parameters being used in a prediction, iteration or optimization process.

3. Combinations of continuous and discrete variables as in the description of a sample data system, or a computer control system.

4. Perturbation analysis about slowly changing, precisely established solutions.

5. Statistical analysis needing repeated solution of differential equations, including Monte Carlo methods for deterministic problems. This is essentially a data storage and simple evaluation task around the solution of differential equations.

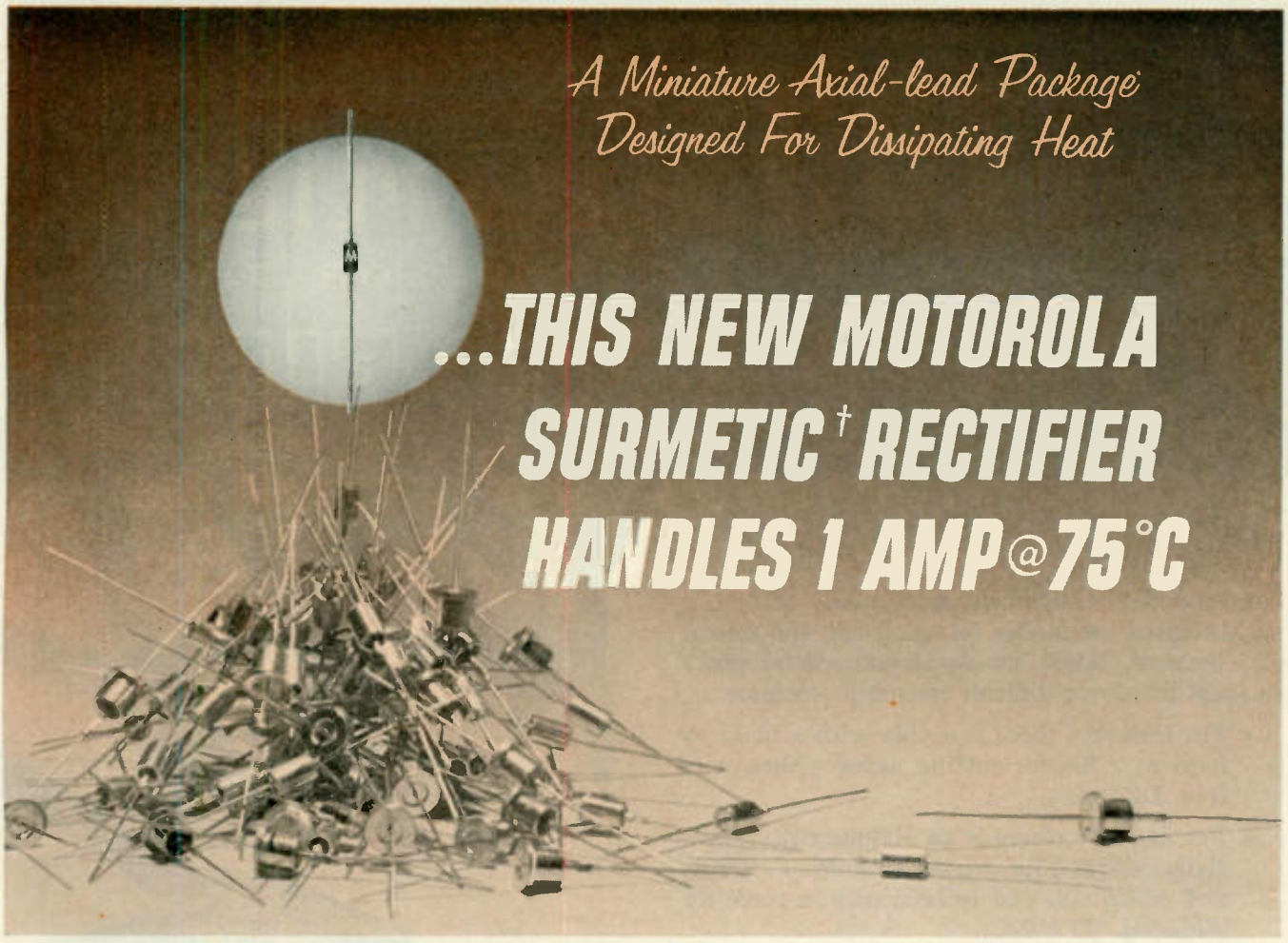
6. Filtering and processing continuous and sampled data for evaluation purposes.

7. Partial differential equations to be solved by serial integration procedures.

8. Ordinary differential equations accompanied by transport delays.

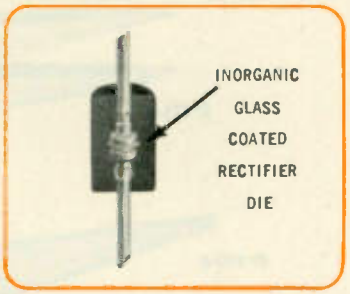
Acknowledgements

We would like to thank those who supplied us with the information contained in this article. More specifically they are: R. C. Lonick and W. J. Onderdonk, Computer Products Inc., S. Belmar, N. J.; O. Serlin, T. Truit and G. J. Jonas, Electronic Associates, Inc., Long Branch, N. J.; R. Gelman and J. Heid, General Electric Re-Entry Systems Dept., Phila., Pa.; and B. Dahlin, Honeywell, Pottstown, Pa.



YET IT OCCUPIES ONLY 0.0016 CU. IN.

Here is a radically new plastic encapsulated silicon rectifier — with a total volume of only 0.0016 cubic inches (about the size of a ¼-watt diode) — rated for 1 ampere at 75°C . . . and priced competitively with units rated for only ¼ amp.



Available in voltages up to 1000 volts (types 1N4001-1N4007), these Motorola "Surmetic" rectifiers feature a rugged, high-temperature silicone-encapsulated package developed especially for use in close packaged, high-density circuit boards where danger of shorting to nearby components may exist. Of special interest in high-reliability applications is the fact that the excellent heat dissipating characteristics of the "Surmetic" rectifier enable operation at lower junction temperatures . . . thus, extending operating life!

Inside the molded case of the "Surmetic" rectifier a thin layer of thermally-grown, inorganic glass covers the semiconductor junction, sealing out moisture and other contaminants. Devices of this type have passed 1,000-hour operating tests at 150°C and storage in air at 400°C . . . far beyond the limits of conventional encapsulated devices. In addition to many standard military tests, the Motorola "Surmetic" rectifier has passed such special tests as: 20,000 g acceleration, 1,500 g shock, and high-temperature lead-pull tests.

ABSOLUTE MAXIMUM RATINGS*

Rating	Symbol	1N4001	1N4002	1N4003	1N4004	1N4005	1N4006	1N4007	Unit
Peak Inverse Voltage (DC or Recurrent)	PIV	50	100	200	400	600	800	1000	Volts
Sine Wave RMS Input Voltage	V	35	70	140	280	420	560	700	Volts
Average Half-Wave Rectified Forward Current (75°C Ambient) (100°C Ambient)	I_0	1000 750	1000 750	1000 750	1000 750	1000 750	1000 750	1000 750	mA mA
Peak Forward Current @ 25°C (½ Cycle Surge, 60 cps) (Recurrent)	I_{surge} I_{rec}	30 10	30 10	30 10	30 10	30 10	30 10	30 10	Amps Amps
Maximum Ambient Temperature	T_A	175	175	175	175	175	175	175	°C

*(At 60 cps Sinusoidal, Input, Resistive or Inductive Load)

†Trademark of Motorola Inc. The Motorola-originated glass-passivating technique used for these devices was perfected for production and military application as part of a military contract program sponsored by the Manufacturing Technology Laboratory of the Air Force Aeronautical Systems Division at Wright Patterson Air Force Base.

Design engineers — now you can economically design in a *single* rectifier type for *all applications up to one ampere* . . . using the low-cost, Motorola "Surmetic" rectifier. Write the Technical Information Center, Motorola Semiconductor Products Inc., Box 955, Phoenix, Arizona 85001, for additional technical information.

"new leader in Total Silicon Technology"

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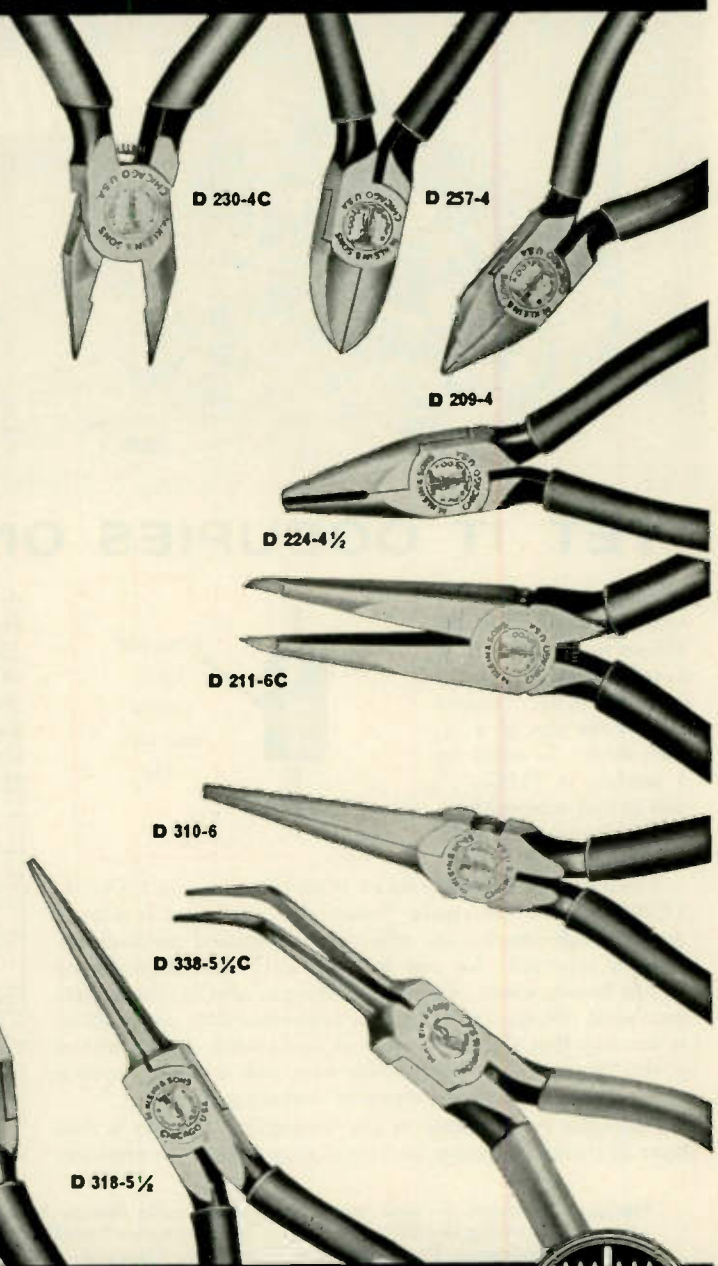
103-071

MORE THAN 100 KLEIN PLIERS SPECIALLY DESIGNED FOR THE ELECTRONIC FIELD

Special skills are important in the wiring of today's sophisticated assemblies for electronic and telemetry systems. Klein has developed special pliers to assist in solving difficult assembly problems.

- For instance, there is a plier with a blade as hard as a file for cutting nickel ribbon wire (No. D230-4C).
- For instance, there is an oblique cutter, specially designed for printed circuits . . . it cuts and crimps the end to hold wire in place for soldering. (D 052-C).
- For instance, there is a needle nose plier with the tip bent to facilitate reaching into confined spaces. D 338-5½ C.

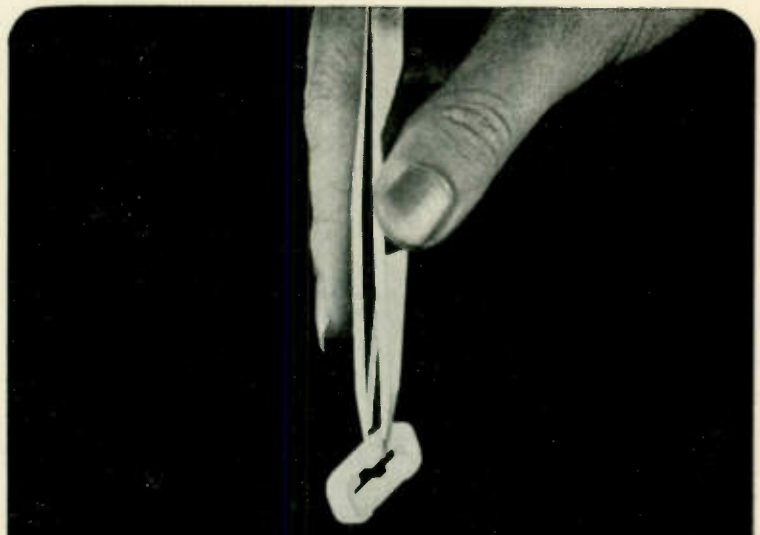
In all, there are over 100 different styles and sizes of pliers available from stock. Klein will be glad to discuss with you the development of a special tool to solve a particular problem you may be facing.



ASK YOUR SUPPLIER

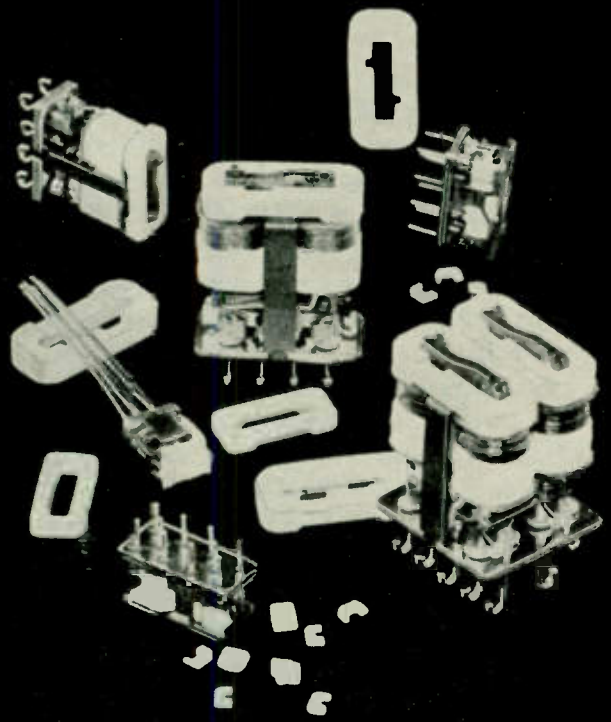
The Klein Plier Catalog illustrating and describing the complete Klein line of pliers is available on request.

Mathias KLEIN & Sons
Established 1857 — Chicago, Ill., U.S.A.
INCORPORATED
7200 McCORMICK ROAD, CHICAGO 45, ILL.



What good is a getter?

Babcock uses them to increase relay reliability.



Exclusive Babcock Design Feature Provides Lower Contact Resistance & Longer Relay Life

Contact contamination from vaporization is one of the major causes of erratic performance and eventual failure of hermetically sealed relays. After extensive investigation Babcock Relays, in conjunction with Corning Glass Works, has developed an activated getter from Corning's Vycor brand porous glass. During operation, the activated getters prevent relay contacts from being fouled by contaminants emitted at elevated temperatures.

Babcock has subjected relays using Vycor getters to hundreds of thousands of operations at loads varying in excess of 200G's for 11 milliseconds and vibration at 35G's, 3-5,000 cps. It has been determined that up to 99% of organic contaminants remaining after production degassing are adsorbed by the dessicant. Conclusive life testing at 125°C has proven that contact erosion and contamination accumulation on all vital areas within hermetically sealed relays has been substantially reduced. Consistently lower contact resistance is also exhibited due to the reduction in contamination.

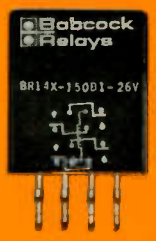
The end result provides Babcock relays with increased performance and efficiency, higher temperature application, and longer, more reliable life.

Babcock reliability rated relays featuring Vycor getters include:

BR-5—Transistor-sized dry circuit to one amp

BR-13—Microminiature, all-welded for dry circuit to 3 amp

BR-17—Half-size magnetic latching for dry circuit to 2 amp operation. Also available as non-latching model.



BR-14—Subminiature 4 PDT available in 10, 7.5 and 5 amp

BR-19—Subminiature all-welded 10 amp relay. BR 20 magnetic latching version also available.

Send for complete catalog.

BABCOCK BR RELAYS

A DIVISION OF BABCOCK ELECTRONICS CORPORATION
3501 HARBOR BLVD., COSTA MESA, CALIF. • 546-2711

WHAT'S NEW

AUTOMATIC TYPESETTING COMPUTER

A COMPACT, LOW-COST COMPUTER designed for auto matic typesetting operations for newspapers has been announced by RCA Electronic Data Processing.

Called the RCA 30 Newscom, the computer was specifically developed for the production departments of newspapers and other publications.

The system can handle production operations for any sized newspaper, but is priced to make computerized typesetting feasible for about 500 medium-sized daily and 900 large weekly newspapers.

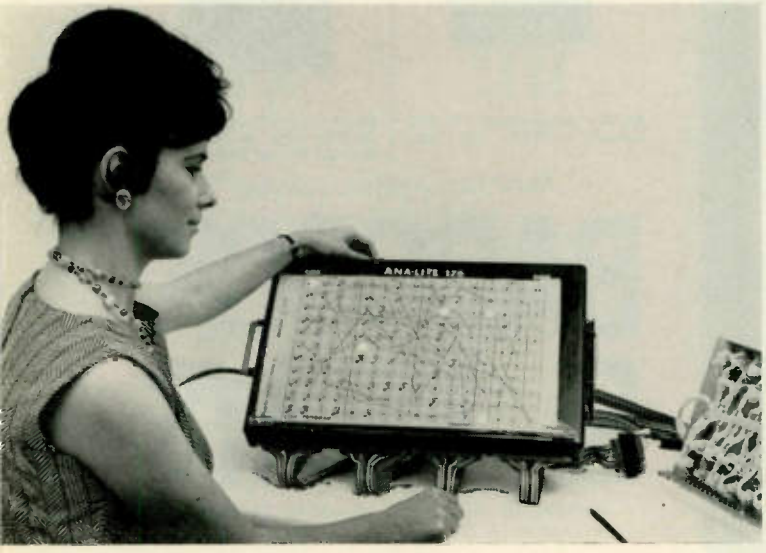
The computer will produce up to 20,000 lines/hr. of automatically justified and hyphenated type on teletypesetter tape. This is about 130 columns of straight news matter/hr., the typical editorial content of a newspaper of about 100,000 circulation.

The tape output can be fed directly to keyless linecasting machines, where lines of type are set to fit within column rules with correct hyphenation. The RCA 30 can prepare teletypesetter tapes for varying type sizes and column widths, without any reprogramming.

RCA 30 computer will produce up to 20,000 lines/hr. of automatically justified and hyphenated type on teletypesetter tape.

FAULT DETECTOR

The capacity of one ANA-LITE unit is 176 terminations. Units may be grouped and larger program sheets used when necessary.



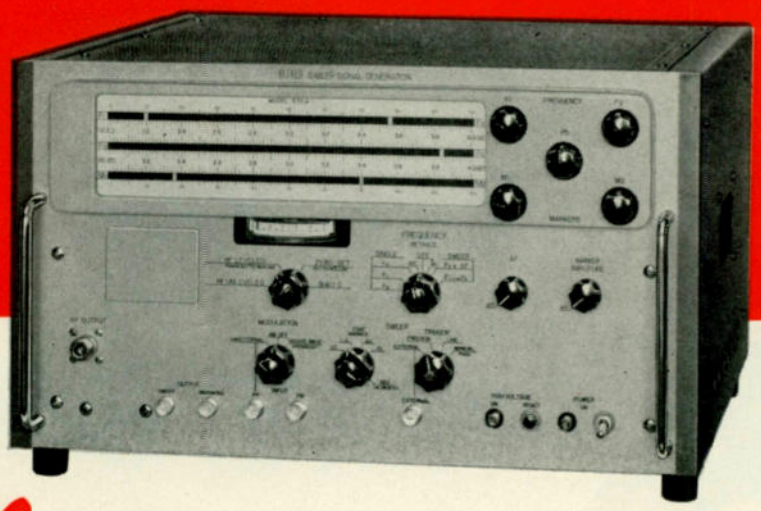
A NEW DEVICE called the ANA-LITE® allows non-technical personnel to detect any type of wiring fault in an electronic assembly within minutes. Developed by Canadian Aviation Electronics Ltd., Montreal 9, Que., Canada, the device uses a system of small lamps to indicate whether a circuit is wired correctly; and, if not, it indicates the terminations between which a fault exists.

Set up time is short, with all programming done on a sheet of paper which is placed over the lamps. Circles have been printed on the sheet, one for each lamp in the unit. When lines are drawn between specific circles by the user, the circles and lines represent terminations and wires in the unit to be tested. Appropriate circles are given numbers to identify them with corresponding connector terminals.

The ANA-LITE offers 3 programming systems to accommodate large quantity runs, medium runs or 1-off setups.

(More What's New on pages 49 & 51)

ALFRED 1 to 18 Gc Sweep Signal Generators



much more

THAN SWEEP OSCILLATORS

☐ Known Power Output
Front panel *power set meter* gives accurate indication of calibrated output power.

☐ Drift Free, Leveled Output
Closed loop leveling, now using low VSWR barretters gives uniquely flat leveling. Use of two barretters in a balanced bridge essentially eliminates power drift.

☐ Two Sweep Modes
Broadband sweep covers the entire band or any part of the band. Symmetrical sweep (0 to ±5%) is available about independently selected center frequency F_o.

☐ Three Single Frequencies
Three single frequencies (indicated on slide rule dial with 1% accuracy) can be selected with front panel switch for CW or modulated operation.

☐ Three Frequency Markers
Frequency markers provide frequency calibration for oscilloscopes or recorders. The F_o marker frequency is the center frequency of the symmetrical sweep.

☐ Two Series Available
Model 630A series, which includes the power set meter, covers 1 to 18 Gc. Model 630D series (1 to 8 Gc) incorporates a *calibrated attenuator with 60 db range.*

BRIEF SPECIFICATIONS

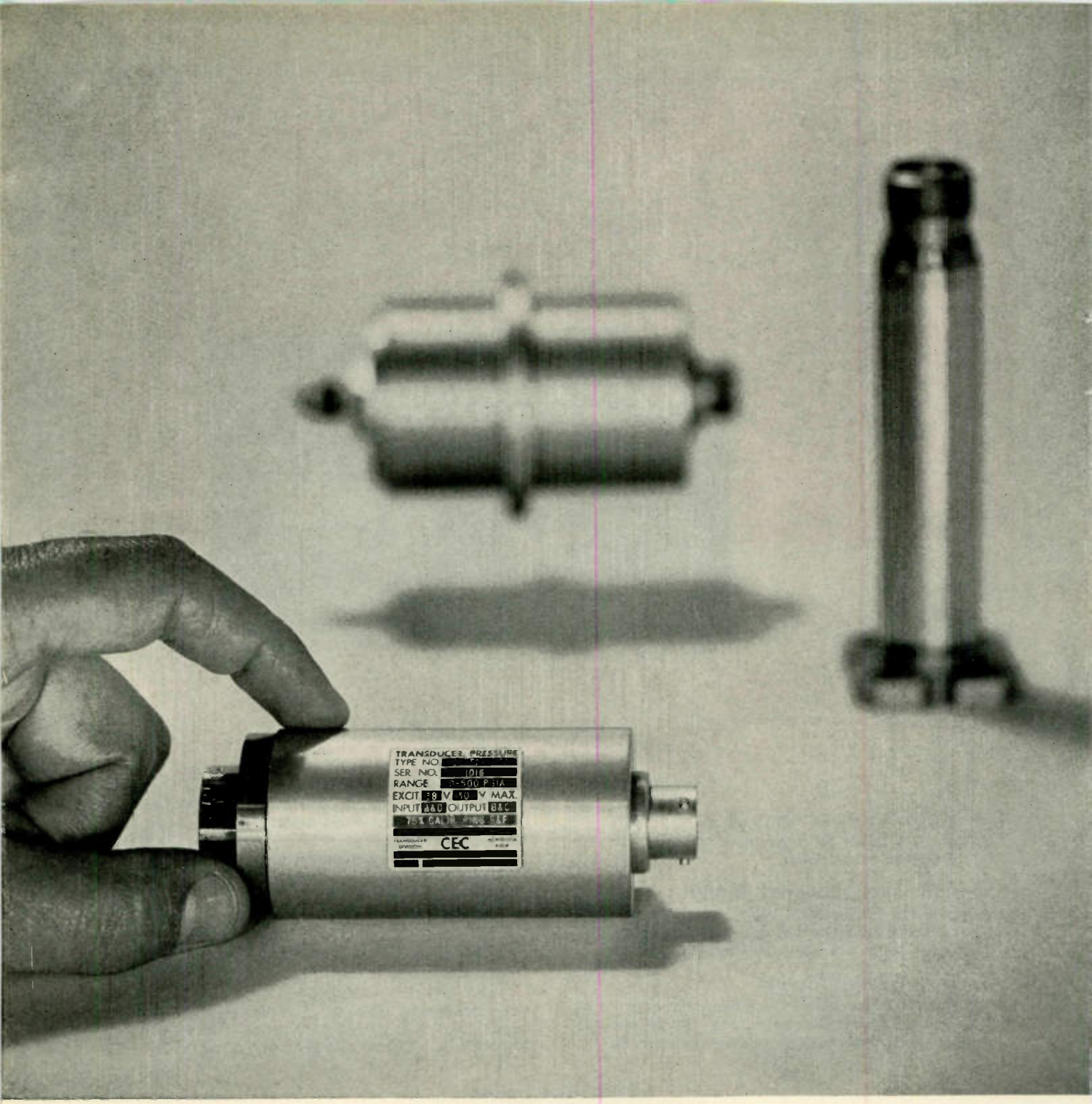
MODEL	FREQUENCY RANGE	LEVELED OUTPUT POWER	LEVELED POWER VARIATION	RESIDUAL FM	PRICE
631A	1-2 Gc	50 mw	±½ db	60 Kc peak	$3490.
632A	2-4 Gc	50 mw	±½ db	100 Kc peak	$3290.
633A	4-8 Gc	10 mw	±½ db	160 Kc peak	$3390.
635A	8.2-12.4 Gc	10 mw	±¾ db	200 Kc peak	$3490.
637A	12.4-18 Gc	10 mw	±¾ db	200 Kc peak	$3790.

FREQUENCY STABILITY Better than 0.01% per degree C.
SINGLE FREQUENCY F_1, F_2 and F_o continuously adjustable, panel switch selected.
FREQUENCY MARKER Three markers M_1, M_2, and F_o adjustable over entire range.
SWEEPS Broadband, 2% to 100% of full range. Symmetrical, 0 to ±5% about center frequency F_o.
SWEEP TIME 10 msec. to 100 sec.
SWEEP TRIGGER External; Free running; Line; Manual (single sweep).
AMPLITUDE MODULATION Internal 800 to 1200 cps square wave; External.

COMPLETE DATA AVAILABLE—Alfred's policy is to publish complete specifications and guarantee them as stated. For detailed information on Series 630 Sweep Signal Generators, contact your Alfred engineering representative or write to us.

ALFRED ELECTRONICS

3176 Porter Drive • Stanford Industrial Park • Palo Alto, California
Phone: (415) 326-6496



Over 1000 delivered

CEC's High Output Pressure Transducer

The CEC 4-390 is a high-output, unbonded strain gage pressure transducer with integral, solid state power supply and amplifier, providing a 5 volt DC output signal. This is a chamber-type instrument designed for absolute and gage measurements of fluids and gasses in pressure ranges of 0-100 psi and 0-5000 psi. Its excitation circuit isolation is 100 megohms minimum between output and primary power ground at 50 volts DC.

Major aerospace contractors have proven this instrument capable of maintaining superior performance characteristics in extreme acceleration, vibration, and shock environments.

The 4-390 is a standard item, being produced in quantity. There are variations for specialized environments or unusual structural application requirements.

If you're in the market for high-output pressure transducers, study the specifications of CEC's 4-390. Those specifications and this instrument are the result of CEC's 27 years of design, engineering, and manufacturing experience; experience that ensures that the 4-390's you order will perform to your specifications — when the pressure's on.

Call or write for Bulletin CEC 4390-X2.

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Transducer Division
CONSOLIDATED ELECTRODYNAMICS
A Subsidiary of **Bell & Howell** • Pasadena, Calif. 91109

Circle 25 on Inquiry Card

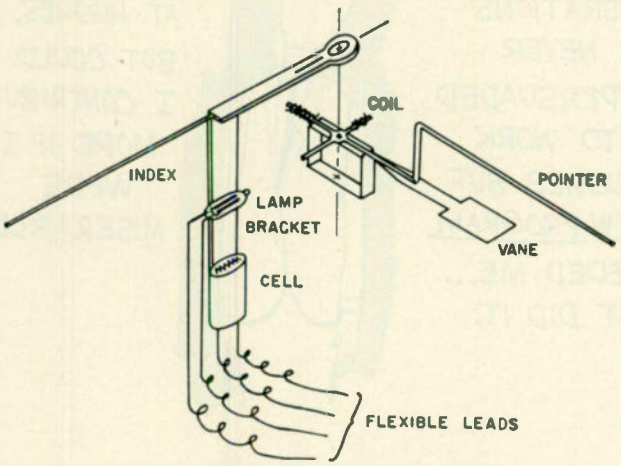
WHAT'S NEW

LOW COST METER RELAY

PHOTRONIC METER RELAY models 1935 and 1945 encompass in one package all circuits needed for 5-amp switching. The unit consists of a basic model 1900 with a neon bulb, photocell, index arm, and vane added.

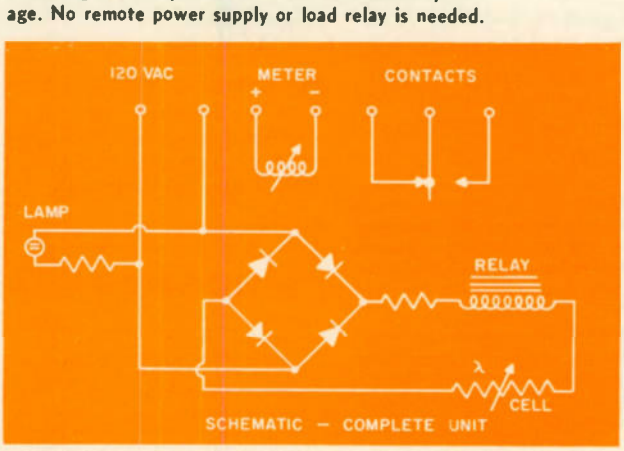
The non-physical, contact-type unit uses a unique circuit design. Here's how it works. Non-physical contact switching occurs when a photoconductive cell changes resistance. This is caused when a vane attached to the meter pointer passes between the cell and its light source. As shown in diagram this cell and light source are part of an arm attached to the top-mechanism jewel cell, which is above and independent of the zero corrector abutment. Full-scale adjustment of this basket and index pointer for either high or low contacts is provided by a knob and crank. Non-continuous reading is provided since the pointer is stopped several degrees beyond the index arm by the bracket supporting the lamp cell. The changing

(*Continued on page* 51)



METER – BASIC PARTS

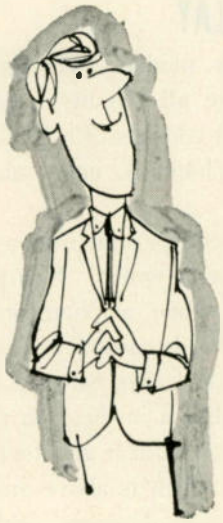
A unique circuit design allows components for 5-amp switching to be placed in a self-contained package. No remote power supply or load relay is needed.



SCHEMATIC – COMPLETE UNIT

THE TRULY ENLIGHTENED ENGINEER AVOIDS ANY THOUGHT OF SELF-INTEREST WHEN CONTEMPLATING A NEW JOB.

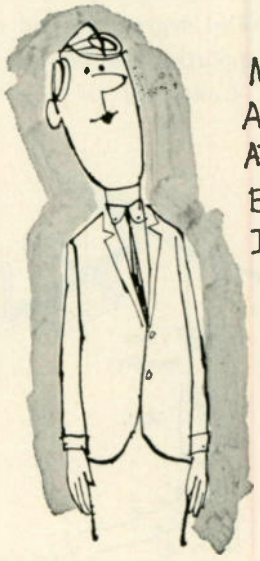
WHETHER ONE CAN SKIN-DIVE IN THE PACIFIC AND SKI IN THE CALIFORNIA MOUNTAINS COULDN'T MATTER LESS



MAYBE WHIZZING AROUND IN AN X·K·E; OR RAISING ONE'S OWN CYMBIDIUMS WOULD TEMPT MY FRIENDS. I REJECT IT.

EVEN THE CHANCE TO RUB MINDS WITH THE KEENER CHAPS AROUND UCLA, USC OR CALTECH LEFT ME STRANGELY UNMOVED.

PERSONAL CONSIDERATIONS COULD NEVER HAVE PERSUADED ME TO WORK FOR HUGHES BUT THE TOW PROGRAM NEEDED ME... THAT DID IT.



MAYBE I AM HAPPY AT HUGHES, BUT COULD I CONTRIBUTE MORE IF I WERE MISERABLE?

Hughes is hiring! Numerous opportunities now exist on a variety of advanced projects and studies. For example: **F-111B PHOENIX** Guided Missile System, **TOW** Anti-Tank Missile, **SURVEYOR** Lunar Spacecraft, **SYNCOM** Communications Satellite, **ARPAT**, Advanced **POLARIS** Guidance, **VATE** Versatile Automatic Test Equipment, Hard Point Defense Systems and others. Positions are open for experienced specialists with accredited degrees and U. S. citizenship.

CONTROLS ENGINEERS. Concerns airborne computers and other controls related areas for: missiles and space vehicles, satellites, radar tracking, control circuitry, control systems, control techniques, transistorized equalization networks and control servomechanisms.

CIRCUIT DESIGNERS. Involves analysis and synthesis of systems for: telemetering and command circuits for space vehicles, high efficiency power supplies for airborne and space electronic systems, space command, space television, guidance and control systems, and many others.

INFRARED SPECIALISTS. To perform systems analysis and preliminary design in infrared activities for satellite detection and identification, air-to-air missiles AICBM, infrared range measurement, air-to-air detection search sets, optical systems, detection cryogenics and others.

SYSTEMS ANALYSTS. To consider such basic problems as: requirements of manned space flight; automatic target recognition requirements for unmanned satellites or high speed strike reconnaissance systems; IR systems requirements for ballistic missile defense.

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WHAT'S NEW

(*Continued from page* 49)

cell resistance may be used to control the SCRs, or, with the module, to control a power relay.

A 120vac input is needed for the neon bulb. The input voltage is also used, through rectification, as the power supply for the power relay. The power relay is normally energized and will drop out if a failure occurs in the bulb, ac line, relay coil, or photocell. Weston Instruments and Electronics Div., 614 Frelinghuysen Ave., Newark 14, N. J.

NEW CUP-CORE INDUCTOR DESIGN

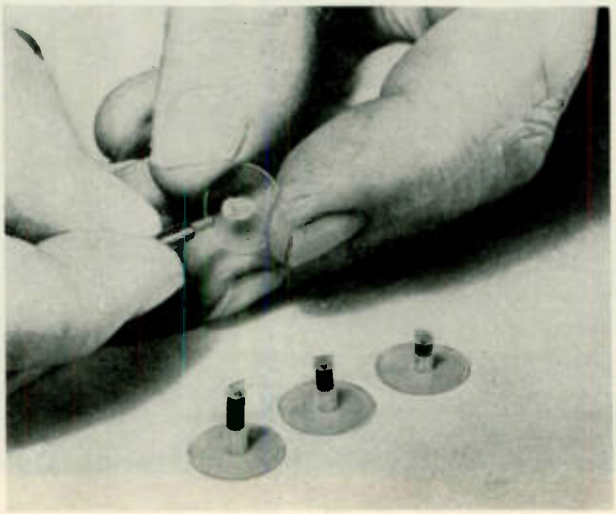
AN ADVANCEMENT IN THE DESIGN AND MANUFACTURING of temperature-compensated cup cores has been provided by Indiana General Corp., Keasbey, N. J. and the Gries Reproducer Corp., New Rochelle, N. Y.

Indiana General's specifications for the cup core called for controlled air gaps, Q-improvement, tuning adjustment, magnetic shielding, and temp. coefficients. The first step was the development of a magnetic ferrite with low-magnetic loss and high-temp. stability. The next step was a design that would make maximum use of the ferrite and also permit economical mass production.

This design was provided by Gries. Precise tuning of the trimmer assembly was achieved by tiny polypropylene screws (1-64 thread size), automatically insert-molded into ferrite tubes, and automatically molded polypropylene trimmer bases with mating 1-64 internal threads.

The cup-core assemblies have freq. of 1KC to 1.5MC; Q to 800; and gapped inductances of 40 to 1000 mh/1000 turns.

Fine-tuning of cup-core inductor is provided by injection - molded polypropylene - ferrite trimmer.



ARTIFICIAL NEURONS— FOR MACHINES THAT LEARN

The study of neurons is being pushed, not only to learn more about animal behavior, but to enable us to build mach nes that can "learn" and "think." This article gives a concise description of neurons and how they work, and how these can be duplicated in electronic devices.

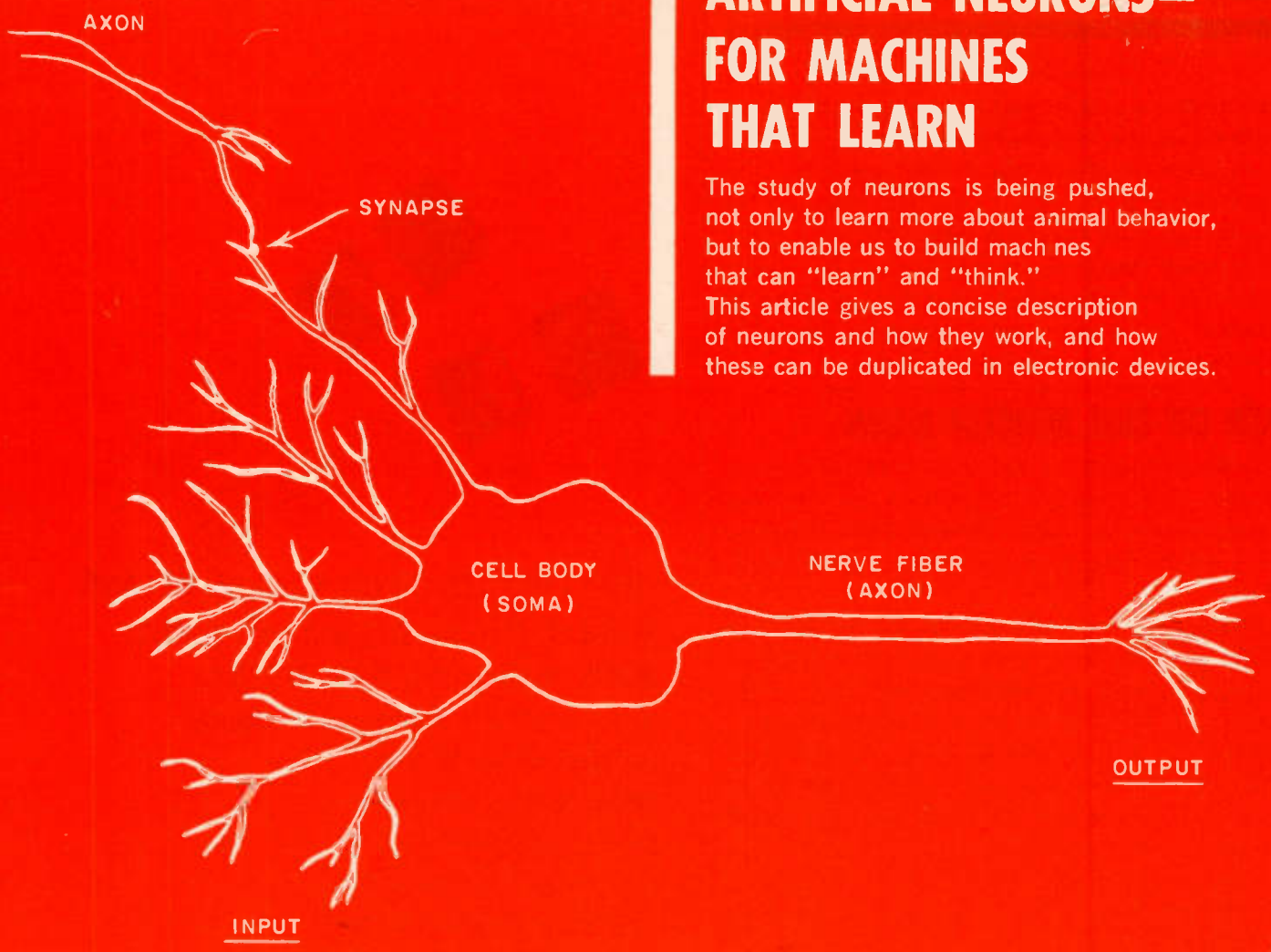
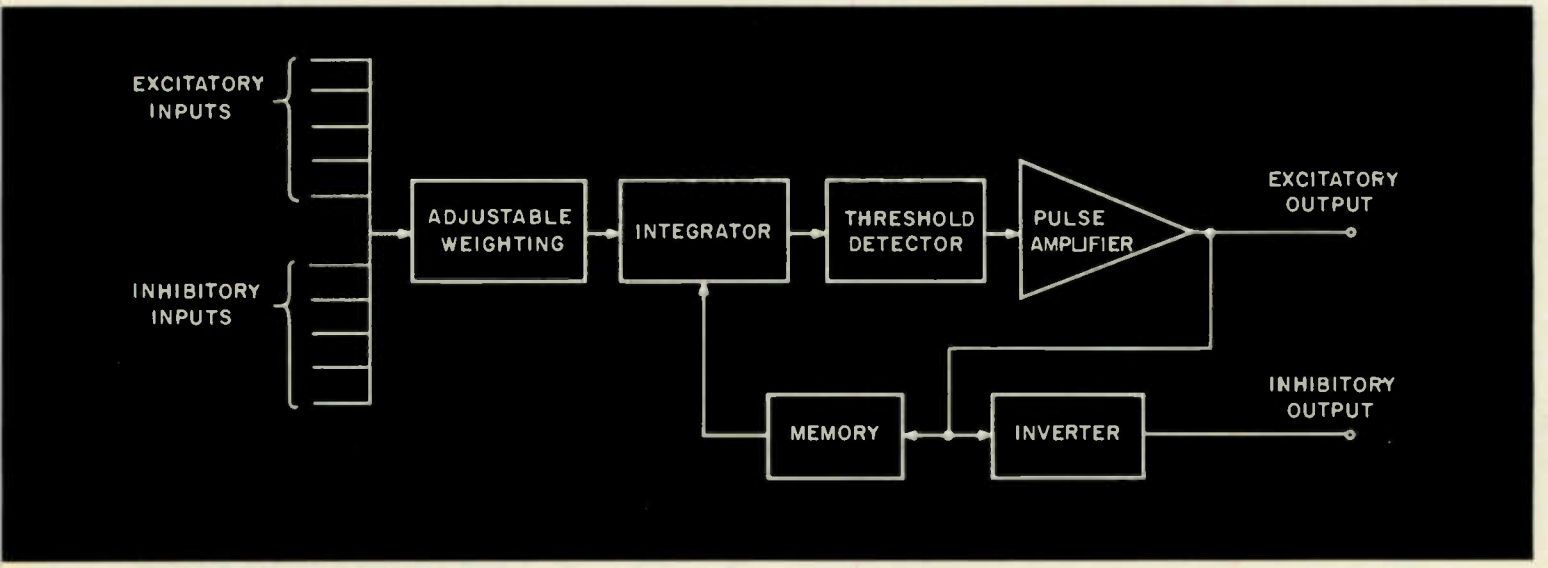


Fig. 1: Sketch depicts the more important elements of an associative neuron. Future "learning" machines will be based on neuron principles.

Fig. 2: The essential parts of the associative neuron shown above are being simulated by this circuitry to develop better "learning" machines.



LIVING ORGANISMS have evolved to their present state by a continuing process of trial and error. Most of the mechanisms by which they process information are reasonably efficient, dependable, and economical. Thus, nature offers a source of schemes which will meet today's demand for sophisticated, "intelligent" machines.

Scientists are studying these mechanisms for the purpose of applying the observed schemes to electronic systems. This area of study—variously called bionics, artificial intelligence, learning machines, and cybernetics—is attempting to fill the need for machines that will be faster, more efficient, and more economical. The new machines must also have a degree of intelligence that will free the human operator from many of his routine tasks.

* * *

Borrowing an Idea

The nerve cell, or neuron, is the building block of animal behavior. Neurons are involved in sensation, perception, thinking, memory, and control of motor activity. Why not, then, use neuron-like elements (analogs) to do some of the work in engineered systems? This approach is meeting with success, and systems are being built which use neuron analogs to recognize characters, speech, targets, and other patterns. At the same time, many investigators hope that by building and studying models of neurons, they can gain new insights into the actual mechanisms by which real neurons work.

In endeavoring to simulate neurons, the purposes of such a project must be defined, taking into account the costs in labor, time, materials, and complexity. These costs depend upon the number and nature of properties to be retained in the model. Some reasons for building neuron analogs are:

1. To realize designs for reliable, sophisticated, and simple schemes for use in target detection and recognition, image processing, signal detection, character recognition, photo-interpretation, and other areas of information processing.

2. To realize designs for efficient computing circuits (e.g., threshold and majority logic circuits, adaptive decision circuits) and develop revolutionary methods for computing data processing, and storage. Many secrets for such techniques lie in the greatest neuron net of all—the human brain.

3. Along with the realization of new and worthwhile engineering techniques, studies of the behavior of networks of interconnected neuron analogs (i.e., neuron nets) may produce concepts and hypotheses concerning the behavior of biological neuron nets.

For studying biological mechanisms, the model must be as realistic and accurate as possible. Some level of functional abstraction is needed; the level depends, of course, on practicality—equipment, convenience, and the available money and labor. Anything omitted from the model itself must be accounted for in theorizing. For engineering uses, only one or a few of the features peculiar to neurons may be of interest; replication of structure or even of detailed function is not important.

The airplane is a good example of a machine which borrows a biological principle—the wing—but the airplane wing is rigid and does not flap like that of a bird. In like manner, computer engineers have borrowed an idea from nature and developed neuron-like computing circuits. These use threshold logic to perform the usual computing functions. For example, if a circuit has 5 inputs, two of these may have to be active to trigger activity in the circuit. Threshold logic is an important property found in neurons, and has wide application in computing and pattern recognition.

Kinds of Neurons

Biological neurons may be divided into 3 basic groups for convenience: (1) sensory neurons, (2) associative, logical, or data processing neurons; and (3) motor neurons. The sensory neurons are activated by receptors which receive input stimuli from the environment in the form of light, heat, chemical or mechanical energy. They convert this energy into electrical impulses (or action potentials as they are known to electro-physiologists) and deliver these impulses to associative neurons. The impulses bear information (in their temporal and spatial distribution) as to stimulus intensity, duration and repetition pattern, and in particular cases, such special characteristics as sound pitch or light hue. Some coding of information often occurs in these sensory neurons.

The largest part of the processing and storage of information is handled by the associative neurons. These are responsible for the generation and control of all conscious behavior, for reasoning, thought, awareness, memory and emotion. (The brain consists mainly of very large numbers of associative neurons together with their life-support system.) The decisions and intent of the associative neurons are expressed by the transmission of action potentials among the associative neurons and from them to the motor neurons. The motor neurons respond to im-

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pulses from the associative neurons by causing muscle contractions and glandular secretions, the sole and universal means whereby we express ourselves to one another and to our environment.

The "Thinking Man's" Neuron

The associative neuron is shown in Fig. 1. This neuron consists, typically, of a cell body to which are attached many branching fibers called dendrites. These receive input impulses from other neurons, and a fiber, the axon, which also branches and carries output pulses to the dendrites or cell bodies of other neurons. The point of connection between two neurons is called a synapse. The most important properties of associative neurons are:

1. A threshold of input electrical energy needed to trigger a response. This threshold may or may not be variable. Input is derived from response of other sensory or associative neurons.

2. Production of an electrical impulse of fixed dimensions and shape when the input threshold is exceeded. The pulse width is typically 0.5 to 2 msec. and amplitude 50 to 150 mv. These parameters normally are constant for a particular neuron.

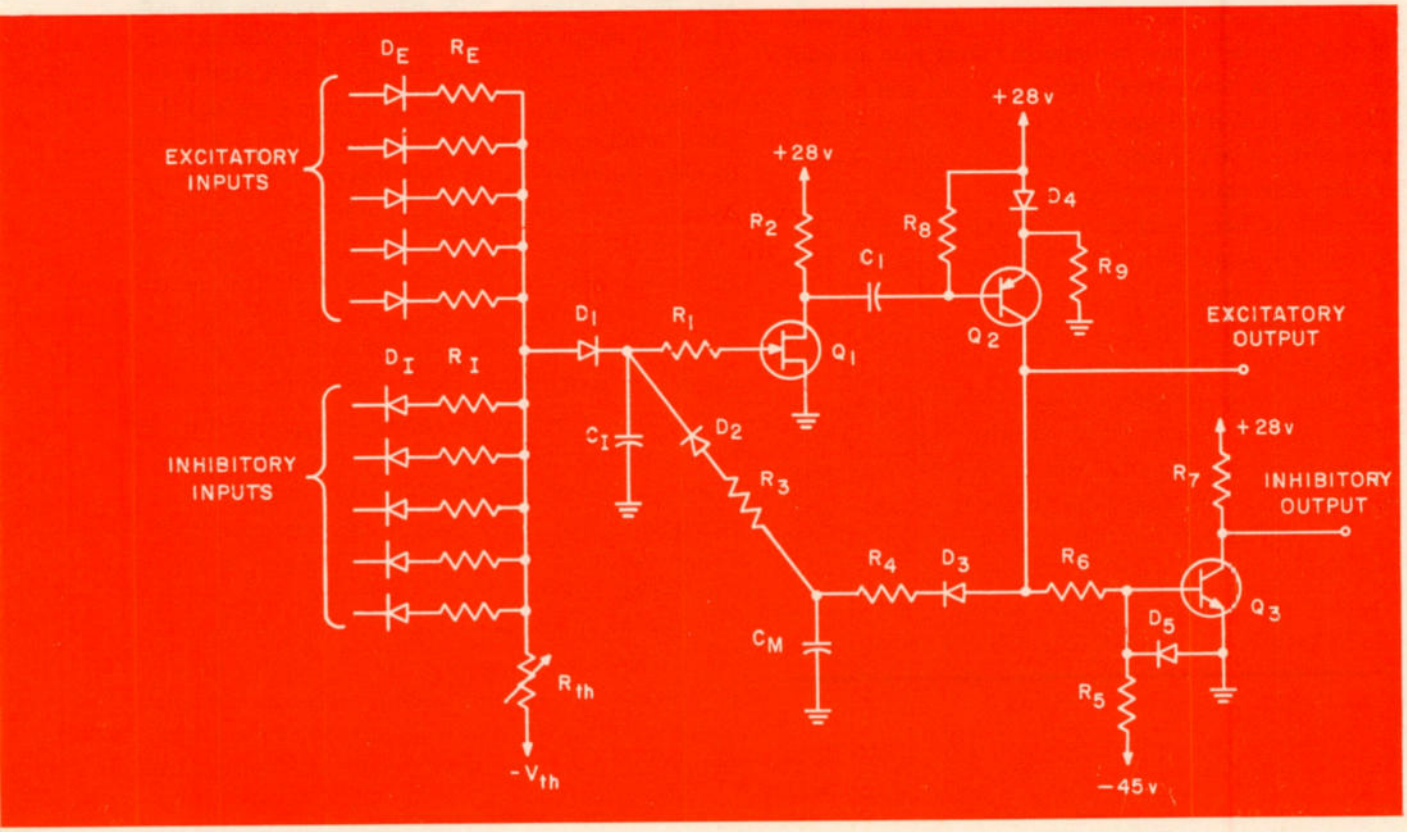
3. A delay in transmission of impulses along the fiber, which depends mainly upon the length and diameter of the fiber. Thus a fixed delay occurs between arrival of an input impulse at a specific connection or synapse, and arrival of the corresponding output impulse at the next neuron.

4. Ability to combine the effects of several simultaneous inputs from different sources, or of several inputs occurring in close time proximity, whereby such inputs which may not individually be able to trigger a response can do so in concert. Summation of the effects of simultaneous inputs from multiple sources is called spatial summation, while summation of effects over time is called temporal summation. The time constant for temporal summation is around 4 msec. Neurons typically have a large number of input connections.

5. An input may have an excitatory effect on the neuron, whereby the neuron is encouraged to fire (i.e., produce an action potential), or the input may have an inhibitory effect, whereby the tendency to fire is reduced.

6. After firing, a neuron is initially incapable of being triggered again. This condition is known as absolute refractory period, and normally lasts about a millisecond. Following this, the neuron returns gradually to its normal state of excitability. This period of subnormal sensitivity is called the relative refractory period, and lasts around 100 msec.

7. Some associative neurons, when stimulated with a constant input frequency, respond with an initially high rate of impulses which decreases with time. This is called adaptation or fatigue. Neurons can also accommodate to a slowly increasing input, without firing at all.



8. Many sources have postulated adaptive interconnections. That is, impulses transmitted from one neuron to another across a specific connection (synapse), increase the conductance of that connection. No conclusive evidence exists to support this, but acceptance of some such mechanism is often convenient. Learning and adaptation are easiest explained in this manner.

The Model

An electronic circuit has been developed which has some of these properties, making it useful for engineering and biological investigations. The circuit has a threshold which may be adjusted by a variable resistor or by an applied voltage. The output is a rectangular pulse of 28 volts amplitude and 200 μsec. nominal width. Both spatial and temporal summation are provided, as well as excitatory and inhibitory inputs. The neuron circuit generates separate excitatory and inhibitory ouputs.* An absolute refractory period follows production of the output pulse.

Input connections are fixed, since adaptation here, although feasible, would be expensive. To compensate for the lack of adaptation in the connections, each neuron is provided with a network for adaptation of threshold. This consists of a memory capacitor which "remembers" previous outputs, and decreases the threshold in accordance with the amount of past activity. This mechanism provides a "learning" capacity for individual neurons. A network may also be added to simulate the fatigue described above.

*Biologically, it is likely that excitation and inhibition are the functions of two different kinds of neuron. Our simplification is an economic convenience which should not sacrifice any capabilities.

How it Works

Fig. 2 is the basic circuit of the neuron analog. Inputs are summed and an adjustable weight applied. Inhibitory inputs act by shunting some of the current delivered by the excitatory inputs, thereby reducing the effective stimulation. The adjustment of weight serves as a threshold control, determining the minimum number of excitatory inputs needed to trigger (fire) the neuron. The weighted signal is integrated

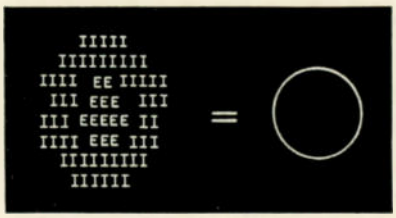


Fig. 4: A single retinal field is depicted. The E's represent sensory cells and I's are sensory cells whose effect is inhibitory.

and applied to the threshold detector, which has a fixed threshold level. When the integrated signal reaches this threshold level, the detector produces a pulse of fixed duration and restores the integrator to its quiescent level.

The detector ouput pulse is amplified to a fixed amplitude and presented as the excitatory output. This output is inverted and presented as the inhibitory output and is also applied to the memory circuit which integrates it. The output level of the memory circuit is used to control the quiescent level of the integrator circuit. Thus, neuron responses are effectively fed back to reduce the threshold of the neuron.

Fig. 3 is a neuron circuit. Inputs are isolated from

Fig. 3 (left): The circuitry outlined in the block diagram of Fig. 2 is shown here. It simulates the function of a neuron.

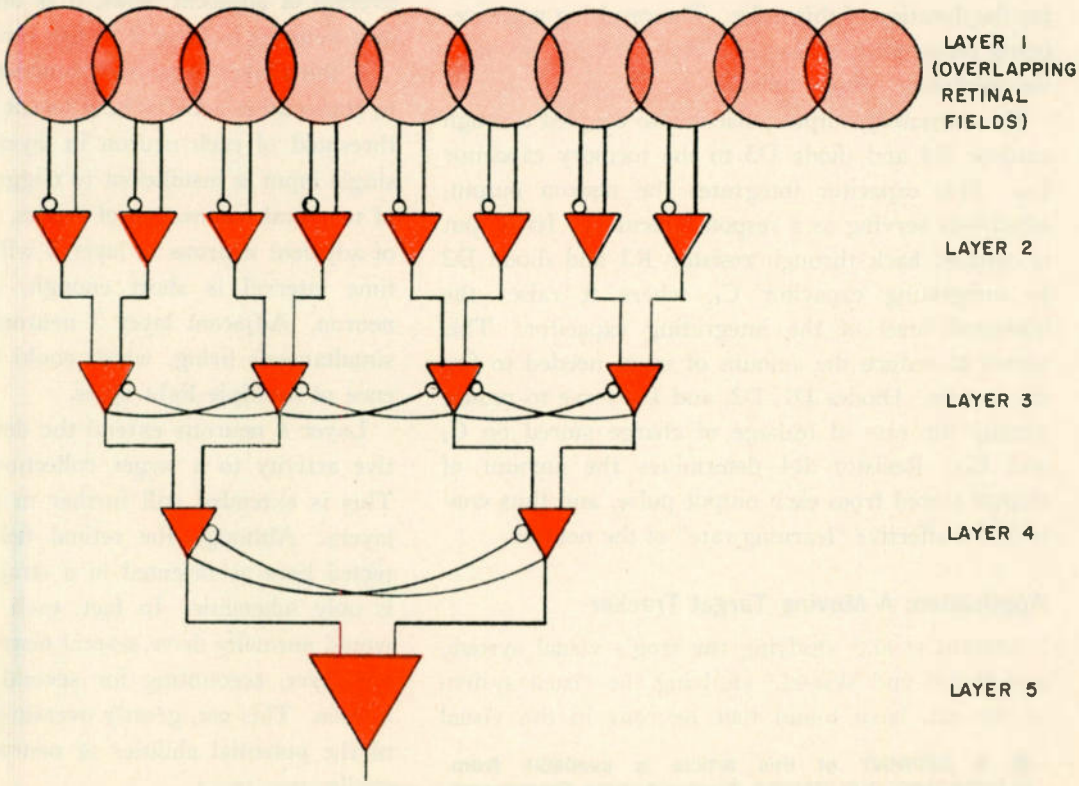


Fig. 5: (right): In an over-simplified example, all of the E's and I's of Fig. 4 would be connected to a single neuron.

each other by means of diodes. A resistor in each input circuit fixes the relative weights (effectiveness) of the inputs. Weight of the combined input is controlled by adjusting R_{th} or V_{th}. Capacitor C_I integrates the combined input. Unijunction transistor Q1 serves as a threshold detector. With no input signal, there is no voltage on C_I, and Q1 emitter is effectively an open circuit. As the integrator level rises, a voltage level is reached at which the emitter-to-base 1 junction of Q1 breaks down, discharging C_I and producing a negative pulse at base 2 of Q1. The width of the pulse is determined by R1 and C_I, and its amplitude by R2.

The pulse is coupled through capacitor C1, to transistor Q2, which inverts and amplifies it. Q2 is normally cut off due to the bias network of resistors R8, R9, and diode D4. The collector of Q2 is thus normally at ground level. The negative pulse applied to the base of Q2 is enough to saturate Q2 during the pulse. This causes the collector of Q2 to rise to +28 v.

The resulting 28-v. pulse is taken as the excitatory output. This pulse is coupled through resistor R6 to the base of Q3, which is normally biased to cutoff by resistor R5 and diode D5. Q3 collector is, therefore, normally at +28 v. Arrival of the excitatory output pulse at Q3 base saturates the transistor and brings the collector to ground level for the duration of this pulse. The resulting negative-going pulse, with a base line of +28 v., is taken as the inhibitory output pulse.

The excitatory output pulse is also coupled through resistor R4 and diode D3 to the memory capacitor C_M. This capacitor integrates the neuron output, effectively serving as a response memory. Its output is coupled back through resistor R3 and diode D2 to integrating capacitor C_I, where it raises the quiescent level of the integrating capacitor. This serves to reduce the amount of input needed to fire the neuron. Diodes D1, D2, and D3 serve to reduce greatly the rate of leakage of charge stored on C_I and C_M. Resistor R4 determines the amount of charge stored from each output pulse, and thus controls the effective "learning rate" of the neuron.

Application: A Moving Target Tracker

Lettvin et al.,[1] studying the frog's visual system, and Hubel and Wiesel,[2] studying the visual system of the cat, have found that neurons in the visual area of the cortex respond to stimulation of a small, well-defined region of the retina. The effect is one of sensitivity to particular image sizes and shapes, and further, a sensitivity to motion of these images on the retina.

A model of this system has been developed which, for example, is capable of detecting light spots moving about on an artificial retina consisting of photo-sensitive devices coupled with neuron circuits. An obvious use is a radar moving-target tracker.

Consider Fig. 4, which depicts a single retinal field. The E's represent sensory cells (photo-cells) which generate a single pulse at the onset of a light input and which have an excitatory effect on neurons to which they are connected. The I's represent sensory cells whose effect is inhibitory. In an over-simplified example, all of the E's and I's in a given retinal field would be connected to a single neuron (see Fig. 5) having a threshold of somewhat less than the number of excitatory inputs to it. The totality of inhibitory connections is represented by a single connection terminating in a dot. The totality of excitatory connections is represented by a single connection without a dot. A spot of light which is roughly the size of the area covered by "E" cells will, if properly positioned, trigger a response in the corresponding neuron of layer 2. Layer 2, therefore, consists of "light-spot detectors." This type of arrangement is typical of "property filters," which abstract some property from an image, such as size, shape, or symmetrical appearance. Note that due to the overlap of adjacent fields, it is impossible for adjacent neurons in layer 2 to fire simultaneously.

A third layer of neurons functions only to respond to consecutive activity in adjacent retinal fields. The threshold of each neuron in layer 3 is such that a single input is insufficient to trigger it, but by means of temporal summation of inputs, consecutive firings of adjacent neurons in layer 2 will, if the separating time interval is short enough, trigger a layer 3 neuron. Adjacent layer 3 neurons mutually inhibit simultaneous firing, which could occur in the presence of multiple light spots.

Layer 4 neurons extend the detection of consecutive activity to a larger collection of retinal fields. This is extended still further in subsequent neuron layers. Although the retinal fields have been depicted here as oriented in a straight line path, this is only schematic. In fact, each neuron in a layer would normally drive several neurons in the succeeding layer, accounting for several possible paths of motion. This net, greatly oversimplified, shows some of the potential abilities of neuron nets to perform challenging tasks.

Incomplete specifications for components greatly extends the design and development time. New circuit designs must be breadboard-ed and tested extensively before being installed in equipment. Poor specifying is due to lack of knowledge of what factors should be considered for a specific component. This article should solve the problem when specifying magnetostrictive filters.

HOW TO SPECIFY MAGNETOSTRICTIVE FILTERS

NEW CIRCUIT DESIGNS are almost never used in final equipment without first constructing a breadboard. The reason lies not in any inexactness in the methods of circuit analysis, but mainly in the lack of complete component specification. For example—in the case of a bandpass filter, there may be only one or two characteristics (bandwidth and center frequency) which show up in the initial block diagram.

Obviously such factors as insertion loss, impedance, and spurious responses are important, but it is assumed that they may be dealt with later in the breadboard by altering circuit gain, circuit impedance, and preselection bandwidths respectively. The attitude is often one of "Don't confuse me with details," at least until after the initial breadboard has been completed and evaluated. Unfortunately if there are a number of incompletely specified components, the evaluation process may become so tedious that the entire scheme is rejected as impractical. The purpose here is to bring to mind some of the characteristics of magnetostrictive filters which may need specification for successful application.

* * *

THE DISCUSSION here will be limited to the simple type of electro-mechanical filter which uses a small nickel alloy rod as the mechanically resonant element. The rod is supported by washers at the nodal points of motion (Fig. 1). The filters get their name from the use of the magnetostrictive effect (or its inverse) in the input and output transducers. Since the magnetostrictive effect is independent of polarity and is a function of the magnitude of the applied field, it is necessary to supply a dc bias field to avoid frequency doubling and non-linear behavior. The transducer coils and bias magnets are usually located just outside the node washers.

From 100 KC to 300 KC this filter offers smaller size and lower costs over other filter types having similar bandwidths. Since the rod length is inversely proportional to the filter frequency, the rods become

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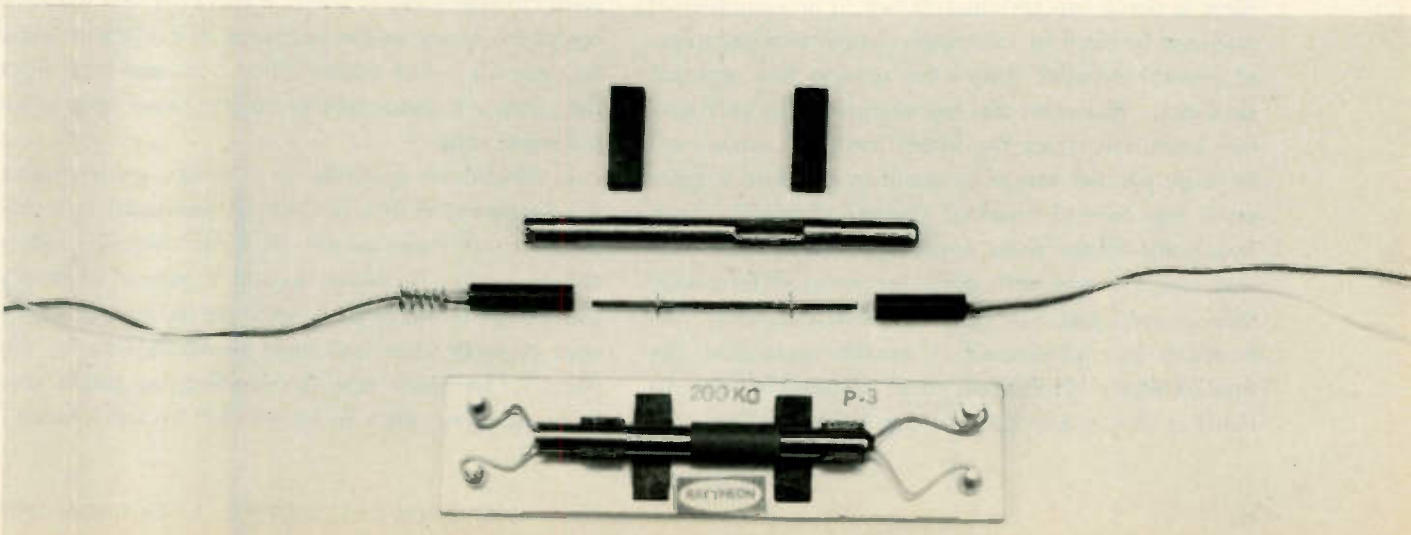
Fig. 1: Filter rod with transducer coils, spring, case and mounting panel with bias magnets is shown in the photograph.



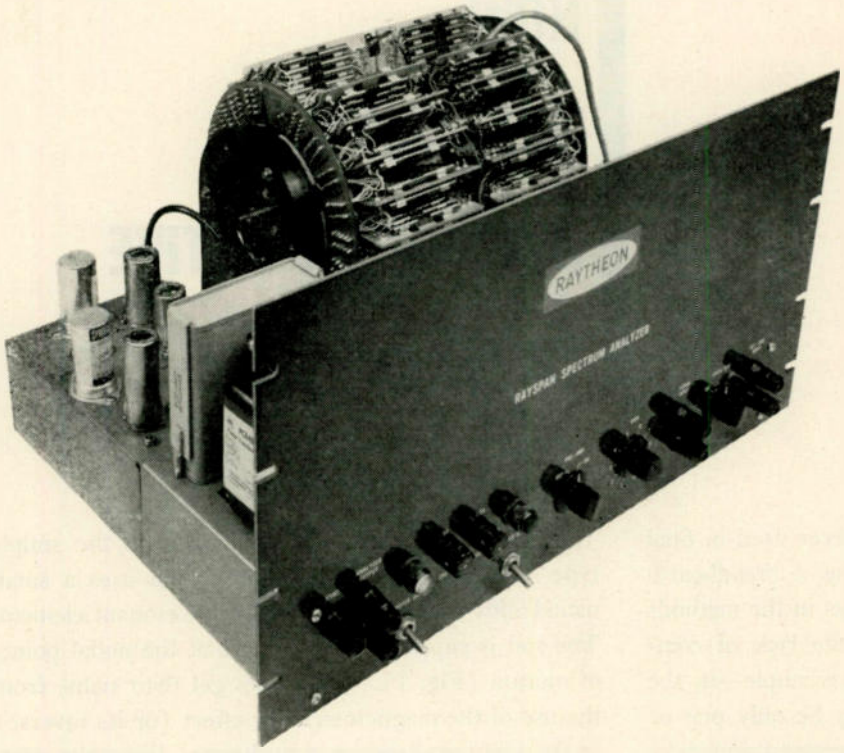


Fig. 2: An array of 420 magnetostrictive filters mounted around a capacitive commutator is used in a spectrum analyzer.

too long at audio frequencies. Above 400 KC the rods are so short that frequency adjustment becomes critical and feedthrough between input and output increases so that dynamic range suffers. They should be considered whenever a Q in the range of 2,000 to 20,000 is needed, and when it is possible to work at frequencies between 15 KC to 400 KC.

One of the keys to the proper use of the filters is to be found in the very loose coupling between the rod and the input and/or output coils. This means that the input and output coils do not generally change their impedance more than a few percent in going through the resonant frequency. As a result the filter bandpass is not very sensitive to the associated circuitry. (This is at the expense of a relatively high power insertion loss compared to other filter types).

A second key to application is to realize that this filter is not a two terminal device. For example—it may not be used in the simple lattice configurations of general network theory for passive two terminal elements. However, this has not proved to be a serious limitation, since the filters are most often used in large parallel arrays to comb or separate a spectrum into several hundred discrete channels. Such uses point up the main advantages of the filter—the ease and economy with which its resonant frequency may be adjusted. In fact, the final frequency and insertion loss adjustment is usually made after the final assembly. If desired, small adjustments may be made at almost any time during operating life.

The ease of adjustment follows from the simplicity of the resonant structure and the equation that relates the velocity of propagation V in a rod, to a stiffness factor λ and a mass or inertial factor M. $V = K\sqrt{\frac{\lambda}{M}}$ (where K is a constant of proportionality). At resonance, standing waves exist and removal of a slight amount of material from near the motional anti-node has the effect of increasing the velocity of propagation and hence, the frequency. Likewise, removal of material from the vicinity of the nodes has the effect of reducing the stiffness and lowering both velocity and frequency.

Definitions

Here we will state a working definition as subparagraph (a) (not always that accepted as standard by the industry for other types of filters) and follow with instructions as to typical tolerances and practical specifications under this definition as subparagraph (b).

Resonant Frequency (Center Frequency) : a. May be defined for a single element (Fig. 4) as that frequency at which maximum output occurs. Since the maximum is quite broad, this leads to some difficulty in measurement. For composite filters, particularly dual elements, where dip in response may occur at the center frequency and when specifying single elements to tolerances of ±5%, it would be best to define center frequency as the midpoint or arithmetic mean between the −3 db points. (For a narrow band filter the arithmetic mean and geometric mean have about the same value.)

b. Should be specified as a design center value. A tolerance of ±10% of the 3 db bandwidth is standard, but ±5% can usually be furnished at a slightly higher price. In some instances, where frequency translation is being used, only the frequency difference between filter and local oscillator may be important. In which case the specification might read "Resonant frequency to be selected by the Vendor."

If certain frequencies must be avoided, for example, harmonics of high level signals in the system, these frequencies should be specified as, "To be excluded from the possible range."

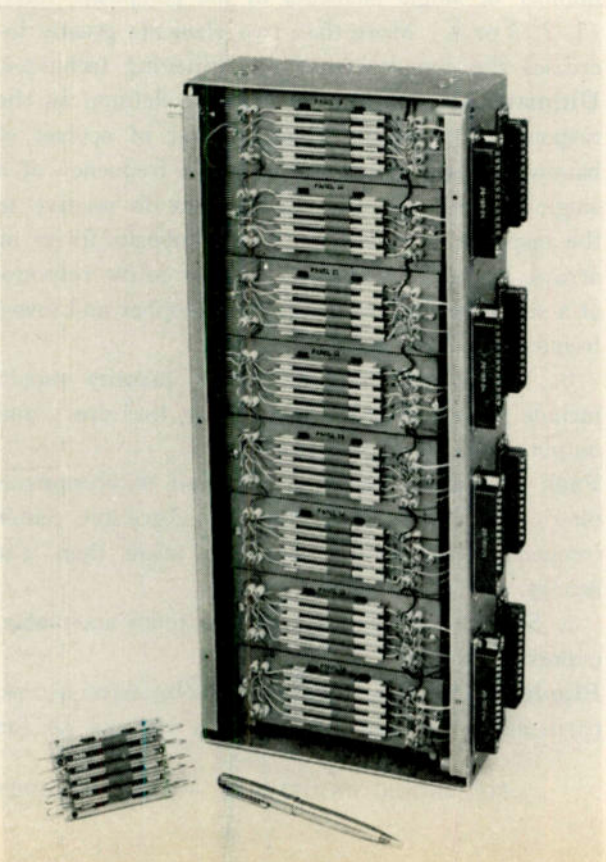
Bandwidth: a. Usually defined as the difference in the frequencies of the −3 db levels (about the center frequency) and expressed in cps. In a dual filter, the −3 db will be chosen with respect to the level at the center frequency levels (Fig. 5). If some other measure of bandwidth is used, it should be clearly emphasized by heavy underlining.

b. Should be specified as a design center value. A tolerance of ±10% is standard but ±5% may be available at a higher price. If the filter is to be used as an oscillator and no particular bandwidth is desired then state "For oscillator use."

Input and Output Impedances: a. Usually stated in terms of magnitude alone with the respective transducer coil untuned. The measurement should be made at or near the resonant frequency. Exactly on resonance there will be a dip in impedance of about 10%. Two or more standard transducer coils are usually offered and their untuned impedances across the frequency range are tabulated or plotted on data sheets. Where high impedance sources or loads are involved, capacitive tuning of the input or output transducers will increase their impedances by some 5 to 15 times.

b. The customer may specify which of these standard coils are to be used at the input and output, and also if capacitive tuning is needed. Such specification is not independent of the voltage transfer ratio. Special coils may be furnished at extra cost, but generally impedance is not so critical as to preclude the use of standard coils.

Fig. 3: Large array contains 160 filters for equalization purposes with random noise shake tables. Small panel contains 5 filters for a missile application.



Voltage Transfer Ratio: a. May be defined as the ratio of the open circuit output voltage to the input or drive voltage at the resonant or center frequency. Values normally expressed as $20 \log_{10} \left(\frac{V_{out}}{V_{in}}\right)$ and labelled in db. (This should not be confused with the true power insertion loss which is not ordinarily specified by the customer.)

b. Should be specified as a design center value but possible range of values is set by the coils. With standard coils, values as high as +3 db may be obtained. Generally the tolerance on the voltage transfer ratio should not be less than ±0.5 db. If the signal source is to be relatively high impedance (compared to the impedance of the input coil), or the load of relatively low impedance (compared to the output coil impedance), or if the load contains appreciable shunt capacitance, then these conditions should be stated and a voltage transfer ratio may be given for these conditions. In such cases the tolerance applied should give due consideration to the circuit tolerances.

Power Insertion Loss: This quantity is not ordinarily specified by the customer.

Drive Level (Input): a. May be defined as the value of the RMS voltage of a single sinusoidal signal appearing at the filter input (drive) terminals. For voltage transfer ratio measurements, the frequency of the drive signal shall be the resonant or center frequency of the filter. For finding the −3 db points and/or shape factor, the drive level shall remain constant as the frequency is changed (unless one is simulating the effect of a high impedance source). If a pulsed wave train or other signals are used, only the RMS value of that part of the signal which is the filter bandwidth should be considered as determining the drive level.

b. Should be specified as an RMS voltage (preferably 50 mv for standard coils unless actual system use will deviate considerably from this value.) If the filter drive is to be subjected to high level signals outside its pass band, for example, white noise or undesired side bands; then the character of these signals should be specified as fully as possible.

Response Time (Rise Time, Fall Time): a. May be defined as the time needed for the filter output to approach within a factor of $1/e$ of its final output after a unit change in its input or drive level (Fig. 6).

SPECIFYING FILTERS (Concluded)

This quantity will be about the same for composite filters composed of paralleled single elements as for a single element, except that the shape of the rise will be different and may show some ripple if the filters are spaced several bandwidths apart.

b. This quantity may be specified in seconds or milliseconds but not independently of the bandwidth. The connecting relation between response time Δt in seconds and bandwidth Δf cycles/second is $\Delta t = 1/\pi\Delta f$.

Spurious Mode: a. May be defined as a response, showing a resonance, at any frequency other than the main or desired resonance. Spurious modes are usually widely removed from the resonant frequency and are usually down by a factor of 20 db or more. Capacitive tuning of an unloaded output coil will provide additional rejection. If arrays are to be built to cover a range of 20% or more of the resonant frequency, then some thought should be given to the possibility of low level spurious modes.

b. The maximum acceptable spurious response level should be specified in db relative to the main response, and as a function of the frequency above and below the main response.

Phase Angle (Input-Output): This quantity is not ordinarily specified by the customer. Frequent checks are made on input and output coils, during fabrication and assembly to assure uniform lead attachment and color coding, so that the phase angle will be uniform within nominal limits. If it is desired that the phase angle be 0° at maximum output this can usually be attained by capacitive tuning of the output coil.

Shape Factor: a. Usually defined as the ratio between the skirt width, at some high attenuation and the 3 db bandwidth.

b. The ratio should be specified as a fixed number with tolerances of ±10% on the skirt widths and 3 db bandwidth.

Skirt Slope: a. Usually defined as the relative attenuation in db per octave of bandwidth (measured at some point well below the –3 db points but well above the point where the skirts flatten out). The value observed usually is a very close approximation to the ideal for the number of elements in use.

b. The ideal slope is usually specified as 6, 12, 18 or 24 db per octave of bandwidth by specifying the number of single elements in the composite filter. (1, 2, 3 or 4.) More than two elements greatly increases the complexity of the adjusting technique.

Ultimate Attenuation: a. May be defined as the response at a certain stated number of octaves of bandwidth away from the resonant frequency of a single element, usually expressed in db relative to the response at resonance. For composite filters or arrays, it may be convenient to refer to the response at a stated number of CPS from the upper and lower frequency −3 db levels.

b. A valid specification of this quantity should include the specification of shielding, lead dress, and output load impedance levels.

Peak to Valley Ratio: a. Applied to composite filters, particularly dual elements where the center frequency response may be much lower than that nearby.

b. Should be specified as a maximum acceptable, expressed in db.

Ripple Factor: a. Applied to composite filters, particularly large arrays. Usually defined as the

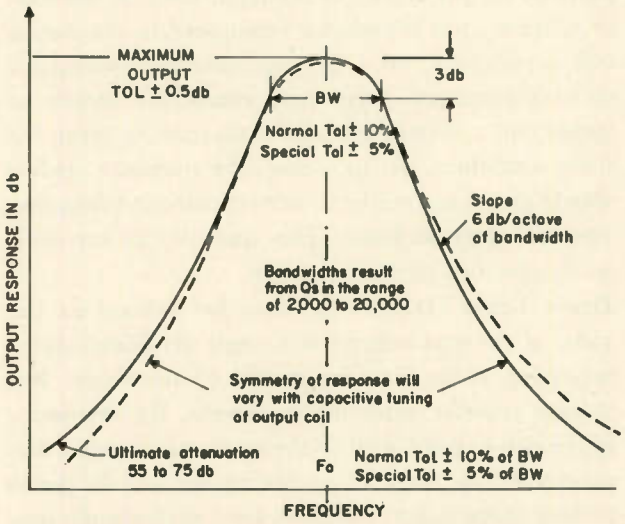
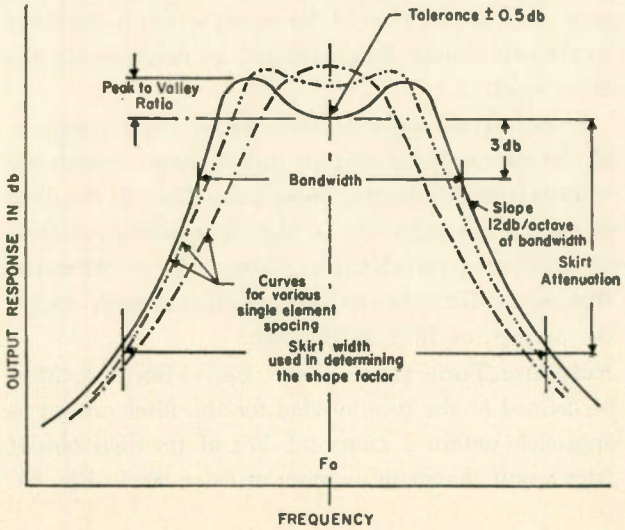


Fig. 4: Curve shows the response of a single filter element.

Fig. 5: Drawing shows the response of a dual filter element.



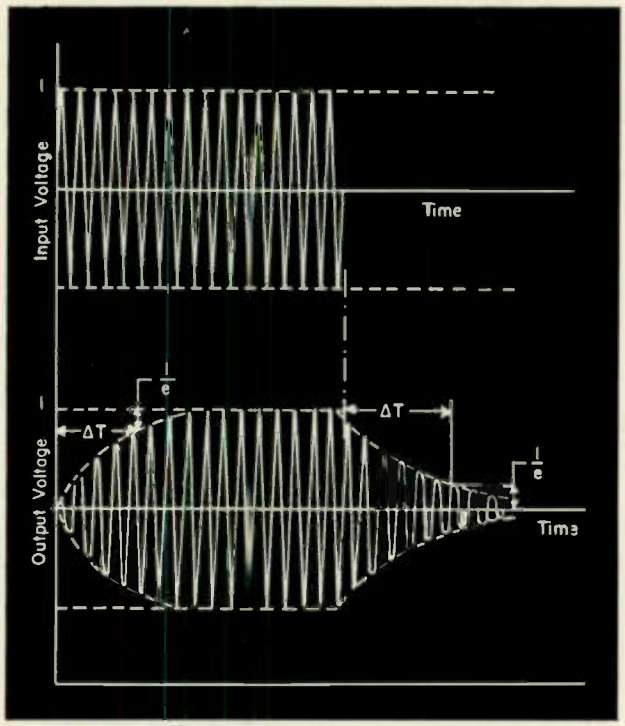


Fig. 6: Normalized response time of a single element filter.

ratio of maximum to minimum response along the pass band of the array and is expressed in db.

b. Should be specified as a maximum ratio acceptable in terms of db. The nature of the input signals and the summing network used during the test should also be given.

Environmental Conditions: a. Most of the electrical characteristics of the filters may be measured and specified under environmental conditions. Some of these conditions such as shock, vibration, acoustic noise pick up, and the like are suitable for type or qualifying tests, but not for 100% production tests. Changes in resonant frequency, bandwidth and insertion loss may require 100% production testing at the end points of the temperature range.

b. Since the actual operations of adjustment are best carried out in an air-conditioned room at a fixed temperature of 72°F, the initial specifications should cover testing at this temperature. These tests should then be supplemented by specifying the acceptable excursions in the characteristics at the upper and lower temperatures. In specifying maximum differential frequency drifts among filter elements, care should be taken to specify the critical combinations. An example might be an oscillator element with respect to several filter elements. The critical differential drifts are not among the filters but between each filter and oscillator. Recognition of such relations may make possible the economical achievement of tighter tolerances where actually required. Careful assessment of the actual environmental conditions when in operating equipment should be made. Specification of an unnecessary large range will result in unnecessary expense and delay.

Mounting: a. General practice is to mount up to ten filters together, using both sides of a single panel 2 in. wide. The panel length varies inversely with frequency. In some cases it may not be practical to mount filters of widely different frequencies on the same panel because of bias magnet spacing problems. It is important to mount all filters which will be operating together as a unit, either on an individual panel or on adjacent panels, so that the same environment will be experienced by all.

b. Should be specified to indicate which filters are to be used together circuitwise, allowing the vendor to group the filters on a panel, or panels to the best advantage. If individual mounting panels are desired for each filter, this should be indicated.

Terminals: a. General practice is to supply common bus connections for one side of the output coils and to bring the other side to individual terminals. The drive or input coils may have common bus connections if parallel drive is desired, and terminals if it is series drive. The use of independent terminal pairs for each filter will require more panel space and the use of flying leads without terminals or bus connections will require a minimum of panel space.

b. The input and output connections should be specified by calling for the appropriate leads, terminals or common bus connections. If it is desired to have one side of a coil grounded then this should be specified, otherwise, all connections will be insulated from the mounting panel. If specified, a ground terminal may be supplied with the mounting panel for grounding the panel where mounting methods do not provide an adequate ground for shielding purposes.

FOR MORE INFORMATION . . . on how to specify components, see these articles in recent issues of "Electronic Industries."

"Selecting the Right Capacitor," June, 1962

"Ordering Mil Spec Components," June, 1962

"Specifying the Fractional Horsepower Motor," June, 1962

"Potentiometers—Terms & Data," June, 1962

"Magnetic Materials Selection Chart," June, 1962

"Specifying DC Electronic Power Supplies," October, 1962

"Selecting Coaxial Cable," June, 1960

"Selecting and Winding Magnet Wire," June, 1960

"Guide to RFI Filters," June, 1960

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  −20 V DC at 20 amperes, 1% Ripple P to P
  +17½ V DC at 5 amperes, 5% Ripple P to P
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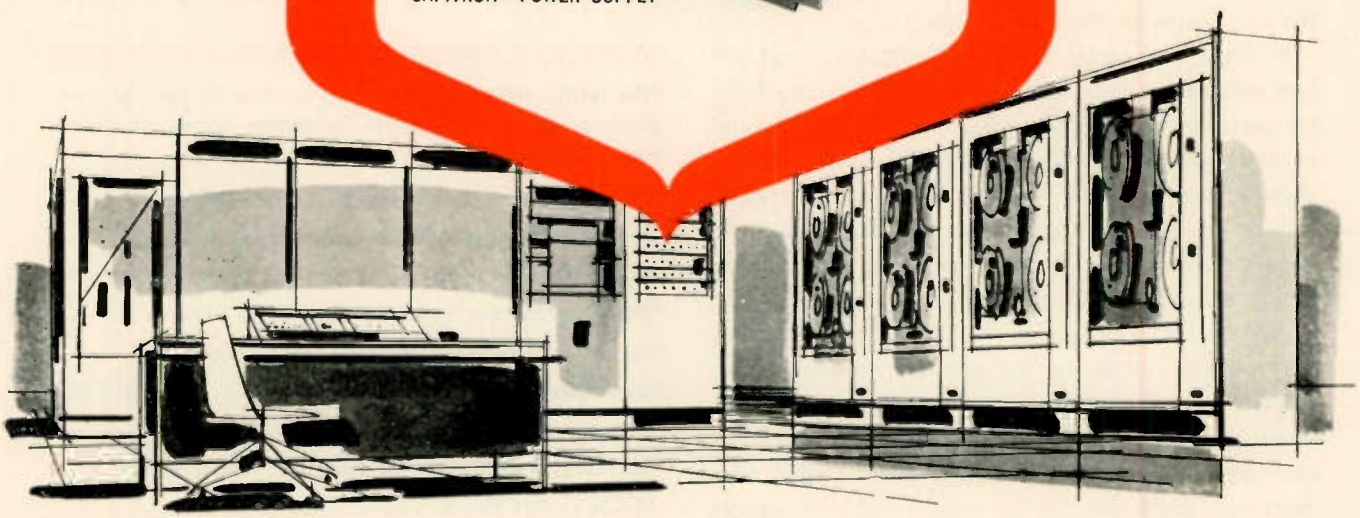

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REDUCING RIPPLE IN REGULATED SUPPLIES

The output ripple in voltage regulated power supplies can be reduced in many cases by the addition of two small resistors. The resistors are used in a feedback circuit to cancel the ripple.

MANY METHODS OF REDUCING RIPPLE in voltage regulated power supplies of the type shown in Fig. 1 are available, but most of them require the addition of expensive components. This article shows how to obtain an order of magnitude improvement in ripple by adding only two ½ watt resistors. Briefly, this method consists of feeding a controlled amount of the ripple from the output of the power supply to the input of the regulator amplifier.

* * *

The regulator chosen for discussion is of the type shown in Fig. 1, capable of delivering 150 ma. at 12 v. All numerical values of ripple given will be for these load conditions, using full wave rectification from a 60 cycle power source.

Consider the complete circuit diagram of a simple regulated power supply shown in Fig. 2. The ripple characteristics plotted against variations in line voltage are shown by the middle curve of Fig. 3.

Let us now modify the simple regulator shown in Fig. 1 by removing C1 and adding C2 and R6 as shown in the color portion of Fig. 1. If R6 is made large enough, the ripple of the output is found to decrease appreciably, having a minimum at some particular value of ac line voltage, as shown in Fig. 4. The null position may be shifted by slightly changing the value of R6. With the circuit values shown in Fig. 1, the value used for R6 was 120 K ohms, with C2 being 25 μf.

The reason for this reduction in ripple is quite apparent. The ripple signal applied to the base of T2 through C1 (and/or through the R3-R4 voltage divider) can never be enough to completely cancel the ripple on the output, since the output ripple *is* the signal. This is not true however, of the ripple signal applied through C2-R6. The size of this signal depends mainly on the value of R6, and may be adjusted to give (in principle) a complete null for some value of line voltage. In practice, some phase shift exists and the null is not perfect.

Since the cancellation is done by applying an inverted signal to the base of T1, we can see that if this inverted signal becomes too large, the original ripple of the output will not only be completely suppressed, but an inverted ripple will be impressed in its place. This is actually what happens in the graph of Fig. 4, with the ripple on one side of the null being inverted with respect to the other side. This effect provides a convenient way of experimentally determining the correct value for R6.

To understand the variation in output ripple with a change in line voltage that is shown in Fig. 4, again consider the circuit of Fig. 1, this time with C1 removed. Since the ripple drop and voltage drop

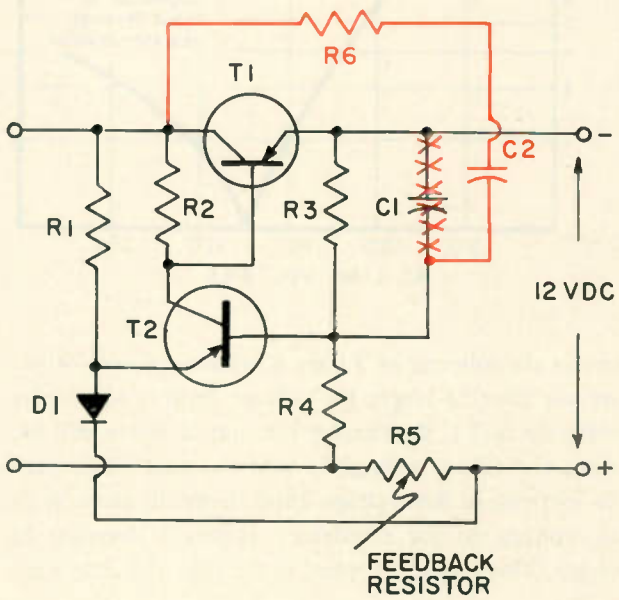


Fig. 1: The regulator circuit can be modified as shown in color to reduce ripple.

By VERNON R. CUNNINGHAM
Assoc. Engineer
Apparatus Division
Texas Instruments Incorporated
Dallas, Texas

Fig. 2 (right): A simple regulated power supply is shown. Color indicates a change to reduce ripple output.

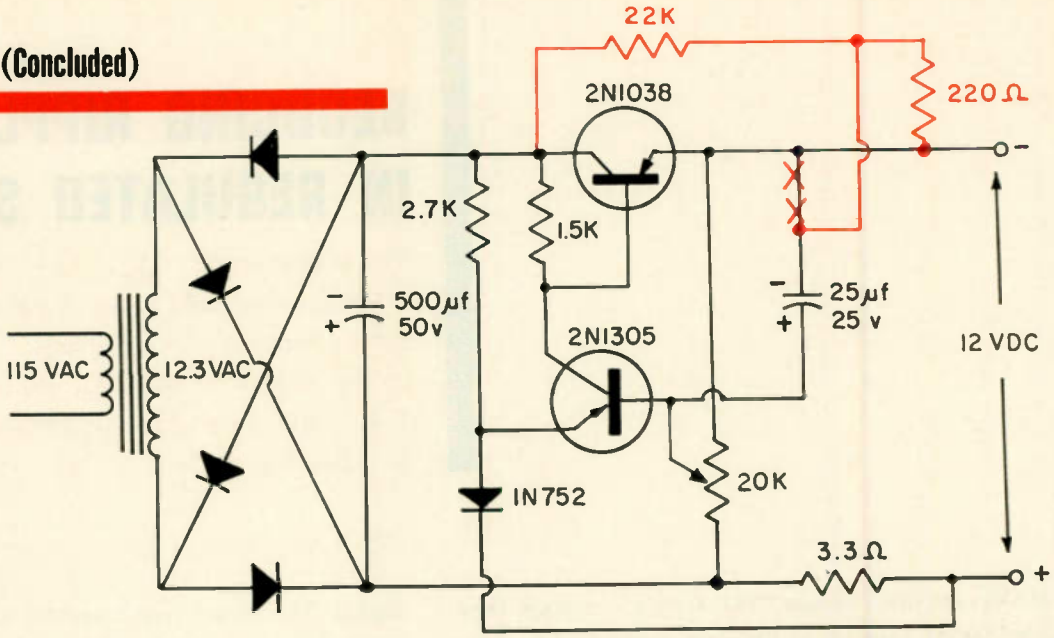
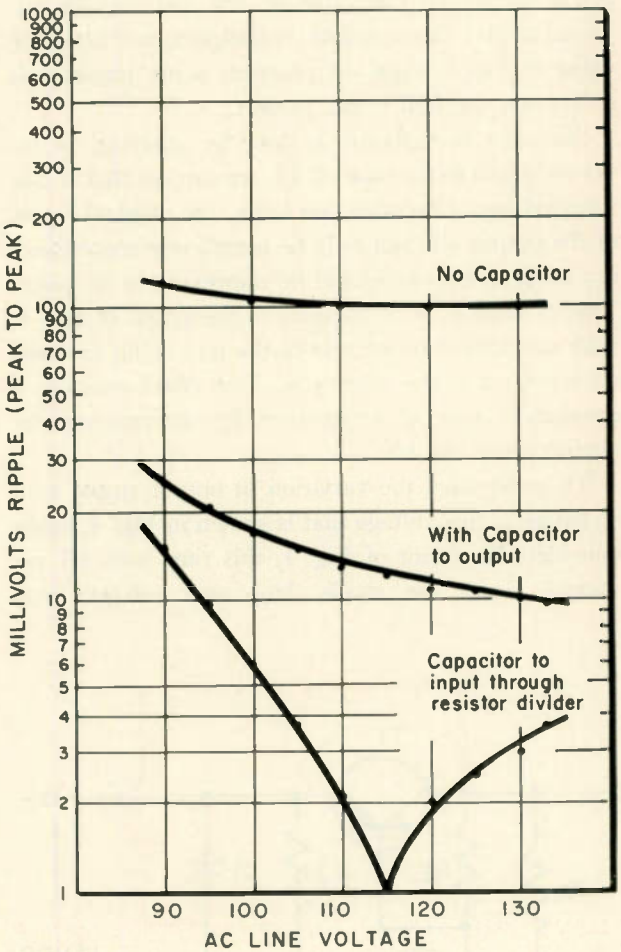


Fig. 3 (below): Ripple characteristics are plotted against voltage in three different cases.



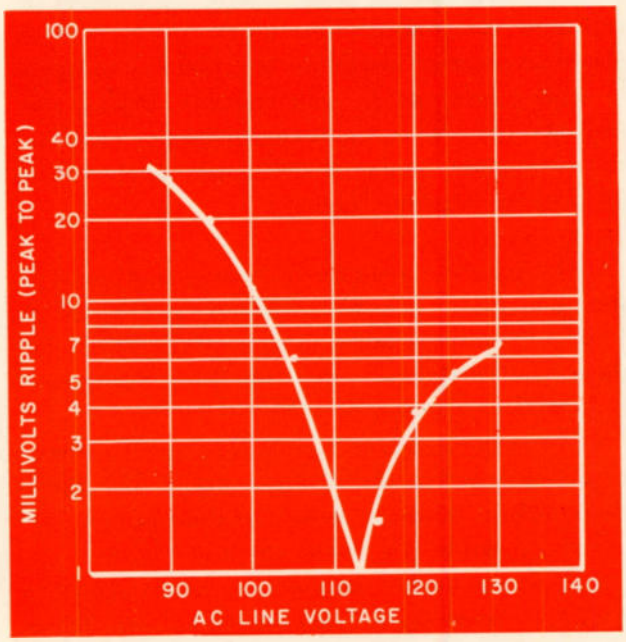


Fig. 4: The ripple output of Fig. 1 (modified) is plotted.

across the collector of T1 are a function of each other, we see that the larger the voltage drop is across the collector of T1, the smaller the output ripple will be, since the output voltage is held constant. Therefore an increase in line voltage (and hence an increase in dc voltage to the regulator) causes a decrease in ripple. This ripple is applied to the base of T2 through the divider R3-R4. If we now add C2-R6, we have two ripple signals applied to T2, one of constant magnitude and one whose magnitude depends on the line voltage. The effect shown in Fig. 4 therefore results.

Several methods of coupling the supply signal to the base of T2 were tried, and the best results were obtained with the changes shown in the color portion of Fig. 2. The ripple of this circuit is plotted in the lower curve in Fig. 3. It is seen that an improvement of slightly more than an order of magnitude is obtained in ripple characteristics at the null point over the circuit shown in Fig. 1. For comparison, the upper curve of Fig. 3 is the ripple characteristics of the circuit of Fig. 1 with capacitor C1 removed.

Computer tape is stored between capstans and reels, in columns, for quick take-off. This "slack" allows the reels time to catch up. Generally, the level of tape in these columns is maintained with a bang-bang servomechanism and a sensor. That method is a little crude. The linear sensing method described here will do a better job economically.

For Computers and Automation...

SENSING AND CONTROL OF TAPE SLACK LEVEL

MAGNETIC TAPE IS USUALLY STORED ON A REEL, and is transferred from one reel to another in the course of reading or writing data. In computer, and other data-recording mechanisms, the tape has to make very fast and accurate starts and stops. In these cases the high-inertia elements should be isolated from the intermittent motion. A common method of buffering is shown in Fig. 1. The relatively large amount of tape that can be stored between the capstans and reels allows the tape at the capstan to start and stop very fast, while the reels follow with lower acceleration rates.

The position of the tape in the column is usually maintained by sensing devices. These devices provide an on-off signal to the servo-mechanism if the tape is above or below a certain limit. These on-off or relay type controllers must possess an inactive zone; i.e., a range of error within which no correction exists, unless continuous oscillations of the response at some amplitude is allowed. In addition, on-off controllers are discontinuous in their action and hence, the output response is never a smooth function of time.

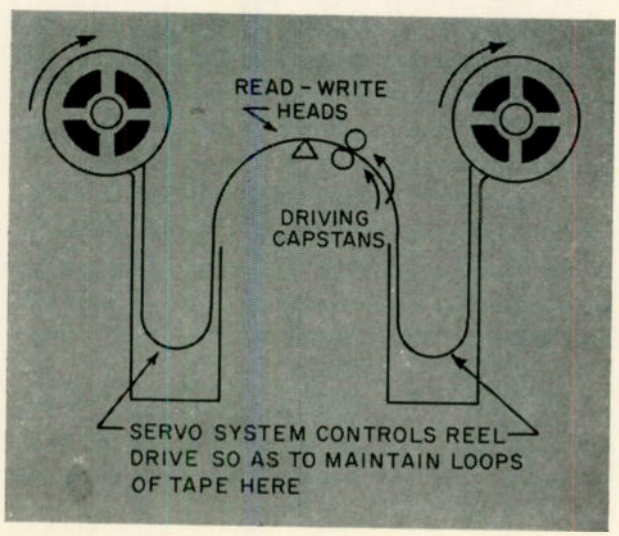


Fig. 1: Usual buffering has large reserves to permit feeding the high-inertia capstans from slower-moving reels.

In contrast to the on-off type control, there is the linear sensing element. This system obviates the disadvantages of the "bang-bang" servomechanism. It provides a continuous correcting signal which is proportional to the tape deviation from a preadjusted null. Several systems have been developed, but most of these are delicate and costly in terms of equipment. They require elaborate electronic circuitry to convert sensing device outputs to useable signals.

* * *

The simple, low-cost technique shown in Fig. 2 affords a good solution to the problem. The neon light "S" provides a light source of constant intensity. The transmittance of the opaque tape is small, so that only the source below the tape contributes any light to the photo-sensing device. Therefore, the quantity of light incident on the sensor (and hence the error signal) is a direct and continuous function of the tape position. The actuating signal is the difference between the photocell amplifier output E_1 and the pre-adjusted null setting E_2.

Luminance at Photo-Sensor

The relationship between the luminous flux incident on the photo-sensor, P, and the tape position can be obtained as follows. Consider the geometry of Fig. 3, where the light source is provided by a narrow slit of width W and length L. The effect of a differential emitting source of area ΔA in the direction toward P is:

(*Continued on page 66*)

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Space Technology Labs, Inc.
Redondo Beach, Calif.

* MR. JIMERSEN was affiliated with Clary Corp., San Gabriel, Calif. when this article was prepared.

TAPE SLACK LEVEL (Concluded)

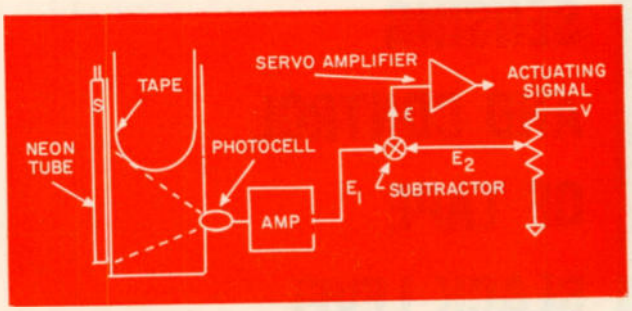


Fig. 2: Functional diagram of the technique to control tape level with linear sensing. Error signal varies with the tape position.

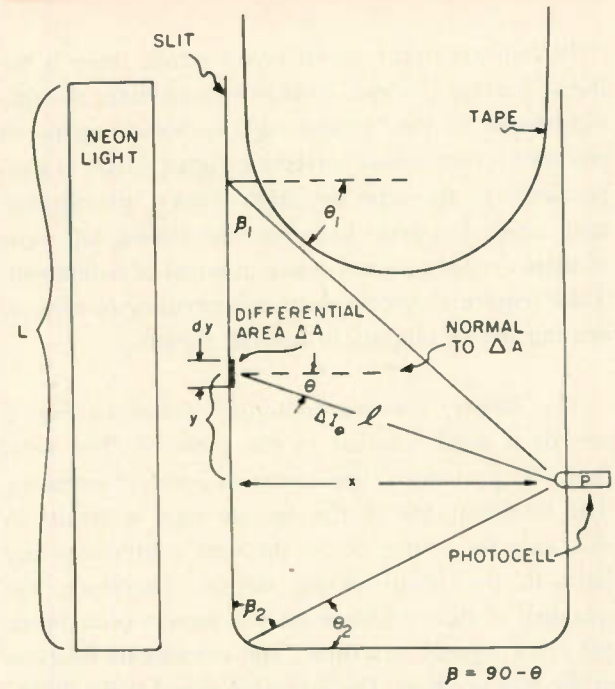
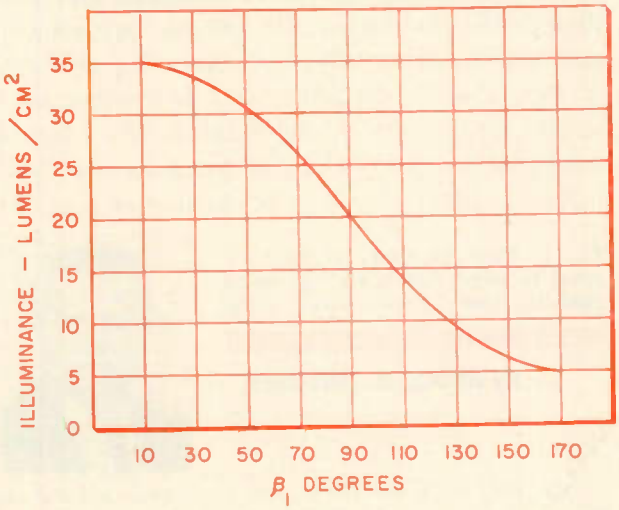


Fig. 3 (above): Diagram of the geometry of the control system. Total luminance at the photocell is calculated from this in the text.

Fig. 4 (below): A plot of the luminance on the photo-sensor from various angles shows good linearity for the null position set at 90°.



$$\Delta I_\theta = \quad_\theta)\ (\Delta A) \cos\theta \qquad (1)$$

where: ΔI_θ is the intensity of the light in a direction making an angle with the normal to the surface.

B_θ is the intensity per unit of projected area of source.

The illuminance at "P" due to the element ΔA is:

$$\Delta E = \frac{\Delta I_\theta \cos\theta}{l^2} \qquad (2)$$

where: ΔE is the differential luminous flux incident per unit area.

From the geometry of Fig. 3.

$$l = X \operatorname{Sec}\theta \qquad (3)$$

$$\Delta A = W(\Delta Y) \qquad (4)$$

$$\Delta Y = X \sec^2\theta\ (\Delta\theta) \qquad (5)$$

Combining Eq. (1) through (5)

$$\Delta E = \frac{(W) \times (B_\theta) \times (\operatorname{Cos}^2\theta) \times (\Delta\theta)}{X} \qquad (6)$$

For the case of a perfectly diffuse substance obeying Lambert's Law the luminance "$\beta\theta$" is independent of the angle θ, or is a constant. Therefore the total luminance at "P" is:

$$E = \frac{W B}{X} \int_{\theta}^{\theta_2} \cos^2\theta\, d\theta$$

$$= K \left[\theta + \sin\theta \cos\theta \right]_{-\theta_2 = \text{constant}}^{\theta_1 = 90° - \beta_1} \qquad (7)$$

A typical plot of the luminance versus the variable angle, θ_1, as determined by Eq. 7 is shown in Fig. 4. As evidenced by the curve, good linearity can be obtained when the tape is operated with the null position near $\beta_1 = 90°$. Extension of the linear region by compensation of the source opacity or variation in slit dimension as a function of length Y is also possible.

Linearity Discussed

To reduce the effects of ambient lighting changes, mount the photocell in some type of enclosure, such that it is most sensitive to light sources in the X-Y plane (See Fig. 3). Another solution is to eliminate background lighting by covering the entire tape column with an opaque material. This method however, would prevent the visual observation of the tape position by the operator.

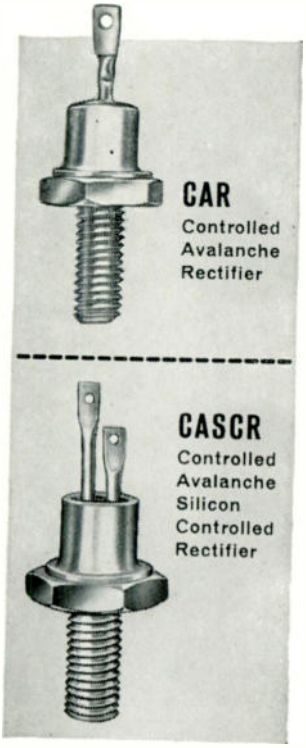
In cases where accurate tape positioning is needed, the dc amplifier may be prohibited. One possible solution is to use a pulsating light source along with an ac amplifier and demodulator. This technique might also be used to reduce the effects of background lighting variations as mentioned.

The utility of the system is not restricted to magnetic tape units. It is quite conceivable that any of the techniques might find application in both paper-tape punching and reading devices.

TARZIAN DESIGN IDEAS

Snowed Under by Transients?

TRY A CONTROLLED AVALANCHE



■ As you may know only too well, transient voltages, superimposed on normal voltages, can cause unexpected field failures of silicon rectifiers. Various devices, some quite effective, are used to suppress these transients. However, the controlled avalanche rectifier contains its own protection, inherent in the rectifier itself. The CAR cycles in and out of its breakdown (or avalanche) region to the full limit of its thermal capacity to dissipate heat losses. For example, a unit capable of handling 12 amperes (or 12 watts) in the forward direction can continually dissipate the same 12 watts in the reverse direction.

Sarkes Tarzian controlled avalanche rectifiers are made from low resistivity, low radial gradient silicon with controlled lattice dislocation. In effect, we've packaged zener diode characteristics into a silicon rectifier with much higher voltage ratings.

The hooker from a manufacturing point of view is that higher operating and transient voltages demand extremely high surface dielectric conditions. Breakdown voltages must be channeled through the junction bulk, not across the surface. Special selection of silicon establishes the path of least resistance, so that power doesn't sneak through narrow paths that lie along lattice faults. Result: Tarzian CARs dissipate, without damage, transient surges that are many times the steady state voltage and power rating of the rectifier.

Controlled Avalanche Silicon Controlled Rectifiers. As an extra added attraction, we've extended the controlled avalanche principle to Tarzian controlled rectifiers—a "built-in" reliability factor on reverse characteristics. These units are now available in 3 and 5 ampere dc ratings, with peak voltage as high as 500 volts.

Data Available. Send today for complete information on currently available Tarzian 6 and 12 ampere controlled avalanche rectifiers, rated to 600 volts, and on Tarzian controlled avalanche silicon controlled rectifiers, rated 3 and 5 amperes dc. Guaranteed to give any circuit designer a warm glow.

FIG. 1. AVALANCHE TEST CIRCUIT

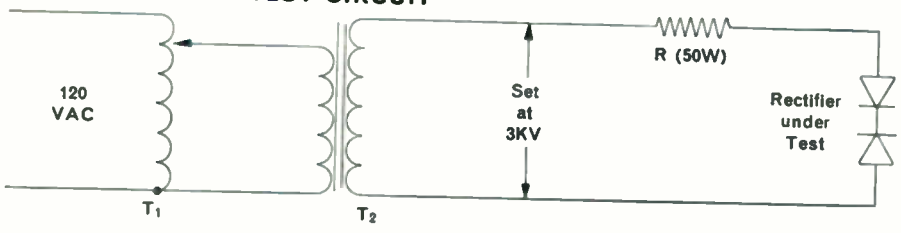


Fig. 1. This circuit tests the ability of the rectifier to operate within ratings in the avalanche region. The value of R is established by maximum steady state wattage rating of the unit under test. Using a 12 watt unit, Tarzian type ST2A60 rated 12 amperes dc, 600 piv, determination is as follows:

$$I_{max} = \frac{12}{600} = 20 \text{ ma}$$

$$R = \frac{3000 - 600}{.02} = 120{,}000 \text{ ohms}$$

T_1 = autotransformer; T_2 = 3KV, 90VA transformer. Provide adequate cooling to prevent thermal run-away.

FIG. 2. TRANSIENT IMPULSE TEST CIRCUIT

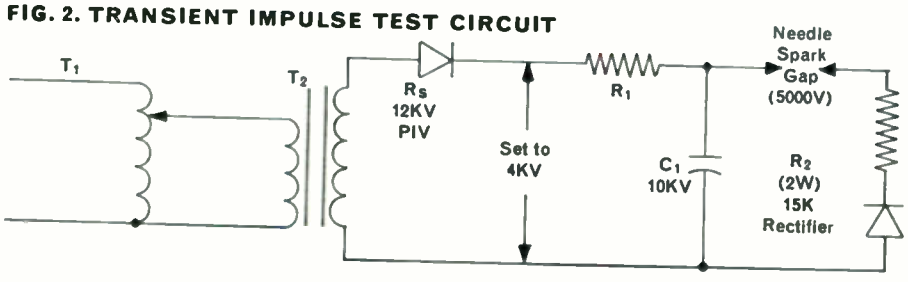
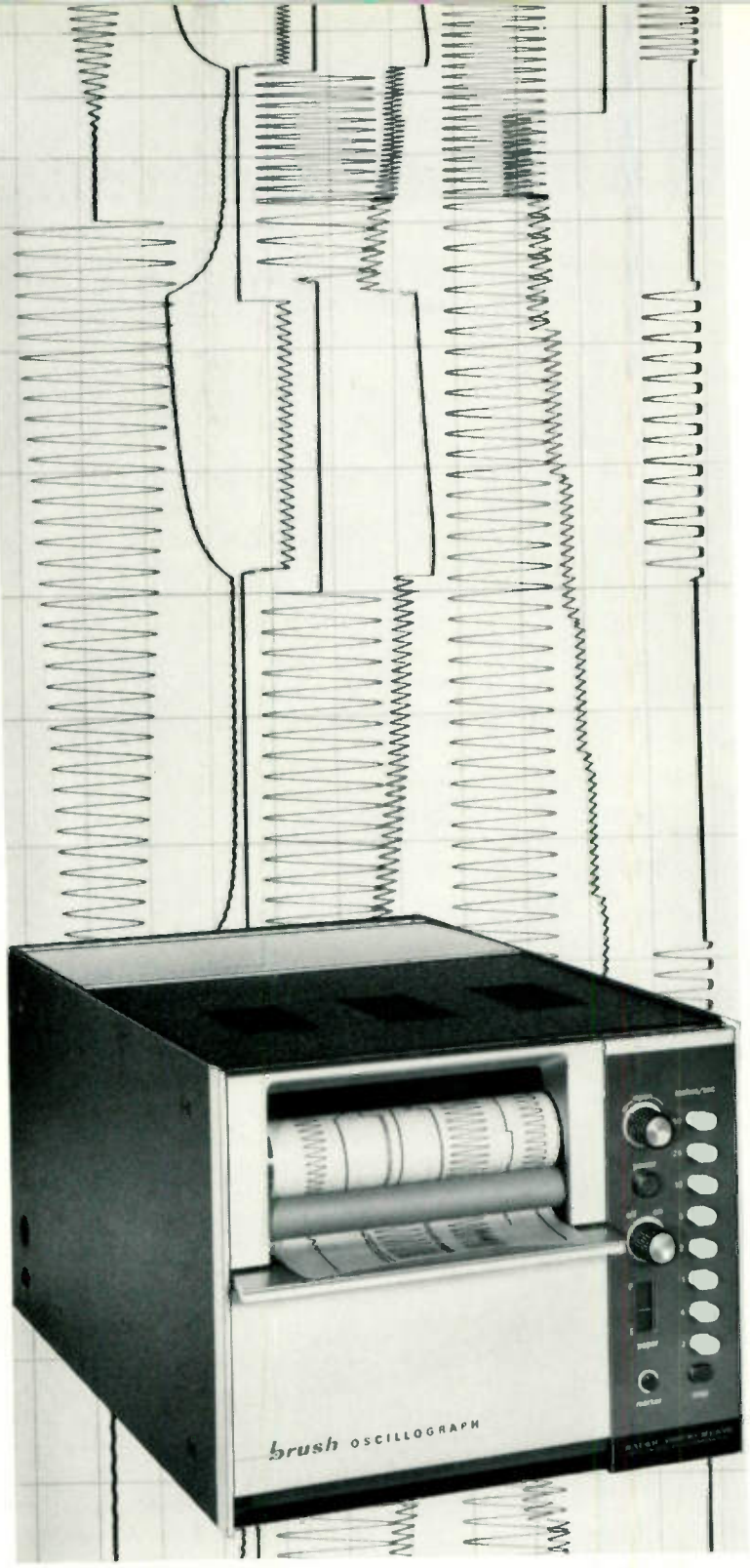


Fig. 2. This circuit tests for transient overvoltage conditions with steep wave fronts that provide high electron acceleration. Current limiting is achieved by R_2, selected for the peak power rating of the unit tested. R_S = Tarzian type S-5505; R_1-C_1 = determinents of proper time constant (RC factor approximately 1-3 seconds); T_1 = autotransformer; T_2 = 4KV, 40 VA transformer.

Actual width of record is 6 inches



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brush INSTRUMENTS

DIVISION OF CLEVITE 37TH AND PERKINS, CLEVELAND 14, OHIO

The transolver has been used as a phase converter and as a synchro transmitter. It has also been used to sum angles, resolve vectors, and to monitor servo instrument systems. As its versatility becomes more widely appreciated, it will be specified more frequently as the pick-off associated with sensitive transducers and central data system.

INTRODUCTION TO THE SYNCHRO TRANSOLVER

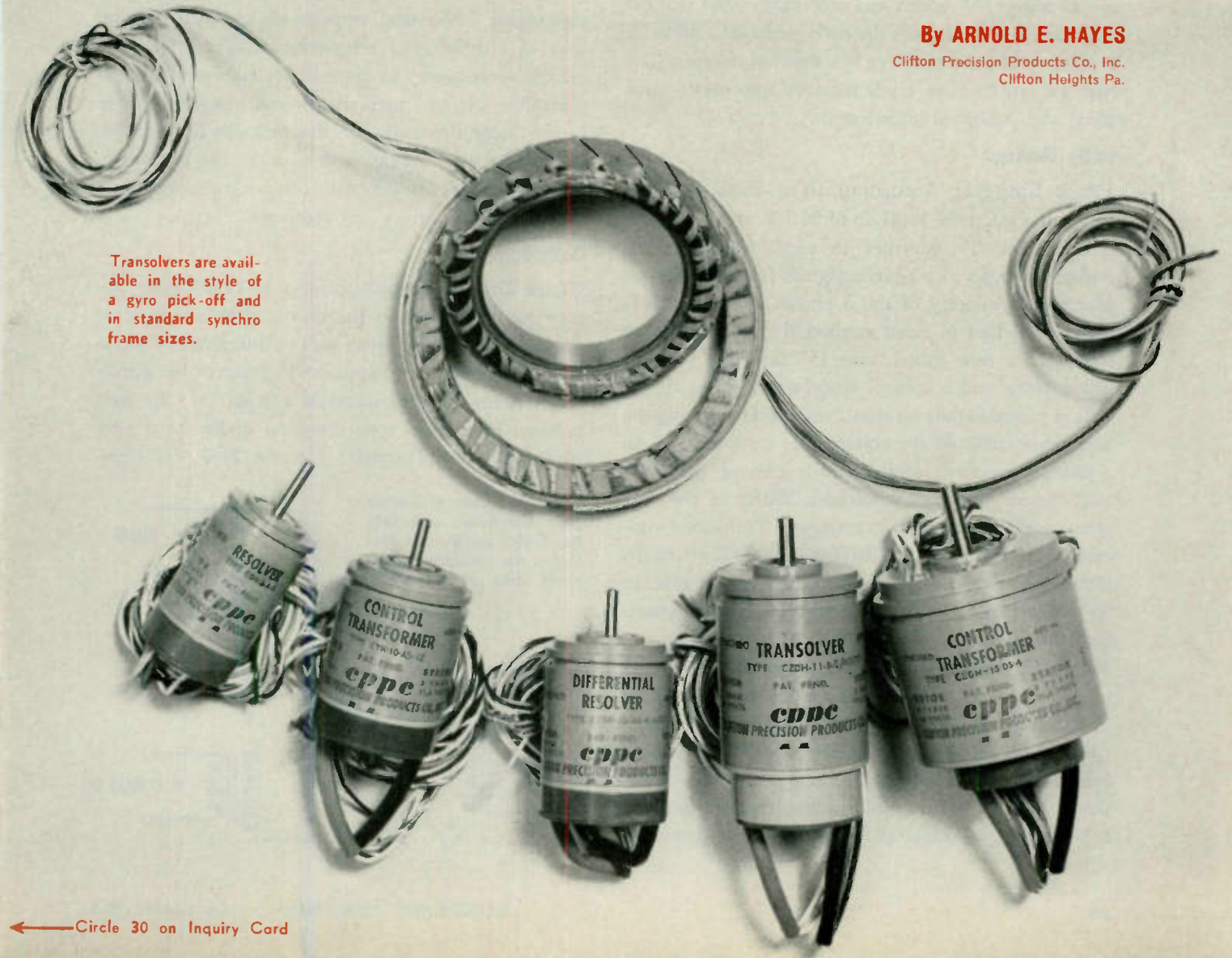
By ARNOLD E. HAYES
Clifton Precision Products Co., Inc.
Clifton Heights Pa.

THE ELECTROMAGNETIC SYNCHRO is the most widely used transducer to convert angular position of a shaft into, or from, an electrical ac analog. Its evolution and development has paralleled that of control technology.

Transmitter, differentials, and control transformers are described in the synchro family of components for control systems. Synchro receivers, resolvers and rotary linear transformers (induction pots) are well known; but, the same cannot be said for the synchro transolver (see photograph). In fact, the most recent government data[1] on synchros does not mention transolvers. Nor do two widely approved industry standards.[2,3]

What then are synchro transolvers? What is their history and what are the prospects for their future?

* * *



Transolvers are available in the style of a gyro pick-off and in standard synchro frame sizes.

A transolver is defined as any synchro that has a 3-phase, Wye-connected element and a relatively rotatable 2-phase element (Fig. 1). This definition cannot be more explicit without contradicting either of 2 pre-set uses of the word. Clifton Precision used the name for years in its synchro catalogs to describe a unit (type CTH-10-AS-12) consisting of a 3-phase stator and a 2-phase, 3-lead (slip-ring) rotor. In MIL - H - 27848,[4] "transolver" refers to a type (CDSH-10-AS-4) synchro having a 3-phase rotor and a 2-phase, 4-wire stator which Clifton Precision calls a "differential resolver."[5] The two styles of construction, of course, were made to serve somewhat different purposes.

The word transolver has synonyms. The transolver has been called a resolver differential generator,[6] a resolver control transformer and a high precision (TY) Autosyn[TM] Synchro;[8] also, a Heading Command Control Transformer[9] or a Course Command Differential Resolver.[10] The most historic of names is "D-Solver,"[11] which did not carry over to the literature and catalogs of the early years after WWII.

History of the transolver is somewhat obscure. The best we can do is to track its developments by personal and published knowledge.

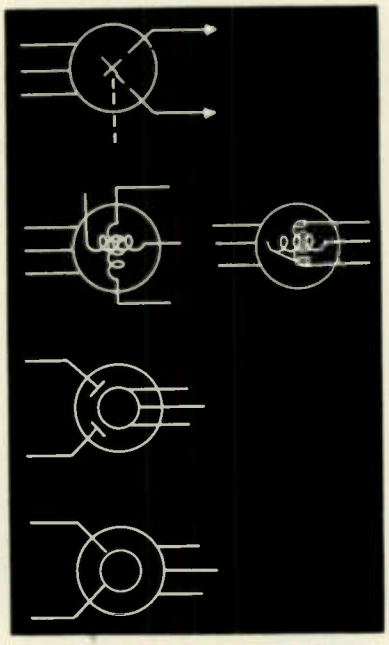


Fig. 1: There are a variety of graphical symbols and diagrams that are used to represent 2-phase — 3-phase transolvers.

Early Devices

Phase Shifters: According to a bona fide account, the war time RadLab of M.I.T. needed a precision Scott - Transformer to convert symmetrical 3-phase voltages into 2-phase signals for radar scopes. Magnetic symmetry of the 3 phases in a synchro is better than that of Scott connected transformers, so they used a now called "size 15" assembly of a resolver rotor and a control transformer stator.[12]

It is probable that someone, somewhere, during the war years inverted the connections to make a 2- to 3-phase converter; and, or also, treated the shaft angle as an independent variable shifter of the time phase angle of the output voltages. Transolver concepts were still novel in 1946 for the solution[13] to the phase-converter problem still called for a synchro transmitter plus a pair of Scott connected transformers (Fig. 2).

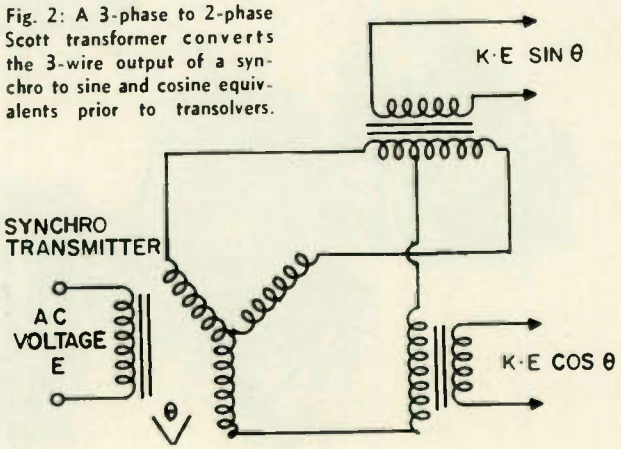
An Early Servomechanism: 3ø-2ø and 3ø-4ø rotary components of a control system were described by Weathers[14] (Fig. 3). For transmitter service, a ring connected 4-phase, 4-wire stator was excited bridge fashion, from a single phase power source and the shaft angle position information was generated in a 3-phase Wye-connected secondary for transmission by wire to the 3-phase primary windings of "receivers," which in turn had 2-phase secondaries.

When the 2-phase receiver secondary was short-circuited, the unit behaved like a synchro receiver except for a 180° ambiguity. With the 2-phase windings of the "receivers" respectively connected to the coils of a differential relay controlling a load positioning servomotor, we have the essence of a modern transolver. It was used as a synchro control transformer, except that the effective null was between the two secondary windings instead of across one winding. Weathers called the components "self-synchronous transmitters and receivers."

Developments

Three Different Applications: 1. Transolver history turns in 1951 to the classic problem of error compensation. The object was to differentially introduce errors equal and opposite to those of the sensor of an earth inductor compass system; or, the loop antenna of a radio type direction finder. For this, McCarthy and Thomas[15] describe how the "con-

Fig. 2: A 3-phase to 2-phase Scott transformer converts the 3-wire output of a synchro to sine and cosine equivalents prior to transolvers.



trollable relationship between transmitter and repeater units is varied by making the field element of one of these units with an additional winding, preferably at right angles to the usual, and supplying this winding with a voltage variable in a predetermined manner." A transolver was used as a synchro transmitter with line excitation applied to 1 winding of the 2-phase element and a variable voltage on the other.

2. Vector addition was used in 1955 in non-avionic or military color comparators. See Fig. 4. The 3-phase element of a size 15 transolver was excited by 3 voltages with amplitudes representing the blue, yellow and red content of the test sample.

3. Use of a single transolver as alternately a transmitter (CX) and then as a control transformer (CT) was reduced to practice in 1957 by the Airborne Instrument Lab. of the Naval Air Development Center in Johnsville, Pa. 400 cycle, 26/11.8 v. size 10 transolvers were chosen for an instrument miniaturization program of that period. Today, both size 8 and 10 units are used in the same fashion by the aircraft instruments described by Refs. 4, 9, and 10.

A single synchro to serve as a CX and alternately as a CT in a closed instrument must be a 2ø-3ø transolver. A 1ø-3ø control transmitter/transformer will not do without means of shifting the visual readout scales, dials or pointers related to the synchro shaft by 90° when the operational mode is switched.

Fig. 3: Here is how 2 - phase to 3 - phase rotary components may have been used in an early follow - up control system.

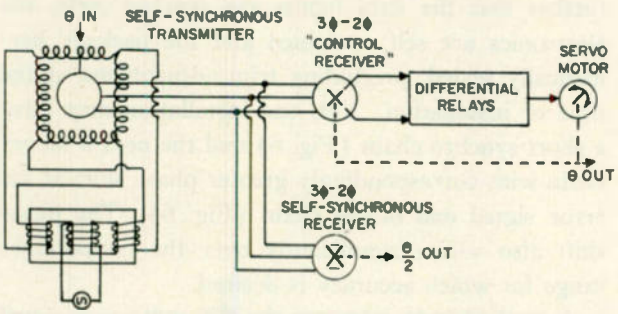
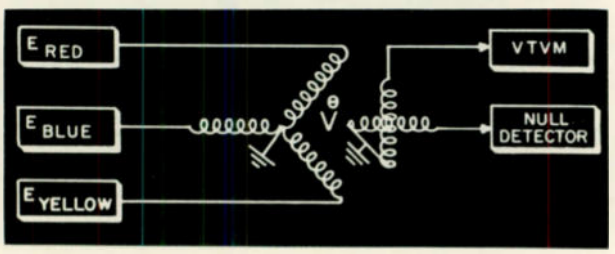


Fig. 4: To facilitate 3 - phase vector addition, a 4th wire neutral was added to a standard 3 - phase stator.



For any chosen electrical angle of the synchro, the nulled winding of a CT is parallel to the stator field, while as a CX the rotor winding is perpendicular to the field. When any transolver is in turn used as a CX and CT, good practice has the unexcited winding of the 2-phase element short-circuited when the unit is serving as a CX, and terminated in the proper impedance during the CT portion of the duty cycle. Of course, if space is available, the alternate modes of operation can be realized by a separate CX and CT to the delight of the synchro suppliers.

Synchro Servo Monitoring: In 1958, the Eclipse-Pioneer Div. of Bendix Aviation completed a "Study of Servo System Failure Warning Devices Pertaining to Remote Aircraft Servoed Instruments." A report [18] described the 3ø-2ø synchro transolver as follows:

"The control transformer has an extra rotor winding at right angles to the null controlled winding. In normal operation this winding is parallel to the flux field and picks up a constant voltage."

"Deviation of the output voltage of this extra winding from its normal output voltage indicates a fault."

The monitoring ability of transolvers will be of future importance since a valuable and practical function of the winding exists but was not used in the past with the transolver employed as a normally operating CT.

The Flux-Valve Transolver: The proper compensation of electric remote reading magnetic compass and heading reference systems led Boose,[19] Seaman,[20] and Whitehead,[21] of General Electric Co., to describe novel methods in 1960. The primary transducer in these systems is an earth inductor type transmitter or "flux-valve" that generates 3-phase second harmonic voltages proportional to the direction and strength of the horizontal component of the earth's magnetic field. The flux valve signals are usually amplified to precess a directional gyro. Compensation is normally introduced by an adjustable mechanical cam mechanism.

The transolver became the means of making an electrical analog of a 3-dimensional adjustable mechanical cam compensator. As in the case of the colorimeter, the 3-phase primary of the transolver is subject to changing levels of excitation.

Summation of Angles: Miniaturized navigational computer set AN/ASN-9 has two size 11 transolver in its complement of rotary components. Alternative synchro systems were considered and transolvers were chosen for the sake of minimizing the total number of components. The transolver was

elegantly used to sum angles in the fashion of synchro differentials while yielding sine and cosine functional outputs.

Transolver Dither and Applications

Our transolver trail returns in 1961 to self-synchronous, torque type transmitter-receiver systems and synchro systems with torque differentials. Torque type synchros have always been susceptible to static friction counter-torques from bearings and brush tension, with consequent errors in the read-out display. It has, therefore, been the custom for torque receivers to get a mild tapping or vibration before error readings are recorded.

Beach and Hurtt[22] have proposed making either the torque transmitter (TX) or receiver (TR) as a transolver by adding a second winding in space quadrature with the otherwise customary single phase winding. A dither voltage is then applied to the auxiliary winding so that the resultant oscillations mask the friction with the net effect of mechanically vibrating the instrument. The dither frequency could be well chosen close to, or the same as, the natural oscillation frequency governed by the TR rotor polar moment of inertia and the torque gradient of the synchro system.

It need not be assumed that the 2-phase element of the transolver is necessarily bi-symmetrical. 2-phase symmetry is clearly essential to the usage in the AN/ASN-9 navigational computer. The symmetry is mere convenience in most other uses. Optimum design of a transolver to serve as a dithered TR or TX would have an asymmetric 2-phase rotor with a solid state microelectronic oscillator built in to the rotor to overcome the drawback of an extra slip ring. But, there is little to show that the potential market will support the cost of trials since bi-symmetrical, transolvers today have a tooling inheritance from other synchros of the same frame size.

Transolver Torque Receiver: The dither winding proposed by Hurtt can alternatively be a signal source when the transolver is used as a self-synchronous torque receiver (Fig. 5). The voltage of the quadrature winding is a measure of the magnitude and direction of the error in the angular position of the synchromotor shaft. It may also be taken as a measure of the torque exerted by the synchro against mechanical loads, which are the main cause of the synchro error in the first place.

The error detecting ability can be useful to see that each of several remotely placed, but parallel wired synchro "receivers" are singly tracking the transmitter within fixed operating limits.

Detecting the error and measuring torque of self-synchronous receivers without using a quadrature wound transolver is cumbersome. For example, another way is to employ a 3ø-3ø synchro differential with line voltage applied across 2 of the 3 phases and an auxiliary 2:1 transformer. The third phase and the transformer secondary are bucked in series to yield a null for the case of zero torque and zero error.

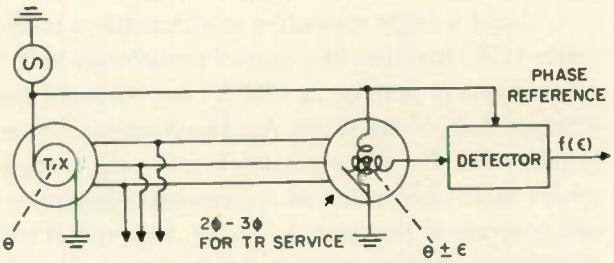


Fig. 5: The phase and amplitude detector can be placed at the transmitting station to provide "feedback" on the proper performance of remotely located synchro "receivers."

Possible Transolver Applications

There are some potential uses for transolvers still unrecorded in the literature. Three of these are perhaps worthy of mention here to predict developments that are apt to occur in a few years.

Error Signal Phase Reference: Let's presume a need to design a precision instrument servomechanism of the high accuracy positioning type. Suppose further that the data inputs are synchro style, the electronics are self contained and the package hermetically sealed, precluding trim adjustments at the time of installation. Yet, one installation may have a short synchro chain (Fig. 6) and the next a longer chain with correspondingly greater phase shift at the error signal end of the chain (Fig. 6). The phase shift also varies significantly over the temperature range for which accuracy is desired.

A method is to integrate the CT null error signal and pump a cancelling quadrature voltage into the servo amplifier, hoping that a proper quadrature reference can be found. If the transolver is used for the CT (Fig. 6), the signal given by the extra winding is robust (rather than a null needing to be integrated), and it is a true in-phase reference voltage for the synchro chain error signal (except when the error exceeds 90°). Thus, there is another function for the transolver signal besides that of failure monitoring.

Central Data Systems: The 400-cycle synchros

and computers of centralized data systems are mostly "transmitters" with a 11.8 v. line-to-line stator and large enough to permit operation of at least 3 (at usually selected for output elements of the sensors times 4 or 5) external high-impedance (500Ω or higher) control transformers.

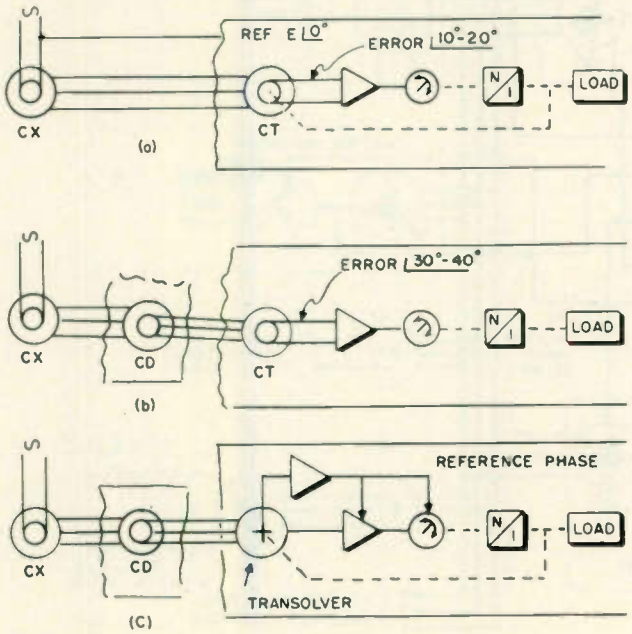
It starts out to be a simple synchro system. Then it "just grows" as new auxiliary equipments come into being, each demanding accurate (perfect input) data to be most effective. Or perhaps, a heretofore successful central data system is chosen for "minor" change in an airframe whose new mission needs accurate data at more stations. The transition is seldom abrupt since one new requirement is added at a time, and there is always room for one more. Nevertheless, the now not so simple synchro data transmission system suffers from what the electric power companies call "octopus outlets" and all equipments suffer from the gradual degradation of the input data. Growth requirements are usually met by adding a sub-servo synchro signal amplifier.

Despite the higher count of slip-rings, connector-pins and cabled wires, the central data systems that judiciously use transolver synchros have fewer problems of sensor loading, blown fuses and functional monitoring that go with growth.

Consider the transolver equipped central data sensor or computer.

A. For the originally expected load of available CT containing equipments, the transolver can be chosen (or made to order) to appropriately serve as a CX (Fig. 7).

Fig. 6: The top two drawings indicate errors when different synchro chains are used. The bottom drawing shows how a transolver is used in place of the CT for accuracy.



B. At the early stage of growth, a suitably powered TX is scheduled into one (Fig. 7) of the related equipments and the sensor/transducer/computer positioned transolver is made to serve as a CT plus as a source of a monitor signal. The latter amounts to more than a power on-off flag.

C. Then, for "octopus outlet" type growth, the process is repeated with an even lower impedance transmitter selected to power the synchro datum lines being placed in any one of the accessories that can be either added or changed at minor expense compared to that of a new central data system.

Note the integrity of central system data can be saved and separated from the ills that plague unplanned complex synchro data sending systems.

Comparators: There are cases when flight safety dictates the use of two completely independent data systems in parallel. A simple comparator shows that a disagreement exists between two sets of transmitted data for a referee to be alerted to and leisurely decide between. Thus, it is a reporter that makes no decision. For data systems having servo style indicators, a synchro CT is added to each indicator to help with the comparator function.

More vital data systems will require data comparators with specific powers of decision which come from a well selected logic. They make emergency switching of controls before reporting the transaction to humans by flags, lights or horns.

To illustrate, assume the case of a central data sensor-synchro system so essential that for safety a stand-by secondary sensor and synchro is required. There are many assumptions and their combinations. Space allows but one, so we elect the instance of a transolver equipped central data sensors (Fig. 8). The switching transfer of data authority from one sensor to the other can be made automatic; or, it may be arranged to simply alert the operator pilot of a contradiction. This extension of synchro servo system monitoring with the aid of transolvers can also be used to verify that the electrical angle position data is being properly tracked by the using equipments. Thus transolvers correctly placed within the synchro chains of independent sensor and data using equipments can provide signals useful to flight safety decision-making comparators.

The applications of 2ø-3ø synchro transolvers has been reviewed along with the history dating from 1940. A possible use for which no record was found is the case of employing transolvers as CT's in a 2-speed servo system, wherein voltages on the quadrature windings are both monitored or used to modify closed loop characteristics. (*Continued*)

SYNCHRO TRANSOLVER (Concluded)

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11. Private communication with Mr. Milton Brown, Eclipse-Pioneer Div., Bendix Aviation Corp., who made the units.....

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16. U.S. Patent 2,488,771 "Induction Devices Having A Substantially Pure Sine Relationship Between the Coupling and the Relative Displacement of its Elements," J. P. Glass, Jr. 22 Nov. 1949. Application filed 21 Aug. 1944.

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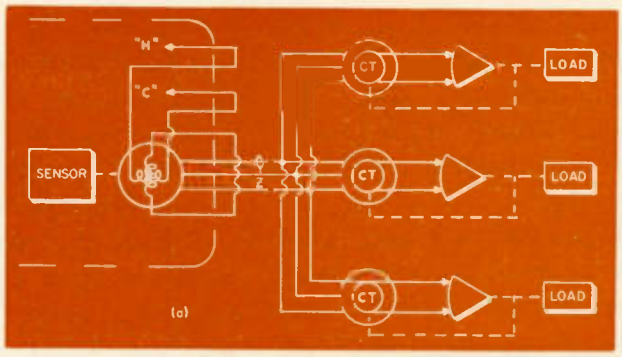


Fig. 7a: A simple synchro sensor system.

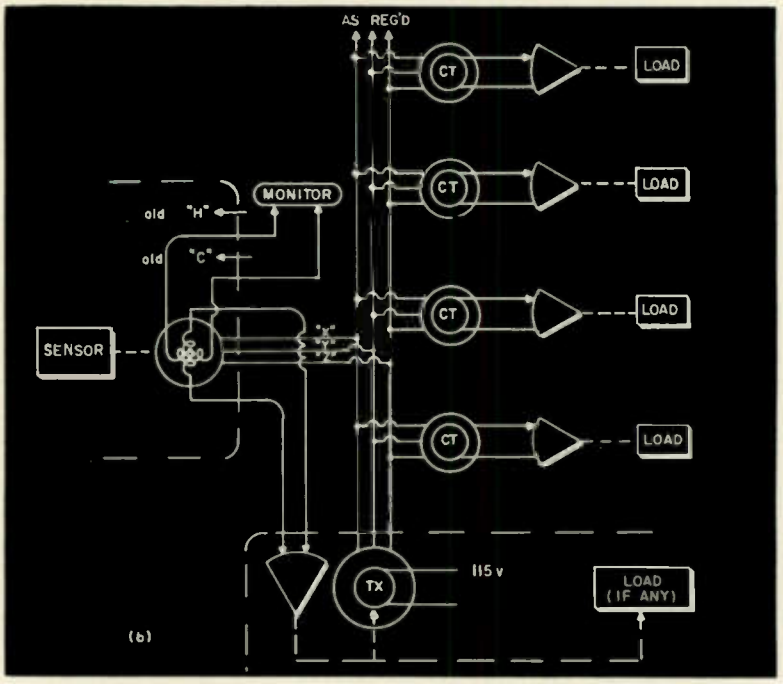
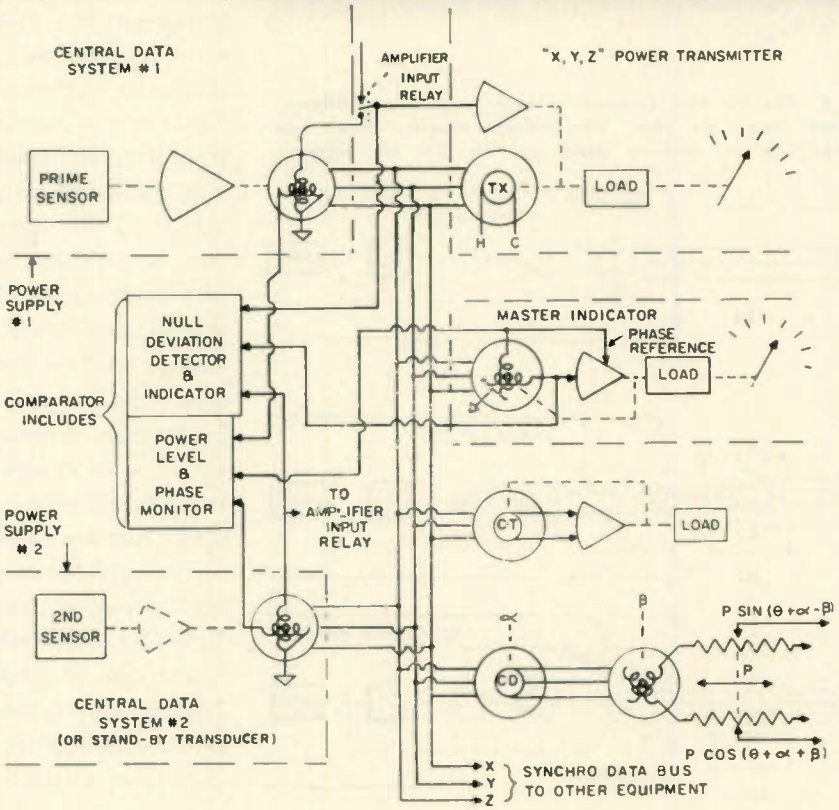


Fig. 7b: Synchro system growth without obsoleting the sensor in 7a.

Fig. 8: Diagram (below) does not show switching logic or means for transfering authority of XYZ datum lines from one sensor to the other.



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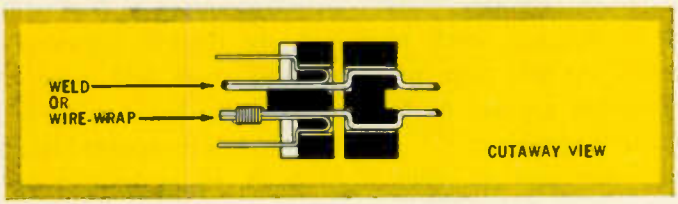

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Subminiature Type 3	34	.050	1.502" x .400"
Subminiature Type 4	18	.100	1.502" x .400"

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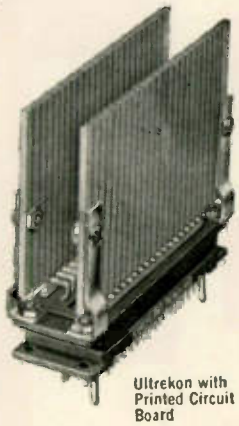
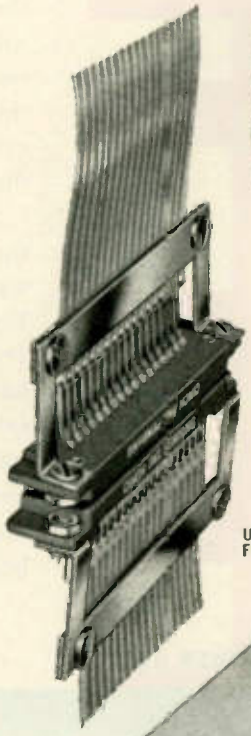
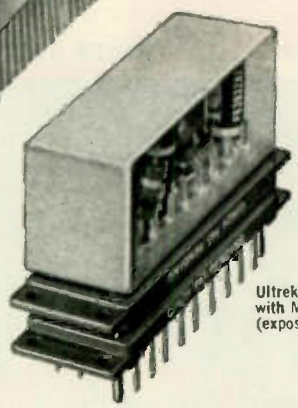

Ultrekon with Printed Circuit Board


Ultrekon with Flat Cable


Ultrekon with Module (exposed view)

CM-6303

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Circle 31 on Inquiry Card

The growth of technology throughout the world is generating an ever increasing amount of technical literature. Much of this material must be translated into other languages. As human translators could not possibly handle the volume, we have turned to computer systems. The memory unit for one such system is described here.

TECHNICAL TRANSLATIONS BY COMPUTER

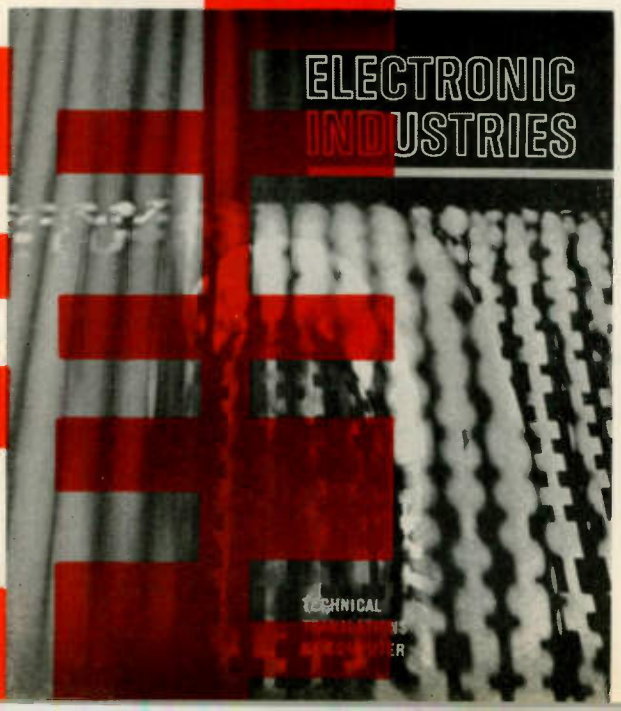
THE NUMBER OF HUMAN TRANSLATORS available for technical translations is limited. At the same time the amount of technical material coming from abroad is growing. To take advantage of the advances that have been made in foreign countries, it is necessary to translate much of this material. At this time machine translation appears to be the answer to the problem.

Several years ago an automatic machine translation system was developed by IBM for the Air Force. The system, which was first shown in May, 1960, translated Russian into English at a rate of 1800 words a minute. The translation was rough but understandable and since then the system has been electronically and linguistically refined.

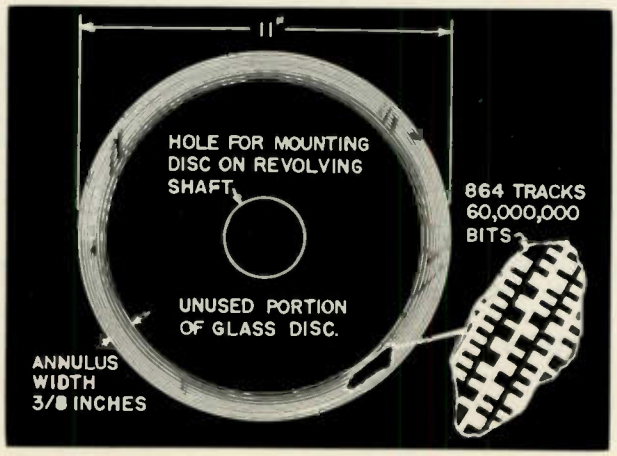
Memory Disc

We will be concerned here not with the machine translation system itself, but with the heart of the machine which is a large and fast photoscopic memory disc. On this disc are stored coded words in the language to be translated with the English equivalents, as well as syntactical rules. This memory disc has a coded dictionary which is represented by tracks of black rectangles put on the disc photographically. The cover of this month's issue of ELECTRONIC INDUSTRIES contains an artist's conception of these tracks. The high resolution of photographic methods allows these patterns to be very small. The disc used in this Russian translation contains 60 million bits—binary digits—with information in a 3/8-

COVER STORY



Layout of coded information in the photoscopic memory disc. Annulus width is kept as small as possible for the sake of rapid access. Film discs are now replacing the glass discs.



in. wide path near the outer edge of the 11-in. diameter disc. These 60 million bits correspond to instructions which include Russian words, their English equivalents and grammatical information.

As Russian was the first language to which IBM Research concentrated its attention, there has been enough time to accumulate this extensive dictionary totaling about 150,000 entries. These entries, along with grammatical procedures which have been developed, have combined to make it possible to translate random text in any field. Thus, if an article is presented for translation, the machine will translate it. A look at Fig. 1 illustrates this. This figure contains an original Russian article, a machine translation of the article, and finally, a human translation of the same article. It may be noted that while the machine translation is rough—much rougher than the human translation—it is still understandable.

Russian Translation

When a Russian word enters the system for translation, its code is compared with the coded words on the disc. This is done by a

ИНДУКТИВНЫЕ СВОЙСТВА СЕЛЕНОВЫХ ВЫПРЯМИТЕЛЕЙ

Г. М. Авакьянц, И. С. Гринберг, Е. Г. Заугольникова, В. И. Мурыгин

Описаны экспериментальные исследования, показывающие, что селеновые выпрямители при достаточно больших смещающих напряжениях, приложенных в запорном направлении, обладают индуктивными свойствами. Определены основные характеристики наблюдаемого явления. Результаты экспериментов сопоставлены с теорией [5].

Можно указать немало работ, отмечающих, что в германиевых и кремниевых диодах, смещенных в прямом направлении, при высоких уровнях инъекции появляется индуктивная составляющая полного сопротивления [1, 2]. Эти исследования проводились в основном в направлении выяснения механизма индуктивного эффекта и не ставили вопроса об его практическом применении. Тем не менее для широкого развития микроминиатюрных схем в последние годы велись усиленные поиски полупроводниковых элементов, обладающих большой индуктивностью и высокой добротностью. Такие поиски, по-видимому, увенчались успехом. В 1960 г. Нишизава и Ватанабе [3] описали индуктивный диод из германия, представляющий полупроводниковый прибор типа p^+npn^+. Вслед за этим Шуллер и Гертнер [4] сообщили, что на базе такого диода ими получен *LC*-генератор.

INDUCTIVE PROPERTIES OF SELENIUM RECTIFIERS

G. M. Avakyants I. S. Grinberg E. G. Zaugolnikova V. I. Murygin

Described experiental investigations, showing that selenium rectifiers at/during sufficiently large voltage bias, add/applied in closing direction, possessed inductive properties. Definite main characteristics of observed phenomenon. Results of experiments compared with theory [5].

It is possible to to indicate a great deal works, marking that in germanium and silicon diodes, displaced in straight direction, at/during high levels of injectionappear appears inductive constituting full resistance [1, 2]. These investigation conduct were conducted basically in direction of ascertaining of mechanism of inductive effect and did not set/place question about him/his/it/its practical application. Nonetheless for wide development micro-miniature diagram/circuits in the last years be ordered reinforced search of semiconductor elements, possessing great inductance and high Q-factor. Such seajch, apparently, were crowned by success. In 1960 g. Nishizava and Vatanabe [3] described inductive diode from germanium, present/representing semiconductor instrument of type p+npn+. After this/these Shuller and Gertner [4] communicated that on base of such diode them received LC-generator.

Fig. 1: At the top of the page is an original Russian article. Just below it is a machine translation of the article. The human translation of the same article is at the bottom of the page. Note that while the machine translation is rough, it is still understandable.

INDUCTIVE PROPERTIES OF SELENIUM RECTIFIERS

G. M. Avak'yants and I. S. Grinberg, Ye. G. Zaugol'nikova and V. I. Murygin

The report describes experimental investigations showing that with sufficiently large reverse bias voltages selenium rectifiers possess inductive properties. The principal characteristics of the observed phenomenon are determined. The results of experiments are compared with theory [5].

Numerous works may be cited in which it is noted that in forward-biased germanium and silicon diodes at high injection levels there appears an inductive component in impedance [1, 2]. These investigations have been performed largely to explain the mechanism of the inductive effect and have not dealt with the problem from the standpoint of its practical application. Nevertheless, for the wide development of microminiature circuits in recent years, intensified research has been conducted in semiconductor elements possessing high inductance and high Q. Such research has evidently met with much success. In 1960 Nishizawa and Watanabe [3] described an inductive diode of germanium which is a semiconductor device of p+npn+ type. Subsequently Schuller and Gartner [4] reported that they had constructed an LC oscillator on the basis of such a diode.

TECHNICAL TRANSLATIONS BY COMPUTER

(*Continued from page 77*)

pencil beam of light which moves over the rotating disc. The light coming through the disc is detected by a photocell, and when a series of white and black rectangles corresponding to the code of the incoming word is detected, the word has been matched in the dictionary. This causes the dictionary code for the word to be transferred into a storage register. It remains here while the rest of the words of a complete sentence are detected and placed in the same register.

U. S. GOVERNMENT BIGGEST SINGLE BUYER OF EDP PRODUCTS

The Federal Government being the largest single purchaser and user of electronic computers, the U. S. Bureau of Budget predicts that the Government will shell out about 15% more for EDP systems in fiscal 1964 than for 1963.

This estimate would put the 1964 figure at nearly $820 million for buying, renting equipment, for salaries, upkeep, installation and supplies.

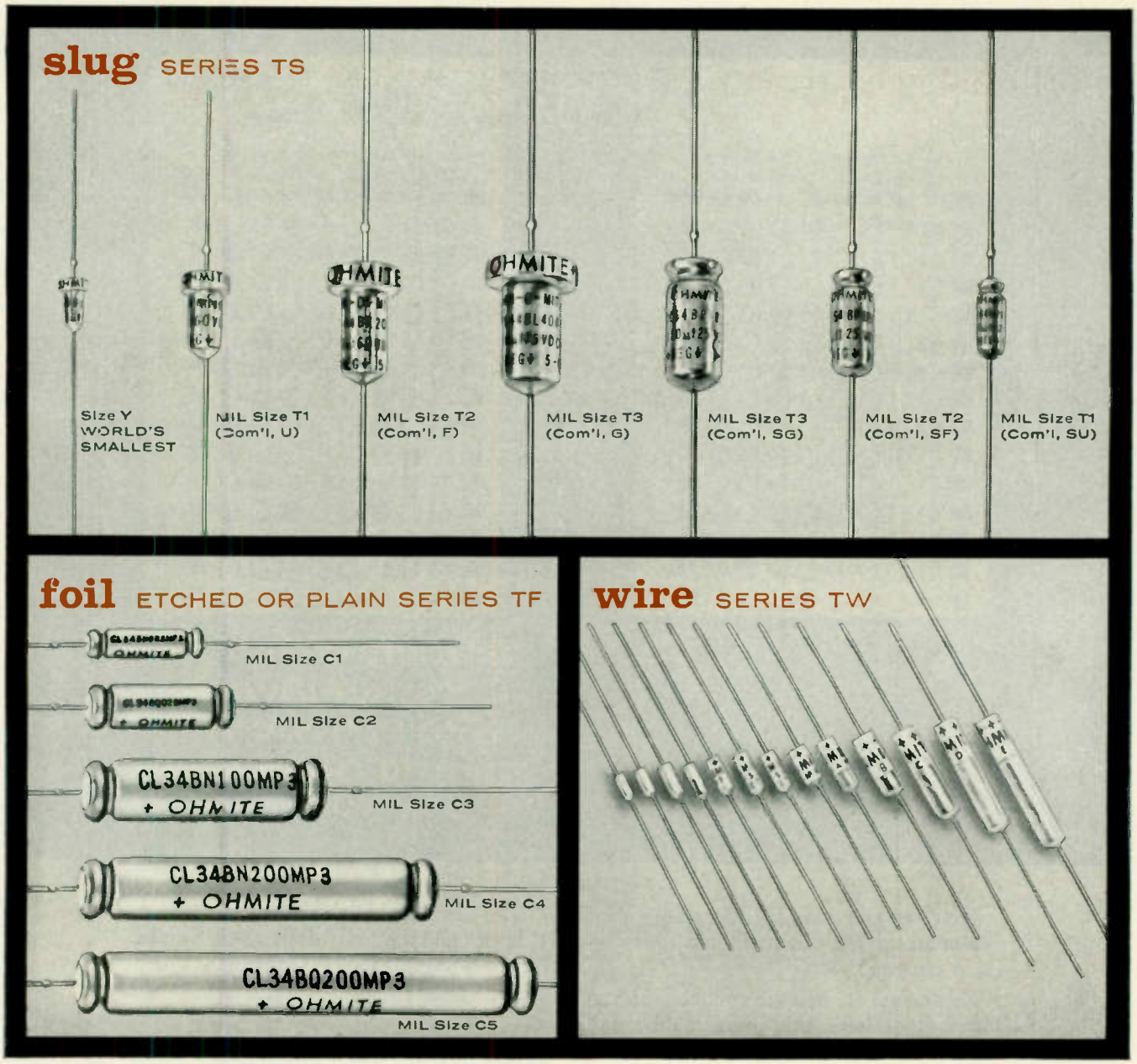
As 1963 ushers out, there are about 1,250 computers in use by the Government. By the end of 1964, the total of computers in operation may rise to nearly 1600. Toward the end of fiscal 1966, the Government may be using as many as 2100 machines or better.

The average time needed to find a word on the disc is 1/30 of a sec. Each Russian word stored in the memory is followed by its English equivalent. It is also followed by as much grammatical information as can be ascribed to the individual word out of context. This information is transferred into the storage register along with the word when it has been recognized. Thus, the storage register at this point contains all the words of a Russian sentence plus a large amount of information about the possible grammatical functions of each word. The machine now analyzes a sentence with its proper English equivalent, using the information contained in word codes themselves, along with rules concerning the functions of each word in relation to other words in the sentence. An example of this is the way certain prepositions are translated. One of these can mean either "with" or "from"; another either "against" or "concerning," etc. The choice between alternative meanings is made by examining the noun or adjective following the preposition. In most instances the case of the following word determines the correct meaning. Many other grammatical rules are applied in a similar manner by the machine.

Using such methods a readable translation can be produced with only an occasional ambiguity. Similar techniques are used in Chinese translations and can be used to translate other languages.

Chinese Translation

While on the subject of Chinese, it might be mentioned that an experimental system for automatic machine translation from Chinese into English has also been demonstrated by IBM. The demonstration was made with a limited vocabulary, but a large Chinese-English machine dictionary now in preparation will permit translations of more extensive Chinese texts. The success of these endeavors serves to demonstrate the feasibility of automatic machine translation systems. It appears that our problems in making technical translations have been resolved. Further refinement should only add icing to the cake.



MIL or commercial—smaller sizes—delivery from stock—to meet all your needs

If you've been searching for an ultra-small hat-shaped wet slug capacitor, you've found it in Ohmite's exclusive Size Y shown above. It's half again smaller than MIL Size T1 (Com'l, U). Or if you've been looking for extra tiny tantalum wire capacitors for less critical applications, you can stop because they are to be found in the Series TW above. For your more routine requirements, try any Ohmite tantalum capacitor and be surprised by the unusually superior way it comes through evaluation tests. Wet slug and foil capacitors come in all MIL-C-3965C (new spec) sizes and meet all requirements. Literally, hundreds of capacitance values in all three types are carried in stock for quick procurement needs. Be sure your capacitor literature is up to date. Write for the bulletins shown below: No. 603, Slugs; No. 602, Foil; No. 148K, Wire.



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

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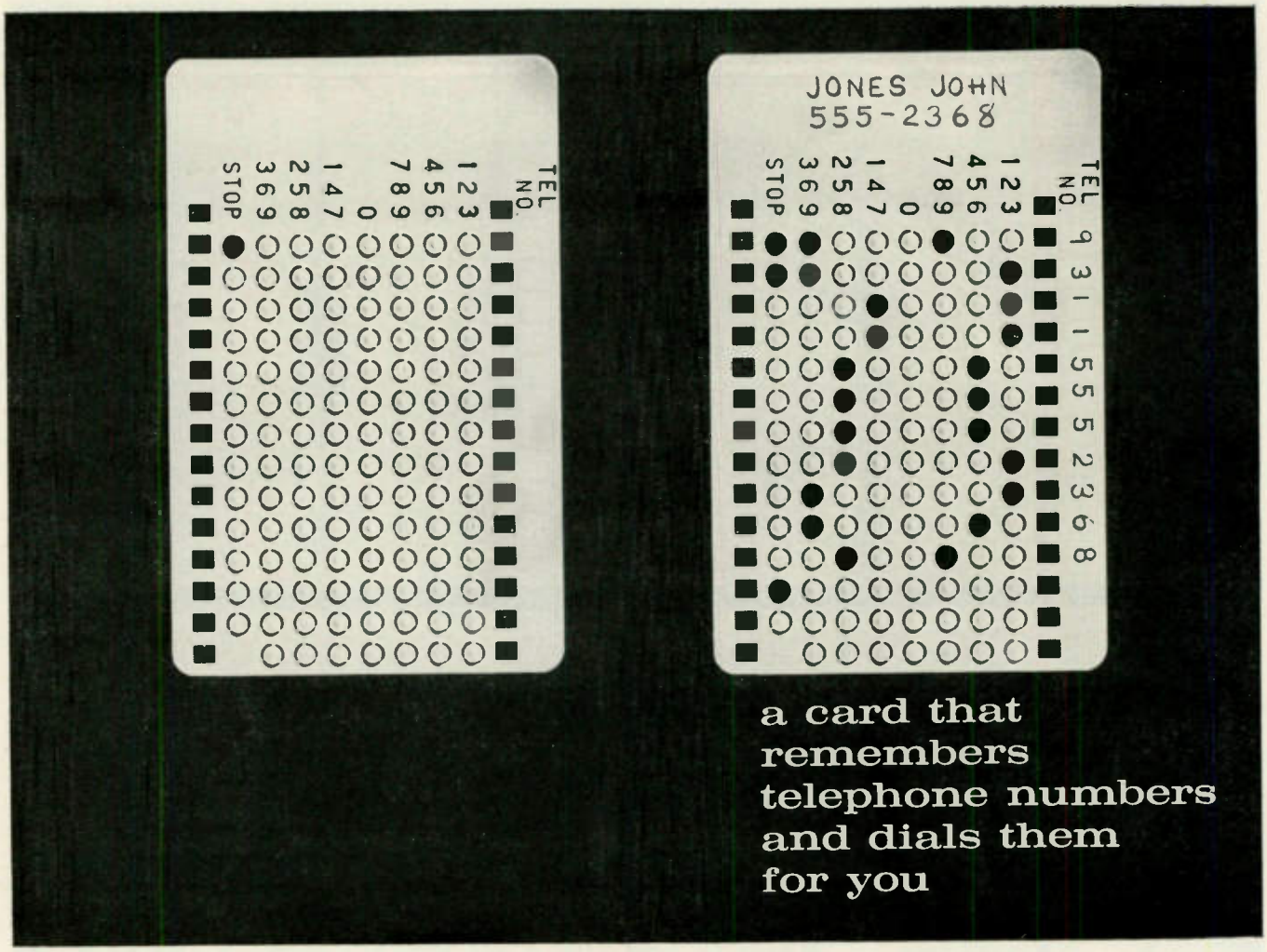


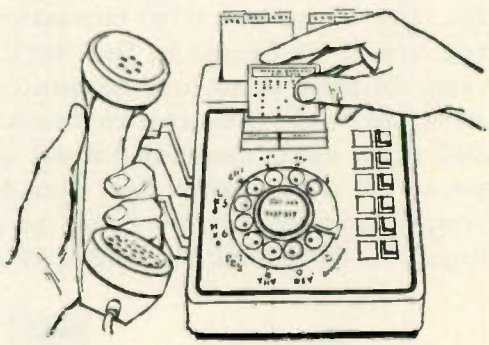
How can you make a telephone remember numbers you often call and then dial them for you?

Engineers at Bell Telephone Laboratories are solving this problem in many different ways. One solution is the Card-Dialer telephone shown at the right. Here the required memory is in the form of economical plastic cards which fit into a slot in the telephone.

Each card contains a complete telephone number punched out in a simple pattern (see upper right). When a card is inserted in a Card-Dialer telephone, the recorded number is automatically dialed. To do this, the telephone senses the code on the card and generates a corresponding train of dial pulses. These pulses are then detected by central office equipment in the same way as those generated by a regular telephone dial. Simply by punching out the necessary holes with a pencil, you can prepare as many cards as you wish for both local or Direct Distance Dialing.

The new Card-Dialer telephone is now being manufactured for the Bell System by the Western Electric Company.

As the card is pushed down, the square holes engage sprockets which wind a spring. Then, as the card emerges, it contacts plastic rollers which detect the round holes and appropriately actuate a pulse generator. The 2-out-of-7 code is easy to use and does not require a costly sensing mechanism.

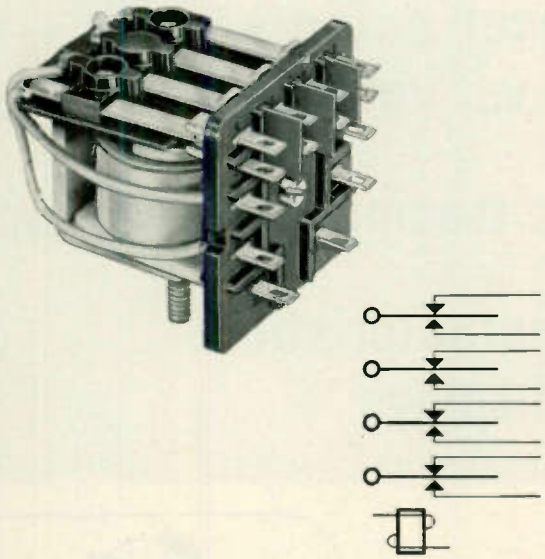


Bell Telephone Laboratories

World center of communications research and development

two new developments in Ohmite "GPR" relays

The only available 4-pole unit in this type of relay



For the first time, you can get the *extra circuit-handling* capability of a 4PDT combination in a good quality, economical, compact relay of this type. This is made possible by the unique design of Ohmite GPR relays which locates *all terminals* (including coil terminal) on *one panel*.

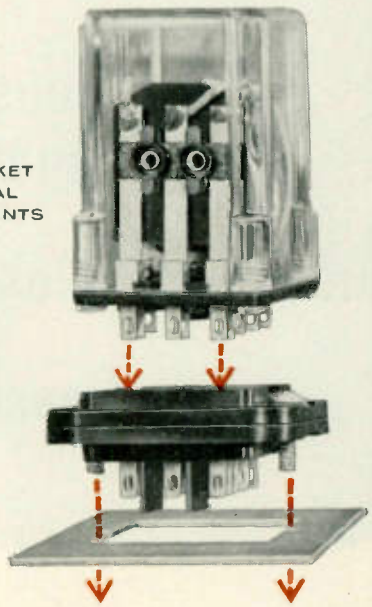
The 4PDT model is currently *stocked for immediate delivery* as unenclosed units with 5-amp or 10-amp contacts—regular models, plate circuit types, and for thyratron (2050, 2D21) plate circuits. Coil operating voltages range from 6 to 230 VAC and 6 to 110 VDC.

(BULLETIN 707)

New, low cost, plug-in socket

NEW SOGPR-9 SOCKET MEETS UL TERMINAL SPACING REQUIREMENTS FOR 150 VOLTS

FOR 3PDT MAX



Here's the welcome convenience of a plug-in connection for the Ohmite line of GPR relays. The SOGPR-9 socket accommodates standard, UL approved models up to 3PDT—both the unenclosed and enclosed types.

Firm, snug mounting is assured even under conditions of vibration and shock by means of a hold-down spring, which can be used at your option, or as the application demands.

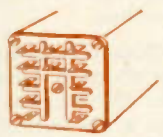
The solder terminals on the new socket are the Ohmite multi-use type, and will accept AMP110 quick-connect (push-on) connectors. SOGPR-9 sockets are carried in stock for *immediate delivery*.

(BULLETIN 706)

OHMITE "GPR" RELAYS ARE LOADED WITH PROBLEM-SOLVING FEATURES

CHOICE of below-chassis or above-chassis connecting in plastic enclosures.

MULTI-USE terminals allow soldering, insertion in printed circuit board, and use of AMP Style 110 push-on terminals.



ALL TERMINALS on one panel . . . permits insertion in printed circuit board.

OCTAL PLUG relays up to 4PDT have recessed pin bases . . . meet UL spacing requirements to 150 V.

ALL ENCLOSED relays mount solidly on base . . . *not* on covers.

INTEGRAL plug-in base up to 4PDT avoids wiring between contact terminals and pins.

Call Your Distributor or Write for Complete Relay Catalog 700

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

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Circle 34 on Inquiry Card

measuring stimulus and reaction on the same time base

measuring transducer outputs, such as pressure vs. volume

measuring plots of X-Y curve-tracing presentations

measuring other characteristics of low-level displays

new Tektronix oscilloscope for general-purpose work

The Type 502A Oscilloscope offers 100 μv/cm sensitivity and dual-beam convenience for a wide range of waveform-comparison applications.

amplifier features ■ 2 Identical Vertical Amplifiers with passbands from dc to 50 kc minimum, to 1 Mc maximum ■ 17 Calibrated Steps of Sensitivity from 100 μv/cm to 20 v/cm ■ Differential Input at All Sensitivities for eliminating unwanted common-mode signals.

time-base features ■ 21 Calibrated Sweep Rates from 1 μsec/cm to 5 sec/cm ■ 4 Steps of Sweep Magnification at 2X, 5X, 10X, or 20X ■ Single-Sweep Operation for photographing single-shot events.

other features ■ Push-Button Beam Finders for quick location of off-screen signals ■ Intensity Balance for identification of upper and lower traces ■ Electronically-Regulated Power Supplies for stable operation under fluctuating line conditions.

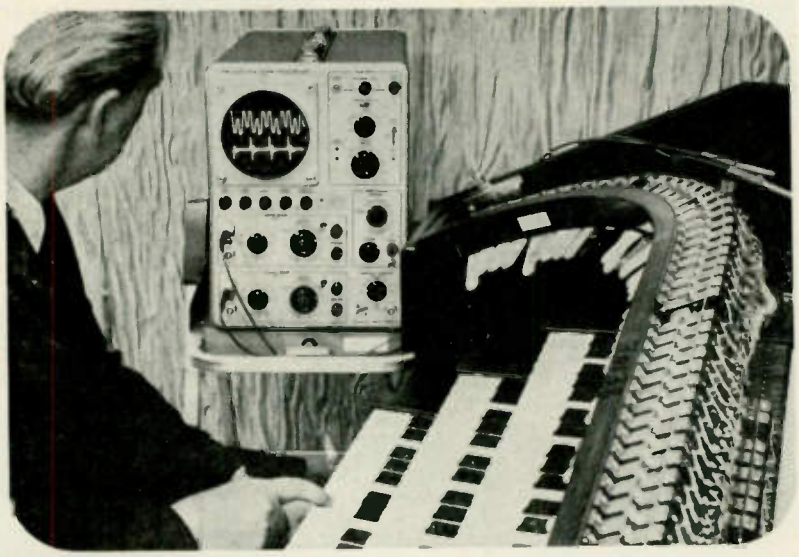
Type 502A Dual-Beam Oscilloscope $1050
U.S. Sales Price f.o.b. Beaverton, Oregon

FOR A DEMONSTRATION IN YOUR OWN APPLICATION, CALL YOUR TEKTRONIX FIELD ENGINEER

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

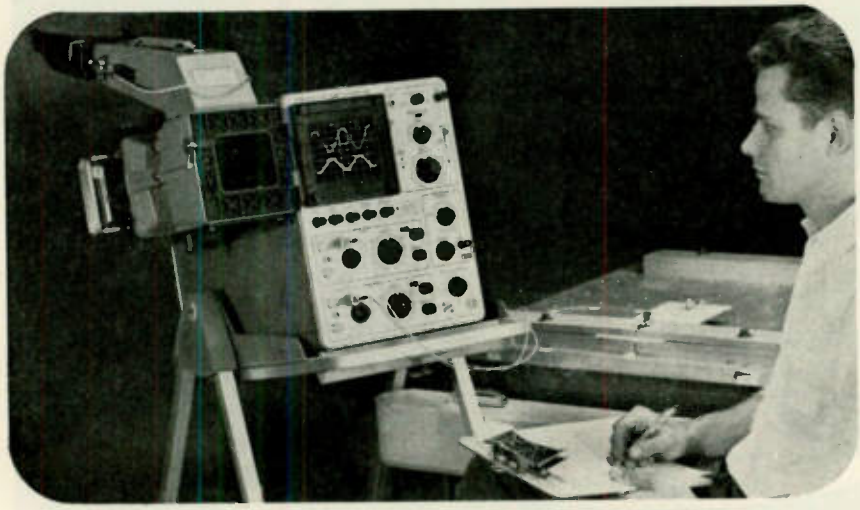
Tektronix Field Offices: *in principal cities in the United States. Consult Telephone Directory* • ***Tektronix Limited,*** *Guernsey, Channel Islands*
Tektronix Canada Ltd.: *Montreal, Quebec* • *Toronto (Willowdale), Ontario* • ***Tektronix Australia Pty. Limited,*** *Sydney, New South Wales*

here's a tonal test on an electronic organ



■ In this quality-control procedure at Rodgers Organ Company, the Type 502A displays waveforms showing response of various organ stops.
■ Each note is generated by a separate oscillator and then shaped by a tone filter.
■ CRT display shows outputs from two of the many tone filters. Upper trace is the clarinet stop. Lower trace is the posthorn stop.
Time-base rate is 1 ms/cm. Amplifier sensitivity is 2 mv/cm.

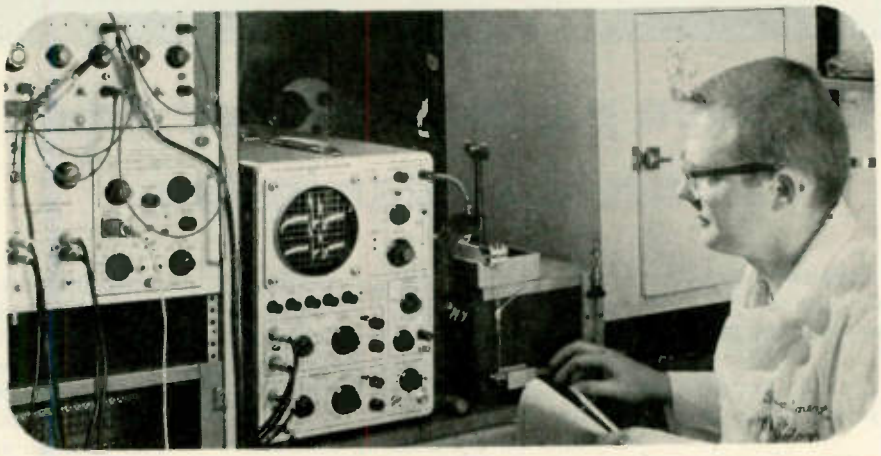
photographed in the Console Test Department at Rodgers Organ Company, Hillsboro, Oregon.



here's a vibration test on a cantilever beam

■ In this environmental procedure at Tektronix, Inc., the Type 502A displays output waveforms from two accelerometers.
■ For direct comparison, outputs of both accelerometers were standardized by amplifiers of the Type 502A.
■ CRT display shows excursion of the cantilever beam and vibration input from the table.
■ Upper trace is cantilever-beam response during vibration. Lower trace is output of vibrator table. (H. F. components are from bearing noise.)
Time-base rate is 5 ms/cm. Amplifier sensitivity is 50 mv/cm.

photographed in the Environmental Laboratory at Tektronix, Inc., Beaverton, Oregon.



here's a design test on two transducers

■ In this research procedure at the University of Oregon Medical School, the Type 502A displays waveforms from a commercially available pressure transducer and from an implantable muscle-tension model under development.
■ For direct comparison, outputs of both transducers—mechanically connected in tandem—were shocked by a lever system.
■ CRT display shows both outputs simultaneously.
■ Upper trace is developmental transducer output. Lower trace is commercial transducer output. Time-base rate is 1 ms/cm. Amplifier sensitivity is 5 mv/cm.

photographed in the Physiological Department at University of Oregon Medical School, Portland, Oregon.

We even put a hat on our drum to avoid contamination

This is only one of the ways we protect GENESOLV® D "Electronic Grade," the purest precision cleaning solvent you can buy.

We do everything possible to protect the purity of our precision cleaning solvent.

Even to using this film cover to keep dirt and moisture from settling on the drum top and possibly contaminating the solvent when you open the drum.

Precautions like this help keep Genesolv D "Electronic Grade" *the purest solvent available.* Residue is less than 1 part per million.

Genesolv D fluorocarbon solvent for critical cleaning cuts rejects due to contamination. It penetrates into even the smallest surface openings for easy, fast cleaning. The solvent has little or no effect on plastics, elastomers, paints and varnishes. There are no additives and it's compatible with any cleaning method.

It offers an outstanding combination of dielectric properties, exceptionally high resistivity with low dielectric constant.

Genesolv D "Electronic Grade" is safer to use than other solvents because it's nonflammable, nonexplosive and virtually nontoxic.

It's easy to recover for reuse. This helps keep your cleaning costs down. And our technical people will be glad to advise you on the best recovery set-up for your particular operation and on proper equipment and solvent storage and handling procedures.

Genesolv D "Electronic Grade" is available in non-returnable drums of 65-, 200- and 690-pound capacity, and in tank trucks of 3800 gallons.

Call on us for answers to any cleaning problems you have. Our years of experience and leadership in supplying high-purity chemicals can help you.

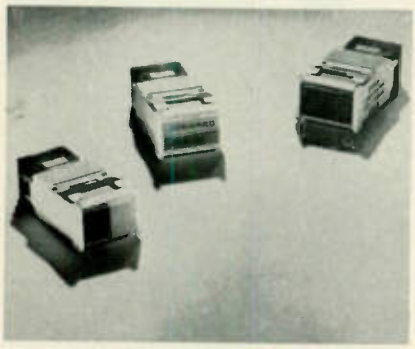
Allied Chemical

GENERAL CHEMICAL DIVISION
P. O. Box 353, Morristown, N. J.

NEW PRODUCTS

ILLUMINATED PUSHBUTTONS

Available in SPDT and DPDT contact arrangements. Lamps rated at 28v. max.

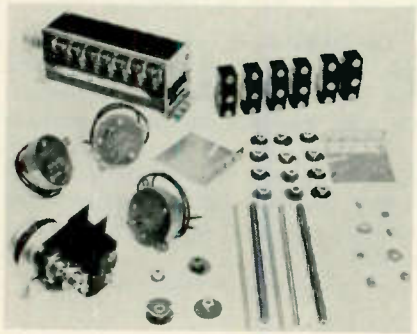


The CR103 Type D illuminated pushbuttons and matching indicating lights are offered with solid, horizontally-split or vertically-split color fields. The compact units have applications including business machines, computers, data-handling equipment, instrumentation and control panels. They are rated 5a. carry, 30a. make at 125vac; 3a. at 30vdc; 1.1a. inductive at 125vdc. General Electric Co., 901 W. Burlington Ave., Western Springs, Ill.

Circle 125 on Inquiry Card

TIMER KIT

Features 11 different time cycles ranging from 7½ sec. to 30 min.

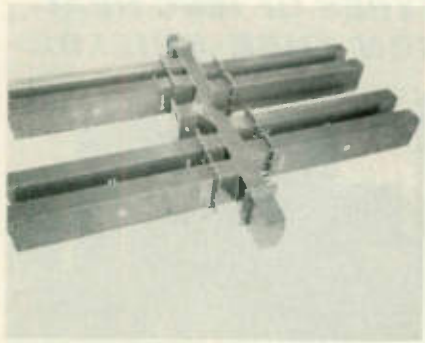


The Model KVC200-1 industrial recycling kit consists of an assembled basic timer; 4 synchronous timing motors; gear reductions, adjustable cams and 2 SPDT snap-action switches. Cams are adjusted from 3% to 97% of the total time cycle to switch current on or off. The motors operate on 115v., 60 CPS; switches are rated at 15a., non-inductive at 115vac. Switch cams can be adjusted to give DPDT switch action. No special tools are required to change the gear motors. Supplementary expander kit available from Controls Co. of America, 2001 N. Janice Ave., Melrose Park, Ill.

Circle 126 on Inquiry Card

BAND-REJECT DIPLEXER

Passband, 3MC; passband insertion loss, 0.35db; passband VSWR 1.25:1.



This easily tunable band-reject diplexer is for 755-985MC. Capable of being designed for all waveguide bands, the unit is easily field tuned by plungers that have factory precalibrated counter settings and tuning stubs for VSWR matching. Operating freqs. can be changed and reset in 30 min. without losing pressure. Unit offers 2nd harmonic rejection of 20db and 3rd harmonic rejection of 10db. Antenna Systems, Inc., Grenier Field, Manchester, N. H.

Circle 127 on Inquiry Card

AUTOMATIC CIRCUIT TESTER

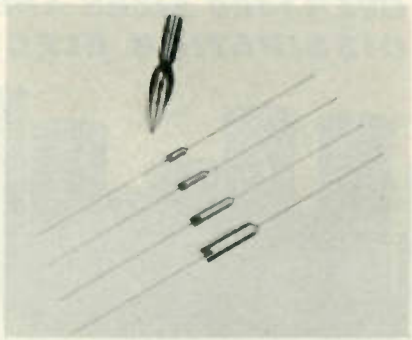
Capable of scanning up to 9600 points or wire ends for continuity.

The Programmed Automatic Circuit Tester (PACT) checks wire ends and extra wires in a harness or assembly and prints out errors. Two operating modes are available. The automatic mode stops the tester long enough to print out errors. The manual mode scans until it locates an error then prints it out and stops. Modular design permits building in 1200 point increments, to a max. of 9600 points. Selectable scan limits allow max. use for units under test smaller than PACT capacity. These scan limits permit multiple units to be tested sequentially. General Electric Co., Schenectady 5, N. Y.

Circle 128 on Inquiry Card

TANTALUM CAPACITORS

C-type liquid-electrolyte units feature 85°C capability.



These subminiature, straight-wall capacitors have liquid electrolyte and highly reliable seals. The package is insulated and the leads can be welded or soldered. The line includes 4 cases ranging between 0.312 in. long by 0.115 in. dia. to 0.875 in. long by 0.225 in. dia. There are 28 standard units with capacitances between 2 and 330μf at 85°C and at working voltages between 6 and 60v. ITT, Div. of IT&T Corp., 937 Commercial St., Palo Alto, Calif.

Circle 129 on Inquiry Card

AIRBORNE PROGRAMMER

Generates selected time outputs in ranges from 1msec. to 5120 sec.

The Model 1000 solid-state programmer generates outputs at times in a binary-type progression which is referenced to a particular starting time. The outputs may be used independently to control logic functions, or in conjunction with EPC logic modules to generate pulse outputs, time duration outputs, or amplified programmer outputs. The time-reference source is derived from either a 60 or 400 CPS power source, or an external oscillator generating pulse-sine or sq. waves. Meets Mil-E-5272-C and Mil-R-5257-D Electronic Products Corp., 2315 Cecil Ave., Baltimore, Md.

Circle 130 on Inquiry Card

NEW PRODUCTS

MULTIMETER

Protects circuit semiconductor components from burnout during test.

The Model 250 eliminates the condition whereby conventional multimeters, especially on their lower ranges, have the ability to "turn on" semiconductor devices which, in effect, gives them a resistance of unknown value. Instead of delivering currents of 130ma and powers of approximately 50-60mw on the R × 1 scale, the power output is limited to a max. of 100μw on any resistance range. American Electronic Laboratories, Inc., Box 552, Lansdale, Pa.

Circle 131 on Inquiry Card

POTENTIOMETER

Power rating is 2w. at 40°C derated to 0w. at 125°C.

The MDU20-10 is a ½ in., 10-turn, size 20 potentiometer. It weighs 55gm. The wiper design eliminates all mechanical wiper backlash. Operational temp. is −55° to +125°C. Stops can withstand 37½ lbs. of static torque. Total resistance is 250Ω to 150KΩ. Litton Precision Products, div. of Litton Industries, Mt. Vernon, N. Y.

Circle 132 on Inquiry Card

TEMPERATURE CONTROL

Simple adaptation into process circuits and OEM applications.

Control action is triggered instantaneously at set points, without contacts. The temp. signal, transmitted directly by thermocouple without amplification or drift, is always indicated on the pyrometer dial, even past set points. The control is inherently fail-safe in the event of failure anywhere in the circuitry. Any one of 8 standard temp. ranges may be specified beginning with 0 to 300°F. Assembly Products, Inc., Chesterland, Ohio.

Circle 133 on Inquiry Card

TRYGON
Half Racks

Model HR40-5A

Model	Volt	Amps	Regulation	Ripple	Price
HR20-1.5*	0-20	0-1.5	0.01% line 0.05% load	0.25 mv	$164
HR40-750*	0-40	0-0.75		0.15 mv	$149
HR20-5A	0-20	0-5	0.01% line 0.01% load	0.5 mv	$299
HR40-2.5A	0-40	0-2.5			$299
HR40-5A	0-40	0-5			$349
HR60-2.5A	0-60	0-2.5			$379

*Single Meter Units

. . . the most versatile power supplies going!

In the lab—you'll find you can't beat a Trygon Half Rack for versatility and low cost! Want constant voltage with adjustable current limiting? You've got it! Want constant current with adjustable voltage limiting? You've got it! Want to select voltage and current with a remote control? You've got this too!

But check the features at the right—and the prices—for yourself. And remember—every Trygon power supply, large or small, goes through the same test procedures before shipment. Each is aged—burned in; each is subjected to stability runs. Each must pass shock and vibration tests—your assurance of long, trouble free performance along with versatility.

In a system—you merely take off the Half Rack dust cover, reverse it, add an inexpensive Trygon adapter, and you have a unit that slides right into a rack. What's more, you can place two Half Racks in a 19" rack width, occupying only 5¼" of panel height.

Two Trygon HR20-1.5's, rack-mounted side by side.

For complete specs—on the Half Rack Series as well as our catalog showing the complete line of over 100 Trygon Power Supplies, write to us today. **Address:** Dept. EI-6.

FEATURES

- **CONSTANT VOLTAGE OPERATION** with adjustable current limiting.
- **CONSTANT CURRENT OPERATION** with adjustable voltage limiting.
- **COMPLETE RANGE REMOTE PROGRAMMING** furnishes voltage and current selection from a remote control.
- **REMOTE SENSING** provides rated regulation at the load, available at both front and rear terminals.
- **HIGH RESOLUTION** for setting current and voltage is provided by coarse and fine adjustments for both (4 controls).
- **AUTOMATIC OVERVOLTAGE PROTECTION**—Trygon's unique overvoltage protection is available as an option.

TRYGON ELECTRONICS INC.

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(516) FReeport 8-2800 TWX (516) 868-7508

NEW PRODUCTS

CAMERA SYSTEM

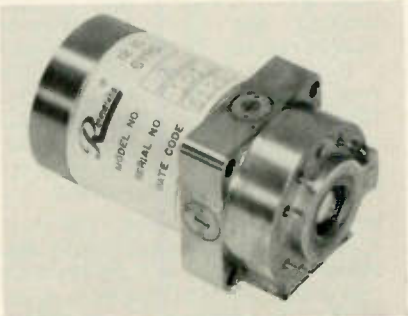
Optional data chamber places the sequence data directly onto the film.

With Type 3003-A (AD) single-frame Polaroid camera system, test number, time, and handwritten data are always recorded on the same portion of the film. The camera portion can be slipped on and off. The lens, shutter assembly and the film holder, with the addition of Type 3683 lensette can be used as a regular camera. A dark slide permits removal of the Polaroid film holder and substitution of other types of holders, even though the original holder is still loaded. Analab Instrument Corp., 30 Canfield Rd., Cedar Grove, N. J.

Circle 134 on Inquiry Card

GYRO

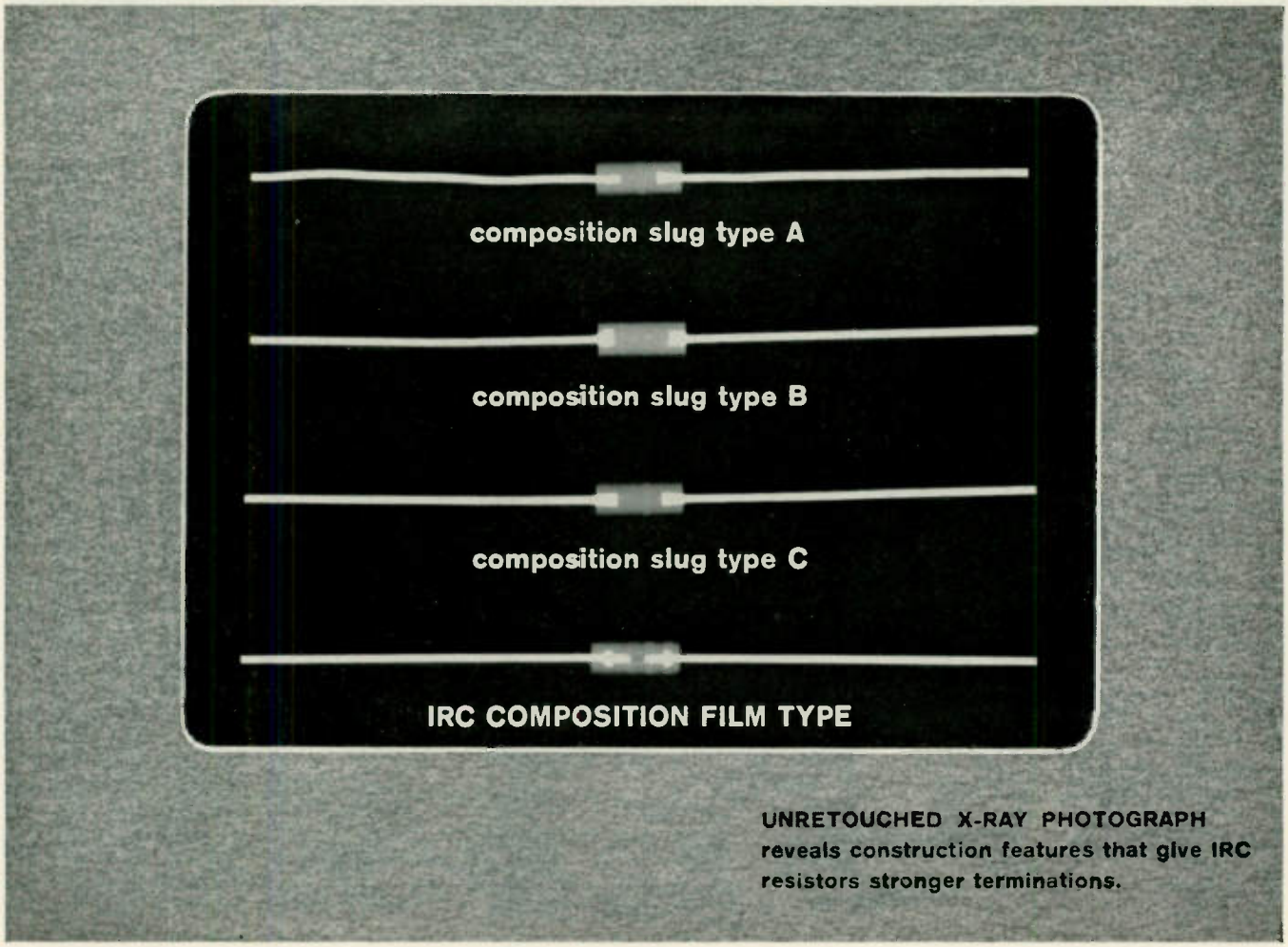
Perm. magnet torquers, spin motor synchronism indicators.



The 121G floated gyro measures 1.2 in. dia. and weighs 6 oz. Both microsyn and permanent-magnet torquer models are available, with trimmed drift rates of less than 0.1°/hr. Both torquer types provide remote indication of spin motor operation and synchronism. The permanent-magnet models have 2 independent coils which may be connected in series or parallel. Reeves Instrument Co., Garden City, N. Y.

Circle 135 on Inquiry Card

In FIXED COMPOSITION RESISTORS if it's news, expect it first from IRC



UNRETOUCHED X-RAY PHOTOGRAPH reveals construction features that give IRC resistors stronger terminations.

IRC Fixed Composition Resistors have a

STRONGER LEAD ASSEMBLY

HERE'S WHY . . . IRC's resistance element is a film of carbon composition thermally bonded to a glass body. This rugged, compact configuration permits 35% more molding around the lead assembly, and a correspondingly thicker molding at the ends. IRC's exclusive talon lead extends farther into the resistor.

Ribbed shoulders are imbedded in the molding to prevent twisting or pull-out. The lead is bonded to the element so strongly, IRC resistors are failure-free under MIL-R-11 shock, vibration and acceleration tests.

In destructive tensile tests, carbon slug types fail at forces averaging 22, 18 and 28 pounds respectively, for brands shown in the X-Ray.

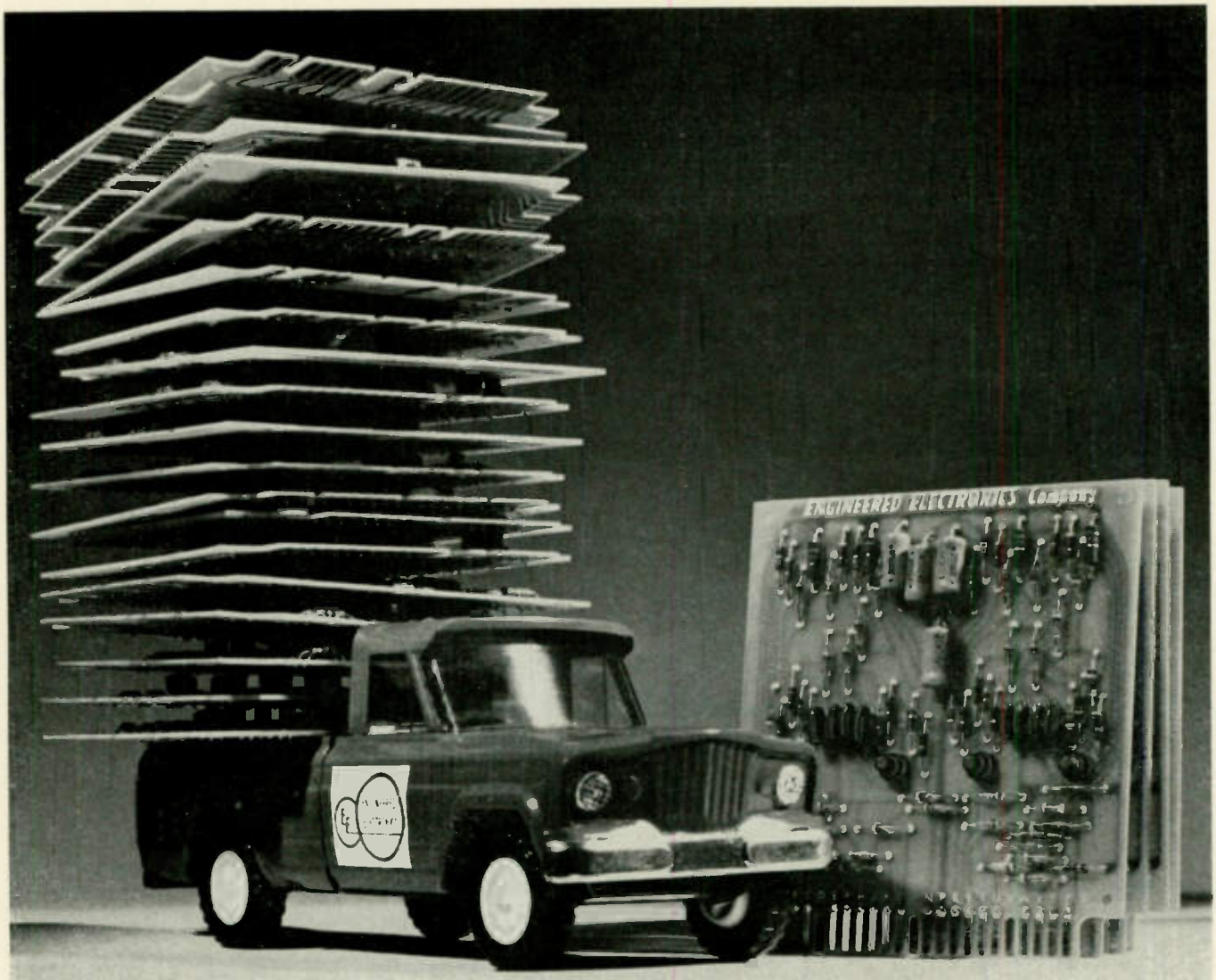
IRC carbon composition resistors withstand forces averaging 33 pounds. Even at that force, IRC leads do not pull out . . . the wire breaks outside the body. Write for GBT bulletin. International Resistance Co., Philadelphia 8, Pa.

PERFORMANCE ADVANTAGES

IRC Type GBT's also provide

- Outstanding load life
- Better resistance-temperature characteristics
- Lower operating temperatures
- Greater moisture protection
- Superior high frequency characteristics
- Ranges to 100,000 megohms
- Weldable leads

IRC



NOW IT'S A FAMILY OF FIFTY-TWO!

EECo's off-the-shelf G-Series digital circuits with speeds to 10 Mpps

Now there are 52 economical G-Series circuits—52 packaged, proven and guaranteed answers to your module needs. Because this family is divided into four compatible frequency sub-groups (10 Mpps, 5 Mpps, 1 Mpps and 100 Kpps), you can get exactly the speed you want and you pay only for the speed you use. You also get a simpler system.

G-Series modules are suitable for both synchronous and non-synchronous use. They feature standard signal levels and standard input impedances, and offer you exclusive integral protection against power-supply shorts. In addition, the cards are keyed for error-free insertion and are repairable.

Whatever you need in digital circuits, you'll save time and money by checking EECo first. EECo offers you the nation's largest selection of catalogued modules—six complete families, more than 300 module types in all. And any of these modules that fails to live up completely to its published specifications will be repaired or replaced free. Now, more than ever, your widest and wisest choice is EECo.

SEND TODAY FOR FREE CATALOG G-53

Fifty-six pages packed with product information, schematics, system design data and applications information.

ASK FOR FREE BREADBOARD DEMONSTRATION

Want to try out your design ideas on the EECo high-speed system breadboard? Just write or call us and ask for a demonstration in your plant. Borrow the breadboard equipment, too, if you wish. Under our 5-year-old loan plan, you can use it up to 30 days free!

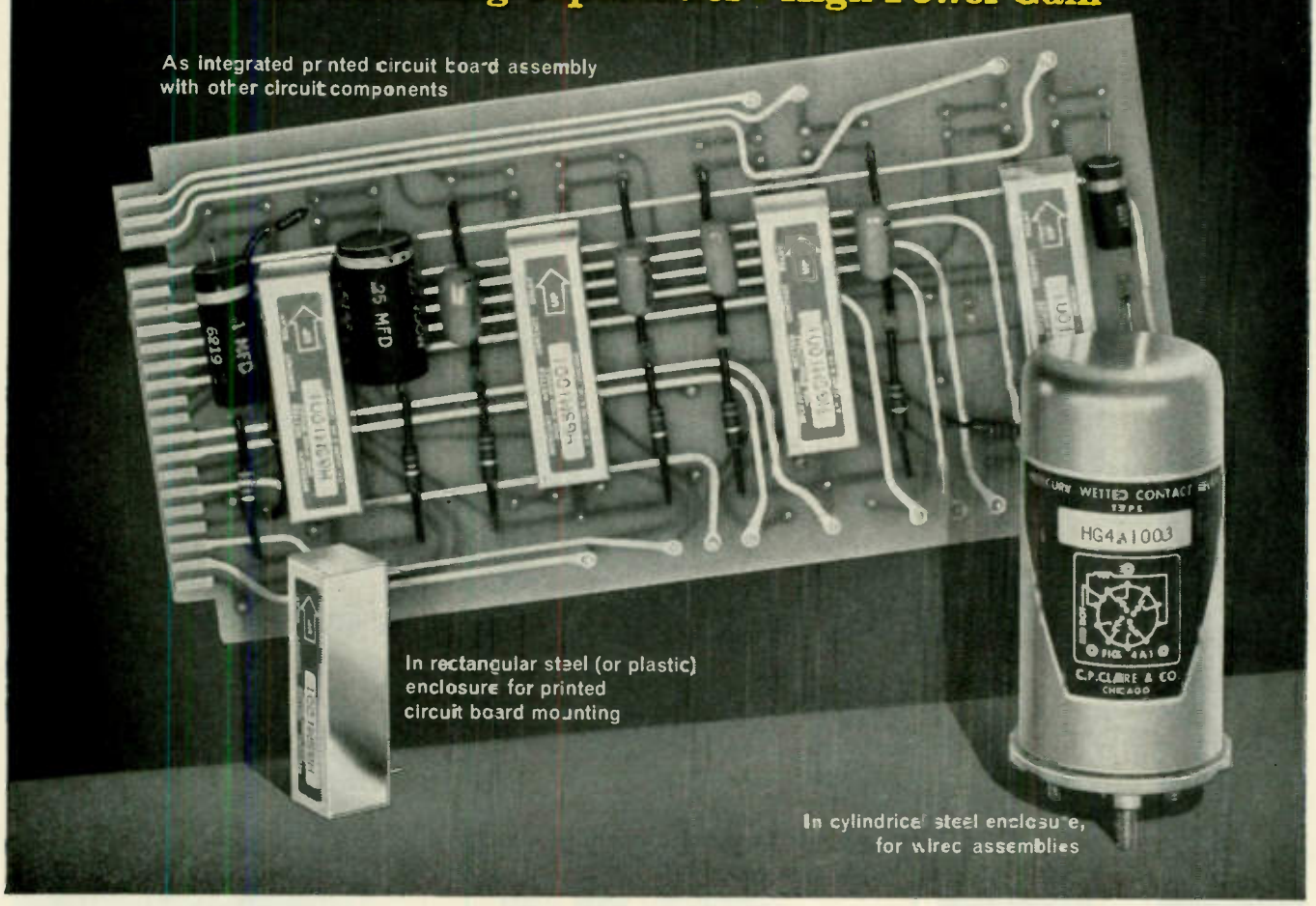
ENGINEERED ELECTRONICS Company

1441 East Chestnut Avenue, Santa Ana, California
Telephone: 547-5651 Cable Address: ENGELEX

specify **CLARE** Mercury-Wetted Contact Relays

for billions of operations with

Low and Consistent Contact Resistance • No Contact Bounce
Versatile Load Switching Capabilities • High Power Gain



CLARE Mercury-Wetted Contact Relays are fast, sensitive and provide high switching capacity. They operate with extreme reliability whether billions of cycles . . . or only one . . . are required. Clare provides both bridging and non-bridging Mercury-Wetted Contact Relays.

For applications where consistent contact resistance is critical, these relays will hold their original resistance within ±2 milliohms through life. There is no contact bounce which may be misinterpreted by electronic circuits.

With CLARE Mercury-Wetted Contact Relays, the same contacts may pass a microvolt analog signal . . . or switch a 250 va tape transport reel motor up to 100 times a second. These relays can be driven at a 40 mw level by diode or transistor logic . . . and handle a 250 va solenoid load on their contacts.

For wired assemblies: plug-in, solder terminal, or AN connectors in one to four-pole multiples. For printed circuit board mounting: modules of molded plastic or steel enclosures. As integrated printed circuit board assemblies: custom-built from your circuits or "black box" requirements.

Complete information: Request Design Manual 201B by circling 120 on Reader Service Card • Concise information: Request Manual 800 by circling 121 on Reader Service Card.

Address: **Group 12D8**, C. P. Clare & Co., 3101 Pratt Boulevard, Chicago 45, Illinois. Cable Address: CLARELAY. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ontario. In Europe: C. P. Clare International N.V., 6 Momberstraat, Tongeren, Limbourg, Belgium.

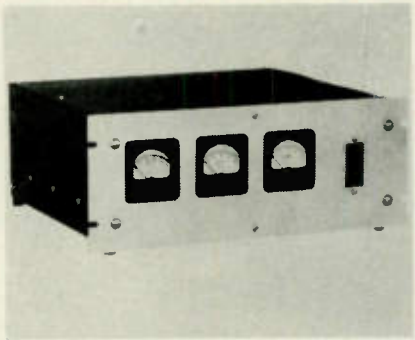
CLARE®

Relays and related control components

NEW PRODUCTS

INVERTER

Converts ac to dc. Low harmonic content and stable voltage output.

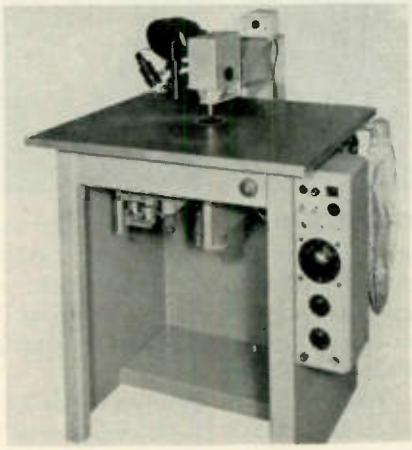


This solid-state inverter is used to power ac equipment from standby batteries or, in conjunction with dc power supplies, as a freq. changer or a dc-to-dc converter. It has current limiting and short-circuit protection. There are no moving parts. Polarity reversal causes no damage. Available in 60-cycle and 400-cycle units. Inputs from 12 to 125v., and outputs from 60 to 3000v. Sola Electric Co., Elk Grove Village, Ill.

Circle 221 on Inquiry Cord

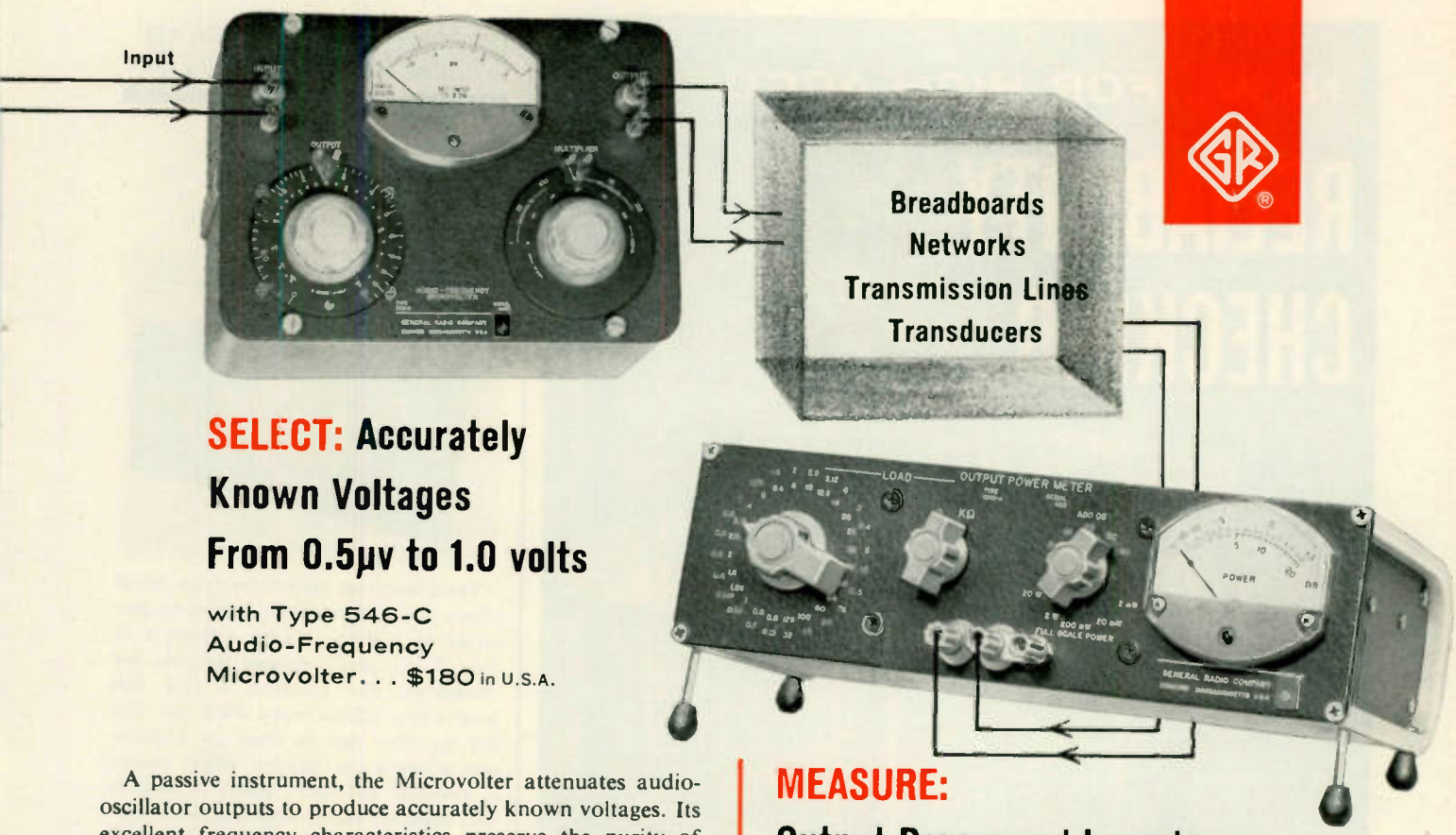
PC BOARD DRILL

Used where capabilities cannot support a multi-spindle drill.



The single-spindle Uni-Drill has a variable 45,000RPM spindle mounted beneath a flat table surface and a positioning stylus over the top. Circuit boards and template can be drilled at rates up to 80 strokes/min. All drilled holes match the template locations within 0.001 in. A sensing-type stylus triggers the drill stroke when dropping into a template hole. Out-of-position drilling and board movement while drilling are impossible. The Merlo Co., 5478 Wilshire Blvd., Los Angeles 36, Calif.

Circle 222 on Inquiry Cord



SELECT: Accurately Known Voltages From 0.5μv to 1.0 volts

with Type 546-C Audio-Frequency Microvolter. . . $180 in U.S.A.

A passive instrument, the Microvolter attenuates audio-oscillator outputs to produce accurately known voltages. Its excellent frequency characteristics preserve the purity of waveform, and its panel meter allows constant monitoring of voltage level.

The wide range of the Microvolter and its ability to provide accurately known, extremely small voltages, makes it ideal for determining the emf generated by microphones, pickups, and other transducers. As commonly used, the 546-C provides a known voltage equal to that produced by the transducer as measured on an external amplifier-indicator (usually a simple, uncalibrated meter).

In addition, this instrument has found wide acceptance for the measurement of gain and loss in such things as amplifiers, transformers, networks, and lines.

Output-Voltage Range: From 0.5 microvolt to 1.0 volt open circuit, when the input voltage is set to the standardized reference value (2.2v). Basic accuracy is ±3% into open circuit.

Output Impedance: Approximately 600 ohms. No correction of the output voltage is necessary for load impedances of the order of 100,000 ohms and greater.

Input Impedance: Approximately 600 ohms, substantially independent of output setting on all but the highest multiplier position.

Input Requirements: About 2.2 volts across 600 ohms, or approximately 8 milliwatts.

Dimensions: Width 10, height 7¼, depth 6¼ inches over-all.

GR Manufactures a complete line of Audio and Sound Measuring Equipment

MEASURE: Output Power and Impedance 0.1mw-20 watts; 0.6Ω to 32KΩ

with Type 1840-A Output Power Meter $210 in U.S.A.

This is a passive instrument for the measurement of output power levels and impedances of audio-frequency equipment. The Type 1840-A presents a constant load to the device under test. Power is indicated directly on a meter-face in both watts and decibels/re 1mw. The impedance value appears at that dial setting which yields the maximum power reading (impedance values are arranged in 48 quasi-logarithmic steps).

Its wide power range and quasi-rms meter make the Type 1840-A an ideal instrument for the measurement of power output of amplifiers, transformers, transducers, networks, and low-frequency lines.

Power Range: 0.1 milliwatt to 20 watts. Auxiliary db scale reads from −15 to +43 db re 1 milliwatt. Basic accuracy is ±1 db from 30c to 10 kc: does not exceed ±1.5 db at 20c and 20 kc.

Impedance Range: 0.6 ohm to 32 kilohms in two ranges; 48 individual impedance settings spaced approximately $\sqrt[3]{2}$ apart.

Waveform Error: True rms indicated despite as much as 20% second and third harmonics present in the input signal.

Dimensions: Width 12, height 4, depth 8 inches over-all. Panel adaptor sets available for 19-inch relay rack mounting (panel height 3½ inches).

Write for complete information

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

IN CANADA: Toronto 247-2171, Montreal (Mt. Royal) 737-3673
IN EUROPE: General Radio Overseas, Zurich, Switzerland

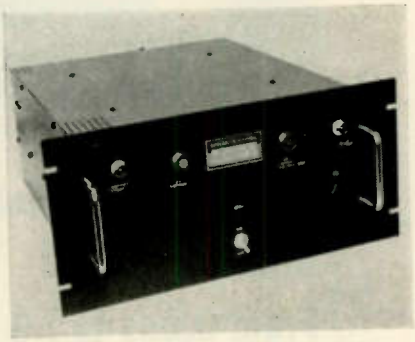
NEW YORK, N. Y., 964-2722 (Ridgefield, N. J.) 943-3140 | CHICAGO (Oak Park) 848-9400 | PHILADELPHIA, 424-7419 (Abington) 887-8486 | WASHINGTON, D.C. (Rockville, Md.) 946-1600 | SYRACUSE 454-9323 | DALLAS FL 7-4031 | SAN FRANCISCO (Los Altos) 948-8233 | LOS ANGELES 469-6201 | ORLANDO, FLA. 425-4671 | CLEVELAND 886-0150

Circle 43 on Inquiry Card

NEW PRODUCTS

FREQUENCY CHANGERS

Lightweight static freq. changers rated from 1kw-30kw.



These units use cyclo-conversion which allows power from one ac freq. to be converted to another ac freq. without a dc link. Thus energy storage elements are eliminated. For example, a 5kw unit weighs only 125 lbs. and a 30kw unit only 315 lbs. 5kw unit is ideal for airborne uses where a conventional 400CPS source is available and 60CPS power is needed. The units are self-protected against short circuits. A "try again" circuit allows recycling and restarting in the event of short time, high-current surges. General Electric Co., Specialty Control Dept., Waynesboro, Va.

Circle 136 on Inquiry Card

SOLID-STATE COUNTERS

Counting rates to 20—50MC; read-out storage for a continuous display.

The Model 5242L has a max. counting rate of 20MC; Model 5244L will count to 50MC. Both counters measure freq., period, multiple period average, ratio, and multiples of ratio. Readout is an in-line display of 7 rectangular digital display tubes, with positioned decimal and illuminated units of measure. Rear terminals provide the digital information in 1-2-2-4 BCD form (1-2-4-8 available) for recording or systems applications. Max. sensitivity for both counters is 0.1v. RMS. Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

Circle 137 on Inquiry Card

Out in Front! New KNOBPOT® Senior Precision Potentiometer with ±0.1% Dial Accuracy

NUMBER 30—NEW PRODUCT SERIES

The acclaim and immediate acceptance which greeted Bourns' original KNOBPOT, a major advance in the state-of-the-art, have led to the development of a "Senior" version, to provide higher resistance values and increased accuracy. You can see in the photo below that this new unit saves you nearly all the back-panel space consumed by the bulky conventional type. That's because it's a potentiometer, knob and turns-counting dial all in one, mounting entirely in front of the panel.

KNOBPOT Sr., Model 3640, a companion unit to the revolutionary Bourns KNOBPOT Model 3500, gives you a bonus in accuracy, resolution, and power, too. The whole unit... including the integral turns-counting dial... is more accurate than the best competitive potentiometer/dial combination.

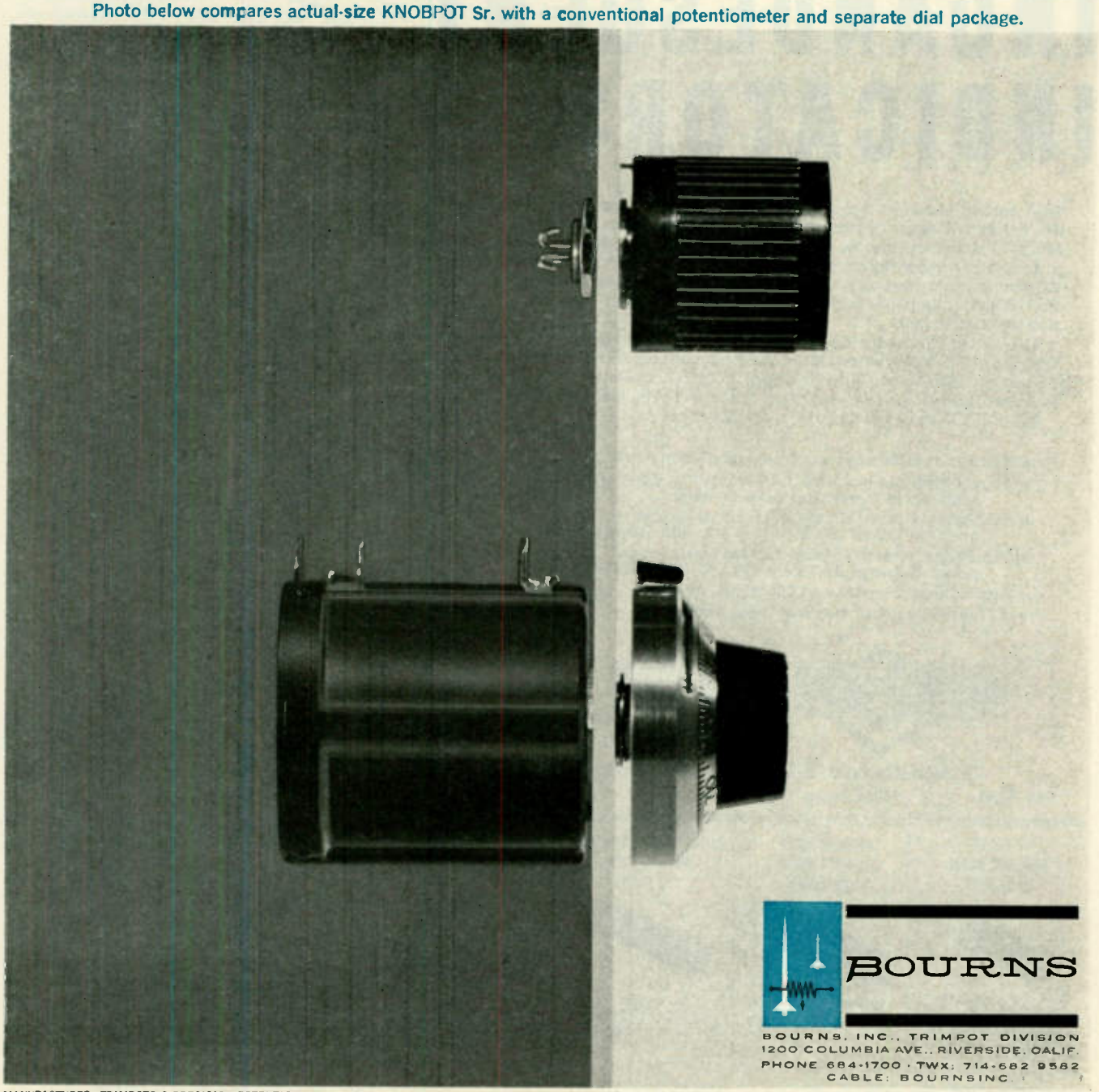
In your production, KNOBPOT Sr. potentiometers save you time and trouble. For example, they put an end to do-it-yourself installation. Phasing is done for you—with extreme accuracy—at the Bourns plant. No separate dial to attach, no complicated mounting procedure. Just drill two holes, put the unit on the panel and tighten the nut. That's the whole installation!

Most important of all benefits, however, is the name on the package! It means that the product has undergone 100% in-process and final inspections as well as the double-check of Bourns Reliability Assurance Program. You can be "out in front" in more ways than one if you specify the Model 3640, KNOBPOT Sr. potentiometer. Write today for complete technical data.

Standard Resistances: 500Ω to 250K
Dial Accuracy (correlation of dial reading to voltage output): ±0.1% max.
Repeatability (ability to return to a previously established setting): ±0.05%
Resolution: 0.03 to 0.006%
Power Rating: 2.5 watts at 25°C
Max. Operating Temp.: 125°C
Dimensions (in front of panel): only 1½" long x 1¼" dia.

ONE-HALF ACTUAL SIZE

Photo below compares actual-size KNOBPOT Sr. with a conventional potentiometer and separate dial package.



BOURNS

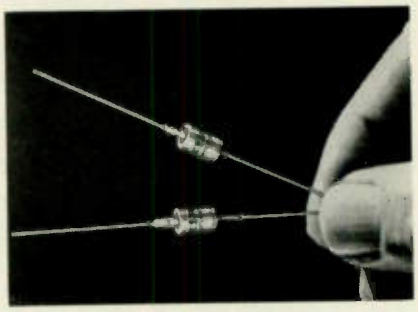
BOURNS, INC., TRIMPOT DIVISION
1200 COLUMBIA AVE., RIVERSIDE, CALIF.
PHONE 684-1700 · TWX: 714-682 9582
CABLE: BOURNSINC

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

NEW PRODUCTS

FLANGELESS RECTIFIERS

1a. @ 100°C; flangeless rectifiers meet Mil-S-19500/155A. (USN).



Types USN1N3189-3191 are rated at 200, 400, and 600v. PRV respectively. They are capable of withstanding high-current surges, and have a peak non-recurrent surge current rating of 30a. over 1CPS @ full load of 1a. @ 100°C. Packaged in DO-13 flangeless package. International Rectifier Co., 233 Kansas St., El Segundo, Calif.

Circle 138 on Inquiry Card

BANDPASS FILTERS

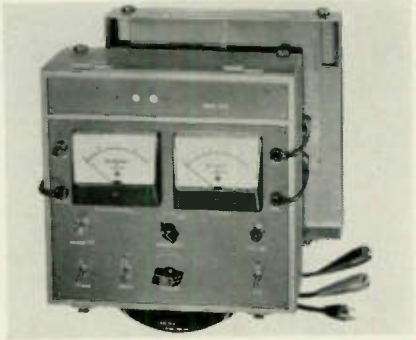
Freq. range from 50MC - 1GC. Bandwidth range is 2.5 to 25%.

Four models of manually adjustable bandpass filters have the following freq. ranges: 50MC to 125MC; 125MC to 250MC; 250MC to 500MC; and 500MC to 1GC. Insertion loss is 2db at 2½% bandwidth; 1db at 4% bandwidth; and is reduced to only ½db at max. bandwidth. Filters feature full octave tunability and low VSWR of 1.5:1. Input and output impedance is 50Ω with power level up to 5w. Resdel Engineering Co., 990 S. Fair Oaks Ave., Pasadena, Calif.

Circle 139 on Inquiry Card

DC TEST SET

For dielectric strength testing and insulation leakage determinations.

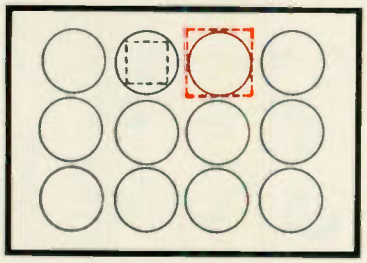


The Model 5212 Hypot® detects leakage currents as low as 0.05μa over 4 ranges: 0-2 / 0-20 / 0-200 / 0-2000μa, full scale. Test potentials from 0-10kv. Associated Research, Inc., 3777 W. Belmont Ave., Chicago, Ill.

Circle 140 on Inquiry Card

WHY A SQUARE THAT'S OUT IS "IN"

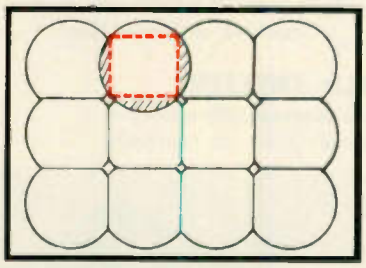
HOW IEE SQUARED THE CIRCLE TO GET 4-TIMES BRIGHTNESS FROM A REAR-PROJECTION READOUT



We're real big in squares and circles this year. Bigger yet in getting our popular Series 10 rear-projection readouts to develop 4-times greater character brightness than ever before (this with conventional MS or commercial lamps operated strictly at rated voltage!). The trick is in the lens.

Above is a horizontal view (actual size) of the old 12-position lens. The dotted square *inside* the circular lens represents the actual usable area that formerly averaged about 20 foot-lamberts with 6.3 v lamps (as bright or brighter than competitive devices). To get even greater brightness while using the same lamps at rated voltage, usable lens area had to be increased. Our problem was limited space. So we put our theoretical square *outside* the circle (shown in red above).

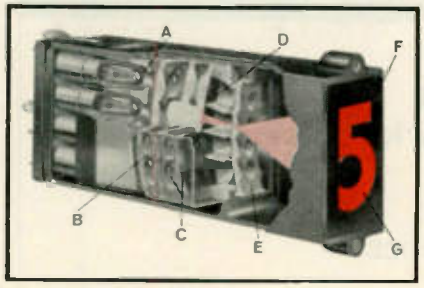
Next, we made the individual lenses larger to encircle the larger square. Now we had an overlap problem. This we solved by squaring the circles to leave off the unused portions, shown below. It's a bit unconventional, or so our lens-maker tells us. The results, however, are most rewarding.



The new Series 10 readout now averages over 75 foot-lamberts of character brightness when used with 6.3 v lamps *at rated voltage*. The increased brightness means visual clarity at wider angles and longer distances, excellent readability even under adverse high ambient light conditions.

And, there's an extra benefit if you're not overly concerned with all this brightness: operate the IEE readout at reduced voltage and you'll get *double brightness plus 10 times the lamp life* (up to 30,000 hours from 6.3 v lamps operated at 5.3 v).

CUT-AWAY SHOWS HOW NEW SERIES 10 READOUT OPERATES:



A. STANDARD MS OR COMMERCIAL LAMP
B. SQUARE LIGHT-COLLECTING LENS UTILIZES APPROX. 100% MORE LIGHT THAN DLD SYSTEM; TRANSMITS DOUBLE-SIZE CONE TO CONDENSING LENS
C. DUAL SQUARE-LENS CONDENSERS PROVIDE GREATER COVERAGE AT LOWER MAGNIFICATION
D. FILM CONTAINING DISPLAY SYMBOL (NUMBERS, LETTERS, WORDS, SYMBOLS, COLORS)
E. PROJECTION LENS
F. NON-GLARE VIEWING SCREEN
G. 4-TIMES BRIGHTER CHARACTER 1-1/16" HIGH (MAX.)

Of the four 12-position lenses used in the new readouts, three are of the new square-lens type (Pat. Pend.). The increased usable area permits each lens to collect twice the light and to project the message indication with half the magnification formerly required. These factors produce 4-times the brightness of older units.

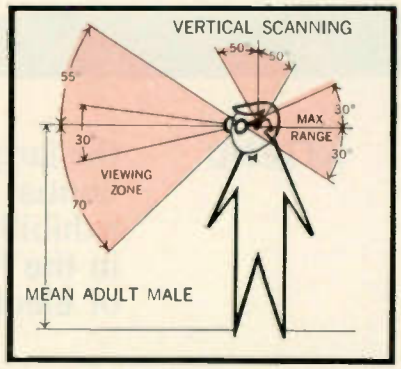
DIGITAL INSTRUMENTS BY ELECTRONIC ASSOCIATES, Inc... VISUAL TRANSLATION BY IEE

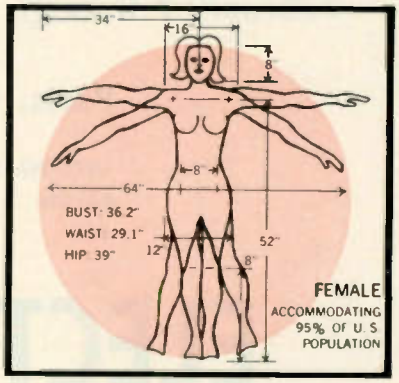
For visual translations, EAI relies on IEE. That's why so many EAI digital instruments are equipped with our rear-projection readouts. Where else can you get such an impressive array of important advantages? Visual clarity, wide-angle readability, single-plane display for crispness (instead of visual hash). Not to mention display versatility that permits you to indicate *anything*. (We mean that quite literally. Anything you can put on film, colors included, can be displayed on an IEE readout.) And, you get 12 message positions that may be displayed individually or in combination.

If you're in the market for a really good Remote Visual Display or an exceptional solid-state DVOM, we hope you look at the EAI units shown here. While you're at it, we hope you'll notice the excellent visual translations, too!

EAI SERIES 5620 REMOTE VISUAL DISPLAY

EAI SERIES 5100 DIGITAL VOLT-OHMMETER





HUMAN FACTORS:

The scanning male & standing female

As builders of display devices for a variety of applications, we are extremely interested in human engineering studies. The July/August, 1963, issue of *Vending Engineer* contained drawings by Walter Koch, Industrial Designer, on which the above illustrations are based (with permission).

The drawings show one of the basic limitations imposed on vertical display areas by physical size of people. Studies show that the effective viewing area of most people is only about 30% of the total of most floor-standing vertical displays. We suspect this data is of interest to readers outside the vending machine industry since human engineering deals in one universal factor: people.

HOW TO INDICATE STATUS CONVINCINGLY & IN LESS THAN 5 SQ. IN.

This little box isn't quite 2½" x 2" yet it replaces 12 indicator lights! With it, you can display the status of just about anything with just about any combination of colors, symbols, numbers, letters, words; up to 12 individual messages all in a single plane and for as low as 80¢ per indication. If you're interested, it's called "Status Indicator"® and we supply it ready-to-use with message configurations custom-designed to your requirements.

Your inquiry will bring the comprehensive new "Readout Display Selector Guide" which includes specifications and other technical information on the entire IEE line of readout devices.

INDUSTRIAL ELECTRONIC ENGINEERS, INC.

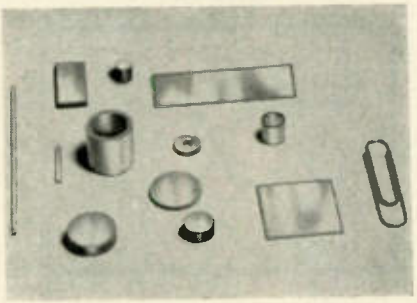
5528 Vineland Avenue, North Hollywood, California • Phone: (213) 877-1144 • TWX: (213) 769-1636

Representatives in Principal Cities

NEW PRODUCTS

CERAMIC MATERIAL

Piezoelectric material has a min. Curie of 180°C; dielectric constant, 3000.



KG-25 is available in discs up to 3 in. dia. and 0.500 in. thick, and in tubes up to 3 in. dia. and 4 in. long. Other sizes and shapes can also be supplied. Electrodes are provided. Freq. constants at 25°C are 85KC-in. radial and 80KC-in. thickness. Mechanical Q is 100. Centralab, The Electronics Div. of Globe-Union Inc., P. O. Box 591, Milwaukee, Wisc.

Circle 141 on Inquiry Card

COMPONENTS OVEN

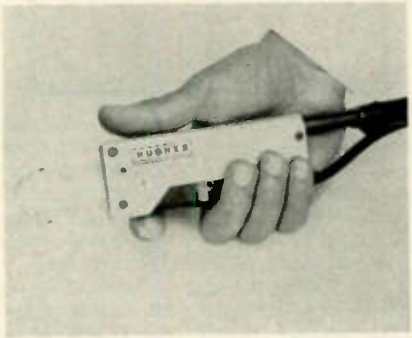
For subminiature circuits and temp.-sensitive components.

Model COMT-175-7 has a temp. stability of 0.2°C at a fixed amb. and will hold within 3°C through a range of −55 to 10°C below the setting of the oven. The oven can be set within 3° in a range of 25 to 100°C. Internal volume of the oven is approx. ½ cu. in. Weight is about 2 oz. Bulova Watch Co., Inc., 61-10 Woodside Ave., Woodside 77, N. Y.

Circle 142 on Inquiry Card

WELD TWEEZER

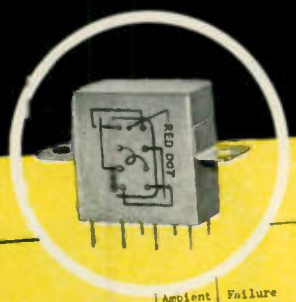
Fires automatically when preselected force is exceeded.



Model VTA-54 welding handpiece makes welds in all types of complex or remotely located thin-metal assemblies. Weld energies up to 150w.-sec. are delivered. Features include provision of a visible force index, and precision steel bearings for non-skid electrode action. Hughes Aircraft Co., Vacuum Tube Products Div., 2020 Short St., Oceanside, Calif.

Circle 143 on Inquiry Card

If you're interested in MILITARY-TYPE RELAY RELIABILITY...



C. P. CLARE & CO.

TYPE F RELAY CONTACT LIFE RELIABILITY

Test Conditions	Ambient Temp.	Failure Criteria	Relays Tested	Operations Per Relay	Total Relay Operations	Early Failure Period Ends (Estimated Operations)	Wear Out Period Begins (Estimated Operations)	(1) Failure Rate per 10,000 operations (2) Reliability Level per 10,000 operations At 90% Confidence Level
Low Level - 10 mv. open ckt. volt, 10 μa, 3 pos. Contacts in series. Checked each 10^6 operations for electrical parameters.	+25°C	Contact resistance > 100Ω on 4 or more operations	407	Up to 8×10^6	381.5×10^6	5000	8×10^6	(1) .158% (2) 99.8%
1.0 ampere, 28 VDC res. Each leg loaded individually. Checked each 10^6 operations for electrical parameters.	+25°C	Welding. No continuity. Contact resistance > .1Ω after test	62	Up to 10×10^6	218.5×10^6	N/A	10×10^6	(1) .054% (2) 99.9%
2.0 ampere, 28 VDC res. Each leg loaded individually. Checked each 2.5×10^5 operations for electrical parameters.	+25°C	Welding. No continuity. Contact resistance > .1Ω after test	66	Up to 1×10^6	62.1×10^6	N/A	1×10^6	(1) .084% (2) 99.9%
3.0 ampere, 28 VDC res. Each leg loaded individually. Checked each 10^5 operations for electrical parameters.	+25°C	Welding. No continuity. Contact resistance > .1Ω after test	61	Up to 4×10^5	22.8×10^6	N/A	4×10^5	(1) .519% (2) 99.5%
1.0 ampere, 28 VDC res. Each leg loaded individually Checked after 10^5 operations for electrical parameters.	+125°C	Welding. No continuity. Contact resistance > .1Ω after test	257	Up to 5×10^6	25.4×10^6	N/A	1×10^6	(1) .306% (2) 99.7%
2.0 ampere, 28 VDC res. Each leg loaded individually. Checked after 10^5 operations for electrical parameters.	+125°C	Welding. No continuity. Contact resistance > .1Ω after test	230	Up to 2.5×10^5	22.3×10^6	N/A	2.5×10^5	(1) .834% (2) 99.2%

draw your own conclusions!

This Clare Relay Reliability Report may be different from some other reports you have seen. For example:

***a*—This data covers standard, production-line relays sampled and tested on a weekly basis.**

***b*—This Report gives the results of a formally-defined Quality Assurance Program, details of which are available for the asking.**

***c*—Data is reported in terms of relay operations, not contact operations. Each operation of a dpdt relay requires four contact operations. Relay operations present the most stringent measurement of reliability.**

***d*—Reliability levels reported above are derived by a recognized statistical method which produces reliability figures of assured authenticity.**

What does this Reliability Report mean to the user of Military Type Relays? You'll draw your own conclusions, of course. But here are two comments which will be important to you if you're concerned with reliability:

1—Clare Relay Reliability statements are completely factual—backed by specific data compiled in actual, routine tests on standard Type F Relays.

2—Every Clare Type F Relay—including those you are now using—carries the same assurance of quality and reliability.

Produced on a mature, controlled-process, large-volume production line, Clare Military-Type Relays are available to you at competitive prices and delivery.

Clare Type F Relays provide non-polarized, single side stable, single coil operation.

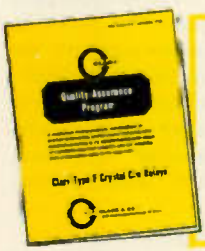
Operate times: 3.5 ms nominal, 5.0 ms maximum (including bounce), at nominal coil power.

Release times: 1.0 ms nominal, 5.0 ms maximum (including bounce), coil not suppressed.

Sensitivity: Just-operate power 250 mw.

(All ratings at +25°C ambient)

For additional information on Clare Military-Type Relays, circle Reader Service Number below . . . or address C. P. Clare & Co., Group 12D7, 3101 Pratt Boulevard, Chicago, Illinois 60645.



24-page Reliability Manual Now Available

24-Page manual presenting complete test specifications, procedures, test results for a one-year period, and a statement of rellability derived from these tests. Explanation of Clare's continuous Quality Assurance Program. For free copy, use Reader Service Number indicated below.

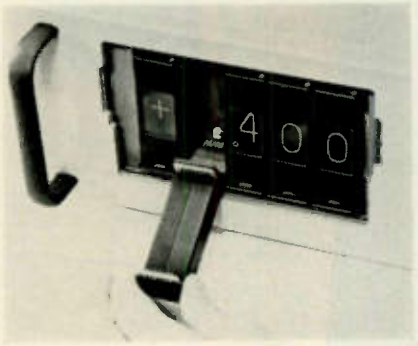
CLARE

Relays and related control components

NEW PRODUCTS

DIGITAL READOUT

Capacity is 12 symbols / window, includes numeral 0-9 and decimal point.

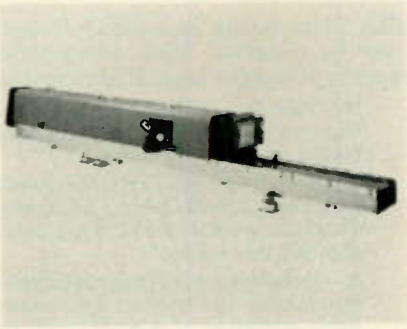


Model 4W readouts have scissors-type connector pins allowing them to be plugged directly into printed-circuit boards. Unit uses 12 transparent lucite plates, arranged one behind the other, in each window. Display symbols on these plates are lighted by incandescent lamps which are positioned at the edge of each plate. Lamp voltages are 6, 14, or 18v. Normal lamp life is 5000 hrs., but 10,000 or 50,000 hr. lamps are also available. Non-Linear Systems, Inc., Del Mar, Calif.

Circle 144 on Inquiry Card

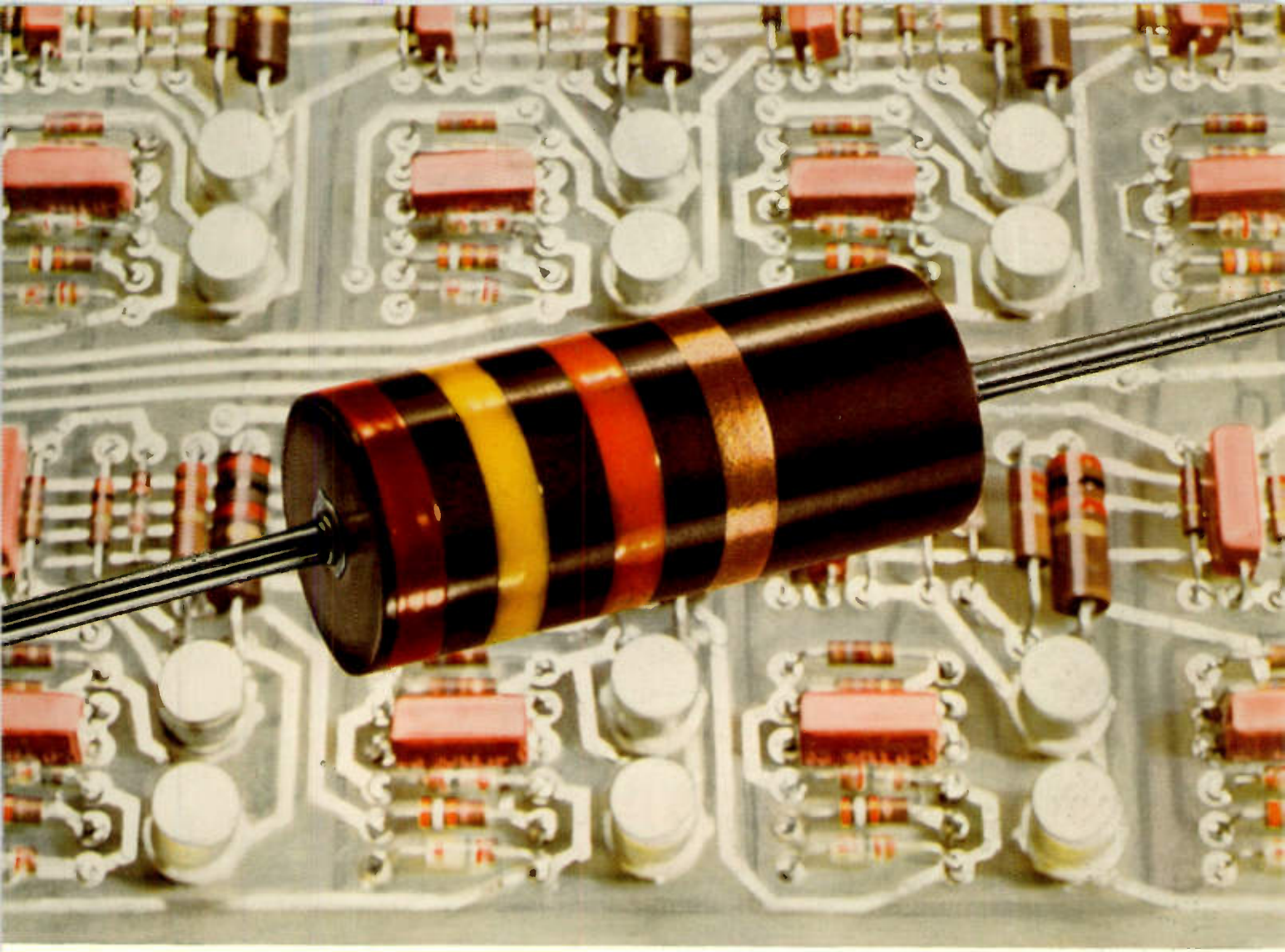
OPTICAL CORRELATOR

Over 1000 independent simultaneous data-processing channels available.



With the model C-100 Optical Correlator, linear operations such as freq. analysis, filtering, auto-correlation, cross-correlation, and a wide variety of transform-type operations such as convolution and Fourier can be performed. Input data are prepared on a photographic film through which a collimated beam of light is passed. The resulting light wave is modulated to represent the single-channel or multi-channel, 1-dimensional or 2-dimensional signal. The varying light passes through lenses which perform the mathematical operations. Conductron Corp., 343 S. Main St., Ann Arbor, Mich.

Circle 145 on Inquiry Card



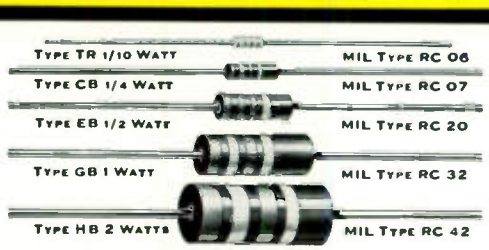
Why Allen-Bradley hot molding is so important to resistor performance

■ First and foremost, Allen-Bradley's exclusive hot molding provides a uniformity that cannot be matched by any other resistors on the market—a fact with which hundreds of Allen-Bradley customers have become acquainted through their experience for over 30 years. Such history of uniformity in physical dimensions and electrical properties from one resistor to the next . . . from one order to the next . . . has been demonstrated in the production of more than *ten billion resistors.*

In addition, with their stable characteristics and conservative ratings providing an *extra* margin of safety, you can accurately predict long term resistor performance under various circuit conditions—and at all times be certain of *complete freedom from catastrophic failures.*

A unique manufacturing method is the key which makes all this possible. Allen-Bradley's hot molding technique is unlike anything in the industry, because both the process and the automatic machines—with built-in precision control—were developed and perfected by Allen-Bradley. Here, the resistance material, insulation material, and lead wires are hot molded into one solid integral structure that's mechanically strong—completely free of cracks which might admit moisture.

There are additional reasons why more and more leading electronic manufacturers are standardizing on Allen-Bradley hot molded resistors. Complete specifications are furnished in Technical Bulletin 5050. Please send for your copy, today: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.



ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

26-63-E

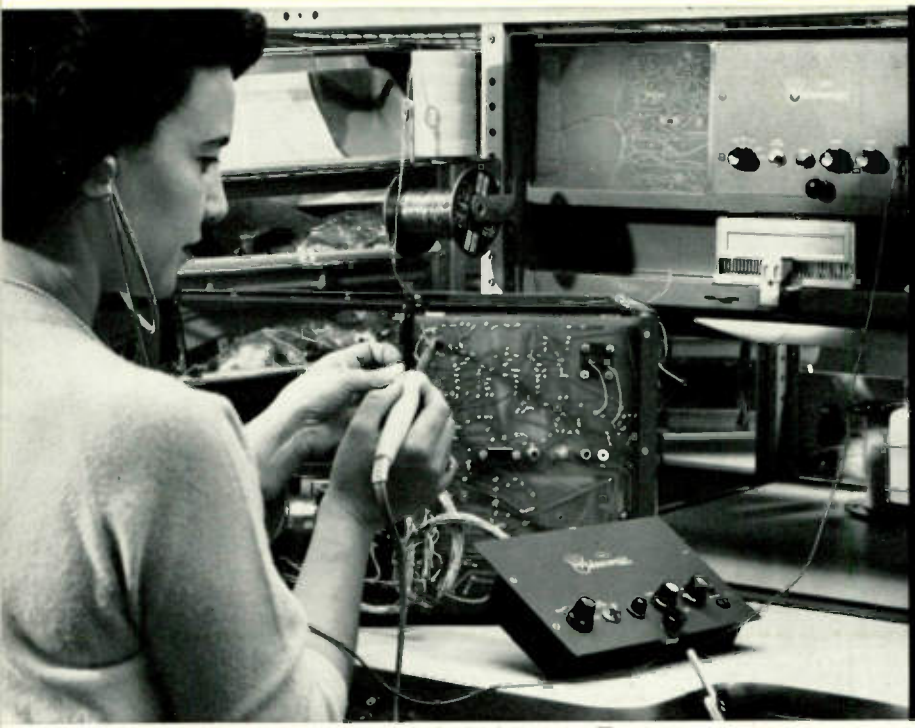
Hughes assures dependability of its Videosonic Systems with Allen-Bradley Hot Molded Resistors

■ Getting production started on complex assembly jobs produces endless problems incidental to the training to get the job started . . . the requirements for quality control . . . the time lost in retraining when production changes . . . etc. But, that's all over now, because of Hughes' new Videosonic System of colored slides synchronized with magnetic taped instructions that can guide even the unskilled assembler to surprising quality production output.

A variety of Allen-Bradley electronic components find application in this Videosonic apparatus. Allen-Bradley Type TR 1/10 watt hot molded resistors are used in quantity, because these hot molded resistors are an assurance of the high quality and dependability that the Hughes Aircraft Company demands. As a result of many years of experience, Hughes is another one of our valued customers who has learned that only A-B hot molded resistors can give their products the reliability that top quality demands, and the uniformity that the most critical operating conditions must have. With A-B hot molded resistors, there's never been a catastrophic failure.

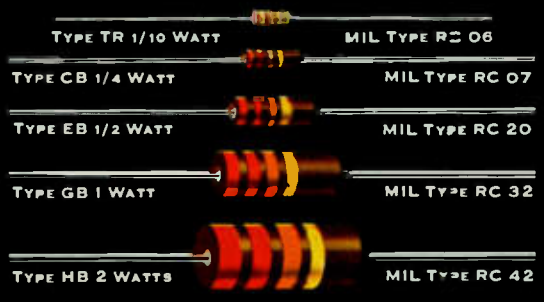
If you are not already a consistent user of A-B hot molded resistors, you'll want more detailed information about them, and also about other Allen-Bradley quality electronic components. So, please write for Publication 6024: Allen-Bradley Co., 222 West Greenfield Avenue, Milwaukee 4, Wisconsin.

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



Hughes Videosonic System is installed at eye level, directly in front of the assembler. Color slides appear on screen at right, while corresponding taped instructions are delivered simultaneously through earphones (as shown in photograph above) or with loud speaker.

A-B QUALITY

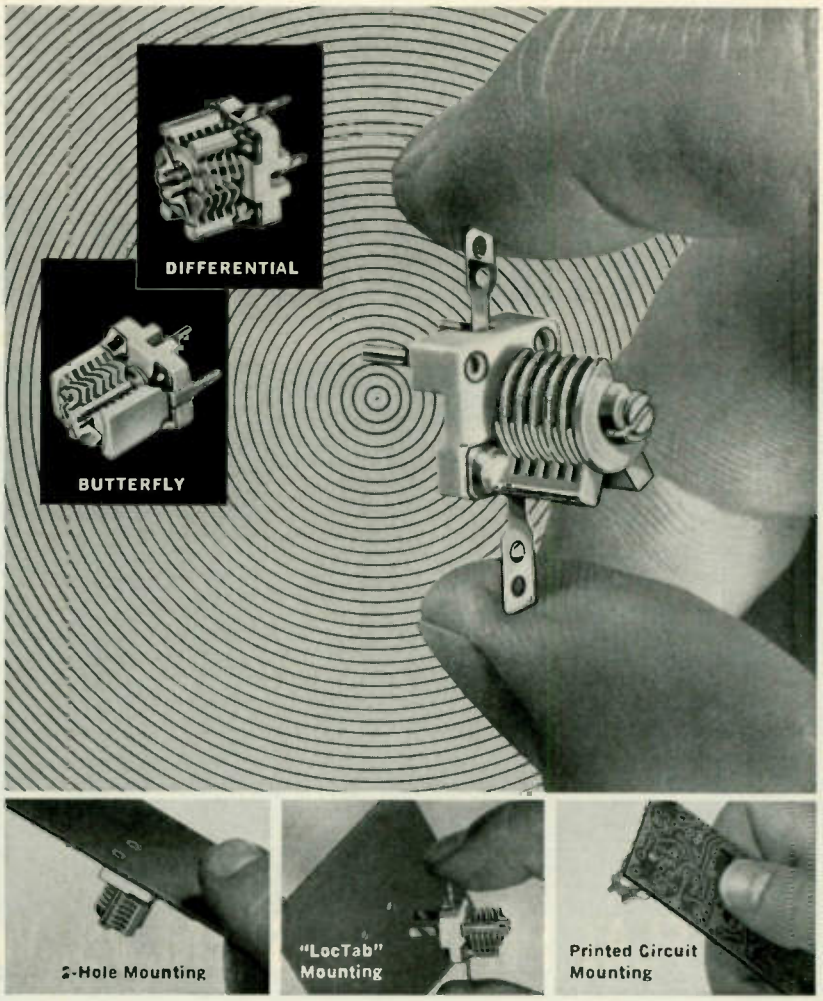


HOT MOLDED FIXED RESISTORS are available in all standard EIA and MIL-R-11 resistance values and tolerances.

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

19-63-E



Cut costs – save valuable space with these

SUB-MINIATURE "U, UA, and UB" AIR VARIABLES

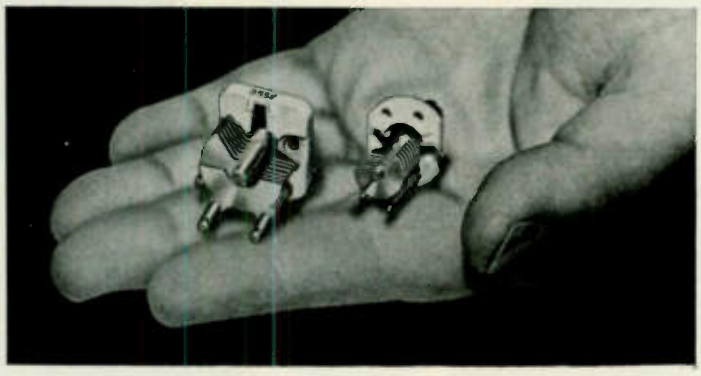
Precision machined for high reliability—exceptional mechanical stability!

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

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

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

DETAILED COMPONENTS CATALOG AVAILABLE — Write for your free copy today on company letterhead.



E. F. JOHNSON COMPANY
2803 TENTH AVENUE S. W. • WASECA, MINNESOTA

CAPACITORS • TUBE SOCKETS • CONNECTORS • PILOT LIGHTS
INSULATORS • KNOBS AND DIALS • INDUCTORS • HARDWARE

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

Significant improvements in the design and manufacture of Sylvania counter tubes mean you can now have high reliability in addition to savings and versatility.

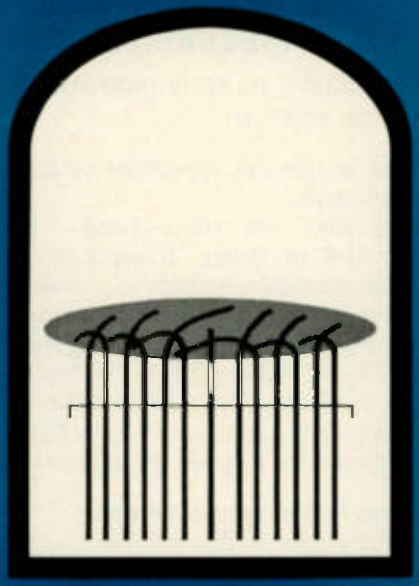
Construction is part of the reason. All Sylvania counter tubes have a circular wafer header, with leads spaced around the circumference rather than crowded along a straight-line, flat pressed stem. This makes possible wider spacing with no interference of leads with each other. Result: greater reliability due to a more rigid mount support, and the ability to withstand a maximum voltage between electrodes (excluding anode) in excess of 200 volts.

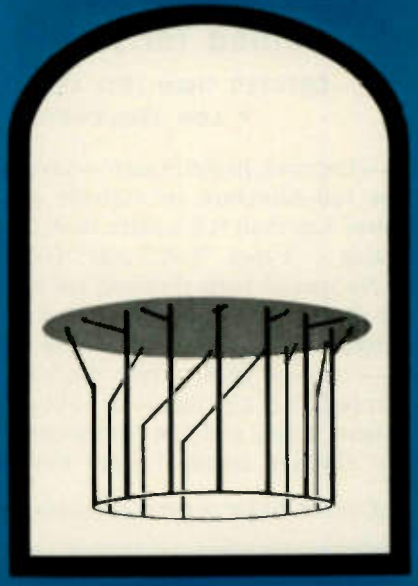
New and unique testing procedures (plus 100% testing to regular specifications) insure that tubes reaching users are skip-free. Additionally, tighter manufacturing controls

Sylvania takes the skip and

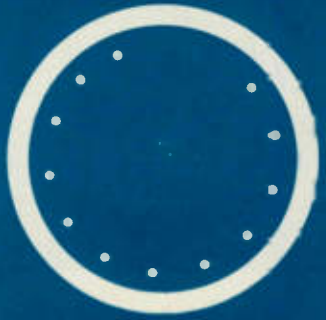
8353	6476A	6802	6879	8035	6909	6910	7155
4 Kc	4 Kc	4 Kc	5 Kc	50 Kc	100 Kc	100 Kc	100 Kc

FLAT PRESSED STEM VS. WAFER HEADER





Circular wafer header, used in all Sylvania counter tubes, permits wider lead spacing. Result: greater reliability due to rigid mount support, high breakdown voltage.



and a refinement in manufacturing process insure against sticking. The result is unprecedented uniformity of product, and extended life reaching thousands of hours.

Take advantage of the savings and versatility offered by Sylvania counter tubes. Savings, because little associated circuitry is needed—these units count and can provide readout, either visual or electrical. Versatility, because they can be used not only for counting but also for subtracting, adding, frequency dividing, keying, timing, computing, scaling, coding, modulating, matrixing, indexing, and multiplexing. All this, with a minimum of associated circuitry.

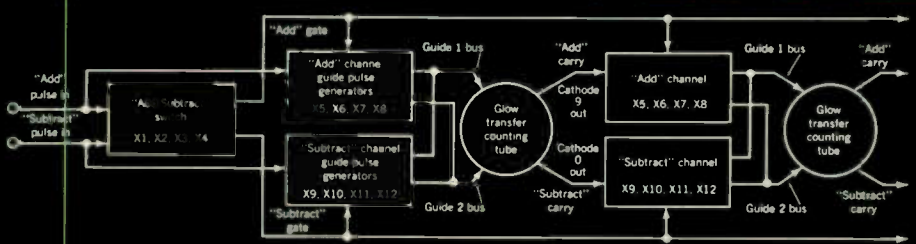
How can Sylvania counter tubes help you? Contact your Sylvania sales engineer or write to Electronic Tube Division, Sylvania Electric Products Inc., Box 87, Buffalo, N.Y. 14209.

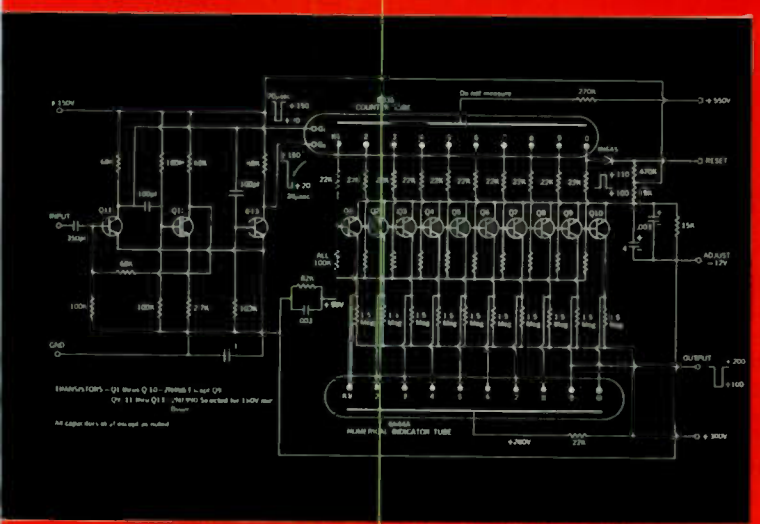
stick out of counter tubes

application help

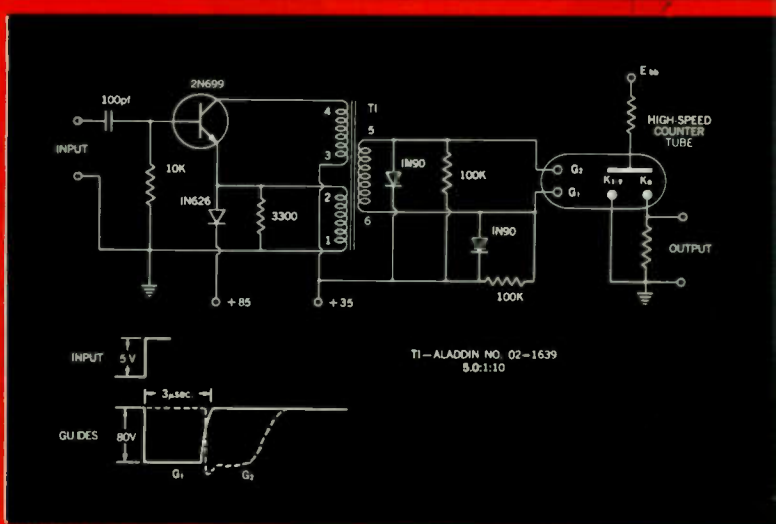
—new brochure details how to use Sylvania counter tubes. Contains more than 50 design circuits, some transistorized, some devised by users.

Reversible counter (Courtesy of Dynapar Corporation)





Counting equipment used in oil pipeline flow measurement (Courtesy of Digitrol Corporation)



High speed driver

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

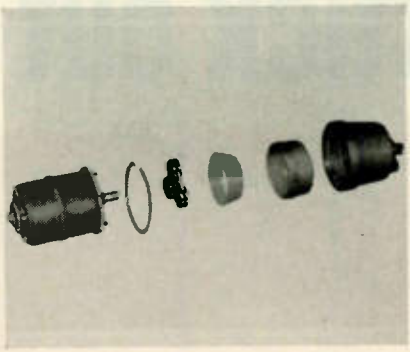
NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS
MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

Circle 11 on Inquiry Card

NEW PRODUCTS

ACTUATORS

The 3 x 2½ in. unit generates 150 in.-lb. torque at about 7 RPM.



This actuator uses controlled elastic deflection of structural members, and consists of a 3-lobe rolling-planetary wave generator, a plastic flexspline, and a precision zinc die-cast circular spline and housing. Reduction ratio is 450:1. It repeatedly withstands full stall torque in either direction. Harmonic Drive Div., United Shoe Machinery Corp., Beverly, Mass.

Circle 146 on Inquiry Card

MAGNETIC-REED SCANNER

Modular construction allows tailoring to exact number of points.

The basic design of this system allows any number of crosspoints to 1000—more by special design. Sequential scan with low/hi-point, stop and recycle modes, as well as random scan of any 10 points, provides program flexibility. The scanner has 2 parts: A counting chain composed of flip-flops, and a matrix driven from the counting chain through mercury-wetted contact relays. The scanner can be provided with contact ratings from low level to 250va, noise interference as low as 5μv and thermal voltage interference as low as 1μv. C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill.

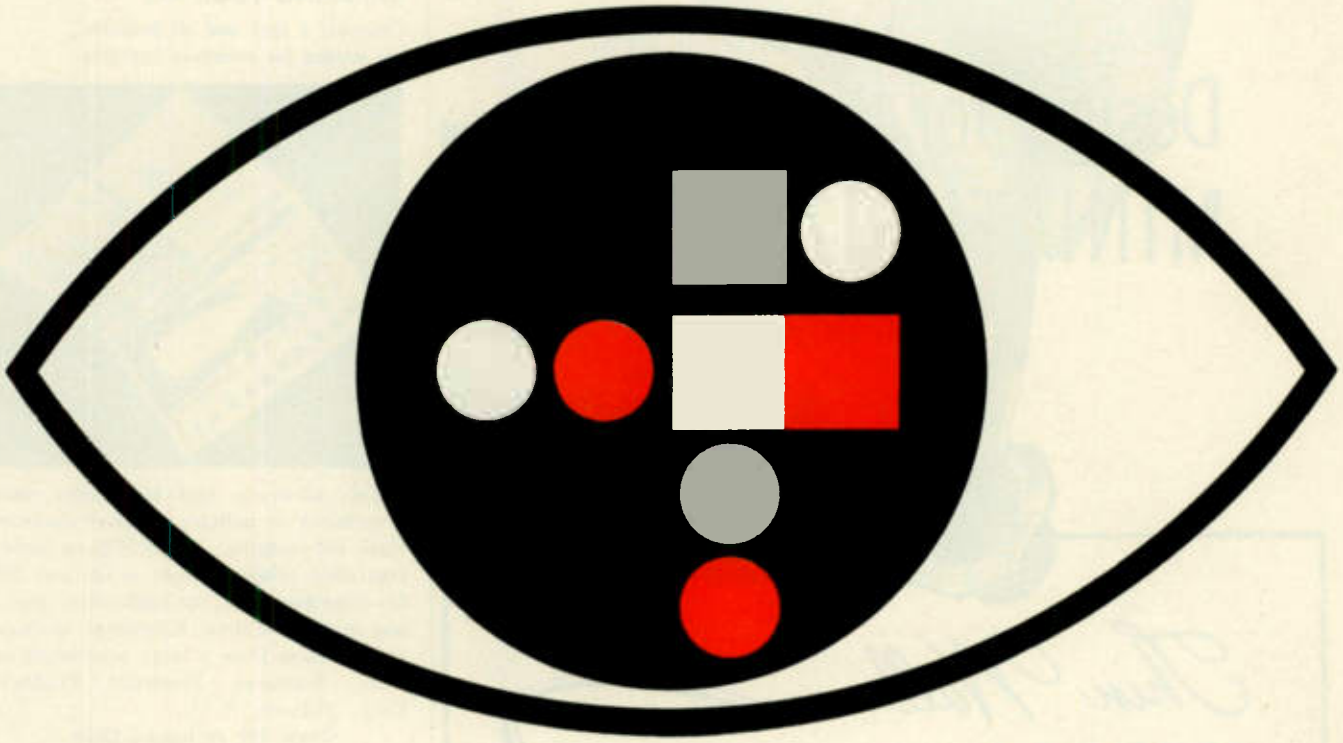
Circle 147 on Inquiry Card

FILTER CAPACITORS

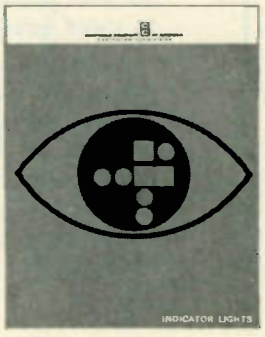
Short-life units offer 10K hrs. at 98% survival and 44K hrs. at 99%.

These units are designed for dc power supply filtering, blocking, and by-pass duty. Ratings for the 10K hr. capacitor are: voltage range, 7.5kv to 60kv; watt sec. range, 1040 to 1900; tolerance ±10%; 40°C amb. There are 20 ratings for this line. For hard tube modulator capacitors: voltage range, 7.5kv to 60kvdc; watt sec. range, 720 to 1320; tolerance, ±10%; 40°C amb. There are 17 different ratings. General Electric Co., Schenectady 5, N. Y.

Circle 148 on Inquiry Card



EYE-CATCHING INDICATOR LIGHTS—designed to meet both military and industrial-commercial design requirements. Select incandescent or neon, 1, 2, 3 or 4 lamps, and round, square, or rectangular faces in many sizes. We offer models to mount in single round or rectangular holes, or to matrix-mount. All colors in indicators, press-to-test, digital readout, billboard message, and read-when-lit styles. Even 60,000-hour subminiatures and edge-lit panel lamps. All indicator lamps and matching lighted pushbutton switches easily relamp from front of panel. Write for new free *Indicator Light Catalog #120.*

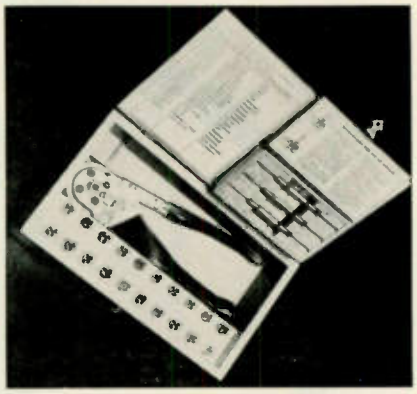


CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION
1420 Delmar Drive, Folcroft, Pennsylvania

NEW PRODUCTS

CRIMPING TOOL KIT

Contains 1 tool and all positioners needed for crimping contacts.



This all-in-one tool kit crimps most proprietary or military standard contacts. Each kit contains: 1 MS-3191—a cycle-controlled crimping tool; a Go and No Go plug gauge kit; an application chart; and instruction data. Eliminates stocking and selecting from a large assortment of tools. Buchanan Electrical Products Corp., Hillside, N. J.

Circle 149 on Inquiry Card

OPTICAL CELL

Provides adjustment of optical elements used in studying lasers.

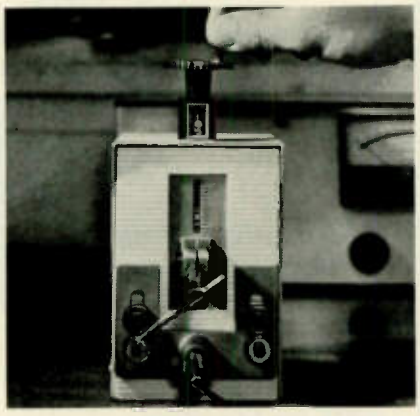
Model ROC-36 is used for holding and orienting elements up to 2.3 in. in their major dimension. The cell can be adjusted on either the vertical or horizontal axis over a max. range of 5° and within 10 sec. of arc. It is used in making interferometric evaluation of gas-laser components, such as the optical flats for Brewster-Angel windows and high-reflectivity mirrors forming the Fabry-Perot laser interferometer. General Dynamics Corp., 1 Rockefeller Plaza, New York 20, N. Y.

Circle 150 on Inquiry Card

NEW PRODUCTS

WELD HEAD

Digital readout allows positive weld-pressure settings.



The digital dial readout of the Model 1101 welding head insures greater speed and efficiency in the welded assembly of high-density packaging, and applications involving freq. pressure changes. The readout precludes need for force gage. It has 240 dial divisions equalling 240 oz. The unit features fully repeatable, uniform accuracy of ±2% of full scale, and head-to-head deviation of ±3% of full scale. Force resetability is ±0.5% of full scale. Weldmatic Div./Unitek, 950 Royal Oaks Dr., Monrovia, Calif.

Circle 151 on Inquiry Card

SEMICONDUCTOR BASES

Bases for high-power transistors and standard TO types.

These components feature high-strength compression seals, and all Mil types equal or exceed government specs. The bases for high-power transistors include types CN-1193 and CN-1160 with compression seals brazed in copper bases. This construction includes TO-3, TO-37, TO-18, TO-5 and TO-9. The latter three are available with Dumet leads. Electrical Industries, 691 Central Ave., Murray Hill, N. J.

Circle 152 on Inquiry Card

PLASTIC POTENTIOMETERS

Single gang units, in any dia., are under ¾ in. long.

Slimline is a complete, standardized line of linear, single-turn rotary conductive plastic precision units. The 1 1/6 and 1 3/32 in. dia. units have 1K, 5K, 10K and 20KΩ units; 1 7/16 and 1 ¾ in. dia. units have 1K, 5K, 10K, 20K and 50KΩ; 2 in. dia. units have 2K, 5K, 10K, 20K and 50KΩ; and 3 in. dia. units have 2K, 10K, 20K, 50K and 100KΩ. Markite Corp., 155 Waverly Place, New York, N. Y.

Circle 153 on Inquiry Card

SPECTROL
HIGH RELIABILITY
SQUARE TRIMMERS
FOR
TRANSISTOR CIRCUITS

Model 50 actual size — ⅜" square

Model 55 actual size — ½" square

Approved for use in many major military programs, Spectrol square trimmers answer all MIL-R-27208A requirements of electrical and environmental performance for missile applications. Note these feaures:

• Small size *(see photo)* • humidity proof at no extra cost • aluminum cases plus unique mandrel design allows high power ratings with ample safety margins • conventional mounting holes • five mounting configurations—insulated leads, pins 90° from shaft, pins 180° from shaft, pins from base, bushing panel mount • dual wiper design for positive contact under severe shock and vibration.

IMMEDIATE DELIVERY – You can get immediate off-the-shelf delivery on Models 50 and 55 at factory prices from Spectrol's 50 distributors. For additional details on Spectrol trimmers, as well as on precision potentiometers and MULTIDIAL® turns-counting dials, ask your Spectrol representative for complete specifications or write us directly.

MODEL 55 – ½" SQUARE

• Power rating 1½ watts at 70° C • 25 or 42-turn adjustment • operating temperature range —55° C to +150° C • resistance range 50 Ω to 50 K • Price $6 in 1-9 quantity.

MODEL 50 – ⅜" SQUARE

• Power rating 1 watt at 70° C • 25-turn adjustment • operating temperature range —55° C to +150° C • resistance range 50 Ω to 50 K • Price $7.50 in 1-9 quantity.

SPECTROL ELECTRONICS CORPORATION

1704 South Del Mar Avenue
San Gabriel
California

Adams Court
Plainview, L. I.
New York

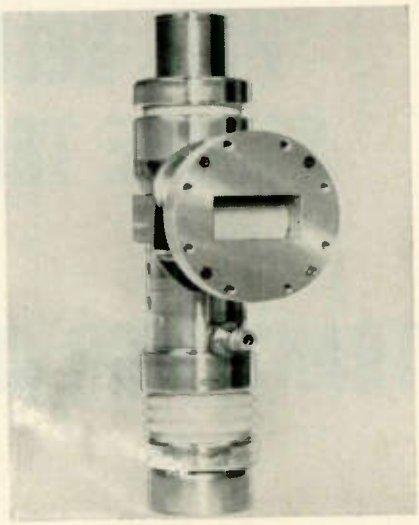
P.O. Box 130
Brampton
Ontario

Circle 57 on Inquiry Card

NEW PRODUCTS

KLYSTRON

Rated at 50kw peak and 5kw average in the freq. range 2.7-2.9GC.



The L3668H S-band electrostatically-focused klystron has a saturation gain of 35db. Weight is 25 lbs. Max. efficiency is 48%. The electrostatic fields are generated by non-intercepting lens electrodes operating at cathode potential. Since the r-f gaps are ungridded, high values of average power, gain and efficiency are achieved. Litton Industries Electron Tube Div., 960 Industrial Rd., San Carlos, Calif.

Circle 154 on Inquiry Card

PULSE MODULATOR

Handles up to 10kw peak pulse at duty cycles of 0.002 or less.

The BLP-030B pulse modulator is for use with beacon-type magnetrons and triode oscillators. Semiconductors are used exclusively in high and low voltage supplies and pulse clipping and trigger circuits. Features include high-voltage overcurrent protection; a solid-state trigger; 3 choices of pulse width; 5 output impedances, and the choice of either polarity on the pulse output. Two trigger modes are provided. Bomac Div., Varian Associates, Salem Rd., Beverly, Mass.

Circle 155 on Inquiry Card

200,000 OHMS PER VOLT

NEW AND THE FIRST

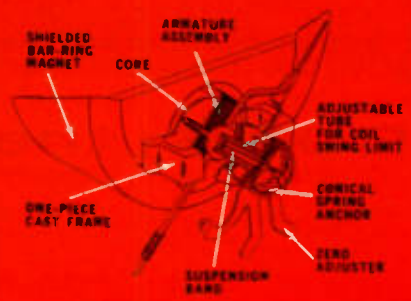
TRIPLETT

Model 630-NS
VOLT-OHM-MICROAMMETER

$99.50
SUGGESTED U.S.A. USER NET

TRIPLETT SUSPENSION MOVEMENT

no pivots . . . no jewels . . .
no hair springs . . . thus NO FRICTION.



FACTS MAKE FEATURES

1. 200,000 OHMS PER VOLT D.C. for greater accuracy on high resistance circuits. 20,000 OHMS PER VOLT A.C.
2. 5μa SUSPENSION METER MOVEMENT. No pivots, bearings, hairsprings, or rolling friction. Extremely RUGGED. Greater sensitivity and repeatability.
3. 62 Ranges, usable with frequencies through 100 Kc. Temperature compensated. 1½% D.C. ACCURACY, 3% A.C.

Low voltage ranges and high input impedance make the 630-NS especially useful in transistor circuit measurement and testing. Input impedance, at 55 volts D.C. and above, is *higher than most vacuum tube voltmeters.*

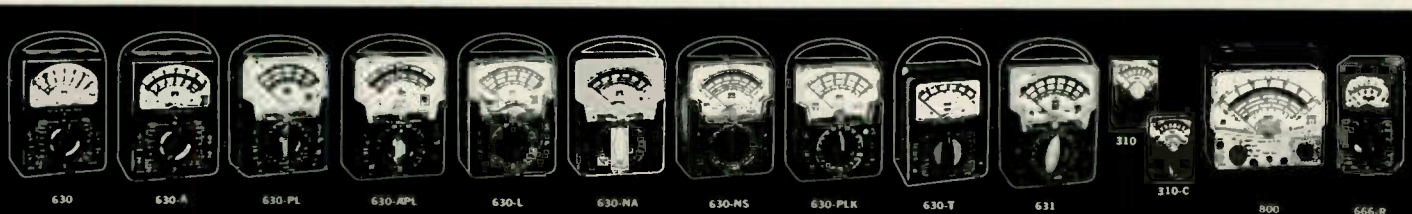
The unit is designed to withstand overloads and offers greater reading accuracy. Reads from 0.1μa on 5μa range. Special resistors are rigidly mounted and directly connected to the switch to form a simplified unit. Carrying cases with stands are priced from $9.90.

TRIPLETT ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO

62 RANGES

D.C. VOLTS	0-0.6-3-12-60-300-1200 at 100,000 Ohms/Volt. 0-0.3-1.5-6-30-150-600 at 200,000 Ohms/Volt. 0-0.150 at 60μa
A.C. VOLTS	0-3-12-60-300-1200 at 10,000 Ohms/Volt. 0-1.5-6-30-150-600 at 20,000 Ohms/Volt.
DB	-20 to 77 in 10 ranges.
D.C. MICRO-AMPERES	0-5 at 300 MV. 0-60-600 at 150 MV. 0-120 at 300 MV.
D.C. MILLI-AMPERES	0-6-60-600 at 150 MV. 0-1.2-12-120-1200 at 300 MV.
D.C. AMPERES	0-6 at 150 MV. 0-12 at 300 MV.
OHMS	0-1K-10K-100K (4.4-44-440 at center scale)
MEGOHMS	0-1-10-100 (4400-44,000-440,000 Ohms center scale)

OUTPUT: Condenser in series with A.C. Volt ranges.



THE WORLD'S MOST COMPLETE LINE OF V-O-M'S. AVAILABLE FROM YOUR TRIPLETT DISTRIBUTOR'S STOCK

NEW PRODUCTS

SOLID-ELECTROLYTE CAPACITOR

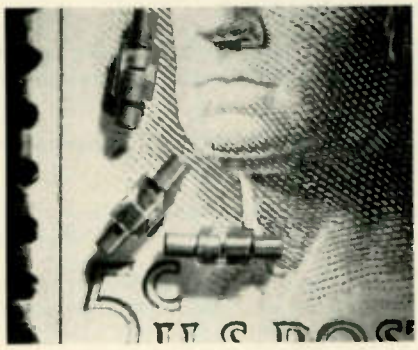
Suited for installation on printed-wiring boards.

The type 154D molded solid-electrolyte Tantalex capacitors are ideal for digital computing equipment. In the 0.090 in. dia. x 0.250 in. long case, max. capacitance ranges from 1.5μf at 6v. to 0.1μf at 75v. For smaller sizes the capacitances range from 15μf at 6v. to 0.68μf at 75v. Sprague Electric Co., Marshall St., North Adams, Mass.

Circle 164 on Inquiry Card

VARACTOR DIODE

Min. efficiency is 60%; input freq., 1.5GC; output freq. 3.0GC.

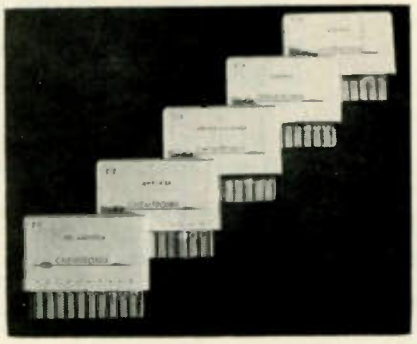


The MD100 is a silicon-planar epitaxial diode used for harmonic generation. Parameters: input power, 2w.; cutoff freq. @ 0v., 70GC; capacitance 0v., 2.0μμf; power dissipation, 0.8w. @ 25°C; breakdown voltage, 60v. Fairchild Semiconductor, div. of Fairchild Camera and Instrument Corp., 545 Whisman Rd., Mountain View, Calif.

Circle 165 on Inquiry Card

SYSTEM BUILDER

Units allow breadboarding at the systems instead of component level.



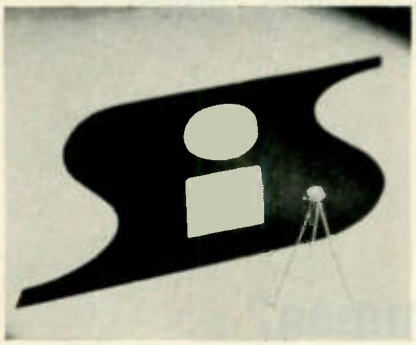
The E-series electronics are for R&D uses where instrumentation must be rapidly created for special purposes. The series consist of 6 plug-in units, a preamplifier, amplifier, emitter-follower, chopper, rectifier, and differential amplifier. Available with germanium or silicon transistors. Chemtronix Co., P. O. Box 245, Goleta, Calif.

Circle 166 on Inquiry Card

NEW PRODUCTS

FIELD-EFFECT TRANSISTOR

For amplifiers, analog multipliers, sample and hold circuits.

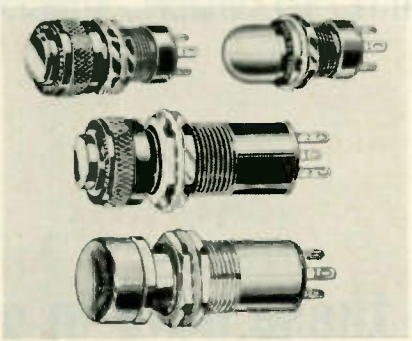


The U-114 p-channel silicon unipolar field-effect transistor is in TO-46 package. This miniature Unifet offers typical pinch-off voltage of 2v.; g_m = 175μmho; typical L_{DSS} is −56μa. Min. gate-drain breakdown voltage of 30v. is guaranteed at I_G = 1μa. They may also be used as choppers. Siliconix Inc., 1140 W. Evelyn Ave., Sunnyvale, Calif.

Circle 167 on Inquiry Card

INDICATOR LIGHTS

Press-to-test indicator reports condition of the lamp, current and PS.

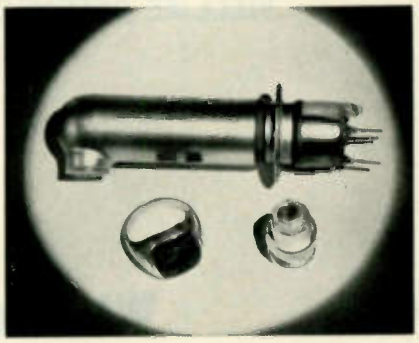


Press-to-test indicator lights allow lamps to be checked instantly. They include units that mount from back of panel in 15/32, 5/8 and 1 in. clearance hole. They are available in a wide range of lens styles and colors. Legends can be hot-stamped on flat lenses. Dimmer caps can be furnished on most assemblies. Dialight Corp., 60 Stewart Ave., Brooklyn, N. Y.

Circle 168 on Inquiry Card

PHOTOMIXING DIODES

Demodulates laser outputs inherent in optical communication systems.



The L4500 series operates between 0.4 to 5.7 microns. The L4501 and L4502 operate between 0.5 to 1.0; the L4530, between 0.4 and 3.4; and the L4540, between 0.4 and 5.7. Typical cutoff freqs. are 40, 10, 0.5, and 0.8gc. Typical photon efficiency is 50% for the silicon diodes, and 25% for the intermetallic diodes. Philco Corp., Lansdale Div. Lansdale, Pa.

Circle 169 on Inquiry Card

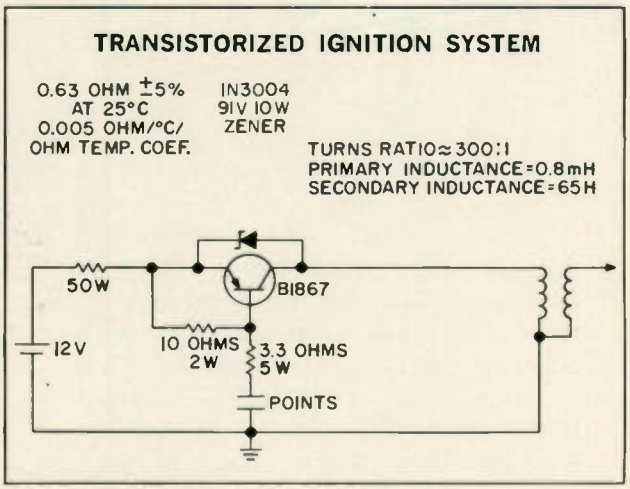
AUTOMOBILES / RACING / TORPEDOES / FLIGHT CONTROL / EXPLORATION OF OUTER SPACE / INDOOR LIGHTING / MISSILES FOR DEFENSE, AS WELL AS OFFENSE / HI-FI / TELEVISION / SURGERY / HEARING / BOATS

What do these have in common?

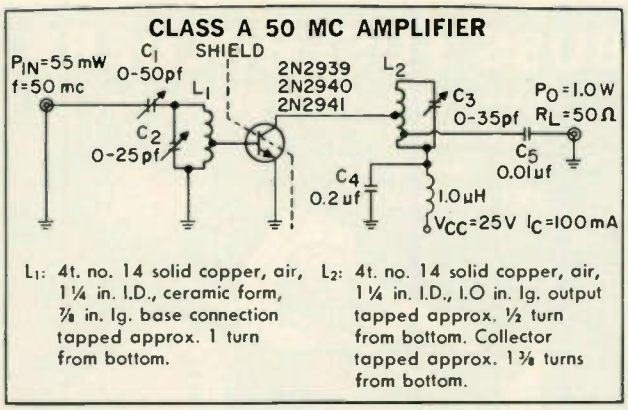
They all utilize one or more Bendix Semiconductors.

Here are other applications you might find useful.

The Ford-powered Lotus—that just raced at Indianapolis and has been winning races ever since—has a transistorized ignition system with Bendix® DAP® transistors. Our interest in transistorized ignition systems is not for fun only. The day is not far off when all car makers will be going this route. Here is one circuit of several that can be used. More later about DAP transistors and SOAR.



Here's another circuit for use in high frequency applications. This 50 mc class A amplifier circuit uses our 2N2939-2N2941 silicon Leaf® planar transistor designed for HF, VHF, class A-class C amplifier and oscillator circuits. The Leaf transistor is "purple plague" free.



L_1: 4t. no. 14 solid copper, air, 1¼ in. I.D., ceramic form, ⅞ in. lg. base connection tapped approx. 1 turn from bottom.

L_2: 4t. no. 14 solid copper, air, 1¼ in. I.D., I.O in. lg. output tapped approx. ½ turn from bottom. Collector tapped approx. 1⅜ turns from bottom.

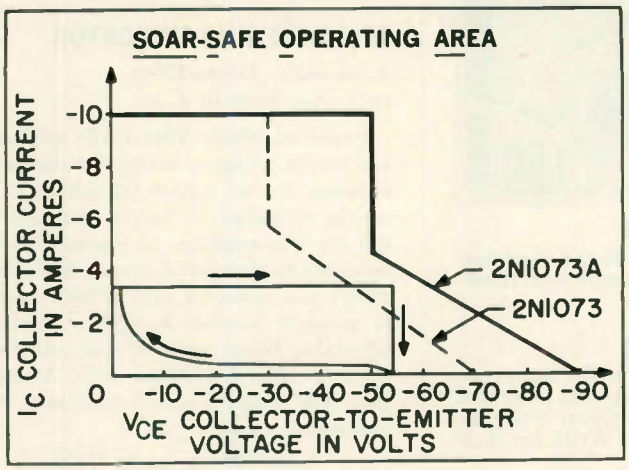
We would like to amplify a bit on our original Leaf design shown below. The Leaf configuration means lower saturation voltage; the larger emitter area means higher gain, and the larger emitter periphery gives improved beta linearity (up to 1 amp). Note the larger bonding area for high reliability.

For still more power at high frequencies you can get the new BIG (for Bendix Interdigitated Geometry) Leaf silicon planar epitaxial NPN transistor. Here's a case where the old saying "big things come in little packages" is actually an understatement, since this transistor offers the highest power-frequency combination on the market today. Class C power out-

puts of 25 watts at 50 mc can be achieved, and the BIG Leaf has gain-bandwidth products up to 300 mc. This new configuration provides a lower collector saturation voltage—typically, 0.2 volt at 2 amperes—higher gain and excellent beta linearity at collector currents up to 10 amperes.

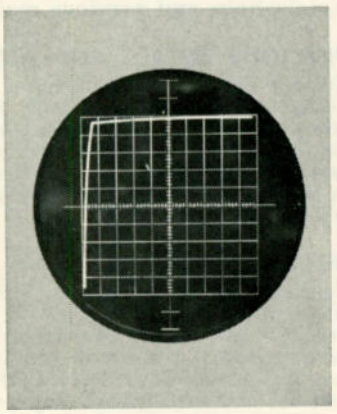
You can now get transistors without "purple plague" for lifetime reliability. Purple plague seriously limits transistorized equipment life. Purple plague results from the intimate contact of gold (in the leads) with the aluminized silicon element. The resulting $AuAl_2$ alloy increases resistance, and ends in transistor failure due to loss of mechanical strength at the bond. How do you avoid it? By using transistors with aluminum leads. With aluminum-to-aluminum bonding, and without gold in contact with the aluminized silicon, there just isn't any purple plague. This isn't quite as simple as it sounds. Bonding the Al leads to the Al metalized contact area is tricky and takes some rather advanced techniques. As proof of our bonding reliability, our planar transistors have been tested in excess of 40,000 G's centrifuge and 5000 G's shock without a failure after 5000 hours at 300°C.

SOAR enables you to select transistors that can reliably switch up to 4500 watts in microseconds. SOAR defines the region enclosing all the points representing simultaneous values of collector current and collector-to-emitter voltage which the transistor can safely handle during switching into any load—inductive, resistive or capacitive. Exact conditions are specified for base current, switching time, junction temperature and average power dissipation. To show how easy SOAR is to use, please go through this example:



Assume maximum circuit conditions in a clamped inductive load switching application are: $I_C = -3.5$ A, $V_{CE} = -55$ V, repetition rate = 1 cps (square wave, duty cycle 0.1%) $P_{c(avg)} = 2$ mW, $T_A = 85°C$, $\theta_{C\text{-}A} = 14.2°C/W$ (case-to-ambient), $t_f = 2$ μsec, $t_r = 60$ μsec, $I_B = \pm 0.8$ A, driving source output resistance = 3 ohms. In this example, the load line does *not* fall within the 2N1073 SOAR but *does* fall within the 2N1073A SOAR. Therefore, the 2N1073A is the proper transistor for safe switching.

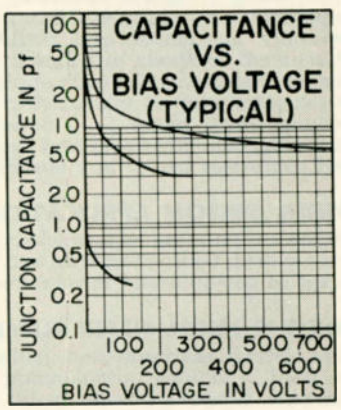
This 10 amp DAP (diffused alloy power) transistor and the one in the ignition circuit are just two in a broad line offered by Bendix. These DAP transistors are so reliable that one of our 25 amp DAP types is scheduled for a trip to the moon (if you want more reliability data, let us know). For versatility in your circuit designs there are DAP transistors from 3 to 50 amps and up to 200 volts.



For rectification, magnetic amplifier, power supply and DC blocking applications, Bendix makes a line of high voltage silicon power rectifiers in two packages. There are 67 types in all to choose from. They are the only ones designed with a single junction to withstand up to 2500 volts and carry up to 10 amps. Because our units have diffused single junctions, they have lower forward drop. And not one unit leaves our plant unless it passes a sweep test. Take a quick look at the typical reverse characteristics of our units.

For VHF-UHF multiplier chains and other microwave applications, consider our silicon power varactor line. There are 64 types available in three packages, the smallest of which will not begin to cover the nail on your little finger, a size factor really important if you are trying to miniaturize a microwave circuit.

Some of our customers have described us as a germanium powerhouse (because of 334 different types)—but we also have 61 types of *silicon* diffused mesa power transistors in 9 packages with currents up to 8 amps and voltages up to 120 volts.



These product lines add up to a large variety of reliable Bendix devices for your use in military, space, industrial, commercial and consumer electronics.

Let us assist you in choosing the semiconductor devices that fit your needs. Just phone or write our nearest sales office.

Bendix Semiconductor Division
HOLMDEL, NEW JERSEY

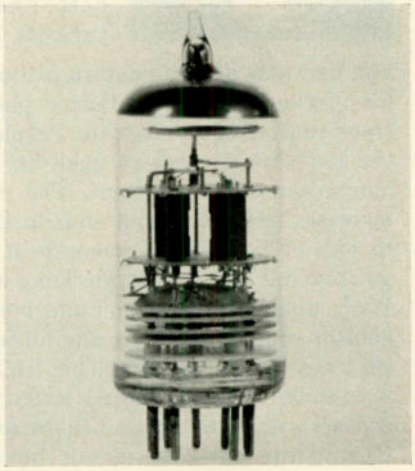
THE Bendix CORPORATION

Burbank, Calif.—(213) Victoria 9-3961; **Chicago**—(312) 637-6929; **Dallas**—(214) 357-1972; **Detroit**—(313) JOrdan 6-1420; **Holmdel, N. J.**—(201) 747-5400; **Minneapolis**—(612) 824-7270; **San Carlos, Calif.**—(415) LYtell 3-7845; **Syracuse, N. Y.**—(315) 474-7531; **Waltham, Mass.**—(617) 899-0770; **Export**—Cable: Bendixint, New York, N.Y. (212) 973-2121; **Ottawa, Ontario, Canada**—(613) TAlbot 8-2711.

NEW PRODUCTS

SPECIAL TUBE

Uses integrated-circuit concept; functions in nuclear radiation.



The Circuitron incorporates active thermionic components and passive components in a common envelope. They function reliably, with no failures, during an integrated nuclear exposure of 10^{16} (n, v, t) epithermal neutrons and 4.5 x 10^{7} Roentgens. A pulse radiation test made on binary counter Circuitrons showed the stored count was unaffected by radiation. They can be operated at an amb. temp. of 200°C, and are not damaged by 160db noise. Sylvania Electric Products Inc., Emporium, Pa.

Circle 156 on Inquiry Card

TELEMETERING INDICATOR

Scans entire 350CPS-120KC subcarrier band in 1 sec.

Panorami, Model TMI-4/120, monitors and checks telemetry subcarrier channels, including the h-f tape-speed reference. It can be furnished to handle channels to 190 KC. Pre-emphasis of channel levels, noise intermodulation distortion and other effects are measured over a 55db range. It provides zoomed in highly resolved adjustable linear scans of any spectrum segment 100CPS to 20KC wide. Metrics Div., The Singer Co., 915 Pembroke St., Bridgeport, Conn.

Circle 157 on Inquiry Card

POWER SOURCE

Solid-state freq. changer converts 60 CPS to precision 400 CPS.

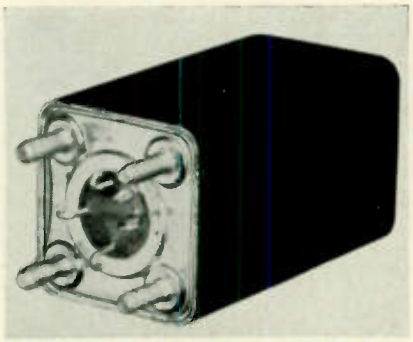
Model PS-62-64 is a portable, precision 400 CPS power source rated at 1kva. The unit features precision and adjustable voltage, light-weight, overload, and short-circuit protection. Unitron Inc., 1624 N. First St., Garland, Tex.

Circle 158 on Inquiry Card

NEW PRODUCTS

SOLID-STATE RELAY

Switching time at max. rated load is less than 20μsec.



The Model 2300 provides a dc-to-dc latching. It operates on input voltages of 8-32vdc at a current of 20ma max. It will switch a load of 100vdc at 25ma to 1a., depending upon amb. temp. Forward drop is 2v. max., and forward leakage in the off condition is 1μa @ 25°C with a load of 100vdc. Hi-G Inc., Bradley Field, Windsor Locks, Conn.

Circle 159 on Inquiry Card

HV SILICON RECTIFIER

Assemblies replace mercury tube rectifiers. DC outputs to 1.75a.

The MB series have peak-reverse voltage ratings as high as 15 kv. Voltage transient protection is provided by an avalanche diode. They are housed in an epoxy sealed, phenolic tube. Syntron Co., 263 Lexington Ave., Homer City, Pa.

Circle 160 on Inquiry Card

D/A CONVERTER

Storage system permits intermittent and continuous BCD inputs.

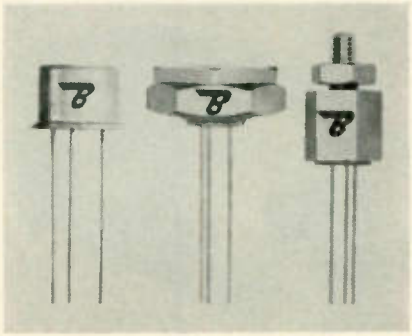
The Type 1136-A digital-to-analog converter selects any 3 consecutive or the last 2 columns of an input up to 9 columns. It operates with 4-line BCD inputs or, with an accessory matrix cable, with 10-line inputs from GR Type 1150 series counters. Nominal overall accuracy is ±0.1%. Output is switch-selected as either 1ma with 15KΩ source impedance or 100mv with 100Ω source impedance. Conversion rate is up to 10K sec., and storage transfer time is 50μsec. General Radio Co., West Concord, Mass.

Circle 161 on Inquiry Card

NEW PRODUCTS

PNP POWER TRANSISTORS

DC current gain to 200 max. VCBO ratings from —40 to —100v.

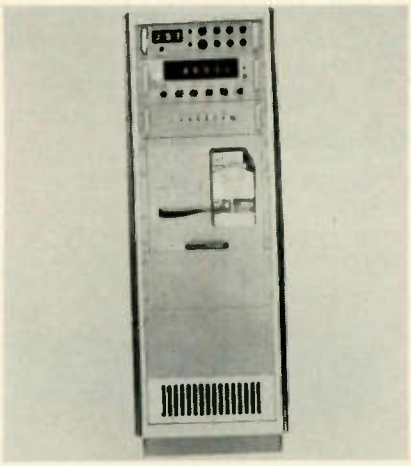


The 2N2552-2N2567 series comes in 3 different packages: MT-27, a press-fit stud package; MT-6, a press-fit hexagonal flanged nut; and TO-5. Continuous power dissipation is 20w. at or below 25°C junction temp. ICBO is —125μa at ½ rated VCBO. These germanium units are suited for audio amplifier, pulse amplifier, relay driver, and switching applications. Bendix Semiconductor Div., Bendix Corp., Holmdel, N. J.

Circle 162 on Inquiry Cord

DATA LOGGING SYSTEM

Logs 165 channels/min. Stability, 0.005% full scale for 6 mos.

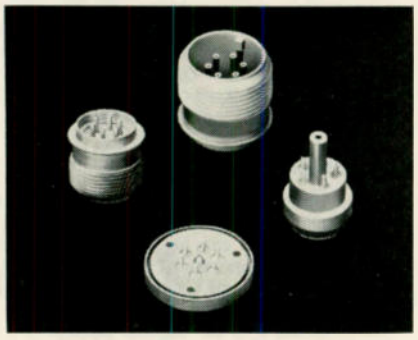


The Kin Tel system, Model 551-100, is a dc digital logging system. It measures and records voltages from 0.0000 to ±999.99v., and produces recorded information of 5 digits, symbol, range indication, and channel identification. System accuracy is 0.005% of full scale +0.005% of reading. Data is recorded by a tape perforator or optionally by a typewriter or printer. The scanner accommodates 100 channels of up to 3-wire inputs. Cohu Electronics, Inc., Kin Tel Div., San Diego, Calif.

Circle 163 on Inquiry Cord

CONNECTORS

Radiation-resistant components operate from −320°F to +1200°F.

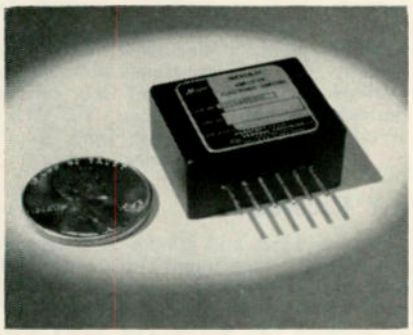


These hermetically-sealed connectors and headers provide resistance against corrosive environments and thermal shock. Radiation resistance: thermal neutron capture across section is less than 1 x 10^{-24} cm^2; leak rate: less than 2 x 10^{-9} cc He/sec.; pressure seal: withstands greater than 10,000 psi; and electrical insulation: more than 400,000 megohms @ 1K vdc. Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles, Calif.

Circle 218 on Inquiry Card

CONTROL SERVO AMPLIFIER

The ¼ in. volume unit delivers 5w. over a temp. range −55°C to +71°C.

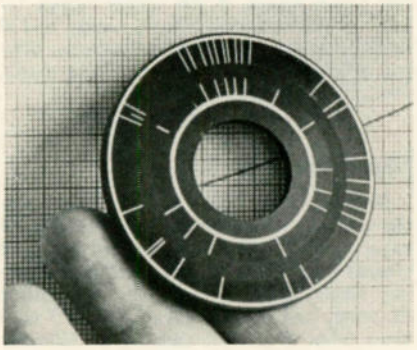


The capacitors, resistors, and conductors of this microblock unit are deposited on ceramic substrates and contained in a hermetically-sealed case. Electrical characteristics include: signal freq., 400 (±20) cps; voltage input, 28vdc (±10%); power input (max. output), 11w.; voltage, 40v. nominal; and gain stability, ±3db. Kearfott Div., General Precision Aerospace, 1150 McBride Ave., Little Falls, N. J.

Circle 219 on Inquiry Card

PLASTIC POTENTIOMETERS

Conductive plastic element can produce simulated radar echoes.



These complex conductive plastic potentiometer elements have 15 taps. They are co-molded with the conductive plastic resistive track to provide sharp pulses of varying amplitude. These pulse positions are held to a tolerance of ±1°. High stability with a life of 10 million revolutions. They have a good accuracy and low noise. Fairchild Controls, div. of Fairchild Camera and Instrument Corp., 225 Park Ave., Hicksville, L. I., N. Y.

Circle 220 on Inquiry Card

NEW TECH DATA

Relays and Switches

Catalog 1162, 14 pages, gives complete descriptions, specs. and drawings for the 100 Series relays, R-200 rocker relays, G-125 printed-circuit relays, and G-130 latching relays, dust-free enclosures, sockets, solenoids, and switches. Relaymatic, Inc., Sag Harbor, L. I., N. Y.

Circle 186 on Inquiry Card

Capacitor Bulletin

Bulletin GET-2984A describes new porous-anode, liquid-electrolyte Tantalytic® capacitors. The data features life test and typical performance curves, charts showing electrical characteristics, an outline drawing, and photos. Available in 5 case sizes from 6 to 60v. and 0.1 to 325mfds. General Electric Co., Schenectady 5, N. Y.

Circle 187 on Inquiry Card

Modules Catalog

Catalog 80, 52 pages, contains circuit diagrams and operating characteristics on the complete line of Cambion® 12-pin digital logic modules. There are 19 families, 43 modules. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass.

Circle 188 on Inquiry Card

Transformer Chart

This transformer selector chart simplifies the selection of small h-f transformers. It is applications oriented. To use it, classify the transformer application as either pulse or sine wave, and locate visually the various transformer styles available in the power and freq. ratings desired. Aladdin Electronics, 703 Murfreesboro Rd., Nashville 10, Tenn.

Circle 189 on Inquiry Card

X-Y Recorders

Models 135A and 2D-2A X-Y recorders have a 1 meg imput resistance. Each operates from 0.5mv/in. to 50v/in. in 11 ranges. Additional data available from F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena, Calif.

Circle 190 on Inquiry Card

PM-Focussed BWO

The type SE 303 is tunable over the full X-band, weighs 1.5 lbs., and has a min. power output of 20mw. Size is 1½ in. sq. x 5 in. long. Additional data available from Stewart Engineering Co., subs. of Watkins-Johnson Co., Santa Cruz, Calif.

Circle 191 on Inquiry Card

Storage-Tube Booklet

This 18-page booklet contains new ideas about scan conversion and the application of recording storage tubes. Photos, performance, special techniques, applications, and circuitry are some of the data given. Image Instruments, Inc., 2300 Washington St., Newton Lower Falls, Mass.

Circle 192 on Inquiry Card

Connectors

This illustrated color brochure shows how 3 basic connectors in the MS Building Block design can be used to assemble all types of connectors, including E, R, A, C. The Standard Connector Corp., 201 State St., North Haven, Conn.

Circle 193 on Inquiry Card

Components & Systems

This 56-page catalog gives detailed descriptions, schematics and illustrations on telemetry systems, voltage-controlled oscillators, component mounts, mv subcarrier oscillators, mixer amplifiers, power supplies, dc amplifiers, reference, oscillators and airborne telemetry calibrators. Sonex, Inc., 20 E. Herman St., Philadelphia, Pa.

Circle 194 on Inquiry Card

In January, 1963 a dynamic new dimension was added to Lockheed Missiles & Space Company in Huntsville, Alabama.

LMSC's now well-established Research & Engineering Center was created to lend close support to the George C. Marshall Space Flight Center, founded by NASA to furnish vehicles for space programs; and the Army Missile Command, home of the Army's missile programs.

The Huntsville Research & Engineering Center, adjacent to the University of Alabama's new Research Center, is largely self-sufficient, capable of carrying out a wide variety of programs. Its capabilities include: Advanced engineering; analytical studies; hardware design, development, manufacturing, testing and evaluation. Specific studies, such as analyzing guidance systems, trajectory computation, optimization of payload and accuracy, post-flight analysis, and thrust vector control through secondary injection, are already being accomplished.

Living in the Huntsville area is delightful. The city, a metropolis of 120,000, is modern and bustling—the fastest growing city in the Southeast. Nearby lakes and rivers provide excellent fishing and water sports. Its scenic countryside offers a wide variety of game to the hunter. New housing is plentiful. Schools have kept pace with the rapid population growth, as have the churches and civic organizations.

In all, you will enjoy living in Huntsville. And you'll appreciate the rare challenge of growing with a new, ambitious organization.

LOOK AT LOCKHEED...AS A CAREER

Consider Lockheed's leadership in space technology. Evaluate its accomplishments—such as the Polaris missile and the Agena vehicle's superb performance records. Examine its outstanding advantages—location, advancement policies, creative climate, and opportunity.

Then write for a brochure that gives you a more complete Look at Lockheed in Huntsville. Address: Lockheed Missiles & Space Company, Huntsville Research & Engineering Center, P.O. Box 1103, West Station, Huntsville, Alabama.

SCIENTISTS & ENGINEERS: Current positions available in Huntsville include work in the following areas: Guidance analysis • Electronics • Stability & control • Astrodynamics • Dynamics performance evaluation • Aerodynamics • Gas dynamics • Control systems analysis • Thermodynamics • Structural dynamics • Computer programming • Propulsion • Flight Mechanics • Optimization techniques in mathematics.

LOCKHEED

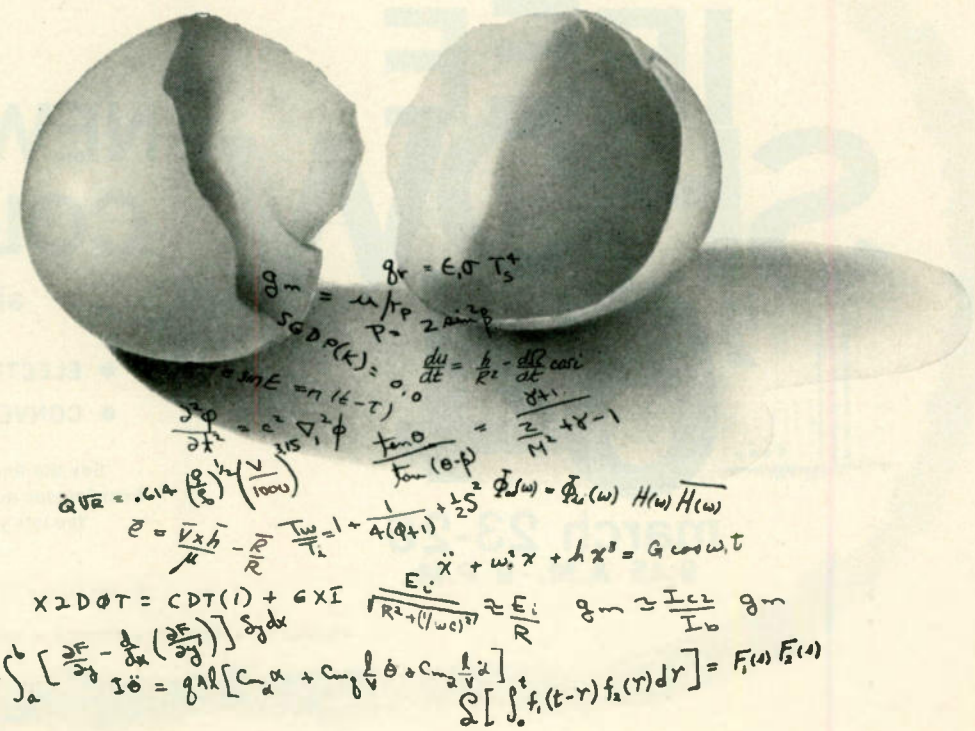
MISSILES & SPACE COMPANY

A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

AN EQUAL OPPORTUNITY EMPLOYER

LOOK AT LOCKHEED...IN HUNTSVILLE

Introducing Lockheed's new Research & Engineering Center



NEW TECH DATA

for Engineers.

Boolean Algebra Guide

A pocket-sized guide to Boolean algebra and logic conventions contains basic logic rules and includes formulas of the De-Morgan theorem, absorption property, and canonical form plus often needed useful identities. Also included are the logic symbols of the positive logic convention, in conformance with Mil-STD-806B, and a list of standard abbreviations. Harman-Kardon, Inc., Plainview, L. I., N. Y.

Circle 170 on Inquiry Card

Silicon Transistors

Information is available on 6 new silicon power transistors which handle high-power and h-f requirements. They can be used in high-current, high-speed switching systems. Transistors can handle currents as high as 25a. Radio Corp. of America, 30 Rockefeller Plaza, New York 20, N. Y.

Circle 171 on Inquiry Card

Fasteners Catalog

This 24-page booklet covers all frequently used MS stainless steel fasteners. Products listed include nuts, bolts, machine screws, screws, etc. Star Stainless Screw Co., 699 Union Blvd., Totowa, N. J.

Circle 172 on Inquiry Card

Printed-Circuit Booklet

This 12-page, 3-color booklet contains charts showing performance characteristics of various base materials, a table of applications and properties of plated coatings, cutaway drawings of multi-layer termination alternatives, and many other charts, diagrams, and photos. It is intended as an aid in selecting the proper PC board for a particular use. Industrial Circuits Co., E. Paterson, N. J.

Circle 173 on Inquiry Card

Switch Catalog

Catalog C-64, 24-pages, describes snap-action switches. It provides complete engineering drawings, specs. and operating characteristics. Cherry Electrical Products Corp., Box 439, Highland Park, Ill.

Circle 174 on Inquiry Card

Design Aids

"Shortcuts in Selection of Tape Wound Cores for Magnetic Circuitry" will aid circuit designers who are interested in inverters, magnetic amplifiers, and transformers. The booklet features characteristic curves for 3 core materials. The curves were developed by solving Faraday's Law and using specific basic assumptions in solving the equation. Magnetics Inc., Butler, Pa.

Circle 175 on Inquiry Card

Solder-Joints Booklet

An illustrated tech. bulletin, MR500, gives information on inspection and quality control of solder joints. It contains data on how to build quality into solder joints and how to visually inspect them. The bulletin also discusses the problems of cleanliness and corrosivity. Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J.

Circle 176 on Inquiry Card

Magnetic Drums/Discs

This brochure contains data on 3 models of magnetic drums with storage to 4,-100,000 bits, and 10 models of discs with storage to 7,680,000 bits. The data includes design information, specs., and photos. Commercial Computer Div., General Precision, 100 E. Tujunga Ave., Burbank, Calif.

Circle 177 on Inquiry Card

Semiconductor Handbook

Silicon diodes, rectifiers, solar cells, regulators, and other devices are described in this 64-page handbook. The data includes characteristic curves, photos, drawings, and tables. American Semiconductor Corp., 3940 N. Kilpatrick Ave., Chicago 41, Ill.

Circle 178 on Inquiry Card

NEW TECH DATA

for Engineers.

Capacitor Catalog

This 28-page catalog provides complete technical, electrical and physical data on all types of film, paper and custom designed capacitors, as well as a new line of miniaturized power supplies. Curves, charts, and photos are provided. Chicago Condenser Corp., 3255 W. Armitage, Chicago 47, Ill.

Circle 179 on Inquiry Card

Detection Handbook

This 17-page illustrated application handbook discusses synchronous detection systems. It describes the use of synchronous detection techniques in electron spin resonance spectrometry, radio astronomy, AFC of klystron oscillators, and detection of narrowband signals buried in noise. Triconix Inc., Bear Hill, Waltham, Mass.

Circle 180 on Inquiry Card

Altitude-Pressure Chart

This wallet-size conversion chart allows direct conversion from altitude to pressure in Torrs. Altitudes from 0 to 2,320,000 ft. are listed. In addition, outgassing data for different metals are given. Kinney Vacuum Div., The New York Air Brake Co., 3529 Washington St., Boston 30, Mass.

Circle 181 on Inquiry Card

Glow Lamp Applications

This 12-page application newsletter is devoted to better circuit design through the use of neon glow lamps. Discussions include a comparison of glow lamps vs. semiconductors; use of glow lamps for arc suppression; and many specific glow lamp applications. The forum section discusses inexpensive harness testing, handling antenna overloads, voltage fuse, bias regulation, etc. All topices are illustrated with circuits. Signalite, Inc., Neptune, N. J.

Circle 182 on Inquiry Card

Printed Wiring Handbook

"Second Generation Printed Wiring . . . Handbook of Multi-Layer, Flexible and Weldable Pre-Fab Circuits" reports the advances achieved in newer more sophisticated wiring. The handbook is thorough, detailed and carries a number of photos and diagrams to implement the text. It is primarily an attempt to bring the art of printed wiring up-to-date and to draw attention to the anticipated directions it will take in the future. Request on company letterhead to Methode Electronics, Inc., 7447 W. Wilson Ave., Chicago 31, Ill.

CRT Handbook

Booklet No. ET-3924 outlines design considerations important to optimum results in the display portion of a system, and shows how CRT performance is effected by various system factors. It offers tube application notes and detailed electrical and mechanical specs. on a variety of multi-gun, high-resolution and double-deflection CRTs. Sylvania Electric Products Inc., 1100 Main St., Buffalo, N. Y.

Circle 183 on Inquiry Card

Screwdrivers

Bulletin N763 describes a complete line of Allen hex fixed-handle screwdrivers and interchangeable Allen hex blades. Listed are 11 sizes of fixed-handle screwdrivers and 8 blade sizes. Also included is a plastic, pocket roll kit containing a set of 6 blades and a regular size handle. Xcelite Inc., Orchard Park, N. Y.

Circle 184 on Inquiry Card

Half-Adder Module

The EMC half-adder module offers a complete half-adder circuit in one module. The pulse repetition rate is 2MC. Logic levels are 0v. and −6v. Additional information available from Electronic Modules Corp., 1949 Greenspring Dr., Timonium, Md.

Circle 185 on Inquiry Card

NEW TECH DATA

Capacitor Brochure

Form 2864, "IEI Tantalum Foil, 85°C Electrolytic Capacitors," provides standard rating and selection tables to assist in selecting etched or plain-foil capacitors. Voltages for the etched foil are 15 to 150wvdc; for the plain foil, 3 to 150wvdc. Units meet Mil specs. Standard Pressed Steel Co., Box 899, Jenkintown, Pa.

Circle 223 on Inquiry Card

High/Low Filter

Catalog sheet 2.3.5 describes the MA-321F filter, which separates the base-band into 2 segments by means of a high and low pass filter. Insertion loss is 1 to 2db, depending on crossover point. Spectrum is 4KC to either side of crossover freq. Motorola Communications and Electronics, Inc., 1400 N. Cicero Ave., Chicago 51, Ill.

Circle 224 on Inquiry Card

Delay Lines

The Type 1376 variable ultrasonic delay lines are used for detection, tracking, and ECCM in airborne and satellite systems. Delay is continuously variable from 50 to 170μsec. Specs., photos and block diagrams are available. Andersen Laboratories, Inc., 501 New Park Ave., West Hartford, Conn.

Circle 225 on Inquiry Card

Connector Catalog

Catalog CM-16 describes hinge connectors that handle up to 100 contacts/connector. It contains complete electrical and physical specs., and illustrations of the various plug and socket bodies, terminations, hoods, and locks available. Cinch Mfg. Co., 1026 So. Homan Ave., Chicago, Ill.

Circle 226 on Inquiry Card

Application Bulletin

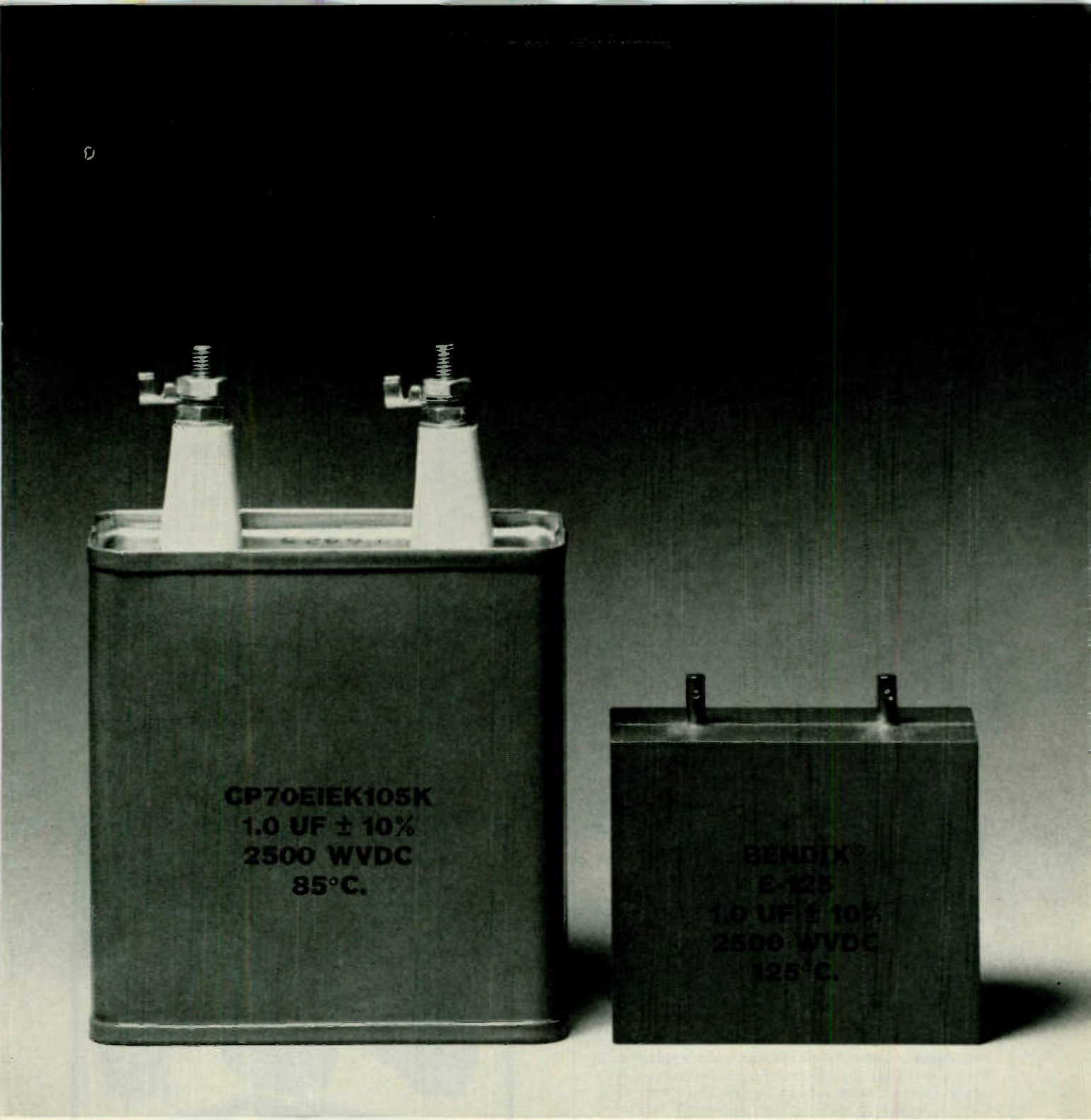
Bulletin No. 113 presents graphs, schematics, logic diagrams, waveform photos, tables, and application data for a planar-epitaxial transistor. The 2N2927 pnp unit offers high switching speeds at high currents. One circuit described below 300ma is switched on in 7nsec. and off in 15nsec., non-saturating. Fairchild Semiconductor, 545 Whisman Rd., Mountain View, Calif.

Circle 227 on Inquiry Card

Ruby Laser

The LH5 double-ended, pulsed ruby laser can be used as a prime source of light energy, or as an amplifier of other light beams of appropriate wavelength. Output of the single-cavity unit is 30 joules at the temp. of liquid nitrogen. It delivers a min. of 10 joules at room temp. Output wavelength is 6943 Å at room temp. Pulse width is 1.5 to 2msec. and input power is 2000 joules. Additional data available from Raytheon Co., 130 Second Ave., Waltham 54, Mass.

Circle 228 on Inquiry Card



We have to show you somebody else's capacitor

to illustrate why ours is better.

Both of these high voltage capacitors are designed to operate at 1.0 UF ±10% at 2500 WVDC. The one on the right—which we modestly hasten to inform you we make—uses a reconstituted mica dielectric and can withstand temperatures as high as 125°C. without de-rating. The one on the left must be de-rated to 1600 volts to withstand 85°C.

As if that weren't enough, the Bendix® capacitor is of solid construction to avert impregnant leakage, is less than half the size of other units, is highly shock resistant, and has better electrical characteristics. Circuit density automatically increases when you specify Bendix capacitors. And, they pack more performance into a smaller package.

Why settle for less? You can have both higher temperatures and reduced equipment size with our high voltage capacitors. Write us today in Sidney, New York, for additional information.

Scintilla Division

THE Bendix CORPORATION

Circle 70 on Inquiry Card

NEW TECH DATA

Power Supply Guide

This guide will aid in selecting power supplies for use in test, service, research, or calibration measurements. Specs. listed in table form are: range, polarity, line regulation, output current, output impedance, output ripple, output stability, output connector, physical characteristics, voltages and power required, voltages and power provided. Radiation Instrument Development Laboratory, 4501 W. North Ave., Melrose Park, Ill.

Circle 195 on Inquiry Card

Instrument Knobs

Form No. 106 gives data and photos on Standard (SS) and Prestige (PS) series of instrument knobs. Both are offered in a range of sizes and consist of single-knob and concentric-knob models. The knobs have rigidity, dimensional stability, high-surface gloss and resistance to stain, weather, corrosion and heat. Each series is available with a number of positioned indicators. Overall dia. range from 23/32 in. to 2 in. The Buckeye Stamping Co., 555 Marion Rd., Columbus, Ohio.

Circle 196 on Inquiry Card

Ferrite Components

This comprehensive 2-color catalog lists ferrite isolators, circulators, and switches. Specs. and ordering information on 150 different ferrite items encompassing the operational range from 100MC to 73GC are given. Ferrite isolators are listed in waveguide and coaxial types. The latter includes min. models with optional magnetic shielding and high ratio units with 75db min. isolation. Ferrite waveguide circulators listed include standard models in H, Y and T configurations and a new waveguide-bandwidth series. Melabs, 3300 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif.

Circle 197 on Inquiry Card

Wire and Tubing

This 58-page illustrated catalog contains photos, characteristic tables, and comparison curves for a line of magnet wire, hook-up wire, high-temp. lead wire, miniature cables, coaxial cables, tubing and sleeves. Hitemp Wires Co., div. of Simplex Wire and Cable Co., 1200 Shames Dr., Westbury, L. I., N. Y.

Circle 198 on Inquiry Card

Solid-State Relays

Tech. data on operational and environmental characteristics of Series 2000 solid-state relays is now available. The units employ solid-state circuits, eliminating moving parts and contacts. Life is virtually unlimited. There is no chance for contact contamination, contact bounce or arcing. The relay line includes dc-ac; and dc to dc latching functions. Hi-G Inc., Bradley Field, Windsor Locks, Conn.

Circle 199 on Inquiry Card

Reference Amplifier

Models SC5191, 92 are designed for dc voltage regulation in precision power supplies. Each is a combination voltage reference and dc amplifier and accepts input voltages from 8.6v. min. to 9.2v. max., with 8.9v. nominal. Temp. coefficient is $\pm 0.002\%/°C$ from 0° to 100°C; small-signal voltage gain ratio is 100 min. and 200 typical. Operating temp. is $-55°C$ to $+100°C$. Data available from Hughes Electronic Products Div., 500 Superior Ave., Newport Beach, Calif.

Circle 200 on Inquiry Card

NEW TECH DATA

Microwave Catalog

This 1963 catalog describes microwave test components. These include attenuators, filters, terminations and absorbing materials. Many units are advanced models. The catalog includes a section giving state-of-the-art for each component type and design data for special problems. Radar Design Corp., Pickard Dr., Syracuse 11, N. Y.

Circle 201 on Inquiry Card

Thin-Film Technology

Thin-film technology is now available to manufacturers through a licensing arrangement. The technology employs inexpensive, simple chemical processes instead of complex vacuum systems. It is especially desirable for companies who wisl to establish an in-house thin-film capability at min. cost. Lockheed Missiles & Space Co., div. of Lockheed Aircraft Corp., Sunnyvale, Calif.

Circle 202 on Inquiry Card

Cooling Equipment

An advanced line of packaged cooling equipment is presented in a colorful brochure. Condensed specs. are given. Over 100 models are available providing air deliveries from 150 to 1000 CFM and panel sizes from 3½ x 10¾ x 19 in. McLean Engineering Laboratories Princeton, N. J.

Circle 203 on Inquiry Card

Toggle Switch

Information is available on a 108 pole DT min. toggle switch with a body dimension of approx. 3¼ x 1½ x 2⅜ in. The T-BAR® Switch/Relay line offers from 4 PDT to 108 PDT switches. Ideal for calibration circuits and peripheral equipment selection. The gold-bonded contacts have initial contact resistance of 10 milliohms or less and will transfer 2a. resistive. Electronic Controls, Inc., Danbury Rd., Wilton, Conn.

Circle 204 on Inquiry Card

Switching Components

This catalog gives complete technical specs. on switching components. Data on general-purpose relays, time-delay relays and coaxial switches are included. Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles 39, Calif.

Circle 205 on Inquiry Card

Current Sensor

Bulletin 11412 describes Models CS1, CS2, and CS3 current sensor, a magnetic device designed for a wide variety of high-current, low-voltage applications. Design characteristics, materials, and applications are given. Electramatic Inc., 3324 Hiawatha Ave., Minneapolis, Minn.

Circle 206 on Inquiry Card

Circle 73 on Inquiry Card →

NEW TECH DATA

Component Selector Guide

This 144-page selector guide contains over 100,000 application and selector charts for capacitors and other components. In addition, application and selection assistance data, specs., ratings, and product information are given. This guide definitely meets the needs for an application engineering aid. Cornell-Dubilier Electronics Div., Federal Pacific Co., 50 Paris St., Newark 1, N. J.

Circle 207 on Inquiry Card

Potentiometers

Catalog P1210, 64 pages, contains design specs., operating characteristics and mounting dimensions of all standard Dynamaster® recording and controlling potentiometers and bridges. Performance specs. of special-purpose recording instruments are also included. The Bristol Co., Waterbury 20, Conn.

Circle 208 on Inquiry Card

Reed Relays

Two modular-type reed relays, Series KR and KRL, are described in this bulletin. KR is available in N.O. and N.C. contact forms; KRL in SPST and SPDT and KRS in SPST. The units have 3 types of mountings: a standard plug connector type; PC board mounted with 4 mounting lugs; and a type for panel mounting with epoxy mounting base. Pick-up sensitivities range from 35 to 400a. turns. Wheaton Industries, Inc., Dept. RR, 422 Interstate Rd., Addison, Ill.

Circle 209 on Inquiry Card

Relay Catalog

Bulletin No. 105 describes many all-purpose economy relays suited for switching of control circuits in electro-mechanical devices. Different types are illustrated and described, including quick disconnect, open relays, latch relays, mechanical actuators, plug-in relays, time-delay relays, plastic and metal housed units. Artisan Electronics Corp., 171 Ridgedale Ave., Morristown, N. J.

Circle 210 on Inquiry Card

Tape Reader

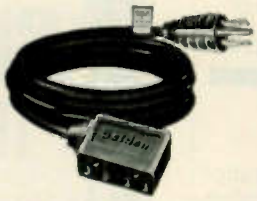
Performance specs. and operating information on the Model 55 perforated tape reader are contained in brochure DSD-SR-23. The reader uses an optical reading system. Capstans are belt driven by a 3-phase, 2-speed synchronous motor. In low, bidirectional tape speed is 20 ips at asynchronous stepping rates up to 80 char./sec. In high, bidirectional rewind or search tape speed is 60 ips. The reader can be stepped asynchronously, character to character, at rates up to 150 char./sec. Cook Electric Co., Data-Stor Div., 8100 Monticello Ave., Skokie, Ill.

Circle 211 on Inquiry Card

Shielded Power Supply Cables—Rubber

Plastic Microphone Cables

Shielded Interconnecting Cables

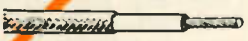


Duplex Connector Extension Cords

Low Impedance Lines

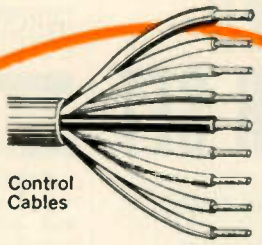
Cathode Ray Tube Lead

Miniaturized Cables



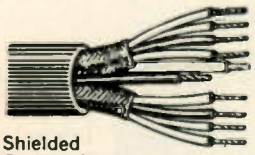
Grid Wires

Unpaired Intercom Cables



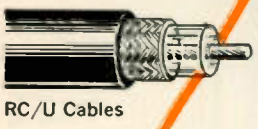
Control Cables

Audio Cables



Shielded Control Cables

Coiled Test Prod Wire



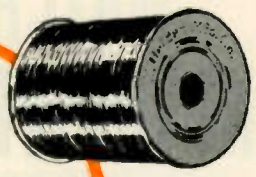
RC/U Cables

Control Cables

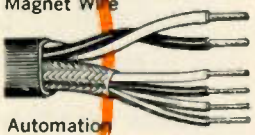
Miniature Audio Cables

2-Conductor Power Cords

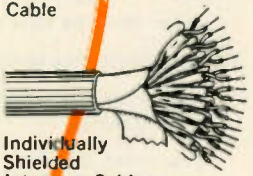
Miniature Microphone Cables



Magnet Wire

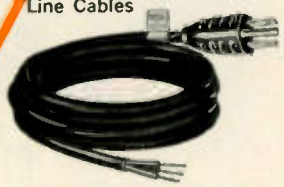


Automation Cable



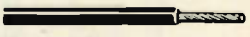
Individually Shielded Intercom Cables

RG/U Transmission Line Cables



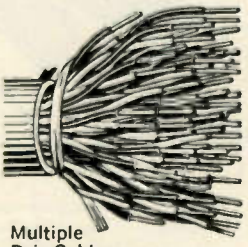
3-Conductor Power Cords

Rubber Microphone Cables



Hook-Up Wires

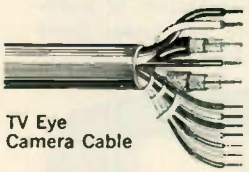
Duplex Primary Wires



Multiple Pair Cables

Strain Gauge Cables

Broadcast Audio Cables

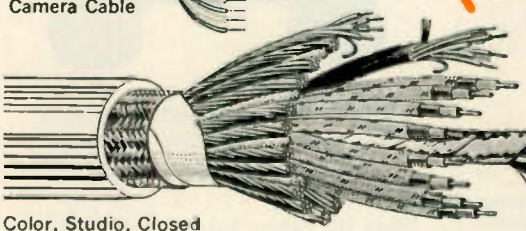


TV Eye Camera Cable

Call System Cables

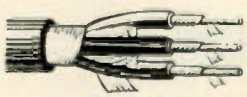
PA System Cables

Sound & Alarm System Cables

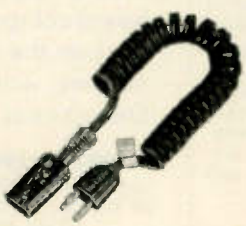


Color, Studio, Closed Circuit Camera Cables

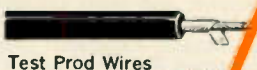
75-Ohm Video Cable



Portable Cordage



Coiled Cords



Test Prod Wires

2 & 3 Conductor Extension Cords

Mil-Spec Wires

Industrial Intercom Wires

Lamp Cordage

Teflon* Wires

*DuPont trademark

Shielding & Bonding Cable

Special Sound Cables

Mr. Design Engineer...

BELDEN Has It

Every electronic and electrical wire you need—from the finest drawn magnet wire to the most complex multi-conductor cable.

There is a Belden wire or cable in every insulation and shielding to meet your design and application requirements. Here is just part of this complete line. Available from stock.

Belden
WIREMAKER FOR INDUSTRY
SINCE 1902 — CHICAGO

One Wire Source for Everything Electronic and Electrical

• electronic wire • magnet wire • lead wire • power supply cords
• cord sets • portable cordage

8-4-1

NEW TECH DATA

Switch Catalog

Catalog No. 7 covers hermetically-sealed and high-temp. precision switches and switch assemblies. Blueprints and complete specs. are available from which modifications, custom switches, and switch and control assemblies can be fabricated. Haydon Switch, Inc., 1500 Meriden Rd., Waterbury, Conn.

Circle 212 on Inquiry Card

Tube Booklet

This 9-page booklet contains design data for the Model 8108 disc-seal triode. The tube may be used as a CW amplifier, oscillator, freq. doubler, or freq. tripler to freq. above 6GC. The information includes general characteristics, schematics of recommended circuits, and characteristic curves. Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle 213 on Inquiry Card

Transistor Catalog

Over 100 silicon-planar transistors, including general-purpose, small-signal, low-noise, saturated-switch, ultra h-f, field-effects, and special assemblies are defined in this short-form catalog. Types B, C, F, G, H, and S microcircuits are also covered. Amelco Semiconductor, 1400 Terra Bella Ave., Mountain View, Calif.

Circle 214 on Inquiry Card

Dielectric Testers

Bulletin 4-1.3 describes portable units which determine current leakage, insulation breakdown, and short circuits in ac electronic components, small appliances, tools and motors. Complete specs. are given. Associated Research, Inc., 3777 W. Belmont Ave., Chicago, Ill.

Circle 215 on Inquiry Card

Step-Servo Motor

This fractional horsepower step-servo motor is designed for high-type-torque (90 in. oz.) at stepping rates to 150 90° steps/sec. It has no mechanical detents, brushes, or drift. Additional data available from Automation Development Corp., 11824 W. Jefferson Blvd., Culver City, Calif.

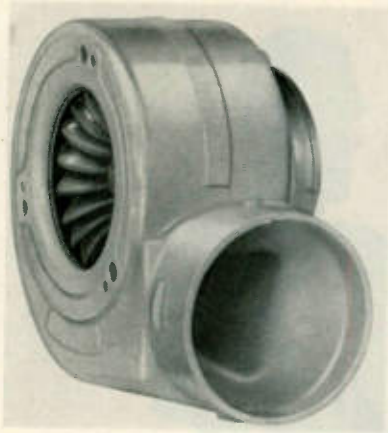
Circle 216 on Inquiry Card

Cables and Wires

"Instrumentation Cables, Cable Assemblies and Hook-up Wires," 20 illustrated pages, provides data on various types of hook-up wire and military classifications of wires and cables. It should be a great aid to military and design engineers. Data covers cable and cable assemblies used in monitoring and telemetering circuits, data recording, circuit-control testing, computers, control circuits, and power circuits. Rome Cable Div. of Alcoa, 669 Alcoa Bldg., Pittsburgh 19, Pa.

Circle 217 on Inquiry Card

HOT SPOT COOLER



The Nugget eliminates hot spots without cooling - system redesign

A COMMON PROBLEM IN PACKAGE COOLING is the hot spot, an area where one component overheats and causes a reliability problem. A simple solution to hot spot cooling is the Nugget Blower™. This compact blower requires a volume of 2 x 4 x 3½ in and weighs 0.6 lb. It operates on 60CPS and requires 7w. The unit gives a concentrated blast of 15cfm for spot cooling. A feature of the unit is a Centraxial wheel which combines the best features of centrifuge impellers and propeller fans. A wheel of this type is said to have almost twice the efficiency of the conventional squirrel-cage wheel. Rotron Mfg. Co., Inc., Woodstock, N. Y.

Circuit Designers Arise!

The revolution in trimmer capacitor design is here!

New JFD 0483 precision glass delivers 30 PER CENT GREATER CAPACITANCE—25 PER CENT HIGHER Q—with no increase in size over previous JFD trimmers of same capacitance . . .

Developed in the JFD glass and ceramic laboratories, 0483 glass offers higher dielectric constant and, surprisingly enough, higher Q over conventional tubular trimmer glass. 0483's superior electrical qualities now help provide standard JFD trimmers of 120 pf. capacitance and higher, facilitating their use at much lower frequencies. Ranges over 250 pf. are now possible, too.

0483 glass also permits use of heavier wall thickness for high shock and vibration applications without change in outside dimensions or electrical characteristics. Its green color screens out effects of oxidation due to light exposure, and alleviates effects of infra-red and ultra-violet radiation.

New 0483 glass is being incorporated into the following new JFD "N" trimmer series: standard and miniature panel mount and printed circuit; Pin-trim; Sealcap; Max-C and Super Max-C. Also, at a later date, into the Plus-C, split-stator and differential series.

0483 is another example of new JFD trimmer technological advances coming your way. For the full story, write for our detailed bulletin—or call your JFD components distributor.

Model NMC609 with 0483 glass
1-120 pf actual size

Model MC609Y
1-90 pf. actual size

JFD ELECTRONICS CORPORATION
THE ★ AMERICA KNOWS BEST!

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- ☐ Mfr. of Guided Missiles and Accessories; Aircraft and Accessories, All Types of Military Products and Equipment.
- ☐ Mfr. of electronic components, parts, tubes and like products.
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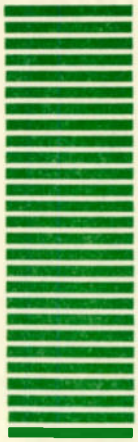

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EDITOR'S MAIL BOX

EVER BREAK DOWN ON A FREEWAY AND WONDER 'NOW WHAT?' That's what the Airborne Instruments Laboratory part of Cutler-Hammer is looking into now. The contract is from Highway Research Board, National Academy of Sciences. AIL will explore problems of auto breakdowns on various and sundry freeways, thruways, expressways and other ways. They'll look into operation needs of communication system and specs for road-side installations.

CB IN STIR IS SPRUNG BUT unauthorized users stay inside, in solitary, in fact. FCC Denver men nosing around on an illegal radio transmission wound up at Utah State Prison. The good-hearted spouse of an inmate, a CB licensee, had smuggled radio gear into him to amuse himself on state time. He sold the rig to another con (no license). The call letters were thrown in. The antenna was made from prison junk yard parts. The warden took away the play toys whereupon the deprived went into solitude for 30.

NEW YORK POLICE ARE GOING INTO ELECTRONICS because good artists are almost as hard to find nowadays as are good engineers. Somebody has come up with something called an "imagemaker" says John J. O'Neill, head of the city's bureau of criminal identification. A witness is interviewed and description recorded on a code sheet. The sheet directs the operator of imagemaker to appropriate slides which are inserted as a group in a projector. The image on a flexible mirror can be adjusted with eight electronic motors to fit details offered by the witness.

UNHEARD SENATORS SEEK HI-FI—The age of horse—I'm sorry—hoarse voices and shouting debates on the Senate floor may bow to electronics. A senatorial group, fearing misquotes or not being heard at all, have resurrected a proposal to wire the Senate chamber. The proposal calls for mikes on each solon's desk and one on the presiding officer's podium. Father of the idea is Jacob Javits (R.-N.Y.) The idea is backed by a half dozen others of both parties. A. Willis Robertson (D.-Va.) was misquoted (he says) earlier in 1963 by a reporter in the press gallery high above.

EDITOR'S MAIL BOX

NEW YORK'S FINEST IS USING NEW RADIOS. About 1000 specially designed two-way sets were ordered from Motorola by New York Police. In addition, the order included eight 250-watt base stations, 10 control consoles, 50 portable sets and 88 monitor receivers. For special requirements, patrol car radios are equipped with controls to operate on two frequencies. One channel is for routine calls within each borough.

COMPUTERS CAN DO IT! They can tell you how safe your home will be from radioactive fallout in a nuclear attack. GE's (GE-225) computer can tell you what part of your home, barn or other structure would give the best protection. New York State Civil Defense Commission is offering free service to state residents based on the computer. Many homes already offer some protection. EDP could tell a homeowner where to modify and strengthen his home to increase the safety factor.

A TALE OF TWO COMETS—OR —WHERE IS MY WANDERING ASTRONAUT? It's now old news that our first astronaut, Comm. Alan B. Shepard, Jr., was also first to go into business. With NASA's blessing and his own money (not NASA's) he took an interest in First National Bank of Baytown, Texas. The world seems to have little noted (save for Pravda) that Soviet's Maj. Gherman S. Titov was already "een bjesiness." Borscht? Nyet. Caviar? Nyet. The "I am Eagle" boy is on the editorial board of Soviet's "Aviation and Cosmonautics." He is also assistant editor.

THINGS ARE GETTING A BIT THICK, what with TV being the way it is and all that. Now the Ministry of Agriculture and Fisheries (at Lowestoft, of course) will be using a Marconi TV camera on the sea bed in order to study behavior and breeding habits of fish. Seems a fisherman must know where his fish are before he can catch them, what? Unit will be automatic, pressure enclosed and without need for adjustments. Fish experts will be able to study fish and net activity as much as 12,000 feet from the ship. Camera will operate without attention and gives excellent pictures at very low light levels. Oh, I say, Good show!

LETTERS

to the Editor

Designing Equipment For Foreign Countries

Editor, ELECTRONIC INDUSTRIES:

Sir, I have read with interest the article on "Low Volume Manufacturing in Underdeveloped Countries" in the April, 1963, issue of EI. I should like to make a few observations on a related subject: the designing of equipment for under-developed countries; especially electronic equipment.

In an under-developed country (nowadays the word "developing" is tactfully used), thousands of miles away from the source of supply of the equipment, the greatest bug-a-boo is the availability or procurement of spare parts. The local owner of foreign equipment desires: (a) his equipment to have the minimum number of components, (b) use of such components which are more or less of standard commercial design, so that most of it is directly interchangeable with those of other makes, or whose near equivalents could be available locally, or in his country, (c) use of components which are more repairable than replaceable. That is, it should be dismantleable for repairs. American components are designed for replacement rather than for repairs, obviously due to the ease of availability of spare parts in U. S. (The USA's is a self-contained economy, or was — it is slowly becoming international), and the mass products are meant for internal consumption: unlike the British products, which are designed for export ("Export or Perish" slogan), and in many cases specially designed for a particular country (for example, bicycles, with different widths of handlebars, and heights, according to local preference): (d) fewer failures, that is, high safety factor. Capacitors used in a British transmitter have a safety factor of 2 to 2.5, compared to 1.5 for American units; the latter giving trouble in tropical high humidity and temperature; (e) absence of "Gadgetary" devices, and non-essential and intricate mechanical systems which need high-level maintenance. One example is push-button switches (in consoles, etc.). These get jammed, or fail mechanically, and they are difficult to re-

LETTERS

to the Editor

pair and maintain, because of the average quality of the local operating and maintenance staff. There is also the tendency to fiddle. It should be understood that technicians are not in every case fully trained or qualified or experienced so as to reach the standards prevailing in advanced countries; (f) minimum maintenance, which should be simple. Good accessibility. Use of ordinary, standard tools and testing devices; (g) design which has taken care of local conditions: dust, heat, high humidity, insects, tampering, floods (floors go under water), safety devices, absence of air-conditioning, lack of transport, communications); (h) instruction books written in non-American and simple English (or language), with basic theory, simplified and block diagrams (introductory), *solid* introductory chapter (teach *and* inform) lots of diagrams and illustrations, expanded chapters on operation and maintenance; detailed tips and procedure on maintenance, maintenance schedule in tabular form, separate stage circuit diagrams suitable for framing; local measures for tackling emergencies (circuit modifications when parts are not available, at least in low-power stages), a list of equivalents and near equivalents of components, instructions on local rigging up of some essential parts; in fact the instruction book should be written from the point of view of instructing the o. and m. staff who are thrown back to stand on their own ingenuity to tackle the problems that are likely to arise in keeping the system running even when completely cut off from all material help (and sometimes guidance) for long periods.

Equipment bought by developing countries does not go out-of-date for years. These are run much beyond their average life, simply because there is not enough money to modernize or buy new equipment unless it is absolutely essential (even then there is no money because there are so many other top priorities in the development programmes, with FOOD at the top of the list).

(*Continued on page* 144)

LETTERS

to the Editor

(*Continued from page* 143)

Purchasing spare parts from abroad is a slow process, sometimes taking one to three years from the time the requisition is forwarded to the head office. Then there is the persistent shortage of foreign exchange, for everything.

American equipment for the developing countries should be designed to withstand years of "rough" handling by inadequately-trained-and-experienced operating and maintenance staff, under circumstances where there is a perpetual shortage of spare parts, in environments equivalent to field conditions in wartime. In short, the commercial equipment for export to such countries should be up to military specifications—to give a general idea.

M. Hamid

15/4 Hatkhola Road,
Dacca, East Pakistan

"New Consumer Products"

Editor, ELECTRONIC INDUSTRIES:

I will attempt to answer the challenge thrown down by Mr. L. Berkley Davis of General Electric in your July Radarscope when he urged the electronics industry to invent a new home product to make life easier and "up our living standard a notch." Try these:

1. A low cost electronic oven.
2. An inexpensive converter to show home movies through present television receivers.
3. A low cost ultrasonic washing machine.
4. A window ornament using static electricity to collect house dust.
5. A more efficient yet lower cost electronic heating system.

Here, now, are five prospective home electronic products either not yet existing or beyond the means of the average working male, of which I am one. I feel that there are many such electronic items that should be examined closely as to cost, such as electronic ovens which retail for upwards of $1000.

R. L. Tubbs

407 Country Lane
Kokomo, Indiana

'SOFTWARE, NEW APPLICATIONS VITAL TO EDP GROWTH'

Advances in computer usage and software made so far are minor compared to what remains to be done, said Isaac L. Auerbach, President of Auerbach Corp.

He told some 1,500 management people at the DPMA 7th Electronic Business Systems Conference in Phoenix that computer hardware can meet most new demands. Much remains to be done, however, in methodology and software techniques. These are the key to the full exploitation of present systems.

"During the past year," Auerbach said, "emphasis has shifted from hardware development to usage development. Attention is now focused on a whole new class of uses in which the operations are both complex and poorly defined.

He said that the chief area of advances in computer techniques will be in software systems and methodology needed to increase the use of equipment in a few fields.

LOW-COST DATA COM. SYSTEM ANNOUNCED BY UNIVAC

A new high-speed data communications system has been produced by the UNIVAC division of Sperry Rand.

The device is called UNIVAC Data Line Terminal. It allows the low-cost UNIVAC 1004 Card Processor to transmit or receive business, scientific and engineering data over telephone lines.

UNIVAC president, Dr. Louis T. Rader, said that the Data Line Terminal makes it possible for one UNIVAC 1004 to communicate with another 1004. A 1004 can also "talk" with the UNIVAC 1107 Thin-Film Memory or UNIVAC 490 Real-Time Computing Systems, both large-scale computers.

TEMEC RELOCATED

Cubic Corp.'s Temec Div. has been transferred from Van Nuys, Calif. to Cubic's 32,000 sq. ft. plant in San Diego. The move was motivated by the fast-growing market for advanced tracking systems.

The new facility has an antenna test range and a controlled-atmosphere, temp.-stabilized room. The Division is currently supplying specialized antennas, pedestals, pedestal control systems, and airborne radar equipment for military and civilian uses.

Dr. Robert L. Pritchard, head of Motorola's Semiconductor Division.

MOTOROLA'S PRITCHARD GETS RADIO FALL MEETING PLAQUE

Dr. Robert L. Pritchard, director of engineering for Motorola's Semiconductor Products Division, was presented with an award plaque at the Radio Fall Meeting dinner on November 12 in Rochester, N. Y.

Given each year to an industry figure for outstanding contribution to the advancement of electronics, Dr. Pritchard's award represents an unbroken chain of such awards that began in 1941.

At the 35th annual Radio Fall Meeting, sponsored by the Engineering Department of Electronic Industries Association, Dr. Pritchard received the 1963 plaque for "his many contributions to the national and international standardization of semiconductor devices through active participation in the work of the IEC, IEEE, and JEDEC." The 1962 award was given to Bernard F. Osbahr, editor of Electronic Industries magazine, for contributions to the industry through the technical press.

RESEARCH IS ON TO FORECAST AUTOMATION EFFECT BY 1974

In an effort to dig deeper into projected effects of automation on society and industry by 1974, a two-year special research program has been disclosed by the Diebold Group, a management consulting firm.

Sponsored jointly by more than 20 major U.S. firms, including most of the major electronics and computer makers, the program will explore future changes held in store by automation and data technology. The Diebold Research Program aims at pin-pointing the course automation will take during the next ten years and deciding how we can prepare for it.

John Diebold, president of the Group, said that two basic assumptions underlie the study. Automation has hardly begun; technical changes in the next ten years will make present "modern" systems appear then as the old Model-T does now.

He said that we also assume that by facing up to the major changes we expect in ten years' time, we can prepare and take advantage of automation, and not be buffeted by waves of technology.

RADIO ASTRONOMY TO HAVE CHANNEL 37 FOR 10 YEARS

The FCC has announced that Channel 37 will be reserved for radio astronomy for the next ten years.

Present television service will not be affected by the ruling, the Commission declared. In planned revisions of UHF allocations table the FCC will propose a substitute for Paterson, N. J., where the channel has been applied for.

Similar action will be asked of Canada and Mexico, FCC said, and it will recommend world-wide reservation.

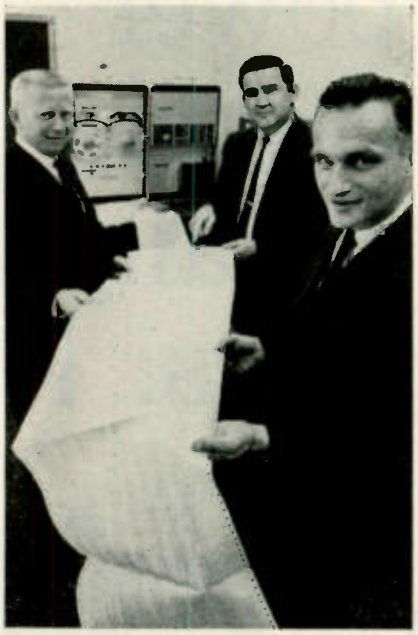
EXPANDED TUBE MANUAL PUBLISHED BY RCA

A new 544-page book of receiving tubes published by RCA is now available from the company and from electron tube dealers at $1.25.

The newest RCA Receiving Tube Manual, RC-22, is the largest issue published by RCA, which calls it a complete reference book. The manual contains data on more than 1,000 receiving tube types. These include home entertainment types of nuvistors, novars, and others.

Data is provided also for television CRTs, both black-and-white and color.

COMPUTER WINS CONTEST



Space engineer George Woodruff, right, may have launched a technical fad by being first to use EDP to win a national contest. His entry had all 95,040 possible combinations, making him the automatic winner of the contest put on by Onan Division of Studebaker. Roy Mullin, Onan vice president, left, was intrigued. He dropped in on Woodruff at Cape Canaveral to find out how he got the data. Woodruff won a 1500-watt portable electric plant. Right rear is Robert Herring, data technician for Woodruff's company, Space Technology Labs. System used was a TRW 230.

WORLD'S EDP NEEDS WILL BE HARD TO MEET, SAYS NORRIS

The world's need for computers and computing is "an appetite which will be difficult to satisfy," asserted William C. Norris, president of Control Data Corp.

He characterized the computer industry as "explosive" and said that only the world's need for energy rivals the world's need for computation and data processing.

From a commercial standpoint, he pointed out, the electronic digital computer industry didn't start until 1952. By the end of 1962 nearly $5 billion worth of standard computer systems were in operation in the U. S. These systems then were yielding a yearly gross income to computer firms in excess of $2 billion.

He predicted advances for EDP as significant as those represented by the move from the vacuum tube computer to the solid state type during 1958 to 1960. Advances will come mostly from engineering in new concepts of machine design plus new wiring and packaging schemes.

GENERAL ELECTRIC PLANNING TO INCREASE USE OF EDP

Leading non-government user of digital computers throughout the world has disclosed plans to widen its lead.

The user—General Electric—is also a major manufacturer of computers. GE President Gerald L. Phillippe said the firm would have 190 digital units in place by mid-1964. Today it has 169. Ten years ago it had none.

Phillippe told the Data Processing Management Association's International Electronic Business Systems Conference that GE would be spending about $30 million yearly by next summer for computer programming.

The firm got into computer business in 1956, when 12 people set up shop in Phoenix. A year later, the staff had grown to 177. The Computer Department, based in Phoenix, now has more than 4,000 on the payroll.

Nationwide, more than a million persons are employed at making, using and servicing computers in government and industry, Phillippe pointed out.

This regulated dc power supply has silicon transistors. It is unconditionally guaranteed for 5 years. It costs $89 ($40 less than germanium supplies)

A Member of The Condec Group

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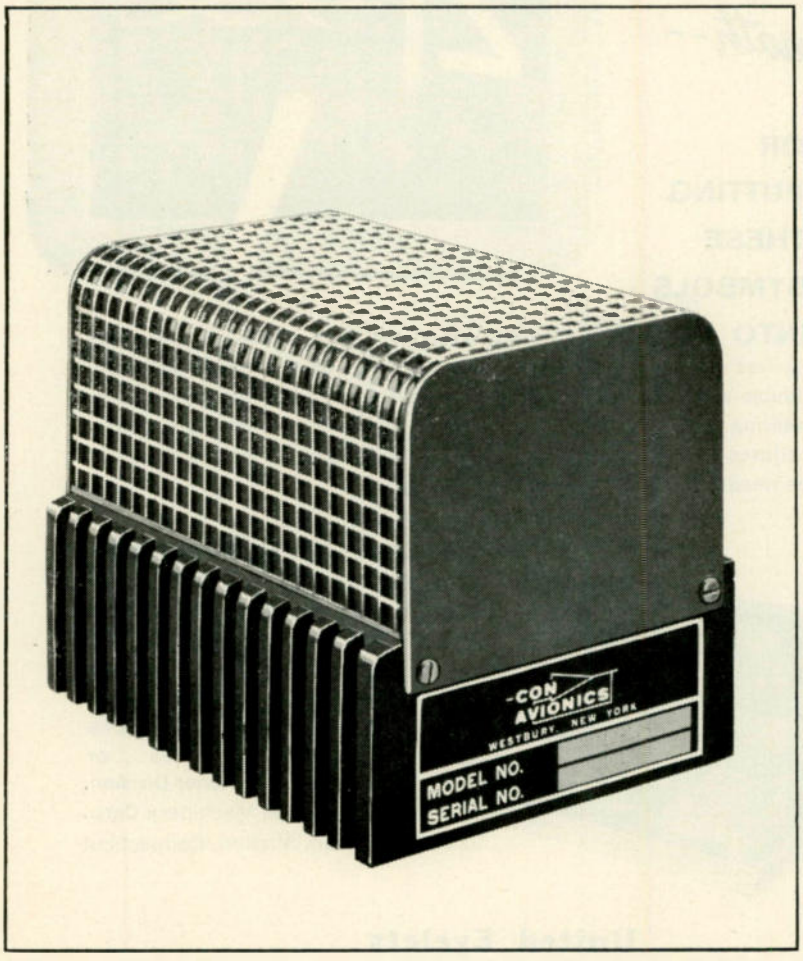

The Silicon transistors in Con Avionics' new HT (High Temperature) power supply offer you several important advantages.

You can operate the supply in ambients of 75°C. (About the best you can do with a comparable germanium module is 55°C.)

The HT has a response time of 10 microseconds — some 40 microseconds faster than most other standard power supplies under $200. This quick response, aside from its obvious advantages in many systems applications, will slash power supply cross-talk problems.

Silicon will give you higher reliability and longer life. We guarantee the HT for 5 years, unconditionally, including transistors and diodes. But you'll run it much longer without any trouble. It has a Mean Time Between Failure of 25,000 hours—roughly more than 8 years of normal operation.

Like all Con Avionics products, the HT meets Worst Case Analysis requirements. It is built with pre-aged components and is itself pre-aged for 100 hours before it is shipped. In addition, it has a current limiting automatic short circuit protection feature. It is available in a wide variety of voltage outputs and current capacities.

Germanium supplies that fit the same wattage requirements sell for about $135 and up. Until now, most silicon supplies cost about $175 and up. Ours cost $89 and down. A letter addressed to Frank Sposato will bring you more information promptly.

SPECIFICATIONS	Standard Model	"A" Model			
Total Regulation (Line and Load)	±0.5%	±.05%	ALL MODELS	Input	105-125 v ac, 47 to 440 cps
Ripple (rms max.)	10 mv	1 mv		Temperature	75 C ambient max. 90 C base plate max.
Temperature Coefficient	.07%/°C	.03%/°C		Response Time	10 microseconds
				Dimensions	4 3/16" H x 4 3/8" W x 5 5/8" D (Overall)

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The Systems Engineering Section of ELECTRONIC INDUSTRIES

ELECTRONIC SYSTEMS

NO MIDDLE MAN

Engineers working on Rocketdyne F-1 and J-2 engines are aided by a high-speed data system called RIDAP (Rocketdyne Integrated Data Acquisition and Processing). Principal elements are a computer and a microwave relay system. The system eliminates dozens of recording charts and manual handling of information. Information is converted directly from analog to digital computer form. The first information on a test can be seen within 45 minutes after the test is completed. Previously, it took as much as 2 days to complete information.

The National Bureau of Standards has devised a simple troubleshooting system to be used on modularized equipment. Designated FIST (Fault Isolation by Semi-Automatic Techniques), the system consists of a small, hand-carried general-purpose test unit, and special circuits and receptacles built in as part of the prime equipment being tested. The test set gives a green (good) or red (bad) indication when plugged into each test receptacle. The operation can test modules in any order with a uniform simple procedure.

Scientists at ITT Federal Laboratories are using an extremely sensitive IR telescope system to detect and map stars with unexpectedly low temperatures. The system is described as so sensitive that measurements were interrupted by the heat from insects' bodies as they flew past the telescope. Interference was also encountered from air currents rising from a cigarette being smoked 50 feet away. The system has revealel that many stars, far too faint to be visible, are extremely bright at infrared wavelength.

An alarm system, for use at unattended facilities such as microwave repeaters of substations, quickly and accurately locates and identifies faults such as equipment failure. The system sounds or lights an alarm at the central station controlling the system. The specific cause may be identified by switching the common alarm decoding equipment to the address of the station signaling trouble. The system, developed by Quindar Electronics Inc., can be supplied to monitor up to 40 points.

Scientists at MIT's Research Laboratory of Electronics, using a laser as part of an optical radar system, have detected minute particles, presumably dust from meteoric fragmentation, in the uppermost portions of the earth's atmosphere. The finding adds support to the theory that very small meteors shower into the earth's atmosphere continuously and do not burn up, but instead fragment into still smaller particles that eventually settle to earth. Concentrations have appeared in two regions—one around 50 miles and the other around 70 miles. These particles may have some connection with noctilucent clouds found at 50-mile heights.

A system using freq. time pulse coded modulation techniques and 50 to 60 relay satellites offers advantages over conventional communications satellite approaches according to the Martin Co. (Orlando). The random-access system provides 50 simultaneous voice, data (at 2400 bits/sec.) or voice-data combination transmissions, with direct service among system users within relay range of any given satellite. The system employs RACEP (Random Access and Correlation for Extended Performance) coded-pulse technique. Each user has a unique address, and all use a common 12 MC wideband freq. Two 15 ft. dish antennas—one for communication and the other for supervision, search, and hand-over—are needed at ground terminal. Transmitter peak pulse power is 50w., with 1w. average power requirement/channel. The ground transmitter peak power is 1 kw at a duty factor of 0.02. Since each transmission is a pulsed signal with low duty factor, the average transmitted power/channel is less than for CW signals.

PLENTY HITS, BUT NO SHELLS

A new electronic system solves the military training problem of firing weapons at live targets and recording hits without using live ammunition. The system, Hit-Kill indicator, uses electronics and infra optics for firing and recording. Firing consists of an infrared flash directed at all targets on the field. Only one target, however, has a matching ID code or pulse. This is flashed back to the firing weapon and is picked up by its photoelectric telescope. When a hit is recorded, the circuits within the "destroyed" target are remotely turned off, and the target is disabled. The entire cycle—aiming, locking, firing, and kill—takes less than one-half second. The device was developed by Aircraft Armaments, Inc.

NEW TECHNICS IN R-F ROOM CONSTRUCTION

What are the problems encountered when building an r-f shielded room? How are these problems overcome? What types of shielded rooms are available ? What have tests conducted on these rooms shown? These and other pertinent questions are answered here.

NEW METHODS OF MANUFACTURING RFI SHIELDED ROOMS have increased the difficulties of evaluating their merits. Similarity of materials used in rooms built for different purposes poses other problems.

Double electrically isolated r-f rooms, double shielded cell type r-f rooms and even sound proof rooms use similar materials. Why then is there such a difference in the r-f shielding ability of each? They all have a double wall of metal, but the main difference is in the seams or in the clamping method.

Although the seams would appear to present no difficult problems, much time and money might be lost if the basic principle of design in a good RFI clamping method is ignored. It is important that the relative merits of different types of clamping are carefully examined.

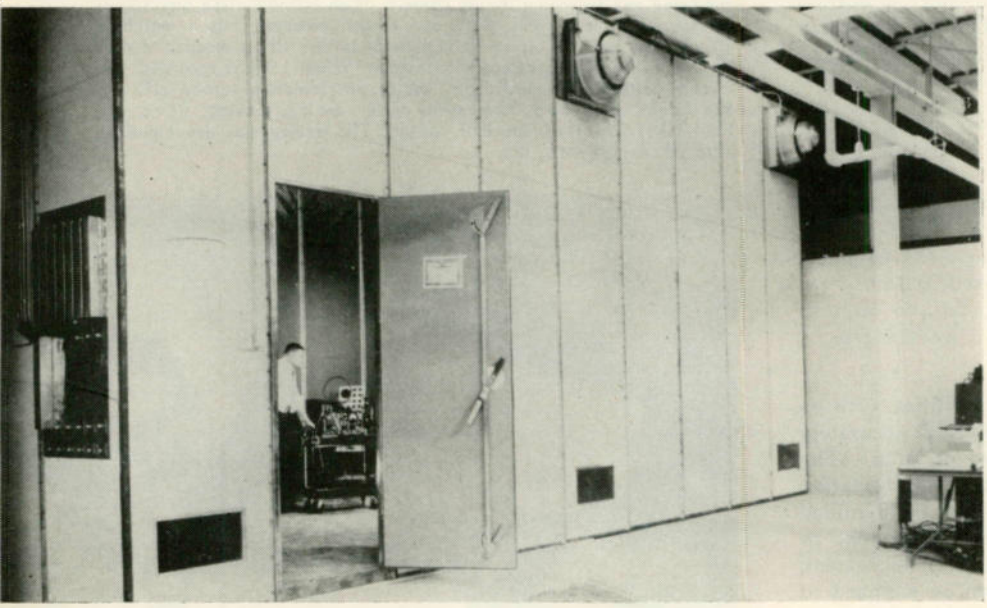
This article will point out facts about clamping based on a careful investigation of the clamping methods of 3 types of rooms (Fig. 1).

Any shielded room which has a bolting system directly connecting the outside and inside shields has a built-in handicap if one or several bolts would loosen ever so little. It is obvious that the type of clamping in which no bolts penetrate the wall structure and connect outside and inside metal surfaces is the most efficient construction. Analyzing degradation of the 3 rooms (Fig. 1) based on information from actual tests, it is obvious that more thought must be given to the type of construction.

The very nature of the Double Electrically Isolated room construction finally decides the issue. It simply could not be an electrically isolated room if the bolts penetrated the outside shield to the inside shield.

Performance

Tests have shown the superior shielding performance of the Double Shielded Electrically Isolated



This 3 oz. solid copper room was tested by the National Bureau of Standards in Boulder, Colorado.

By ERIK A. LINDGREN
President
Erik A. Lindgren & Associates, Inc.
4545-17 N. Ravenswood Ave.
Chicago 40, Ill.

R-F Shielded Rooms represent a business of $7,000,000 to $8,000,000 annually. Some 60% to 70% of the sales are made directly to the government.

The three principal types of construction are described in this article. A number of the firms in the industry will manufacture any one of the three types of rooms to order, but each firm is primarily identified with one type of construction. Lindgren & Associates holds basic patents on the "Double Shielded Electrically Isolated" Screen Room.

Room, over the entire electronic and magnetic spectrum.

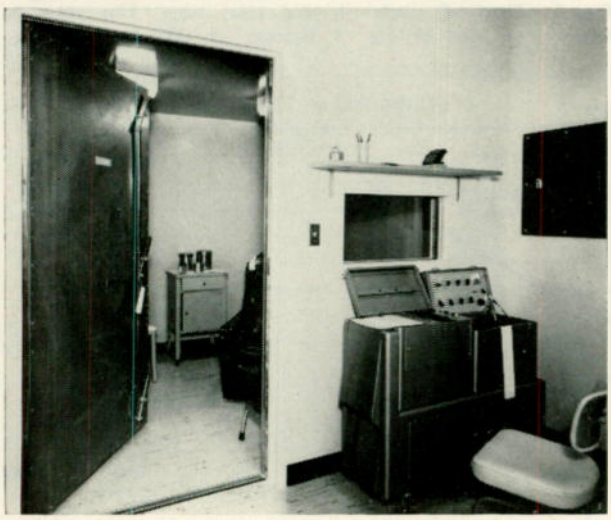
Reports of these tests, conducted by independent engineering labs, are available.

Ten years ago, in building an efficient double electrically isolated room, all joints had to be continuously soldered. Today these rooms are built in sections that can be joined without soldering with no loss of shielding efficiency. This is made possible by the patented construction and design of the joints at panel sections, roof and floor.

Isolation is insulation and insulation is shielding. In passing through a conducting sheet of metal such as steel, loss of energy occurs when an electronic wave travels through it. Total attenuation experienced by the wave in passing through the sheet may be divided into 2 components; (1) a reflection loss which is the total of the reflection losses at each surface and (2) a penetration loss which is proportional to the thickness of the material.

Attenuation or performance of an r-f shielded room is also influenced by the type of construction used. All types of shielded rooms are only as good as the joints. Measurement of signal attenuation of an r-f shielded room is mainly the measurement of leaks in the seams between 2 or 3 enclosure panels. Thus a poorly assembled, double shielded room might have only 40 db at 1000 MC while a tight, well assembled, single shielded room might have 100 db at 1000 MC.

Single steel room used at Stanford Medical Center in Calif.



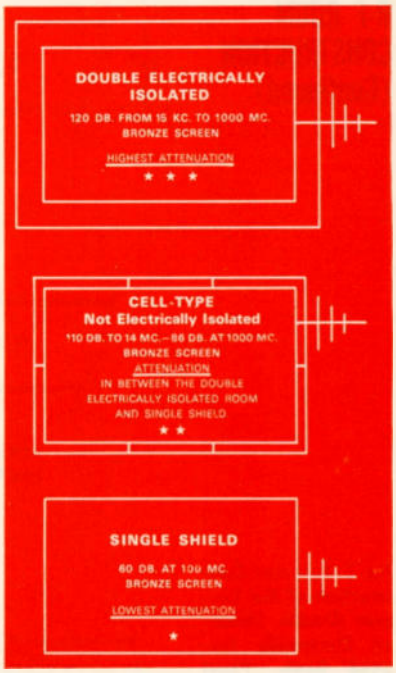


Fig. 1: Three of the most popular types of r-f shielded rooms currently in use are diagrammed here.

Construction & Design

Because good performance in any r-f shielded room depends upon leak proof seams, construction and design are of great importance. Fig. 2 illustrates the patented joint constructions of a modern double electrically isolated room. It shows that no metallic paths or connections exist to provide a conductor for any r-f signal from the outside to the inside. Fig. 3 shows methods of construction in which the bolts extend from outside to inside.

If strength and rigidity were the only considerations the construction used in Fig. 3 would be equal to that used in Fig. 2. But conductivity is a more important factor and here the type shown in Fig. 3 falls short. Any bolt penetration from inside to outside is a direct conductor for any signal when the bolt loosens even slightly.

Figs. 4 and 5 demonstrate the importance of a good clamping design. They show signal attenuation of 2 different rooms over a range of frequencies. They also record results of tests made by an independent engineering lab in accordance to MIL-STD-285.

Test Report #758 (Fig. 4) shows attenuation of an r-f room with 2 shields of steel. Report #957 (Fig. 5) is that of a single steel shield. The single steel shielded room is superior because different methods of clamping were used. The room tested with results shown in Report #758 uses the method of clamping shown in Fig. 3. Report #957 shows that the method of clamping (Fig. 6) is most important and merits a more detailed examination.

(Continued on following page)

R-F ROOM CONSTRUCTION (Continued)

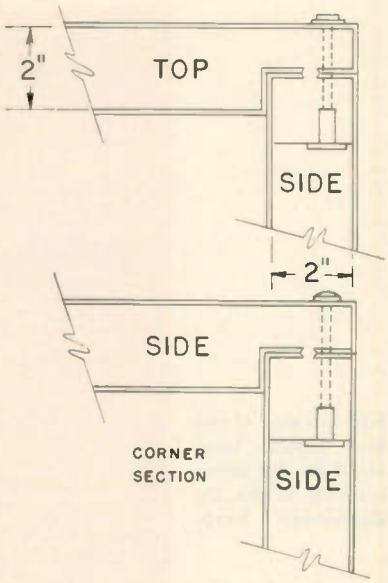
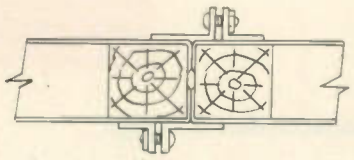


Fig. 2: Patented Construction of the Lingren Double Shielded Electrically Isolated Room. Panel construction permits easy remodeling or enlargement that may be needed.



SIDE PANEL CONNECTION

The entire room with the single steel shield was built without using any bolts except in the floor sections. Bolts were used there to secure the plywood floor to the wall section. Seams were not soldered. The Duo-Filter system used in this room has 120 db attenuation from 15KC to 1000 MC, thus the drop at 500 MC must be in the room itself. Probing the room revealed that the seam around the floor was leaking at the bolts where they penetrated the walls. This explains the drop down to 106 db at 1000 MC.

We might thus assume that if the top and sides had been fastened together with bolts as the floor was fastened, the overall attenuation would be below 80 db, at 1000 MC.

Logical explanation of why in this case a single shield was superior in performance to a room which had a double shield is that each bolt which goes from the inside to the outside represents a possible r-f leak if the bolt is loose or if 2 bolts are drawn too tight. In this case a bow is created in the panels making a gap, or leak shield.

Design shown in Fig. 2 permits no bolt to penetrate from the outside shield to the inside shield.

The chart in Fig. 7 shows test results of a double shielded electrically isolated bronze screen room. This room has attenuation of 120 db from 15KC to 1000 MC. (Attenuation of 120 db shown in charts accompanying this article was probably greater since this figure was the maximum limit of the instrumentation used.) Actual tests reveal that all rooms have an inbuilt handicap if bolts penetrate from the inside to the outside surface of the shield. By comparison, in this same report, the cell-type room shows attenuation falling below 100 db at 1000 MC and as low as 87 db at 400 MC. Most rooms will have 120 db attenuation for frequencies from 15KC to 150 MC, if erection is correct. However, for frequencies of 450 MC and higher a bolting system which does not permit direct metal contact by bolts bonding the inside and outside shields is definitely indicated. This is also true below 15KC.

In every test for the last 10 years the attenuation difference between the electrically isolated and the non-isolated room has shown the superior shielding provided by the former. This is substantiated by

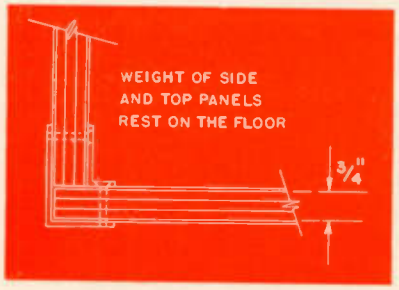


Fig. 3: Construction of non-electrically-isolated double shielded room showing bolts passing through both shields.

Fig. 4: Chart of double shielded non-isolated, solid steel room. This room uses the methods of clamping in Fig. 3 above.

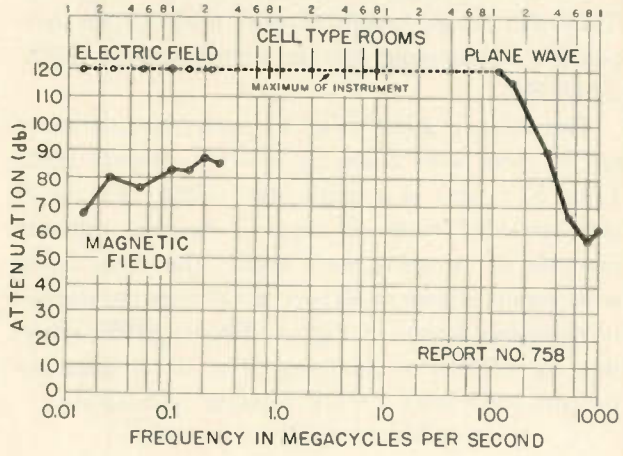


Fig. 5: Chart of single-shielded steel room. This room is superior to that of Fig. 4 because of different clamping.

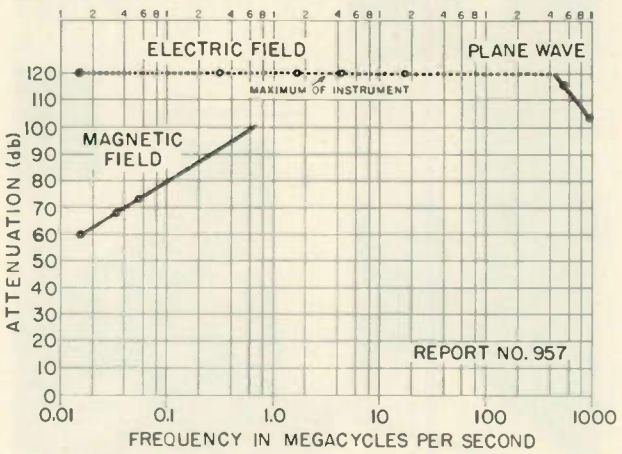


Table 4, pg. 9 of Naval Research Laboratory Report 3908, Nov. 14, 1951. See Fig. 8.

In this report comparative tests of a cell type room and a double isolated room are described. Results are indicated by (X) chart A, showing lower attenuation for the double shielded room. Openings for light and ventilation in the latter were covered by hardware cloth dipped in a copper plating solution. Shielding effectiveness of this material was challenged, as noted in the report. "It was suspected that if ordinary bronze fly screen had been used over the openings in the double shielded room, in place of hardware cloth, the overall shielding effectiveness of the room would have been better. The hardware cloth over the door opening, about 8 x 10 in. was replaced with bronze screening to test their contentions and the leakage as measured in the center of the room again was found at 3 frequencies. Table 4 summarizes the results and indicates that fly screen is superior"—(X) curves (O) and (X) on chart A.

Improved attenuation obtained by the substitution of wire screen over the openings of the double shielded room when added to the curve (X) makes a new curve (Δ) that shows the superior attenuation of the double shielded room. Even the most cursory comparison of engineering appraisals will point out the superiority of the construction covered by patent #2,765,362 (issued in 1956) and shown in Fig. 2.

Improvement Continuing

Improvement is continuing and at present double electrical isolated rooms built with 24 oz. copper and 24 ga. steel attain an attenuation of 36db at 60 Cycle magnetic field, 100 db at 15KC and 120 db at 1000 MC.

Most rooms have the same attenuation of 120 db (limit of Instrumentation) in the electric field from 100KC to 30 MC but this does not mean that they all have the same attenuation at other frequencies. In the magnetic field at 15KC there is much difference and this difference is of extreme importance.

It is probably safe to state that out of thousands of r-f rooms existing in the U. S. there are less than 10 that can claim 120 db attenuation at 10,000 MC. Engineering reports have indicated and field use has confirmed that it is impossible to get 120 db at 10,000 MC with any screen shielded room. It requires a particular type of construction and a solid copper r-f shield to achieve this attenuation at this frequency—a real accomplishment.

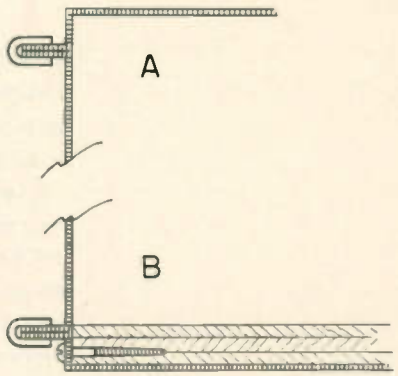


Fig. 6: Construction and method of clamping of single shielded room covered by Report No. 957.

Fig. 7: Chart shows attenuation at various frequencies of Double Shielded Electrically Isolated Room compared with Cell type.

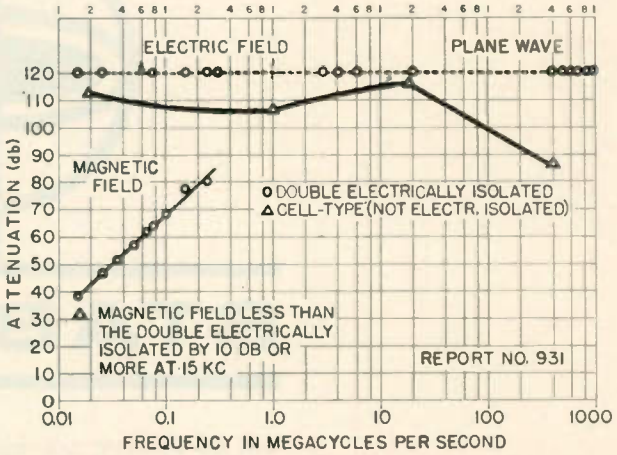
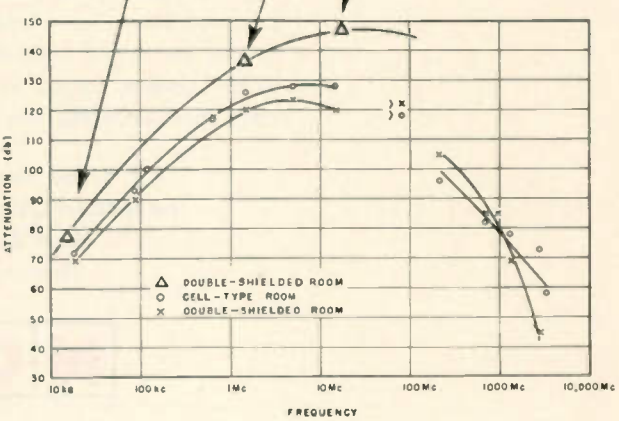


Fig. 8: Chart is a comparison of the attenuation curves for the double-shielded and cell-types of room. Table is above.

Comparison of Hardware Cloth with Bronze Fly Screen in Door Opening

Frequency	Improvement in Attenuation Realized by the Use of Bronze Screening (db)
18 kc	8
1.5 Mc	16
15 Mc	26



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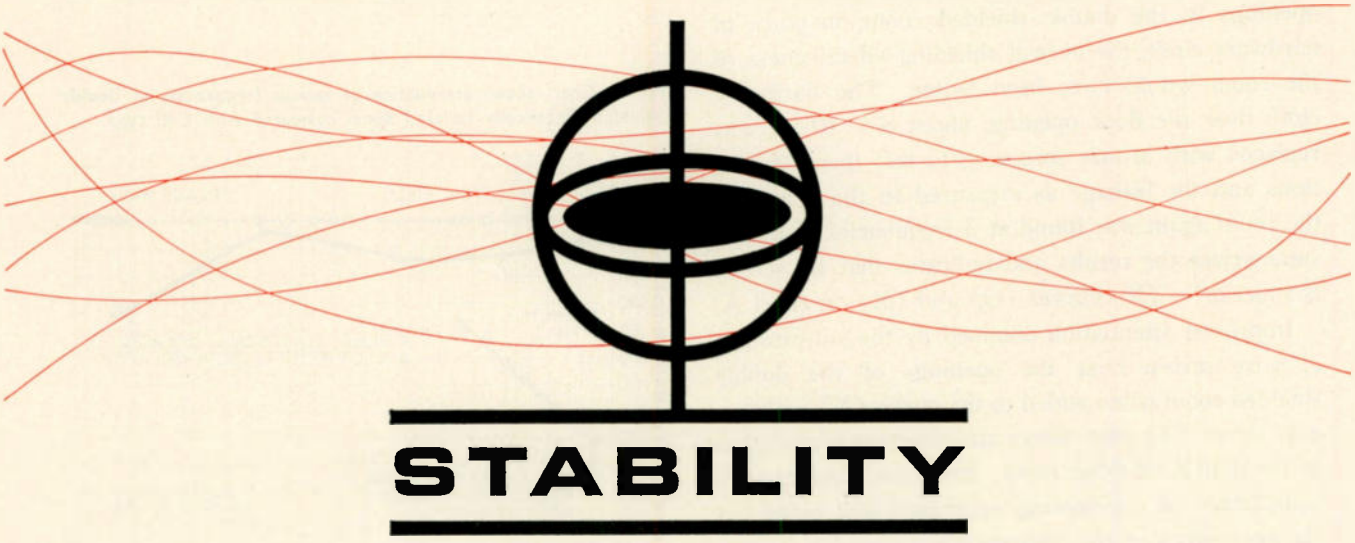

and development, are respected throughout the world in 120 countries.

Research and development at NCR is broad and reflects a seriously considered investment of past years. Plans for future expansion of facilities reflect a faith in the stability of the Company and in the devoted talents of the NCR men of science who will add impetus to the overall plans.

The stability of NCR is conducive to the advancement of career-minded scientific and engineering personnel. Creative efforts are rewarded with responsible challenging work. Professional individuals at NCR find the personal stability, understanding and encouragement required for growth.

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PROFESSIONAL GUIDELINES

Reporting late developments affecting the employment picture in the Electronic Industries

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RECRUITING STUDY REVEALS HOW FIRMS HIRE ENGINEERS

Some 131 U. S. firms recruited nearly 25,000 engineers and scientists in 1962, according to a report on hiring practices issued by Deutsch and Shea, Inc.

The study, Technical Manpower Recruitment Practices, covers size, makeup and background of the recruiting staff. It also goes into recruiting methods, specific hiring deals such as paying moving costs, and some forecasts by managers of future trends in hiring technical people.

The average organization hired 189 technical persons during 1962, according to the study. More than half expect to have added even more technical people to their staffs by the end of 1963. Few changes or new ideas in hiring methods are foreseen. Some managers predict more precise approach to filling professional jobs. Some see greater individual attention given to each job prospect.

Most used methods are employee referral programs, newspaper and technical journal ads, field trips and agencies. Other methods, such as recruiting at conventions, direct mail, and career centers, did not rank high.

Great time lags in dealing with prospects continue, as job-seeking engineers and scientists complain. Some firms are able to react fast in deciding and contacting applicants. A greater number, though, reports that it takes several days to answer a prospect's first contact with the firm. There follows a usual ten-day period or longer to take action.

Paying costs of moving the households of new professional employees is universal among participating firms. About 48% also pay for travel to the company area by husband and wife before moving. Some also pay living costs for families while they wait for household goods. Most firms assist hirelings in finding housing. Less than 39% have programs to help newcomers adapt quickly to their new surroundings.

Only about 17.9% of all recruiters have engineering or scientific backgrounds. The rest are from management, personnel and industrial relations backgrounds. In 1962, the average recruiter hired 45.6 technical people. Most are the product of informal training within their firms.

NAVY TRAINING STUDY

Brooklyn College freshman George Glick sets scope trace of new training device in study for Naval Training Devices Center. Dr. Edwin M. Hudson, Otis Elevator's Defense/Industrial Division, looks on. Study seeks training systems that can adapt themselves to efficiency level of human operator. An instructor can pre-set more than 34,000 performance characteristics of a real or imagined vehicle.

GRAD ENGINEER WAGES RISE AS SCIENTIST PAY DECLINES

Average salaries in 1963 for science graduates from University of Detroit dropped $17 to $488 a month, while engineering graduates averaged $604.

Starting salaries for Detroit science grads have fallen since 1961. Yet, salaries for engineer graduates have steadily risen year by year since 1954, according to the University's placement report.

Top factors in selecting a position were salary and location. To engineering graduates, location meant climate, recreation and educational opportunities. Geography was not important.

ELECTRONICS COURSE OFFERED TO SCIENTISTS, ENGINEERS

An intensive two-week course on the principles of electronics for graduate scientists and engineers (other than electronic) will be offered by the University of California January 27 to February 7, 1964 in San Francisco.

Presented by the University's Engineering and Scientific Extension, the course will also cover the use of electronic instruments and systems in research.

The course is aimed mostly at the scientist or engineer who must know something about electronic systems and circuits but whose formal training is in some other technical field.

For more data, get in touch with the Extension, University of California, Berkeley, Calif., 94720.

TWO UNIONS VOTED OUT BY ENGINEERS' BALLOT

Two engineer unions were put on the skids by somewhat unexpected ballot results in two major electronics firms.

After more than 20 years of union affiliation, engineers at Westinghouse plant in Lima, Ohio, voted out their independent union. At the same time RCA engineers at Burlington, Mass., rejected an organizing bid from the Association of Scientists and Professional Engineering Personnel Union (ASPEP).

Westinghouse engineers, after a number of meetings with various professional groups and chapters, dumped their Lima Westinghouse Salaried Employees Association by a 181 to 118 vote out of 330 engineers.

As 53 RCA engineers voted "yea," 288 said "nay" to ASPEP. The union still represents some 1,600 RCA men at the firm's Camden and Moorestown, N. J., plants.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 158.

ELECTRONIC INDUSTRIES Professional Profile

The ELECTRONIC INDUSTRIES Job Resume Form for Electronic Engineers

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☐ Single ☐ Married ☐ Citizen ☐ Non-Citizen Date of Birth _____

Will Relocate ☐ Yes ☐ No. If Yes ☐ Another City ☐ Another State

Salary Desired to Change Jobs in present area _____

Salary Desired to Change Jobs and relocate in another area _____

Professional Memberships _____

College or University	Major	Degree	Dates

RECENT WORK EXPERIENCE

Company	Div. or Dept.	Title	Dates

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STATE ANY FACTS ABOUT YOURSELF THAT WILL HELP A PROSPECTIVE EMPLOYER EVALUATE YOUR EXPERIENCE AND JOB INTERESTS. INCLUDE SIGNIFICANT ACHIEVEMENTS, PUBLISHED PAPERS, AND CAREER GOALS.

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This resume is confidential. A copy will be sent only to those Companies whose number you circle below.

800 801 802 803 804 805 806 807 808 809 810

BECOMING A PROFESSIONAL ENGINEER

Not knowing what the future holds,
electronic engineers would do well
to obtain a license to practice
before the public for added flexibility.
Licensing requires some work by the engineer,
but it certainly is not beyond his reach.
This article will point the way.

TO BECOME A PROFESSIONAL ENGINEER we must first know what we mean by the expression. A model law, prepared by professional practitioners to assist state legislatures in formulating a suitable statute for their particular commonwealth, offers this definition: "The term *professional engineer* (P.E.) means a person who, by reason of his special knowledge of the mathematical and physical sciences and the principles and methods of engineering analysis and design, acquired by professional education and practical experience, is qualified to practice engineering as attested by his legal registration as a professional engineer."

The same source goes on to say that the practice of engineering means any service or creative work requiring engineering education, training, and experience for assuring compliance with specifications and design.

Motivation

We recall from courses in general psychology that motivation is that which incites an individual to act. Most individuals, once they know what is meant by the term, would quite naturally react with the question, "Why become a professional engineer?" So let's try to resolve that issue right now.

The state is charged with the protection of life, health, property, and rights. Three professions—medicine, law, and engineering—are primarily entrusted with the responsibility incident to such activities.*

No one ever questions why a doctor or a lawyer needs a state license to practice; probably because such professionals usually operate as individuals or in very small groups, and thus their responsibility to the public is readily understood. Most engineers, at least most electrical and electronic engineers are employed by large corporations, and their responsibility is not so apparent.

In most, if not all, states, those engineers that are in business for themselves are required by law to be licensed—or to have licensed a senior member, responsible for the firm's activities—before they can engage in such practice.

To put it in simpler terms, an engineer should register to:

1. Receive authority to practice his profession before the public.

2. Establish his professional standing on the basis of legal requirements.

As we have stated, the law requires only those offering their services to the public as professional engineers to register. But, engineers in employment not requiring registration have no assurance that they will always be in such a position. Therefore, it behooves them to obtain legal recognition.

Completing a project is always easier if it is properly planned and organized at the outset, rather than when half completed. Therefore, the planning to qualify for legal registration should be done early. If possible, this planning should be done in the last year of formal education. But, this is not a necessity.

Requirements

Registration has only three requirements—education, experience, and examination. Most of us are inclined to think that education is merely the formal technical training for our specialty. But, to be a true professional, we must be familiar with the humanities, as well as the technical; and discipline ourselves to an accepted code of conduct.

Table 1 is a suggested code of ethics for the engi-

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Pa. State Reg. No. 6971E
International Resistance Co.
401 N. Broad St.
Philadelphia, Pa. 19108

*NEXT STEP . . . REGISTRATION, a pamphlet published by the National Society of Professional Engineers.

PROFESSIONAL LICENSING (Continued)

neering profession. Since subscription to such a code is not an easy matter, the principles must be part of an individual's way of life.

We mentioned earlier that prior planning facilitates action, and indicated that the senior year of formal education was an ideal time to start. Actually, many states have engineer-in-training programs which permit the theoretical portions of engineering examinations to be taken around graduation time, when the material is fresh in the individual's mind.

After acquiring the experience deemed necessary under state law, generally four years, an engineer who has completed the theoretical requirements for registration need only demonstrate that he has obtained the requisite experience to obtain his certificate as a P.E. But experience means more than just a period of time. It must include the application and a working knowledge of the principles learned in formal education. And, this must be under the guidance of a qualified engineer.

The other requirement—examination—is the vehicle used for measuring the capabilities of large numbers of applicants in a reasonably short span of time. Most professional licensing boards would prefer, I am sure, to grant licenses based on an individual's proven accomplishments. However, in today's vast society this is practically impossible. Therefore, most states have resorted to the written examination. This examination is to evaluate the applicant's ability to apply his technical training in practical situations.

How to Register

Now to the actual mechanics of registration. First, I would suggest that your state board of professional licensing be contacted for details. A complete listing of these boards is contained in Table 2. *(Continued)*

TABLE 1

CODE OF ETHICS
OF THE ENGINEERING PROFESSION

It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any Professional Engineer:

1. To act for his client, or employer, in professional matters otherwise than as a faithful agent or trustee, or to accept any remuneration other than his stated recompense for services rendered.

2. To attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects, or business of anyone.

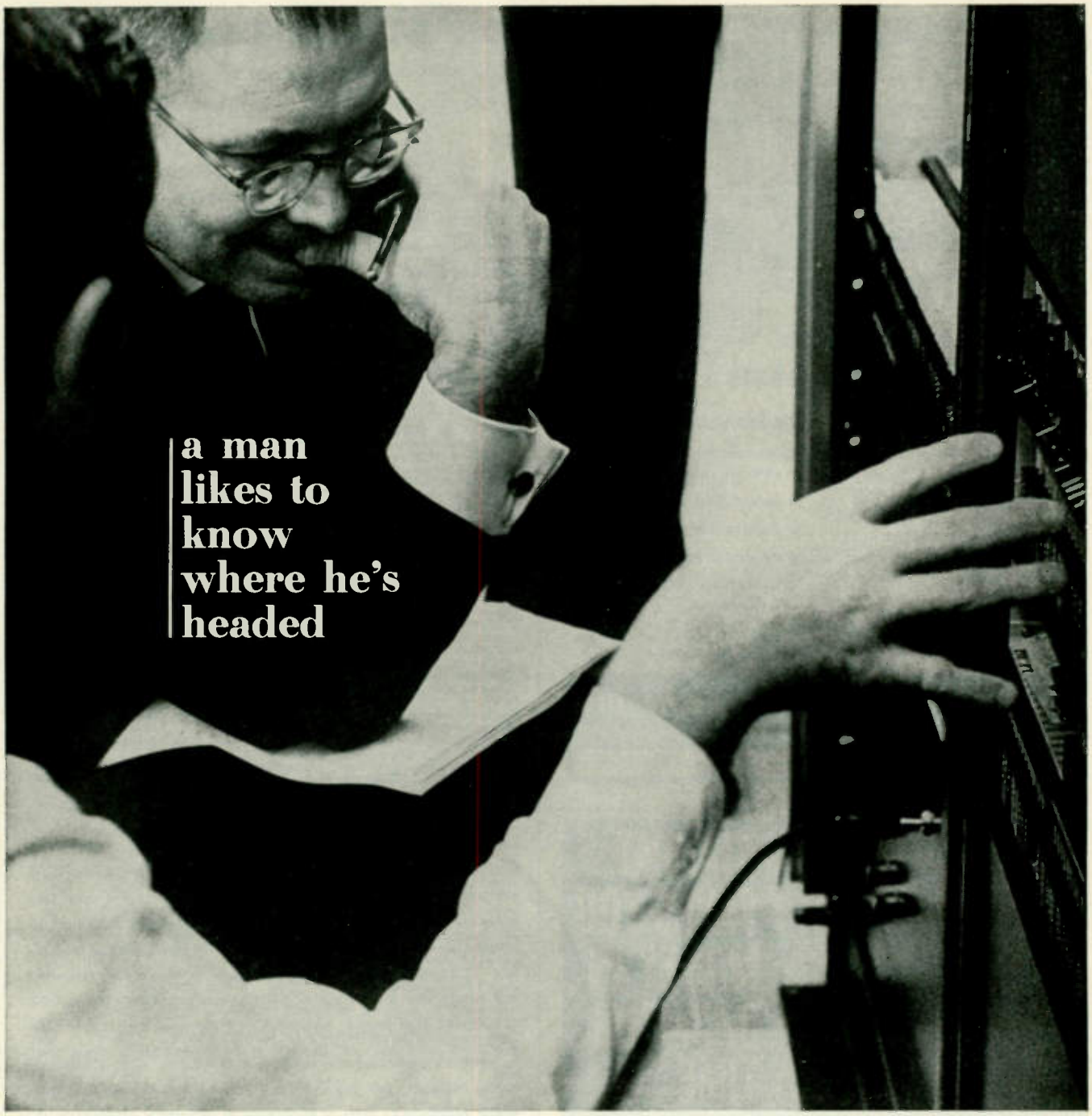
3. To attempt to supplant another Engineer for employment by the use of unethical practices.

4. To compete with another Engineer for the same client, except with the knowledge of such Engineer or unless the connection of such Engineer with the work has terminated.

5. To attempt to obtain or render technical services or assistance without fair and just compensation commensurate with the services rendered.

6. To advertise in self-laudatory language, or any other manner derogatory to the dignity of the profession.

7. To attempt to practice in any field of engineering in which the registrant is not proficient.



You are the best judge of your own talents, your ability, your job interests. Collins offers you an opportunity to grow in the areas of engineering which best match your capabilities and which will give you the most satisfaction and sense of accomplishment.

It isn't always easy to find opportunities like this. Perhaps you've felt restlessness from not being able to make full use of your talents. Maybe you've found yourself going off in a direction which held no particular interest for you. Or which didn't challenge your ability. Or spark your imagination. Or get you excited over the potential and possibilities.

Whatever your engineering interest might be, we'd like to talk with you. We make this broad statement because the scope of our work is broad. The challenges presented in such diverse fields as Space Communication, Data Processing, Avionics, Microwave, Antenna Systems and HF, VHF and UHF Communication to mention a few, offer you creative opportunities in every area of engineering activity.

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PROFESSIONAL LICENSING (Continued)

When details are received from the state board, recent graduates should plan their careers to get the

TABLE 2

STATE REGISTRATION BOARDS

ALABAMA State Board of Registration for Professional Engineers and Land Surveyors, 711 High St., Montgomery 5, Ala.
ALASKA State Board of Engineers and Architects Examiners, Box 854, Anchorage, Alaska
ARIZONA State Board of Technical Registration, Room 403, 128 N. 1st Ave., Phoenix, Ariz.
ARKANSAS State Board of Registration for Professional Engineers, P. O. Box 175, Pulaski Heights Station, Little Rock, Ark.
CALIFORNIA State Board of Registration for Civil and Professional Engineers, 529 Business and Professions Bldg., 1020 "N" St., Sacramento 14, Calif.
CANAL ZONE Board of Registration for Architects and Professional Engineers, P. O. Box 223, Balboa Heights, Canal Zone
COLORADO State Board of Examiners for Engineers and Land Surveyors, 20 Capitol Building, Denver, Col.
CONNECTICUT State Board of Registration for Professional Engineers and Land Surveyors, 30 Oak St., Hartford 6, Conn.
DELAWARE State Board of Registration for Professional Engineers and Land Surveyors, 11 E. 12th St., Wilmington, Del.
DISTRICT OF COLUMBIA Board of Registration for Professional Engineers, 1740 Massachusetts Ave., N.W., Washington 6, D. C.
FLORIDA State Board of Engineer Examiners, 408 John F. Seagle Building, Gainesville, Fla.
GEORGIA State Board of Registration for Professional Engineers and Surveyors, 224 State Capitol, Atlanta, Ga.
HAWAII State Board of Registration for Professional Engineers, Architects and Land Surveyors, 1909 Aleo Place, (Manoa) Honolulu 14, Hawaii
IDAHO State Board of Engineering Examiners, 500 Idaho St., Boise, Idaho
ILLINOIS State Department of Registration and Education, Capitol Bldg., Springfield, Ill.
INDIANA State Board of Registration for Professional Engineers and Land Surveyors, 145 W. Washington St., Indianapolis, Ind.
IOWA State Board of Engineering Examiners, State Capitol Bldg., Des Moines 19, Iowa
KANSAS State Board of Engineering Examiners, 422 Garlinghouse Bldg., Topeka, Kans.
KENTUCKY State Board of Registration for Professional Engineers, University of Kentucky, Lexington 29, Ky.
LOUISIANA State Board of Registration for Professional Engineers and Land Surveyors, 233 Civil Engineering Bldg., Tulane University, New Orleans 18, La.
MAINE State Board of Registration for Professional Engineers, Box 103, Waterville, Maine
MARYLAND State Board of Registration for Professional Engineers and Land Surveyors, 1101 Key Highway, Baltimore 30, Md.
MASSACHUSETTS State Board of Registration of Professional Engineers and of Land Surveyors, Room 34, State House, Boston, Mass.
MICHIGAN State Board of Registration for Architects, Professional Engineers and Land Surveyors, 1604 Cadillac Square Bldg., Detroit 26, Mich.
MINNESOTA State Board of Registration for Architects, Engineers and Land Surveyors, 316 New York Bldg., St. Paul 1, Minn.
MISSISSIPPI State Board of Registration for Professional Engineers, P. O. Box 3, Jackson, Miss.
MISSOURI State Board of Registration for Architects and Professional Engineers, Box 184, Jefferson City, Mo.
MONTANA State Board of Registration for Civil Engineers and Land Surveyors, Civil Engineering Dept., Mont. State College, Bozeman, Mont.
NEBRASKA State Board of Examiners for Professional Engineers and Architects, 210 Ferguson Hall, University of Nebr., Lincoln 8, Nebr.
NEVADA State Board of Registered Professional Engineers, College of Engineering, University of Nevada, Reno, Nev.
NEW HAMPSHIRE State Board of Registration for Professional Engineers, State House, Concord, N. H.
NEW JERSEY State Board of Professional Engineers and Land Surveyors, 1100 Raymond Blvd., Newark 5, N. J.
NEW MEXICO State Board of Registration for Professional Engineers and Land Surveyors, P. O. Box 2074, Santa Fe, N. M.
NEW YORK State Board of Examiners of Professional Engineers and Land Surveyors, 23 South Pearl St., Albany 7, N. Y., c/o N. Y. State Education Dept.
NORTH CAROLINA State Board of Registration for Engineers and Land Surveyors, P. O. Box 5131, N. C. State College, Raleigh, N. C.
NORTH DAKOTA State Board of Registration for Professional Engineers, P. O. Box 1265, Minot, N. D.
OHIO State Board of Registration for Professional Engineers and Surveyors, 21 West Broad St., Columbus 15, Ohio
OKLAHOMA State Board of Registration for Professional Engineers, 225 Cameron Bldg., 2901 Classen Blvd., Oklahoma City 6, Okla.
OREGON State Board of Engineering Examiners, 717 Board of Trade Bldg., Portland 4, Ore.
PENNSYLVANIA State Registration Board for Professional Engineers, 324 Education Bldg., Harrisburg, Pa.
PUERTO RICO Board of Examiners of Engineers, Architects and Surveyors, P. O. Box 3271, San Juan, Puerto Rico
RHODE ISLAND State Board of Registration for Professional Engineers and Land Surveyors, 246 State Office Bldg., Providence, R. I.
SOUTH CAROLINA State Board of Engineering Examiners, P. O. Drawer 1404, Columbia, S. C.
SOUTH DAKOTA State Board of Engineering and Architectural Examiners, South Dakota School of Mines and Technology, Rapid City, S. D.
TENNESSEE State Board of Architectural and Engineering Examiners, 503 Nashville Trust Bldg., Nashville 3, Tenn.
TEXAS State Board of Registration for Professional Engineers, 308 W. 15th St., Austin 1, Tex.
UTAH Representative Committee of Professional Engineers and Land Surveyors, 324 State Capitol Bldg., Salt Lake City 1, Utah
VERMONT State Board of Registration for Professional Engineers, Norwich University, Northfield, Vermont
VIRGINIA State Board of Examination and Certification of Professional Engineers, Architects and Land Surveyors, P. O. Box 1-X, Richmond, Va.
WASHINGTON State Board of Registration for Professional Engineers and Land Surveyors, Dept. of Licenses, Olympia, Wash.
WEST VIRGINIA State Registration Board for Professional Engineers, 301 Morrison Bldg., Charleston, W. Va.
WISCONSIN State Registration Board of Architects and Professional Engineers, 1140 State Office Bldg., Madison 2, Wisc.
WYOMING State Board of Examining Engineers, 201 State Capitol Bldg., Cheyenne, Wyo.

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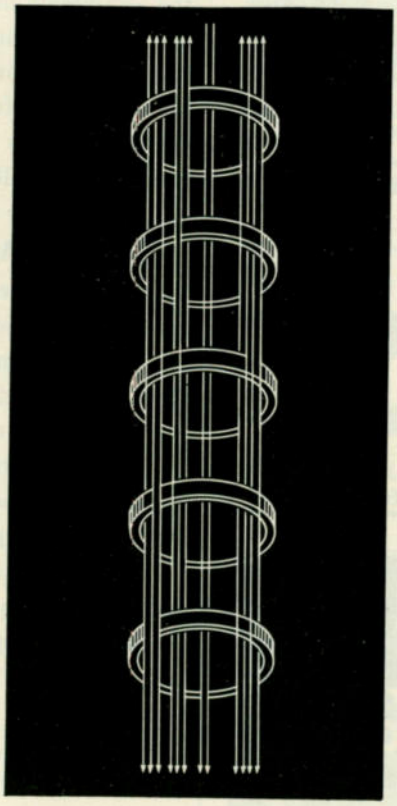
The midget computer—D210—(briefly described to the right)—is one recent example. Another is Burroughs' new, large scale command/control multi-module processing system—D825. This carries on parallel computation, controlled by automatic programming and is, in fact, the first totally modular processor.

Engineers at the Laboratories find our friendly, informal atmosphere conducive to creative work of this calibre. Here a man is associated with cooperating groups but, at the same time, finds management doors always open for the discussion of original ideas.



Logic in this computer is physically implemented with a device resembling the core-rope fixed memory but distinguished from it by certain novel characteristics. Designed for an astronaut's cabin, this magnetic computer fits into a breadbox, weighs only 19 lbs., but can solve guidance and control equations at lift-off, in orbit and at re-entry at minimum 1-kc rate.

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PROFESSIONAL LICENSING (Concluded)

needed experience as soon as practicable. Other engineers should perform a candid self-evaluation to determine if they honestly measure up to the requirements. If they do not, they must then plan and take steps to become qualified. If they do meet the basic requirements, I would suggest that they contact a local engineering college to see if that institution offers refresher course for the P.E.'s examination. Sometimes this information is supplied with the details from the state board. Many of the engineering schools cooperate with the state boards in holding the examinations and offer the special sessions to better prepare an applicant for the formal examination. If truly qualified, an applicant does not necessarily need a refresher course. However, most practicing engineers have a specialty, and the refresher courses materially assist them in those areas where they are not too familiar due to lack of contact.

Preparing the Application

All too frequently engineers, when asked to mention what their job entails, tend to be vague in describing their responsibilities. In preparing an application, one should give the desired information in as much detail as may be indicated, and be as specific about actual activities as possible. But, applications should reflect facts and not be verbose.

Preparing for the Examination

There are many good reference books available on preparing for the P.E.'s examination. These books go into much detail. One word of caution in preparing for the examination (this applies to almost any major test)—avoid cramming. It is better to schedule a definite period of time each day for several weeks and to establish definite objectives for weekly accomplishment. Finally, a good night's rest before the examination is essential.

Taking the Examination

As proctors have always told examinees, it is highly advisable to read an entire examination before attempting to answer any of the particular requirements. Then, attack the familiar problems first. Solving several familiar problems will get you in the proper frame of mind for attempting the more difficult ones. In this way you will avoid getting the idea that all the problems in a test are difficult should you experience extreme difficulty on the first one or two.

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ANNUAL INDEX OF ARTICLES—1963

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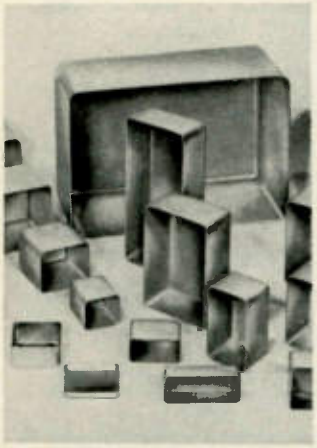

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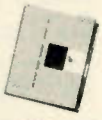

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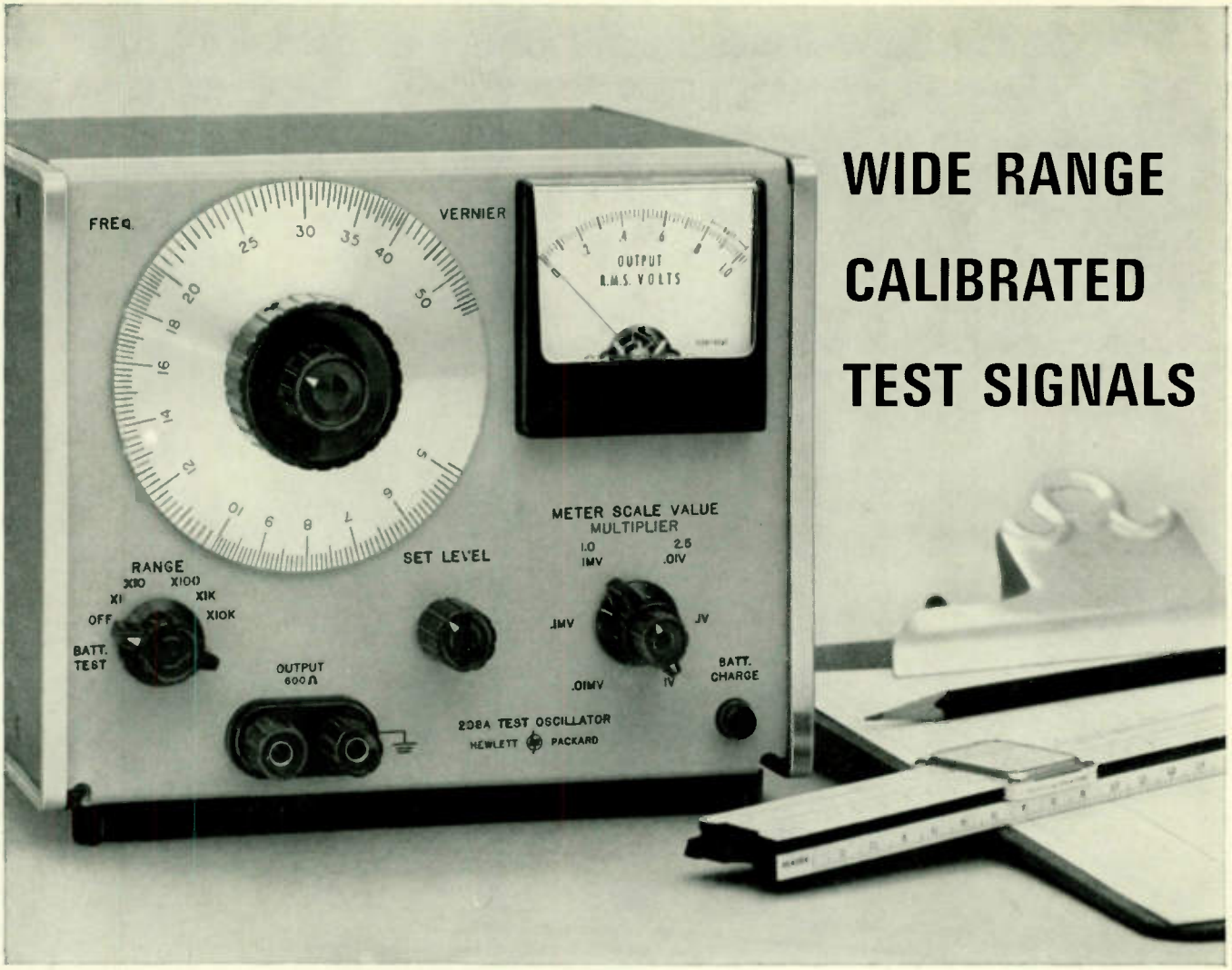

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Frequency range: 5 cps to 560 kc, 5 ranges

Dial: logarithmic calibration, ± 3% accuracy

Frequency response: ± 3% into rated load

Output: 10 mw (nominal 2.5 v rms into 600 ohms)

Output impedance: 600 ohms

Output attenuator: 6 position, 10:1 steps from 0.01 mv to 1 v; times 2.5 multiplier gives 10:1 steps from 0.025 mv to 2.5 v

Output monitor: transistor voltmeter monitors level at input to attenuator and after set level

Set level: continuously variable attenuator with 10:1 (20 db) minimum range

Distortion: less than 1%

Hum and noise: less than 0.05%

Power: four rechargeable batteries (furnished), recharge during ac operation; 30 hours per charge, more than 500 recharges

Size: 6½" high, 7¾" wide, 8" deep, 8¼ lbs.

Price: hp 208A, $525

Data subject to change without notice. Prices f.o.b. factory.

Also available: Model 208A-DB for audio, communication system testing. Model 208A-DB, same as 208A except that output is calibrated in dbm, has a 110 db attenuator calibrated in 1 and 10 db steps. Price: $535.

New hp 208A Test Oscillator

Solid state and operated from a rechargeable battery pack or ac line, the 208A can be used anywhere to provide stable, accurate signals that are calibrated with a built-in attenuator and voltmeter. The precision attenuator adjusts the output in 20 db steps from 0.01 mv to 1 v or from 0.025 mv to 2.5 v. A metered set level control provides continuous adjustment between 20 db steps. Output is calibrated into 600 ohms, single ended.

While operation on rechargeable battery pack makes the 208A ideal for field use, battery operation is also useful in general lab work, providing isolation from power line ground to avoid hum and ground loop problems. The long-life nickel-cadmium batteries recharge automatically while the oscillator is operated from the ac line so that the 208A is always ready for portable use. Output is flat within ± 3%; frequency stability is typically better than 5 parts in 10^4.

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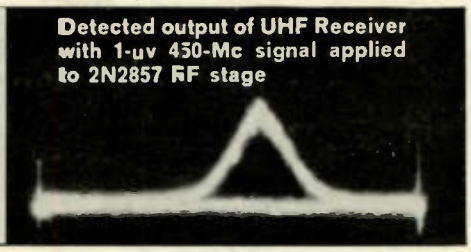
4 db NOISE FIGURE AT 450 Mc



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The low-noise npn 2N2857 uses a new miniature structure to achieve these outstanding characteristics:

- Extremely low noise...4 db typical in 450 Mc common-emitter RF amplifier
- High Gain...14 db typical at 450 Mc in neutralized 20 Mc bandwidth amplifier
- Excellent 450-Mc Mixer Performance...NF = 7 db, Gain = 15 db (typical)
- Excellent UHF Oscillator Performance...Power Output = 40 mw typical at 500 Mc, 20 mw typical at 1 Gc (unit will oscillate at frequencies to 2 Gc)
- Maximum Ratings...V_{CBO} = 30V, V_{CEO} = 15V, P_t = 200 mw at 25°C free-air
- Gain–Bandwidth Product = 1200 Mc Typical

Each RCA 2N2857 is tested for maximum noise figure and minimum power gain @ 450 Mc as a standard factory procedure. Specified 2N2857 values are based on ½-inch leads. With shorter leads gain can be improved as much as 1.5 db gain and noise figure as much as 0.5 db.

RCA also offers New Silicon NPN Transistor 2N2708 designed specifically for VHF Applications. The new RCA 2N2708 planar epitaxial transistor is specifically designed for VHF applications to 500 Mc. Here are some of the features of this new transistor:

- 200 Mc wideband RF amplifier...15 db min. gain (neutralized common-emitter)
- Maximum ratings...V_{CBO} = 35V, V_{CEO} = 20V, V_{EBO} = 3V
- Gain–Bandwidth Product...700 Mc min.
- NF = 8.5 db max. at 200 Mc, I_C = 2 ma

Each RCA 2N2708 is tested for maximum noise figure and minimum power gain @ 200 Mc as a standard factory procedure.

Call your RCA Representative today for complete information on these outstanding RCA transistors. For further technical data, write RCA Commercial Engineering, Section CJ-12, Electronic Components and Devices, Harrison, N. J.

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