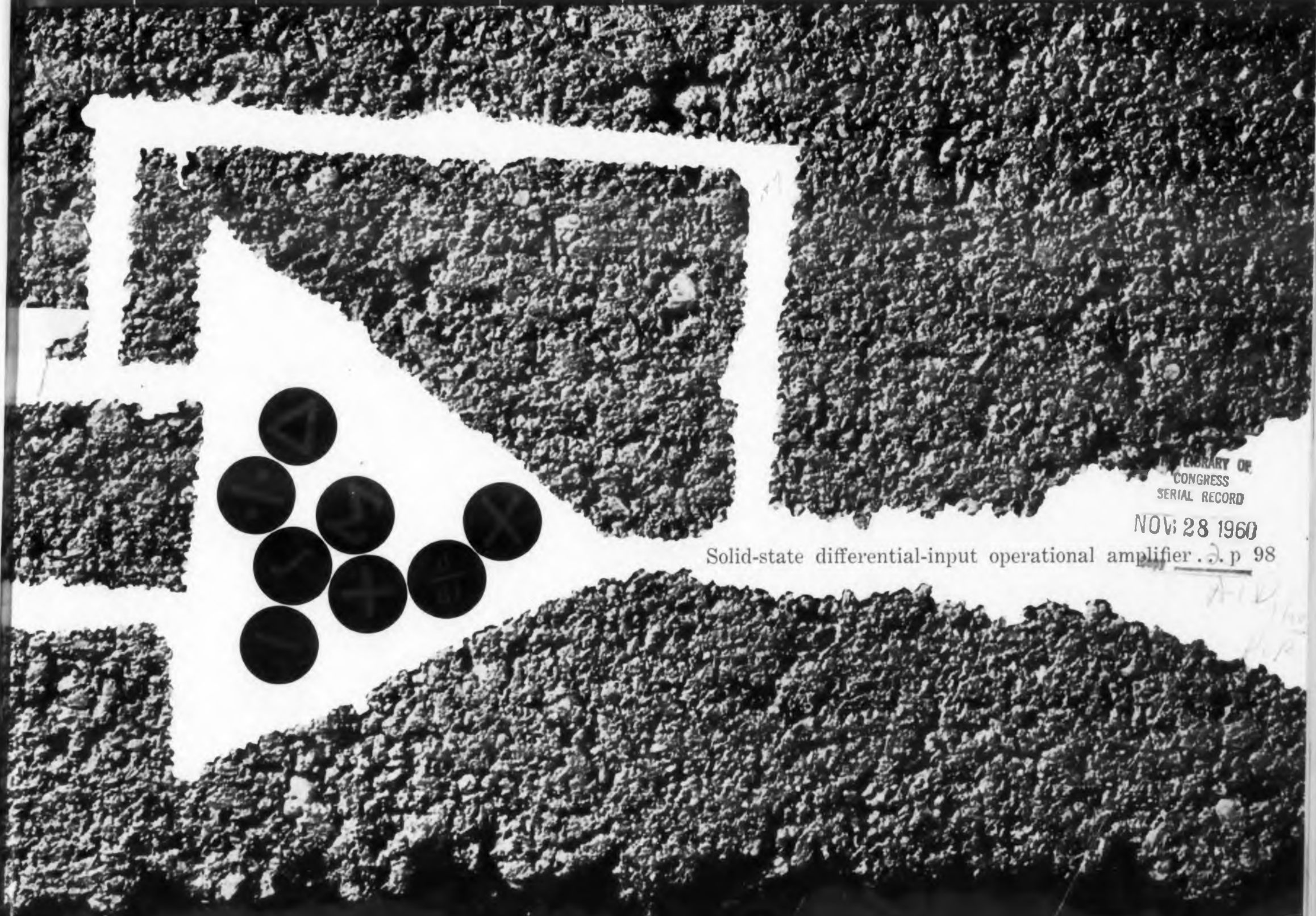


ELECTRONIC DESIGN

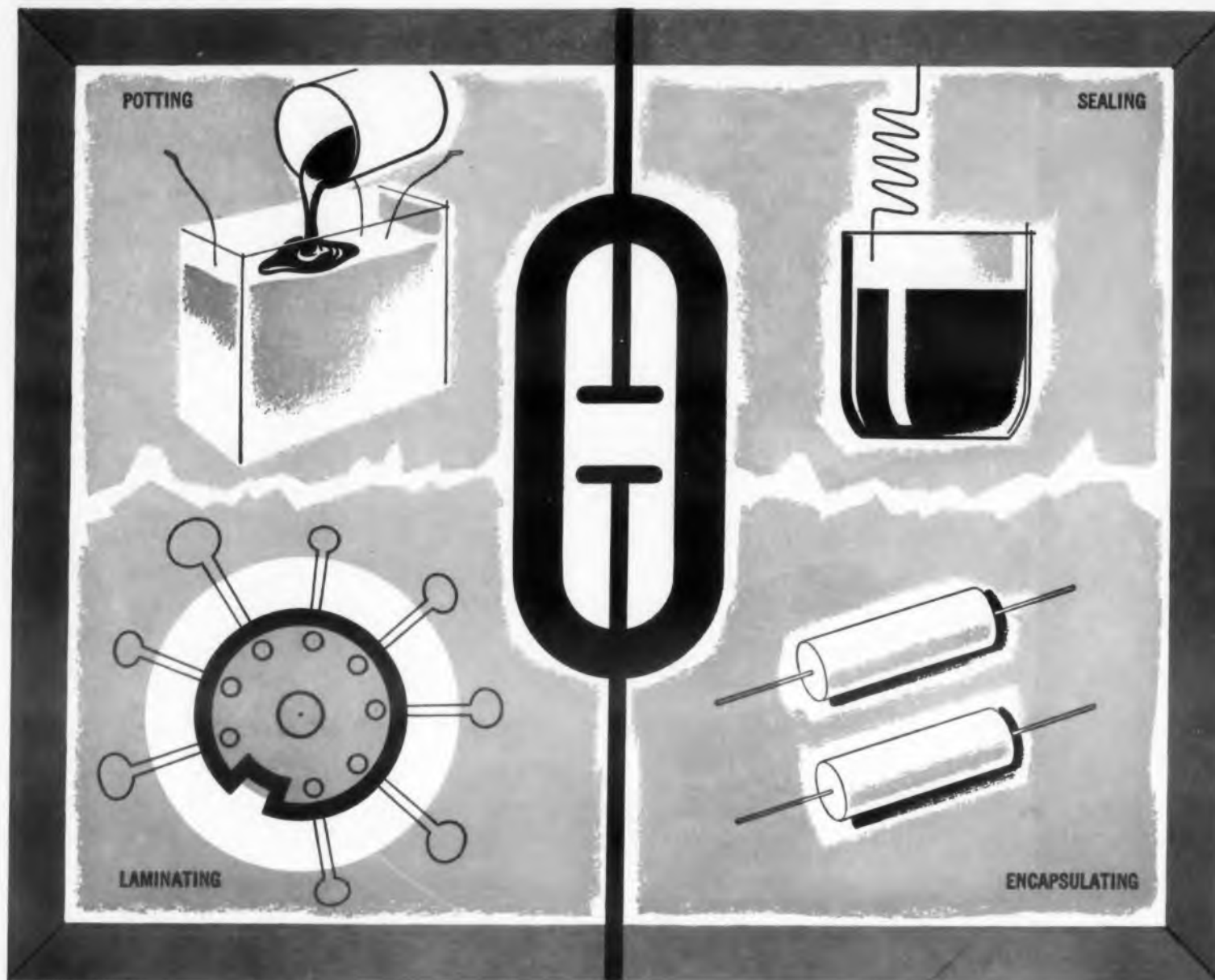


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NOV 28 1960

Solid-state differential-input operational amplifier . 2. p 98

Guidelines for Microminiature Design



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CIRCLE 1 ON READER-SERVICE CARD



COVER: The solid-state differential-input amplifier which is our cover feature for this issue can perform all eight of the functions symbolized and draws no more than 10^{-10} amp. To show the stability of the device, a schematic of a feedback amplifier has been placed on a photo of a block of concrete. The story about the Philbrick product starts on p 98.

Selected Topics In This Issue

Communications

- Experimental Satellite TV Relay
Planned 4
- General-Purpose Computers to
Direct Communications 32

Microminiaturization

- Guidelines to Microminiature
Designs—A Staff Report 61
- Five Major Approaches
Pursued 62
- Interconnections Lag Device
Development 84
- Comparing Key Characteristics of Major Microminiaturization Approaches 94
- Looking at Microminiaturization in Perspective 96

Semiconductors

- Complementary Transistors Form
Two-Stage, High-Gain Amplifier 192
- Thermoelectric Junction Cools
Transistors for Temperature
Testing 194

Systems

- Facsimile Mail System Beats
Privacy-Rule Problem 10
- Plan New Monitoring for
Supersystems 26
- Machines Monitored by New
German Device 42

TK7500
E437

NOV -7 1960

Sidelights of the Issue

Words, Words, Words

"This writing business," a veteran reporter once said, "would be great if you never had to sit down at a typewriter and write."

To make the writing process as painless as possible, *ELECTRONIC DESIGN* editors, in conjunction with the NEREM conclave in Boston (see p 24) will hold a seminar on technical writing at 9 am, Nov. 16, in the Oval Room of the Sheraton-Plaza Hotel. Four *ED* editors will be on hand to discuss improving technical communications, including articles, reports, and letters. Among the editors at the seminar will be *ED* Managing Editor James A. Lippke, recently named National Workshop Chairman for IRE's Professional Group on Writing and Speech (PGEWS).

It Started with Swift

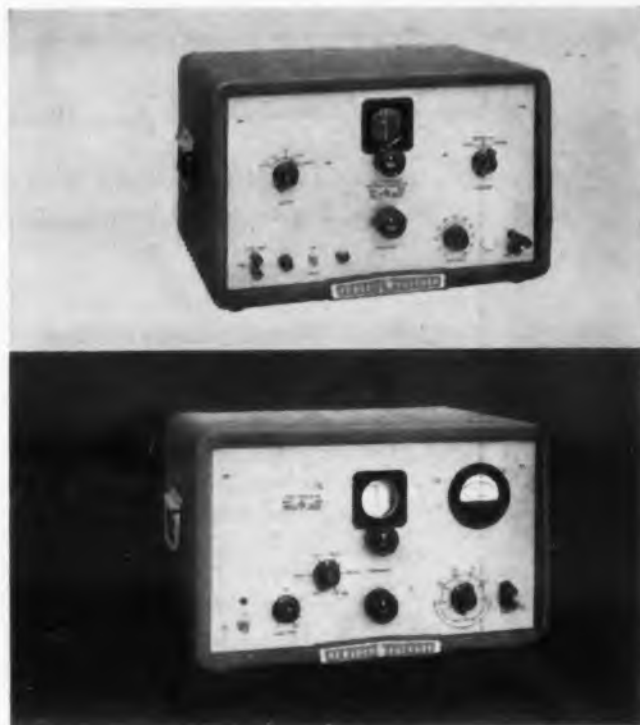
In the course of gathering data for their Staff Report, "Guidelines to Micro-miniature Designs," which begins on p 61 of this issue, editors Howard Bierman and Robert Haavind reported that their assignment had left them with mixed feelings. When it comes to handling components, they said, they feel all thumbs. Indeed, according to Haavind, "I happened to take home one day a special diode for an electronic watch. The thing looked like a short length of thread with a knot tied in it. While I was showing it to my wife, it dropped onto the rug. It took forever to find it and both of us almost went blind in the process."

The two editors interviewed numerous people for their report, and while any resemblance in the accompanying cartoon is purely coincidental, they reported that they came away from the story feeling like a couple of Gullivers in Lilliput.



"As I see it, being small isn't enough . . ."

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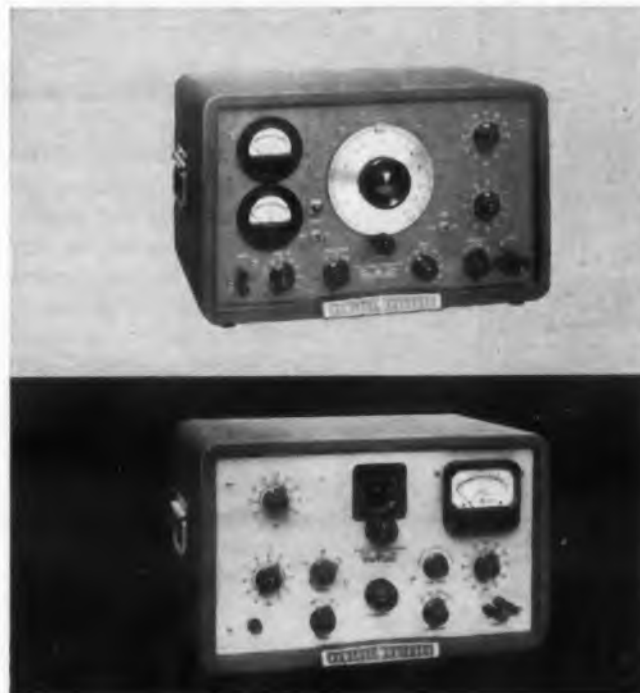


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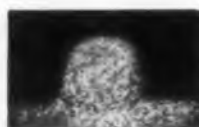
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CIRCLE 3 ON READER-SERVICE CARD

ELECTRONIC DESIGN News	4
Experimental Sattellite TV Relay Planned	4
Lenticular Character Reader Promises Low Cost	8
Facsimile Mail System Beats Privacy-Rule Problem	10
Progress Speeded on Airborne Microwave Power Converter	12
Micromin poses Business Threat	18
Washington Report	22
NASA and Gruman In Talks for Orbiting Space Observatory	25
Plan New Monitoring for Supersystems	26
System Alerts Drivers Nearing Road Edge	30
General-Purpose Computer To Direct Communications	32
Two-Thirds Cost Slice Claimed for Recorder	36
Analog Computer Helps In Man-Machine Study	38
Capsule To Test Radiation Is Recovered from Space	38
Data-Processing Systems Edited With Datacom	40
Growing Up to Scaling Down	47
An Editorial	
Choosing Optimum DC Supply Voltage Minimizes Power Dissipation	48
A simple formula makes it easy to take the additional design step of calculating the supply voltage that gives minimum power dissipation—R. W. Hofheimer	
A Quick Method of Selecting Minimum Time Constants for Time Base Functions	52
For a specified allowable deviation from linearity, a few simple steps permit choosing proper time constant for exponential functions—W. Wagner	
Test Equipment: Types and Characteristics—Part 2: Oscilloscopes and Oscillographs	56
A survey and tabulation of the various devices that give readout in picture form—A. J. Reynolds	
Guidelines to Microminiature Designs	61
Much of the attention given to microminiaturization has emphasized positive aspects and glossed over drawbacks. To give the design engineer the insight needed to achieve effective size reduction, this ELECTRONIC DESIGN Staff Report presents a rounded view of the field. The information is summarized in tabular form in a chart comparing the key characteristics of the major approaches.	
Five Major Approaches Pursued	62
The efforts of more than two dozen companies engaged in micromin development are grouped into five categories. Approach description as well as key advantages and problem areas are presented.	
Interconnections Lag Device Development	84
Although small wafers or blocks have replaced larger component assemblies, equipment still is in need of clever interconnection ideas for optimum size reduction.	
Comparing Key Characteristics of Major Microminiaturization Approaches	94
A comparative tabulation of key factors associated with major micromin approaches has been prepared as a guide for the design engineer.	
Looking at Microminiaturization in Perspective	96
Based on interviews conducted during preparation of this special report, ELECTRONIC DESIGN editors evaluated the present and future state-of-the-art. A systems engineer's view of micromin pros and cons is also included.	

4	Solid-State, Operational Amplifier Features Fully Floating, Low-Current Input	98
	Unusual performance marks this differential-input, operational amplifier	
	True-RMS VTVM Gives High Accuracy With Clean or Distorted Waveshapes	100
	Rms vtvm gives accurate digital readout over wide range of voltages and frequencies	
	Design Decisions	180
	Conventional Resistance Networks and CRT Generate Characters as a Series of Dots	180
	Compartment Separators in Wall Slot Improve Isolation in RF Equipment	181
	ELECTRONIC DESIGN Engineering Data	183
47	Graphs Plot Coil Resistance As a Function of Temperature	183
	Ideas for Design	192
48	Complementary Transistors Form Two-Stage, High-Gain Amplifier	192
	Thermoelectric Junction Cools Transistors for Temperature Testing	194
	Transformer Senses Filament Fault Current	195
	Russian Translations	200
52	Combined Double Tee	200
	German Abstracts	202
	Tantalum Capacitors	202
	New Products	102
56	Services for Designers	178
	New Literature	185
	Patents	196
61	Books	198
	Report Briefs	204
	Letters	206
	Careers	208
	Your Career	208
	Career Brochures	211
	Advertisers' Index	213



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MT9*	Line to P.P. Emit.	600 C.T.	1,200 C.T.
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MT13*	P.P. Coll. to Speaker	4,000 C.T.	3.4
MT14*	Coll. to Speaker 2N179	400	10
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M8004	Coll. to P.P. Emit.	5,400	600 C.T.	15	.075
M8005	Coll. to P.P. Emit.	7,000	320 C.T.	7	.040
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UM31(*)	Interstage	10,000 C.T.	1,200 C.T.
UM32(*)	Output	1,500 C.T.	600
UM33(*)	Output	1,000 C.T.	600
UM34(*)	Driver	10,000 C.T.	600 C.T.

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Satellite TV Relay Planned Within Year

Experimental Relay Traveling in 2,200-Mile Orbit Will Link U.S., United Kingdom, and Continent

EXPERIMENTAL commercial intercontinental television transmission via an active satellite repeater is planned within a year by the American Telephone & Telegraph Co.

This satellite, to be orbited at a 2,200 mile altitude, will mark the first commercial venture into space. AT&T is designing the payload for the relay, however it is asking for some assistance from the National Aeronautics and Space Administration in contracting for a launch vehicle and suitable facilities.

The sky link will allow one-way transmission of TV programs between the United States, United Kingdom and the European continent for about 35 minutes at a time three or four

times a day—when the satellite is in line-of-sight range of both transmitting and receiving stations. Intercontinental TV has not been possible because of the narrow bandwidth of the Trans-Atlantic cable.

Transmission of telephone, data and other traffic is also planned to test the effectiveness of the intercontinental relay.

This communications satellite will mark a step beyond either the passive reflector of Project Echo (*ED*, April 13, p 4) or the delayed repeater of Project Courier (*ED*, Aug. 31, p 4). Real-time transmission of high-quality TV, similar to that provided by overland microwave relay links, will be accomplished.

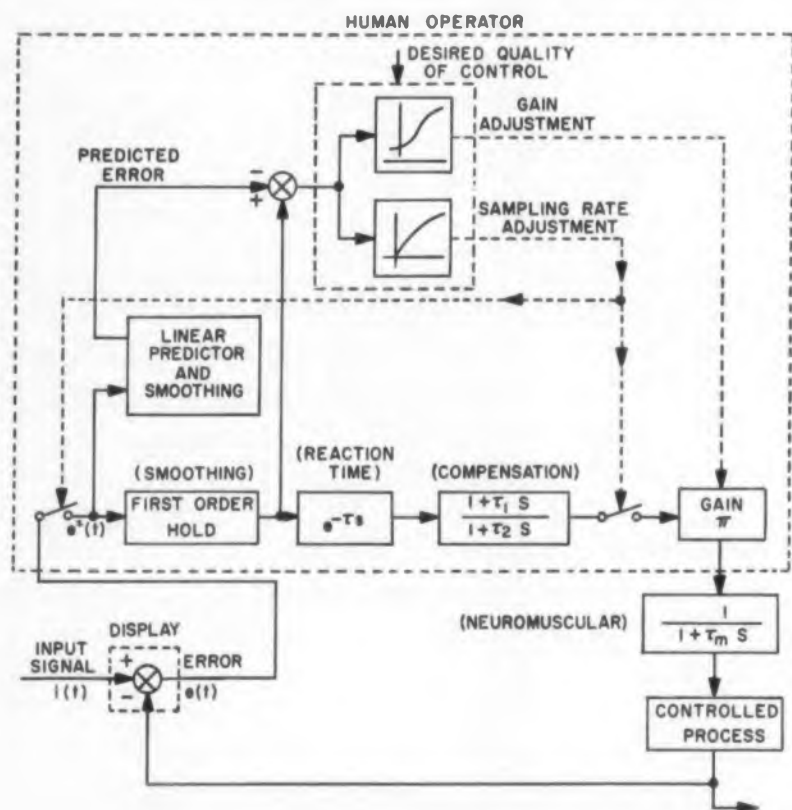
Overseas terminal facilities for the planned experiment will be supplied by mutual cooperation between AT&T and foreign carriers, following the precedents set in previous terminal construction for transoceanic facilities, such as the

TV transmission comparable in quality to that provided by land microwave systems is a design objective for the AT&T program. To achieve this aim Bell Labs designers will use some of the technology developed for the Echo balloon satellite—such as low-noise maser receivers and horn reflector antennas. The satellite payload on the other hand, offers some new and severe problems.

The 2,200-mile orbit puts the vehicle in a Van

Adaptive Interest Moving Towards Learning Systems

Widened Attention Is Evidenced at Long Island Meeting; Stress Is on Search for Cybernetic Mechanizations



The human operator adaptive servo system may be the best indication of future trends. Note use of prediction.

THE INTEREST in adaptive servo systems is widening into a search for learning control systems. This has been evidenced by the widened selection of papers for technical symposiums on the subject, such as the recent three-day conference sponsored by the Long Island IRE section at Garden City, N.Y., and from discussions with engineers working in the field.

The adaptive servo movement, which started out as an effort to add automatic-gain adjustment loops to high-performance aircraft control systems, and has gone through a period of freeing servo designers from the limitations of linear servo theory, now shows signs of further expanding into a search for cybernetic mechanizations.

An indication of the direction that this is likely to take is given by the schematic (left). This attempt to represent the adaptive characteristics of the human operation in servo-diagram terms was proposed to the Garden City conference by George A. Bekey, Space Technology Laboratories, Inc., Los Angeles.

Mr. Bekey's model of the human servo system is a number of levels beyond present adaptive

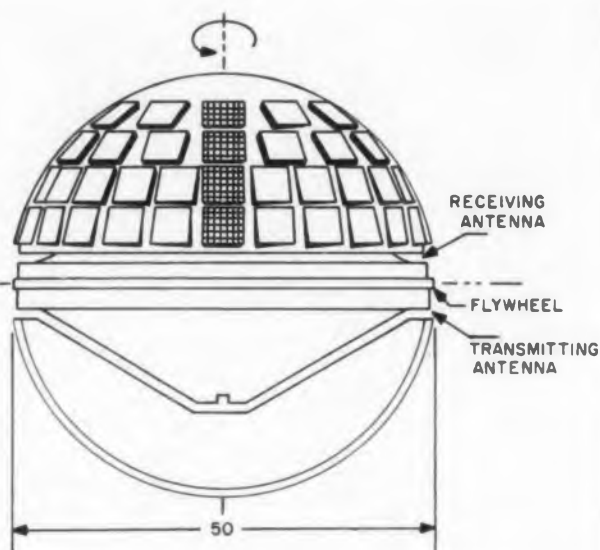
systems. Particularly significant is the pattern recognition, logical decision, and memory capabilities implied in the upper loop.

Here, the human's error prediction is used to adjust the gain and data sampling rate of the system according to desired performance. A by-product of the sampled-data mode of operation is the well-known use of intentional stick dither by pilots to test aircraft control response, Mr. Bekey said.

Two Papers Delivered In Bionics Field

Further substantiation of the trend to extend adaptive research to learning systems was given at the conference by the presence of two papers from the bionic or neuron-network field. One of these papers, "A Memory Complex for an Adaptive Control System," underlined that there may be a fruitful merging of these two fields.

Actually, the research described by author M. J. Pedely of Case Institute, Cleveland, was much further away from useful form than most adaptive systems.



Proposed active satellite repeater design presented to the FCC by AT&T in requesting allocation of frequencies for space purposes represents tentative plans for this type relay link. Solar cell patches on the skin feed energy to nickel-cadmium storage batteries in the instrument package.

Allen radiation belt, for example. Glass shields on the solar cells mounted on the outer skin will cut off some radiation, but some penetration by high-energy protons must be expected, causing gradual decay of the cells. Use of the new

(continued on p 6)

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*Grid Resistor = 5 megohms

**Grid Resistor = 2 megohms

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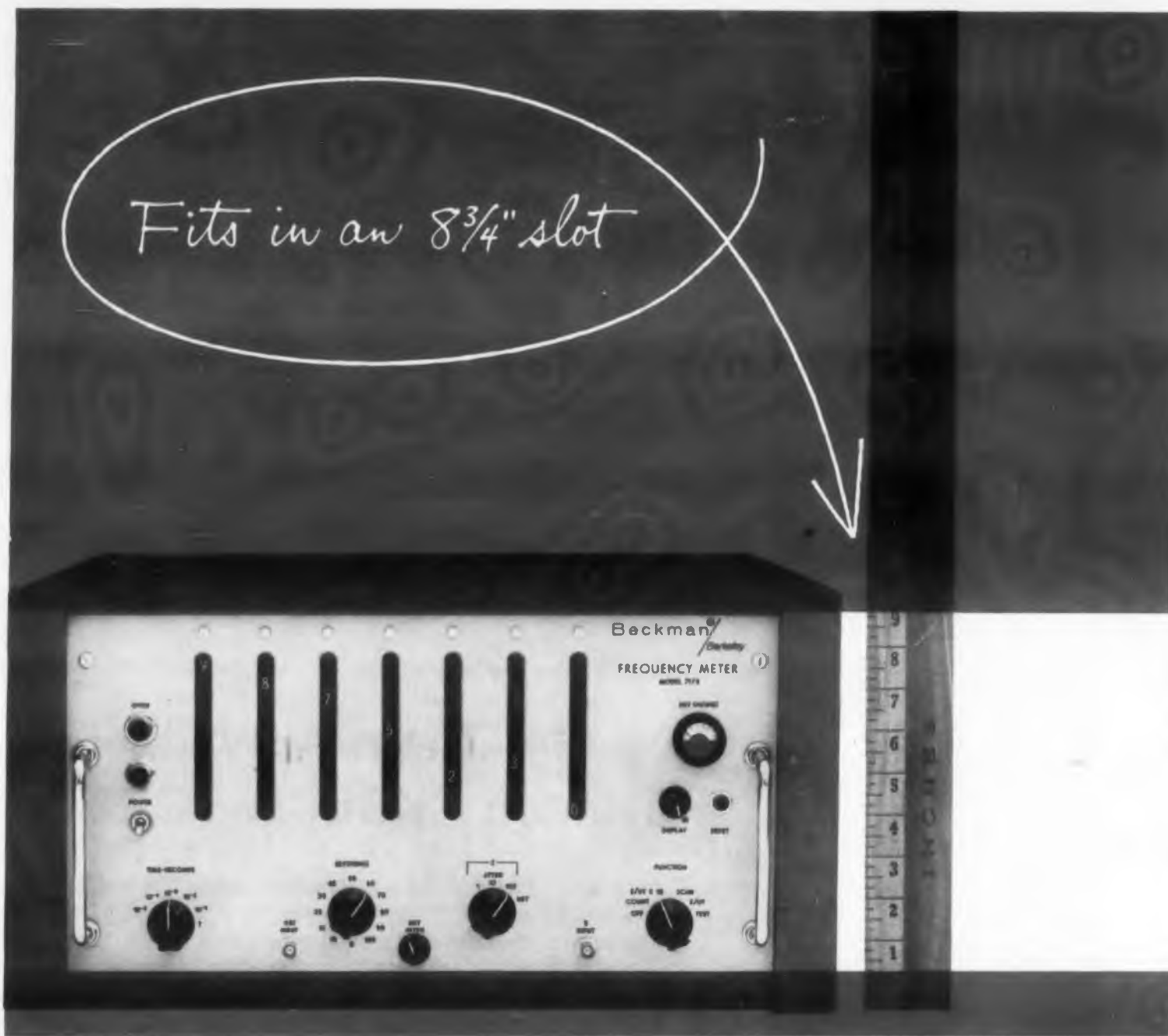
INDUSTRIAL COMPONENTS DIVISION

Mr. Wallace has proposed a learning demonstrator built from analog radar-type building blocks which incorporates his hypothesis that learning (or problem solving) can only be achieved by a machine able to transform problems into simpler forms which can be handled on lower levels. This would be similar to the way in which engineers use Laplace transforms to put differential equations in a form which they then can manipulate by ordinary math.

But with all the rapid advances in definition of the research area, many of the engineers at the conference seemed somewhat ashamed that there are so few convincing hardware systems in being, even those based on the most elementary adaptive principles. Otto H. Schuck, whose Aeronautical Div. at Minneapolis-Honeywell Co., Minneapolis, produced two of the three applications described at the conference, said that more applications were urgently needed for the field to make a good name for itself.

The most timely application described at the meeting was the M-H system for the control of large "jellyfish-like" booster rockets. ■ ■

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NEWS

diffused phosphorous technique for making silicon solar cells of high radiation resistance may help designers on this score (*ED*, Oct. 12, p 12).

The decision to orbit the satellite in a radiation belt was based on other, more important systems needs. The higher the orbit the greater the time that the relay would be in the line-of-sight from sending and receiving stations on opposite sides of the ocean. Correspondingly, the power reaching the receiver decreases as the height of orbit increases.

Power is limited both by ground transmitter and satellite repeater transmitter limitations. It will be difficult to transmit much more than a kilowatt from a ground station operating in the 6 kmc region, and the output of the traveling-wave tube to be used in the satellite will be held to about 2 w. This means that if an orbit much higher than 2,200 miles is chosen, signal-to-noise ratio at the ground receiver would become too high for high quality TV transmission.

The satellite relay system has not yet been designed, however some tentative decisions have been made. A continuous unmodulated carrier will be transmitted by the 2-w TWT—between 6.425 and 6.525 kmc if the Federal Communications Commission grants permission for use of these frequencies in the experiment. When the satellite is in the proper position for relaying, the ground transmitter will send modulated signals at 6.775 to 6.875 kmc. These signals will be received by the satellite, beat down to an intermediate frequency of about 4 mc for amplification, and then stepped up again to the offset frequency for relaying to the ground.

Various Repeater Schemes Include TWT, Solid-State Types

Various broad-band repeater schemes are being investigated for possible use in the satellite, including an all solid-state system using tunnel diodes or transistor harmonic generators as 6 kmc local oscillators, and another system using a TWT as a local oscillator operating at an offset frequency. Amplitude of oscillation in this second system would be limited by a non-linear element in the oscillator feedback path.

Power to operate the satellite equipment will probably be supplied by nickel-cadmium storage batteries along with a transistor inverter. With the solar cells to recharge the battery a power level of about 25 w dc is expected to be available.

The satellite will be about four feet in diameter and weigh about 175 lb. Two slotted an-



Traveling-wave tube similar to this 444A 5 w type used in AT&T's TH microwave relay link system will be used in TV relay satellite. Power output will be held down to 2 w in the satellite system, however, to minimize satellite weight.

antennas will provide sending and receiving capabilities.

The space-frequency allocation problem is again being put squarely before the FCC with AT&T's satellite relay plan (*ED*, Aug. 3, p 4; Sept. 14, p 26).

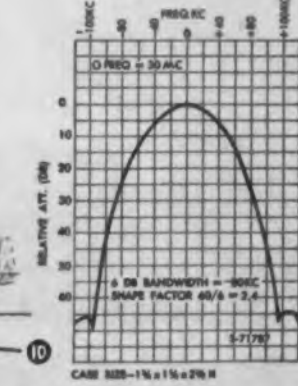
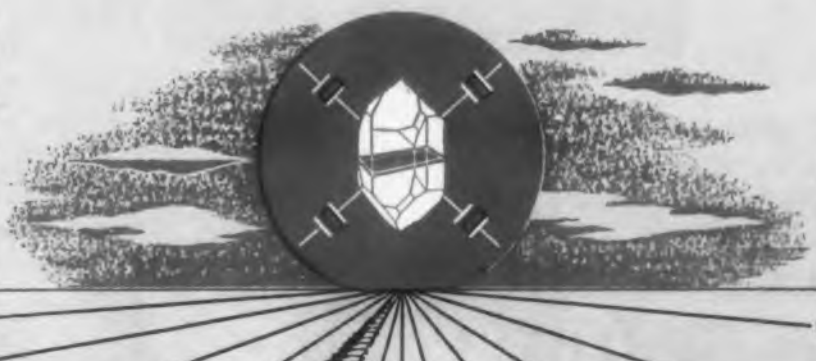
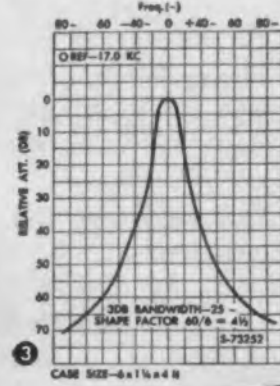
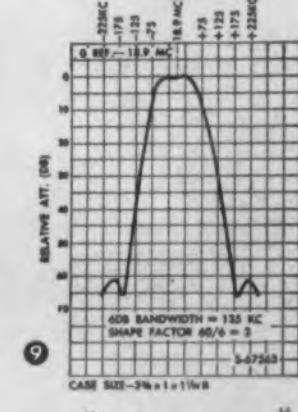
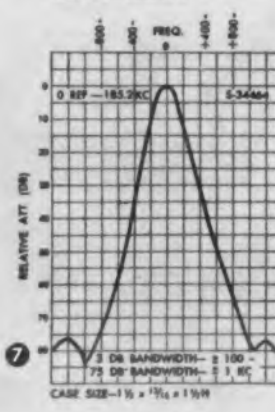
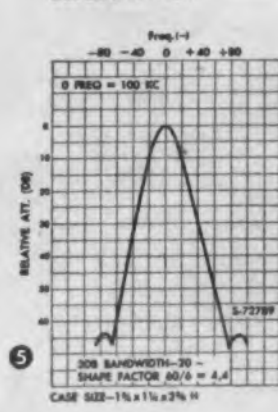
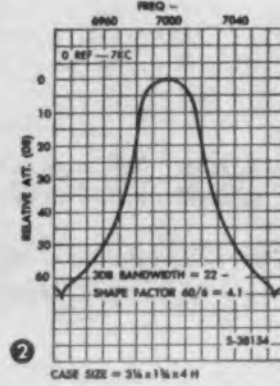
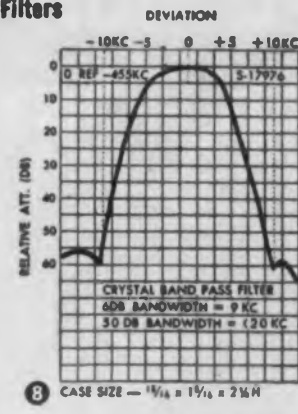
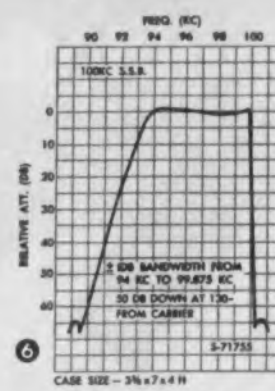
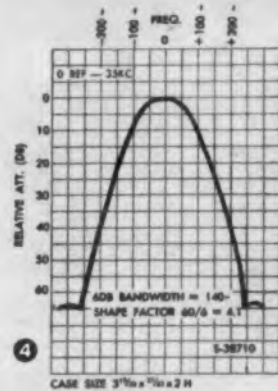
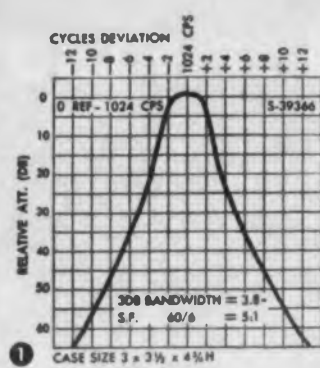
The frequencies requested by AT&T for its experiments in intercontinental TV fall within two bands presently allocated to other services. Until just a few weeks ago the FCC withheld the use of these bands from private microwave users despite the allocations already made to them. Then a new ruling was made allowing private users to start operating equipment in these frequencies bands, all over 890 mc. This new ruling followed by only a short time the request by AT&T and other common carriers that the FCC reallocate some portions of the spectrum for future requirements.

The band from 6.425 to 6.575 kmc is now assigned to land and mobile services and frequencies between 6.575 and 6.875 are assigned to fixed services and closed-circuit TV operations. Since private users are now beginning to operate equipment in these bands, the AT&T space communications experiment should provide an opportunity to see how much interference results from sharing frequencies between ground and space services.

In addition to this request, AT&T has further asked the FCC for a rules change to allow this type of frequency sharing. The company has asked that the band from 6.425 to 6.925 kmc be reallocated as a band to be shared between present services and space systems.

In addition to the allocations in this region already indicated, the portion from 6.875 to 6.925 kmc is assigned to TV pickup, transmitter link and intercity relay services. ■ ■

Typical response curves indicating the various shape factors available in standardized Burnell Crystal Filters



Running the gamut in crystal filters

BURNELL CRYSTAL FILTERS NOW COVER FULLEST RANGE YET POSSIBLE
1 kc to 30 mcs

To its notable achievements in advancing the electronic arts, Burnell & Co. now adds another—the development of moderately priced high attenuation crystal filters covering the extraordinary range of 1 kc. to 30 mc. This represents a range many times broader than previously thought practicable. In addition, the Burnell Crystal Filter line now includes several types heretofore considered impossible.

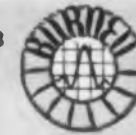
More than 15 years research, development and experience are represented in the designs illustrated in the response curves shown. Burnell & Co. has taken crystal filters out of the luxury class in applying its experience to their design and manufacturing without incurring developmental and engineering costs.

Whether your crystal filter needs are for standard units or those engineered to center frequency, band width, selectivity and impedance level, call on our Crystal Filter Division for quick delivery. Send now for Crystal Filter Catalog, XT455.



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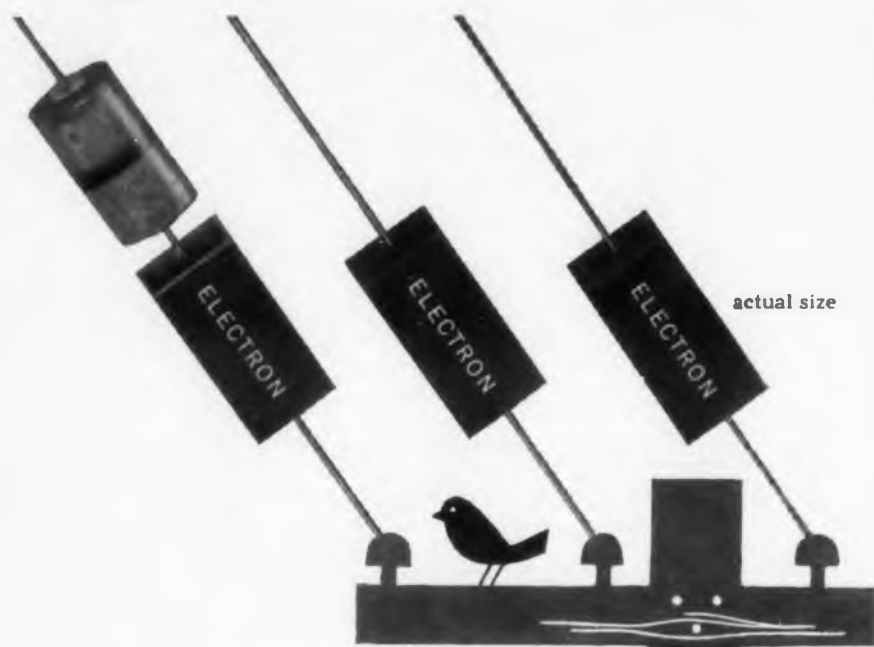
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CIRCLE 8 ON READER-SERVICE CARD

NEWS

Full-scale model of microwave converter for RAMP. Air enters through the two large parallel grilles at front; microwaves enter through smaller grilles on both sides of large grilles. Heated air emerges at apex of A. A working unit would weigh about 250 lb.



Progress Made on Microwave Converter

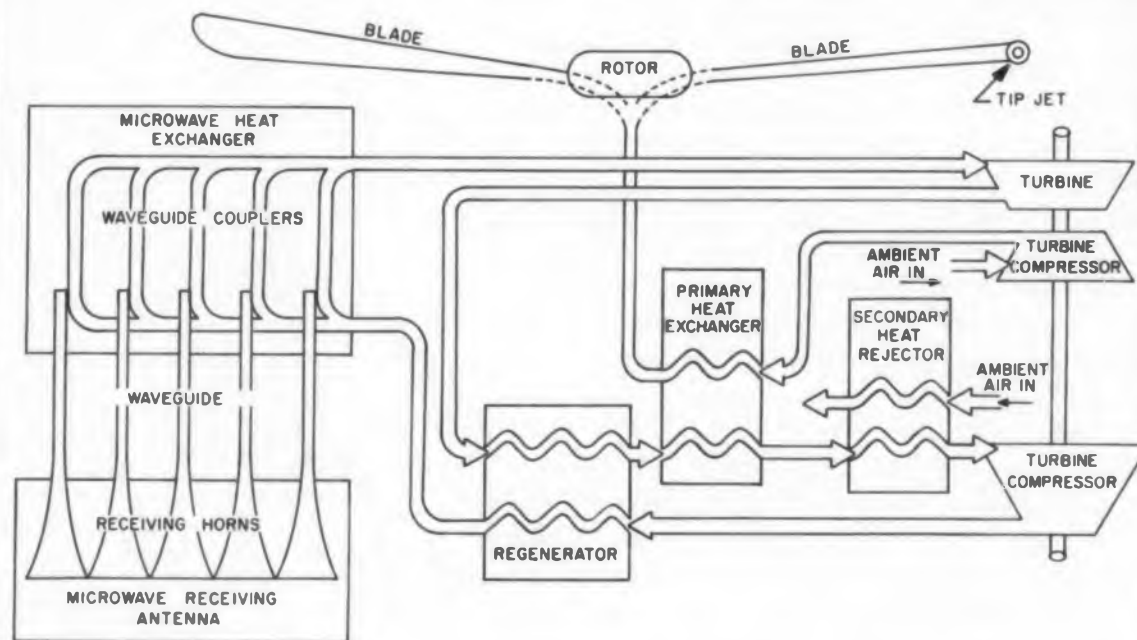
Unit for Raytheon-Developed RAMP 'Copter Becomes Major Target of Stepped-Up Efforts

AN IMPORTANT step towards realization of wireless power transmission via tight microwave beams is reported by Raytheon's Wayland Laboratories, which have completed preliminary design of the airborne microwave heat exchanger for its proposed microwave-powered helicopter. With the receiving end of the system thus under control, the company is stepping up its efforts to land a major contract for actual construction of its RAMP (Raytheon Airborne Microwave Platform) helicopter. A five-year system engineering effort would be needed to get one of these units aloft,

according to a Raytheon spokesman.

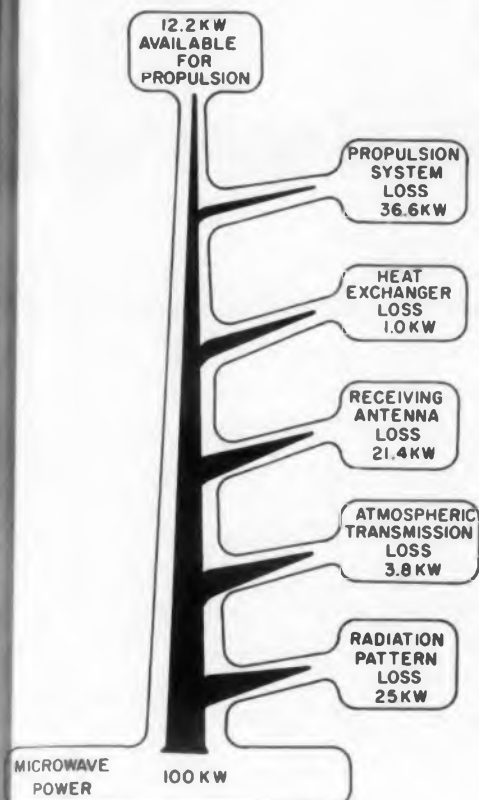
The airborne power converter has a designed output of 1,500 kw and a conversion efficiency approaching 99 per cent. Microwave power received by an array of horn antennas on the underside of the vehicle is coupled to silicon-carbide power converters located in a circulating air stream. Due to the skin effect resulting from the 6 kmc beam, the heat is generated primarily at the surface of the converters and is immediately transferred to the air.

The air stream powers a turbine-driven compressor, whose output propels



Receiving end of RAMP. Microwave heat air in exchanger at left. Heated air at 1,620 F. then powers turbine which drives tip jets through secondary, open cycle system. Heat exchangers and regenerator give high thermodynamic efficiency. Not shown is auxiliary chemical engine required for take-off and to propel vehicle into the microwave beam.

PHILCO Offers the Industry's Broadest Line of Switching Transistors



Where the power goes in RAMP. For every 100 kw radiated by ground antenna, 12.2 kw are finally available for propulsion. Smallest loss (1 per cent) is in the newly developed microwave power converter. Total rf power generated to keep vehicle aloft would be about 1.4 megawatts.

the craft by jets at the tips of the blades.

Up to 100 receiving horns would be distributed along the bottom of the 50-ft diam vehicle. The transmitted beam is designed to cover a 77 ft diam area at the 13-mile operating altitude of RAMP. Taking into account the increasing intensity towards the center of the beam, antenna-radiation losses would run somewhat more than 20 per cent.

The beam would be radiated by a 400-ft-square antenna excavated at the takeoff site. The planned antenna configuration is a quarter section of an elliptical cylinder.

Over-all efficiency of the system from ground antenna to propulsion output is said to be 12 per cent. Raytheon designers indicate that a payload of 2,000 lb is possible with the system as described here. Since on-station time of up to 1,000 hr is considered feasible, the vehicle would likely be unmanned. The present design calls for a fixed antenna and a hovering vehicle. ■ ■



NEW! Transistor Guide for Switching Circuit Designers

To help you find the right transistor for your switching requirements, this brand new guide will be a valuable aid. It contains a complete selector chart, covering 42 different Philco switching transistors . . . descriptions of major types . . . their important parameters . . . helpful application information. A copy of this 8-page guide, plus a price schedule, is yours for the asking. Write Dept. ED11960.

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Miniaturization of electronic components put the pressure on circuitry to keep pace. Photocircuits took up the challenge and

turned an idea into the space and weight saving reality of *Tuf-Plate* plated thru holes — *reliably* interconnecting conductor patterns on *both* sides of the circuit board.

Where even greater component density is required — up to 50% — Photocircuits now offers printed circuit boards with miniaturized conductor patterns using *landless Tuf-Plate* — another first by P/C.

The inset at left offers a visual comparison between outdated eyelets and *new* landless *Tuf-Plate*. Get the whole exciting *Tuf-Plate* story today — it's likely that conventional or landless — *Tuf-Plate* can save you space, weight . . . often at lower cost. Write Department A-1590, Photocircuits Corporation, Glen Cove, New York.

Photocircuits
C O R P O R A T I O N

CIRCLE 10 ON READER-SERVICE CARD

NEWS

Facsimile Mail System

Automation Key to Mail Secrecy; Letters Untouched by Human Eyes

LEGAL restrictions against violating the privacy of first-class mail in transit constituted a major problem in the design of the Post Office's newly inaugurated facsimile mail system. As a result of the "non-peeking" rule, terminals of the experimental Washington-Chicago-Battle Creek link are replete with automatic paper-handling equipment, sealed, tamperproof transfer cartridges, and automatic provisions for detecting interruptions in transmission.

Unlike conventional facsimile systems, in which the received document can be visually inspected, letters coming off the "Speed-Mail" wires are automatically folded and sealed into envelopes—literally untouched by human hands. In the event the signal is degraded or reception interrupted, the letter at the transmitter is immediately placed in a container for resending.

According to a spokesman for International Telephone and Telegraph's InteleX Division, prime contractor for Speed-Mail, this is the first time that fully automatic methods are being used to examine the output of a facsimile system. The effectiveness of this procedure is among the factors to be evaluated in the government's 60-day initial test of the system.

Letters Read by Flying Spot Scanner; Automatic Routing Also Provided

The system includes four facsimile transmission channels, each with a capacity of one page per 4 sec. Each channel is 240-kc wide. The video signal is developed by a flying spot scanner with a resolution of 100 lines per inch. Photographs, however, cannot be transmitted.

Letters for transmission by facsimile are typed on one side of the paper on the lower two-thirds of the page, folded into a "Z" and sealed along the edges. The address, typed on the upper third of the page, is on the outside of the folded page. At the transmitting station, letters are automatically unfolded, scanned, and deposited into a sealed container.

System Also Capable Of Routing Mail To Major Substations

The system can also automatically route mail to certain major substations near Washington and Chicago. Before transmission, the letters can be marked above the address with a bar

Beats Privacy Problem

code corresponding to the substation. This code is detected at the receiving end and automatically switches the rest of the letter to satellite printers at the substations. The Chicago terminal serves two satellite printers in the area and the Washington terminal includes three satellite printers. These printers are in addition to the four regular printers at the main terminal in Washington and three printers at the Chicago terminal. The Washington terminal is equipped with four transmitters and the Chicago terminal with three. The Battle Creek station, added to the system only recently, includes one transmitter and one receiver. Message routing from Washington to Chicago or Battle Creek and return is automatic. If necessary, however, a manual patch will connect Chicago to Battle Creek.

The receivers employ a flying spot scanner which sensitizes a xerographic printer. After printing, the letters are Z-folded, sealed, and inserted into window envelopes for delivery. Each envelope will include a card to be returned by the recipient advising the Post Office as to the quality of the facsimile. Letters only partially received due to interrupted transmission are removed from the main flow and destroyed. Letters at the transmitter are also to be eventually destroyed.

System Limited to Government Mail Until Legal Problems Are Solved

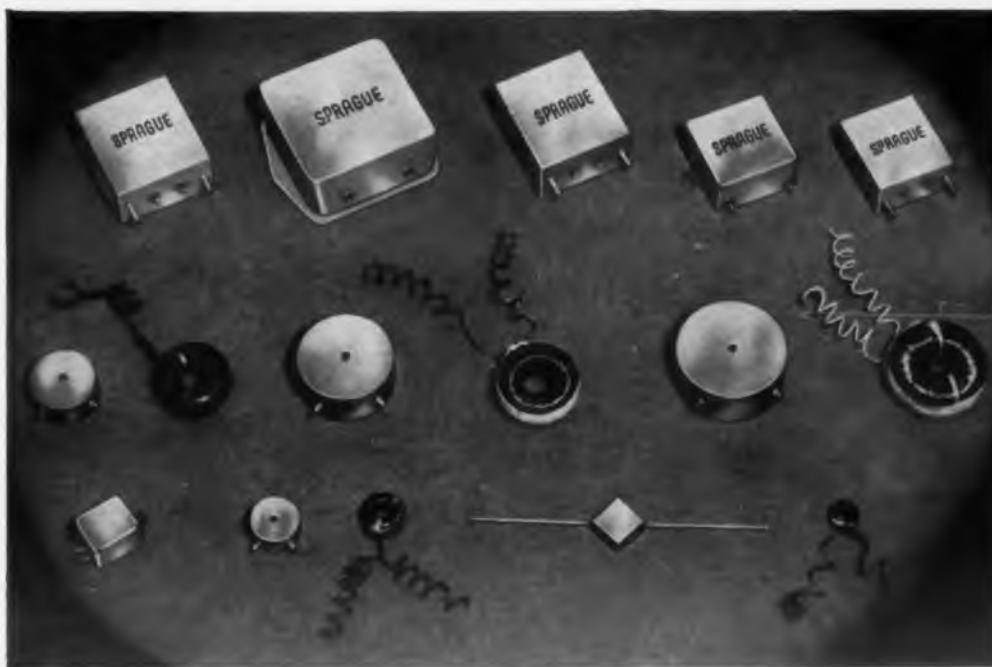
Present tests are being limited to government mail and such traffic will not be heavy enough to pay for the system. However, the necessary control of format and contents (no enclosures, photographs, paper clips, etc.) can be more effectively controlled in this manner. Also, the eventual destruction of letters after transmittal raises still unresolved legal problems.

Cost of the Speed-Mail installation is approximately \$3.2 million. Various aspects of the system have been in development for several years, but actual go-ahead for the test installation was granted only last February.

Major subcontractors for the system include:

- Stromberg-Carlson—Flying spot scanners.
- Haloid—Xerographic printers.
- Pitney-Bowes—Paper-handling equipment.
- ITT Laboratories—Distribution amplifiers and monitoring and control equipment.
- American Telephone and Telegraph Co.—Transmission lines and multiplexing equipment. ■ ■

Breadth of Sprague's Line of Precision Toroidal Inductors Offers Standard Units for Practically Every Application



DESIGNED FOR USE in commercial, industrial, and military apparatus, Sprague Precision Toroidal Inductors are customarily supplied to the close inductance tolerance of $\pm 1\%$. The broad line of Sprague Precision Toroidal Inductors includes such styles as open coil, plastic-dipped, rigid encapsulated inductors with tapped or through-hole mounting, and hermetically-sealed inductors.

All styles, with the exception of the open coil type construction, meet the appropriate requirements of Military Specification MIL-T-27A.

Sprague Precision Inductors are manufactured in modern plants which are equipped with the most up-to-date facilities for winding, processing, and testing the cores. Production instruments used in the manufacture of Sprague inductors are calibrated periodically to assure desired levels of accuracy. Quality control and inspection departments, which function independently of each other, maintain close surveillance over all production operations.

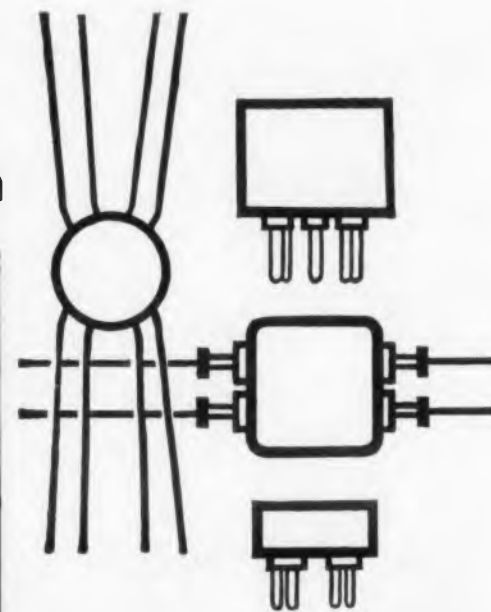
Several core permeabilities may be obtained in each of the five basic sizes of Sprague inductors to give the circuit designer the optimum selection of desired Q and current carrying abilities. Further, each of the core sizes is available with sev-

eral degrees of stabilization. Inductors made with cores which have not been subjected to the stabilization process exhibit low inductance drift with time and have a low temperature coefficient of inductance. Where a greater degree of permanence of characteristics is required, cores with two different stabilization treatments can be used for most types of inductors.

All standard inductors by Sprague may be operated over the temperature range of -55 C to $+125\text{ C}$. Temperature cycling of finished inductors is a standard production procedure in order to equalize internal stresses and insure permanence of electrical characteristics.

In those cases where the extensive line of Sprague standard inductors is unsuitable for a particular application, the Special Products Division of the Sprague Electric Company will be glad to work with you to custom-tailor designs to meet specific customer requirements.

For detailed information on standard ratings, package sizes, Q, current carrying abilities, properties, etc., write on company letterhead for portfolio of engineering data sheets on precision toroidal inductors to Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.



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Standard or special... military or commercial... in any size or shape... Sprague Pulse Transformers are designed to give top performance... in high-speed computer circuits, pulse inversion circuits, impedance matching circuits, blocking oscillator circuits, and many others.

Special designs for high acceleration, high ambient temperatures or minified circuits can be furnished to suit requirements. Units are also available in lower-cost commercial housings.

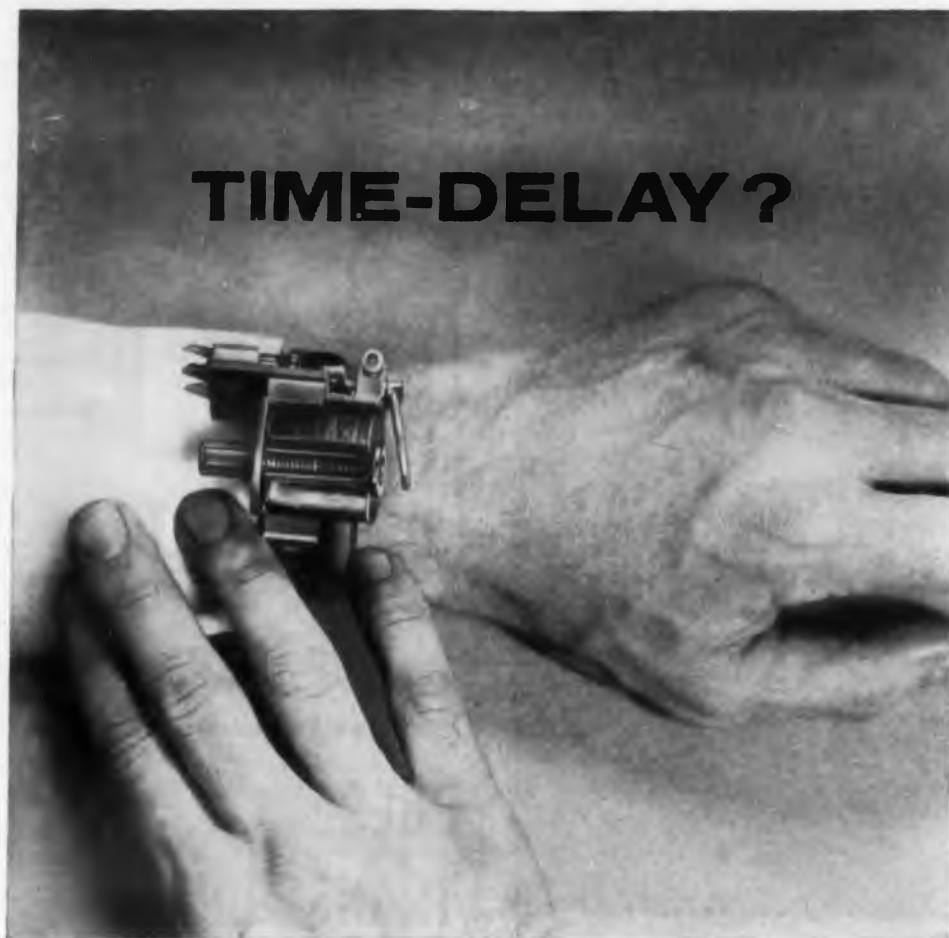
For engineering assistance on your pulse transformer problems, write to Special Products Division, Sprague Electric Company, Union St., North Adams, Mass.

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TIME-DELAY?



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HEINEMANN ELECTRIC COMPANY

156 PLUM STREET

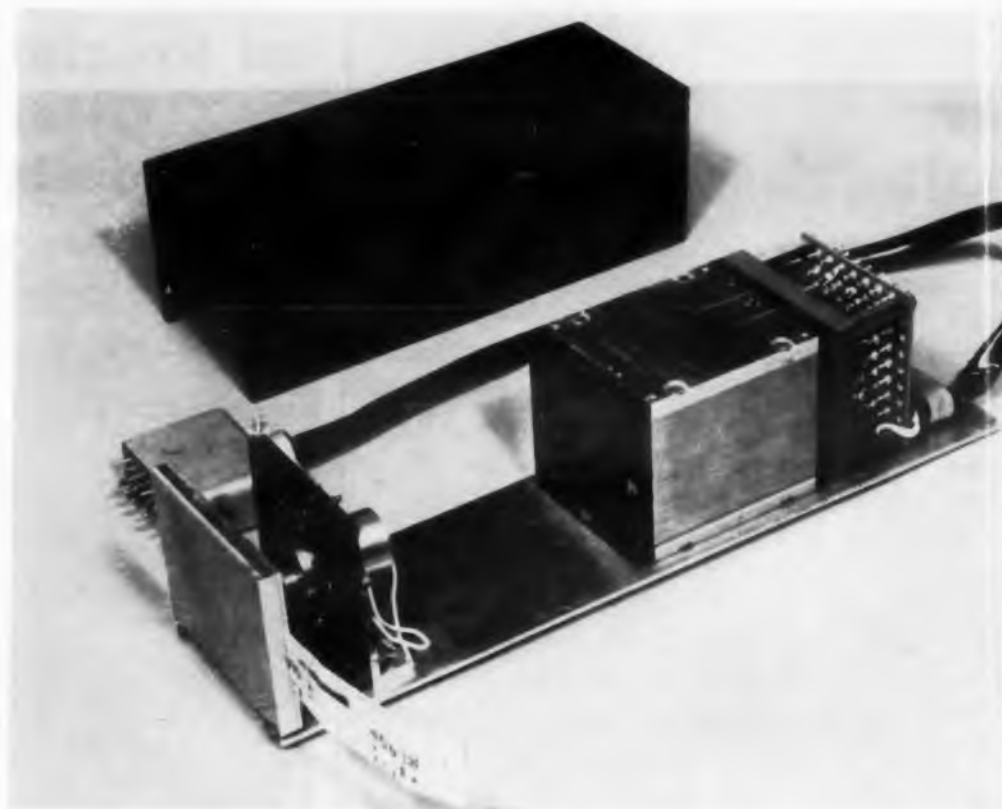


TRENTON 2, NEW JERSEY

2175

CIRCLE 12 ON READER-SERVICE CARD

NEWS



Laboratory model of lenticular character reader. Lenticular array and mask are the small square near center held in place by insulating tape.

Lenticular Reader Promises Low Cost

*Decisions Take Place in Reading Head;
Basic-System Cost Could Be Under \$1,000*

A NEW, extremely simple character-recognition technique employing lenticular optics is in advanced development at Briggs Associates, Inc., Norristown, Pa. Company officials claim that a basic system could be marketed for less than \$1,000. Company spokesmen said they were discussing licensing with several "major concerns."

The reader consists of a dot-patterned masking screen, a lenticular array (such as used in the novelty rulers that flash decimal and fraction conversions when viewed from different angles) and a photocell array. The lenticular array (composed of small, square, plastic lenses) is placed immediately behind the masking screen so that each square in the array sees a corresponding square area of the screen. The optical properties of the lenticular array are such that all points having the same relative position in every square of the masking screen are projected upon a single point at the photocell array. For example, all the lower left-hand corners behind each lenticular element are projected to the upper right-hand corner of the array.

Each square of the screen is then di-

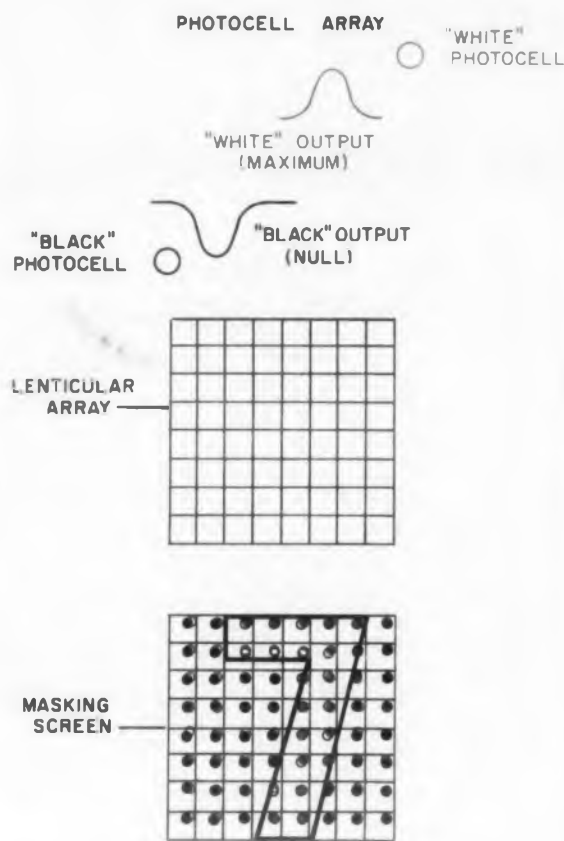
vided into many small points with a corresponding photocell for each set of points (e.g., all lower left-hand corners) is assigned as the mask area for a particular character. If that character is then projected onto the screen, a number of points in that set are covered by the image of the character while other points of the set remain uncovered.

The character can be recognized by a null criterion as follows. The masking screen is prepared so that the points (in the given set of points) covered by the character are left transparent; points not covered by the character are made opaque. A perfect match for the character thus gives minimum output at the photocell serving that set of points.

Conversely, a second set of points located elsewhere within the squares (and a corresponding photocell) are assigned to recognize the configuration of the white area surrounding the character. Here, the detection criterion is maximum photocell output.

Small Masking Screen Required For Complete Alphanumeric Font

Since only two points per square are needed for each character, a complete



Recognition of "7" by lenticular reader. Upper right-hand corners of each square on mask match the black elements of the number; lower left-hand corners match the white part of the number. Lenticular optics project these corners to the corresponding photocells. When the "7" is matched, the "Black" photocell has minimum output, and the "White" photocell (shown in red) maximum output. Other letters would be detected in similar fashion using other areas of the screen and additional photocells.

alphanumeric font could be readily accommodated within a very small masking screen. The screen consists of film and is essentially prepared by photographing the characters through the lenticular array.

The low price of the reader is due to the comparatively low manufacturing tolerances required. "The lenticular optics are very forgiving of error," Laurence Brown, the inventor of the system, told **ELECTRONIC DESIGN**

The optics also simplify the problem of character misalignment. "We could nutate the mask and optics by an open or closed-loop servo until we obtained a match," Mr. Brown said.

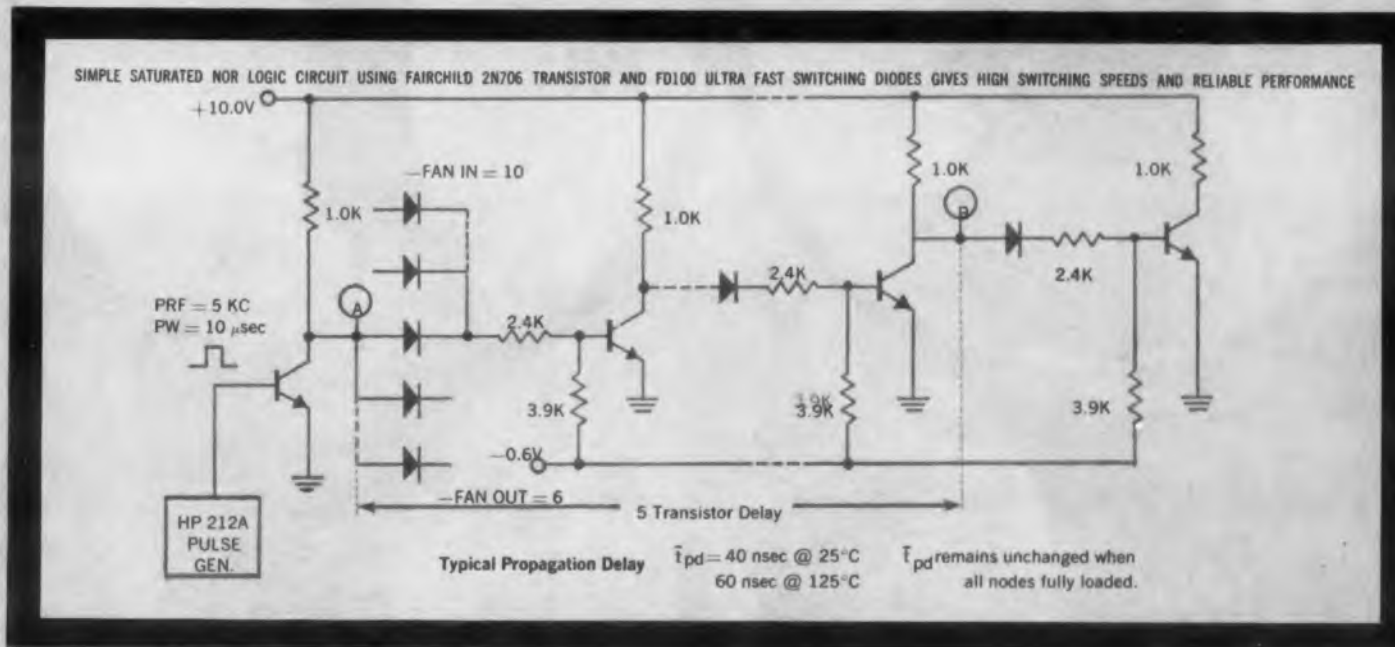
The company is reluctant to divulge accuracy and reject rates as only laboratory models have been tested to date. However, Mr. Brown indicated that he does not foresee any serious problems in this area. ■ ■



NEW RELIABILITY IN COMPUTER LOGIC CIRCUITRY

WITH FAIRCHILD CONTROLLED LIFETIME TRANSISTORS AND DIODES

These Fairchild transistors and diodes permit the design of simple, reliable computer logic circuitry through elimination of circuit clamps and speed-up capacitors. Also, transistor power dissipation is reduced. Even in this simple circuit, these Fairchild diodes and transistors — because of their controlled lifetime characteristics — permit switching speeds of 40 microsecond delays per logic function. The transistors have low controlled storage time under severe overdrive conditions. The diodes have fast decay time at very low reverse current conditions. Stability over the full silicon temperature range of -55°C to $+125^{\circ}\text{C}$ provides high fan-out and very high fan-in capability.



RATINGS AND CHARACTERISTICS (25°C) — 2N706 NPN DIFFUSED SILICON TRANSISTOR

SYMBOL	CHARACTERISTICS	RATING	MIN.	TYP.	MAX.	TEST CONDITIONS
V_{CB0}	Collector to base voltage	25 v				
V_{EB0}	Emitter to base voltage	3 v				
	Total dissipation, 100°C free air ambient	150 mw				
h_{FE}	D.C. pulse current gain	20				$I_C = 10\text{ mA}$ $V_C = 10\text{ v}$
$V_{BE(SAT)}$	Base saturation voltage		0.3	0.6		$I_C = 10\text{ mA}$ $I_B = 1\text{ mA}$
$V_{CE(SAT)}$	Collector saturation voltage		0.3	0.6		$I_C = 10\text{ mA}$ $I_B = 1\text{ mA}$
h_{fe}	Small signal current gain at $f = 100\text{ mc}$	4				$I_C = 10\text{ mA}$ $V_C = 10\text{ v}$
C_{ob}	Collector capacitance (140kc)	3.5 pf	6 pf			$I_E = 0\text{ mA}$ $V_C = 10\text{ v}$

SPECIFICATIONS — FAIRCHILD FD100 — 25°C Except As Noted

SYMBOL	CHARACTERISTICS	MIN.	MAX.	CONDITIONS
BV	Breakdown Voltage	75 volts		@ $I_R = 5\text{ }\mu\text{A}$
I_R	Reverse Current		.100 μA	@ $V_R = 50\text{ v}$, 25°C
V_F	Forward Voltage Drop	1 v		@ $I_F = 10\text{ mA}$
C	Capacitance	2 μf		@ $V_R = 0\text{ v}$
t_{rr}	Reverse Recovery Time To $I_r = 1\text{ mA}$	4 μs		@ $I_F = I_r = 10\text{ mA}$
	Maximum Power Dissipation		250 mw.	
	Temp. Range Operating	-65°C	175°C	
	Storage	-65°C	200°C	

Write for full information on this circuit and complete specifications on the transistor and diode.

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of Fairchild Camera and Instrument Corporation



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CIRCLE 13 ON READER-SERVICE CARD

PRECISION FILM RESISTORS

if it's news, expect it first from IRC



**Most moisture-resistant coat ever achieved...
withstands 30 cycles of MIL moisture!**

IRC precision film resistors with M Coat take 30 cycles of moisture, 300% of the MIL-R-10509C Characteristic B requirement, tested in accordance with MIL standard 202.

M Coat adds greater protection for the resistance element, eliminates handling and assembly damage. Insulation resistance after 30 cycles of moisture is over 100 megohms.

Rating: $\frac{1}{2}$ watt at 70°C ambient. Standard tolerance: $\pm 1\%$. Range: 10 ohms to 2.49 megohms. Maximum continuous working voltage: 350.

Write for Bulletin AE-15, International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

*Trademark exclusive IRC moisture-proof coating



Leading supplier to manufacturers of electronic equipment

CIRCLE 14 ON READER-SERVICE CARD

NEWS

New Research Slated For

Studies by SWRI Investigators Show Possibilities of Molecular Solids

TWO SUGGESTED research programs for learning more about organic semiconductors and the mechanism of semiconduction have been proposed to, and reportedly scheduled for support by, a military agency. The programs, which are an outgrowth of reaction mechanism studies in organic materials conducted at Southwest Research Institute, San Antonio, Tex., have given SWRI investigators confidence in the ability of molecular solids, which are primarily organic in nature, to prove suitable as electronic materials.

Dr. George Pish, director of materials research at Southwest Research Institute, predicted in an interview that important advances will come in high-power semiconductors and that when the breakthrough material is found it may turn out to be an organic or organo-metallic compound.

Organic semiconductors, Dr. Pish believes, have characteristics that make their development very attractive. Some of these are:

- Potentially high-voltage, high-current handling capabilities.
- Organic polymers can be deposited in thin film layers relatively easily.
- Because the number of possible organic compounds exhibiting semiconduction is very large, materials for many applications may be possible.
- Synthesis and purification of organic and organo-metallics is easier and more predictable than for inorganic materials.

In the continuing research programs proposed by SWRI, both pyrolysis and ionizing radiation would be used to modify the materials under investigation. Pyrolyzing with heat is the method used by some organizations conducting similar research. Direct synthesis of promising compounds, the favored approach at Princeton University's Plastics Laboratory and at National Carbon, would not be tried at Southwest Research until charge transfer mechanisms have been charted in certain organic structures as a basis for the synthesis of new compounds having improved semiconductor possibilities.

Direct Synthesis, Heat Pyrolyzing, Used in 70 Compounds

At Princeton, Dr. H. A. Pohl, of the Plastic Laboratory, reports that about 70 semiconductor polymer compounds have been made, approximately 45 of these by direct synthesis, the rest

Organic Semiconductors

by heat pyrolyzing. Energy gaps of 1.5 electron volts and very low resistances have been achieved, Dr. Pohl says. But in most respects, the organic semiconductors produced at Princeton do not so far come close to matching the performances of traditional electronic semiconducting materials. Carrier mobility in particular, is disappointing, Dr. Pohl reports. Carrier mobility values of about 0.1 to 100 cm² per v-sec achieved with several polymers are about one thousandth those of inorganics like germanium.

Pyrolyzed polymers, however, can be made with positive, zero, or negative temperature coefficients or resistance because of the way conductance and valence bands can be overlapped. But, because electron population is so high, in organic semiconducting materials, Dr. Pohl says, even room temperatures swamp and degenerate the carrier. This is said to be the main reason organics have not yet convinced many researchers that they are promising materials for transistors and rectifiers.

However, says Dr. Pohl, because the possibilities of semiconduction and of the organic semiconductors have barely been tapped, organic polymers may prove useful for such non-transistor applications as photo cells and solar-cell electrodes.

Possible Use Is Seen In De-Salting Sea Water

In addition, some organic semiconducting compounds have recently been shown to be absorbing, indicating that these materials might be useful in de-salting sea water. They could be made to absorb ions in a cyclical de-salting operation.

At Princeton, pyrolyzing is accomplished in a special oven at temperatures of 800, 1,000 and 1,200 C in an inert-gas atmosphere.

At National Carbon "a small number of compounds" have been made by direct synthesis, reports J. C. Bowman, director of research, who feels that at least a long time will pass before the organic semiconductors escape their temperature limitations. Researchers at National Carbon, which is a subsidiary of Union Carbide Corp., do not foresee organics with higher carrier mobilities than those found so far. All research at the company has been conducted on crystalline polymers, which company investigators have tried to grow with as great a purity and with as little scattering as possible, Mr. Bowman reports. ■ ■

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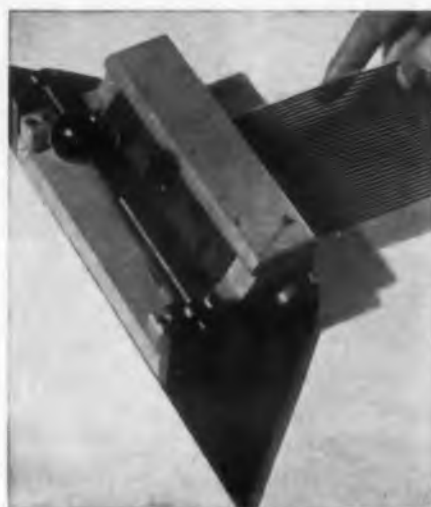
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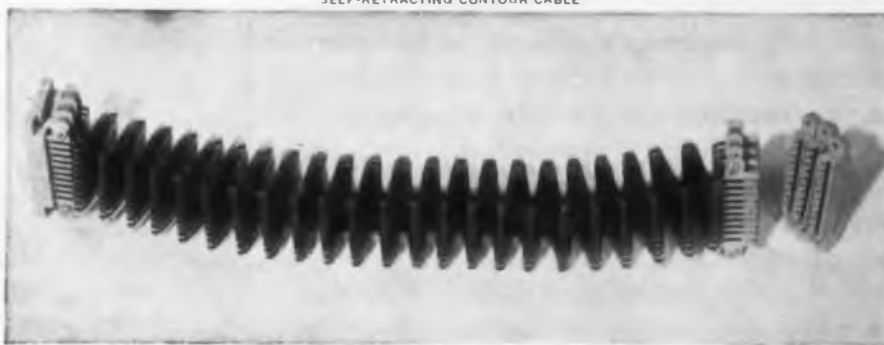
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NEWS

High Thermoelectric Figure of Merit Possible for Gadolinium Selenide

An experimental material, gadolinium selenide, shows possibilities of giving higher performance at higher temperatures than thermo-electric materials now known. The figure of merit for gadolinium selenide has approached 5×10^{-2} .

The figure of merit is Z at 800 C in the equation

$$Z = \frac{S^2}{\rho k}$$

when S is the Seebeck coefficient in mv/C, ρ is electrical sensitivity in ohms-cm, and k is thermal conductivity in w/cm/C.

Studies are under way for further development and evaluation. The material and its thermoelectric properties were first described at a recent meeting of the American Rocket Society by Dr. Eugene V. Kleber, general manager of the Research Chemicals Div. of Nuclear Corp. of America, Burbank, Calif. He is in charge of development under a contract from the Navy's Bureau of Ships.

One possible application, according to experts, is in the direct conversion of heat to electricity at very high temperatures.

Dr. Baker, Electronics Pioneer, Dies at 67 After Brief Illness

The annual Radio Fall Meeting in Syracuse this year was saddened by the death of Dr. W. R. G. Baker, 67, radio and television pioneering. Last Monday, as the meeting was about to get under way, the news came of Dr. Baker's unexpected death.

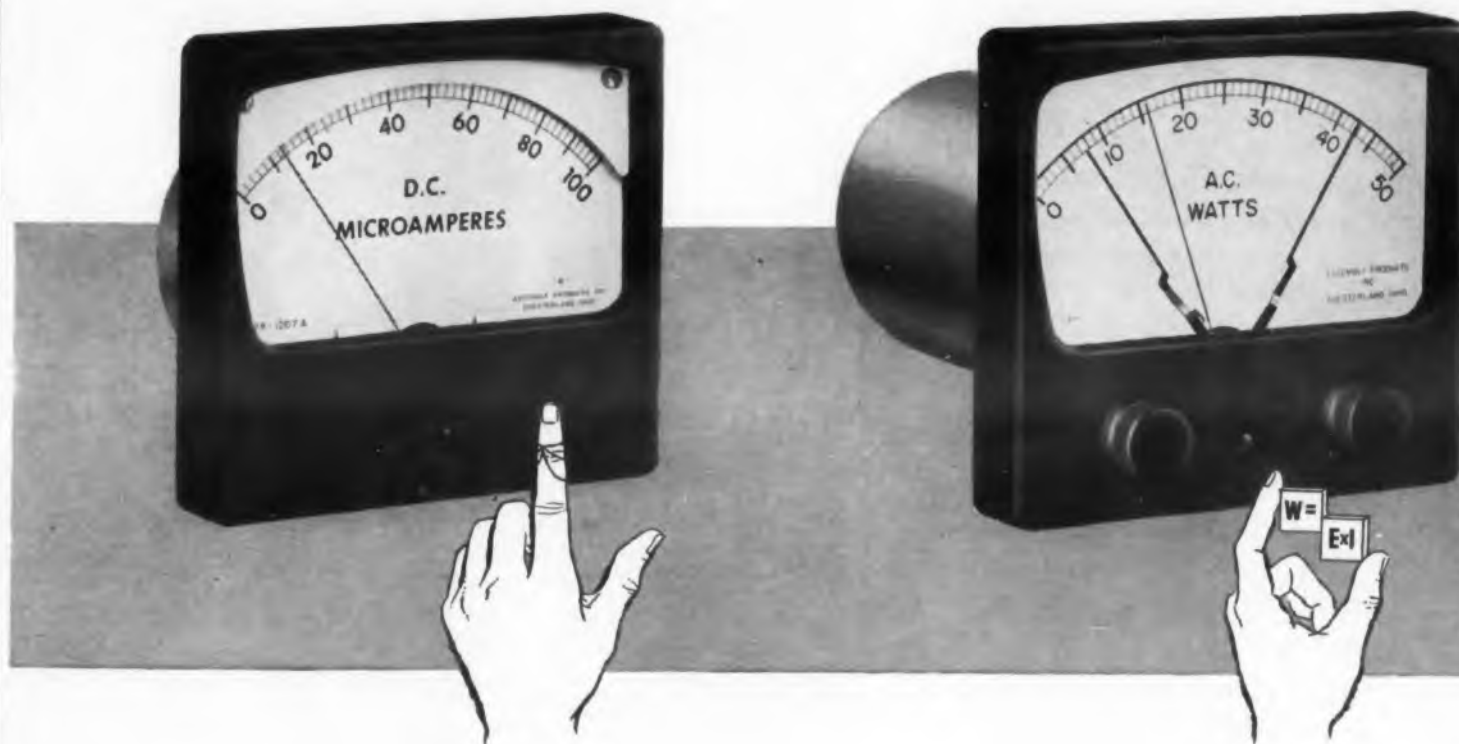
For his outstanding efforts in the design and development of complex communications equipment, Dr. Baker was awarded high honors by both the Army and Navy.

Dr. Baker joined General Electric's research laboratories in 1917 and became head of radio development, design, and production in 1926. In 1929, he moved from GE to Radio Corp. of America and shortly became general manager and vice president. In 1936, he returned to GE and five years later was named vice president.

During Dr. Baker's chairmanship of the National Television Systems Committee, the standards for monochrome and color TV were prepared. He also served as president of EIA and was EIA's first director of engineering.

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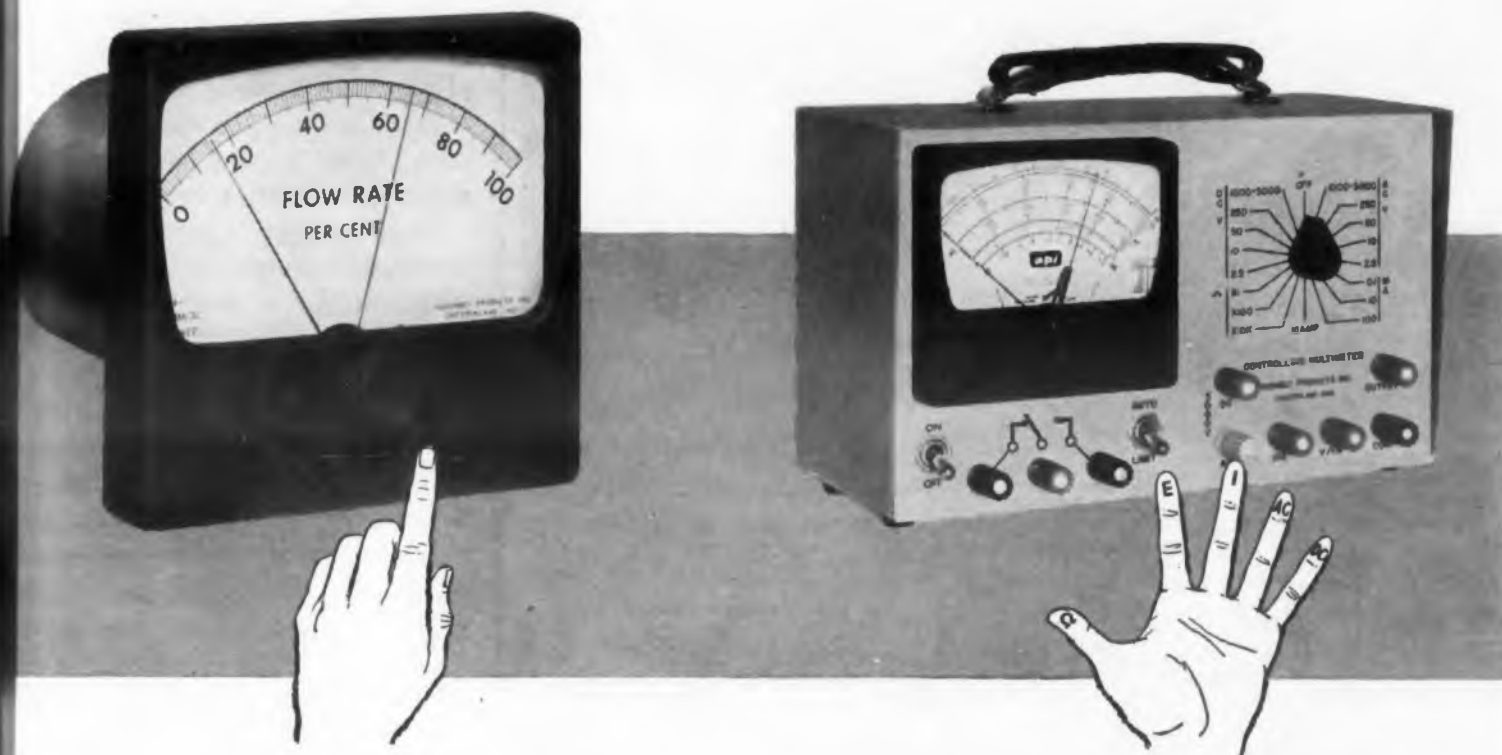
A METER WITH A MEMORY. Retains a reading on command, holds it until intentionally "erased." Especially useful where simultaneous readings must be taken from a number of meters at a critical instant. Solenoid-actuated memory element, an integral part of the meter package, can be manually or automatically controlled from a remote or local source through conventional devices. Meter can be supplied to measure any AC or DC current or voltage, from microamp and millivolt ranges on up. *Request Data Sheet 11 for more information.*

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Maximum-reading meter shows highest level attained by a varying current or voltage signal. Unit consists of a modified meter-relay movement with two indicating pointers. Upscale pointer operates only in response to signal-indicating pointer, is designed to remain "fixed" at the last maximum reading until manually reset or moved further upscale by signal increase. Meter, which is based on D'Arsonval principle, is available in all API standard AC and DC current and voltage ranges; can also be furnished as minimum-reading meter. Request Data Sheet 21 for more information.

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Continuous-reading meter-relay instrument monitors and controls resistance, AC/DC current and voltage in all conventional multi-meter ranges. Meter-relay's adjustable set-point has toggle contact that gives control action on both rising and falling signals, with no interruption of signal indication. Unit has built-in load relay with 5-amp contacts, can be used to provide alarm signalling, or to control motor-driven auto-transformers, servo motors, timers and other devices. Request Data Sheet 19 for more information.



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CIRCLE 16 ON READER-SERVICE CARD

1960 Electron Devices Meeting Hears Papers on Epitaxial Process

At last year's Electron Devices Meeting in Washington, eager audiences gave undivided attention to speakers outlining the fabrication of a new semiconductor marvel—the tunnel diode. Last week, another development, the epitaxial transistor, held the audience's attention at the 1960 meeting.

Representatives of major manufacturers who are sampling, or ready to sample, epitaxial transistors detailed the processing steps involved in the preparation of a thin layer on a semiconductor substrate. The problem of obtaining single-crystal growth involves such factors as substrate surface preparation, substrate temperatures, and the tetrachlorides used, speakers told the meeting.

Motorola, which was one of the first companies to recognize epitaxial transistors, already sampling silicon units, will soon make available a 2N828, an epitaxial version of the 2N705, according to George Russell of the company's Phoenix Div.

In another paper at the meeting, Dr. Wayne Nottingham of the Massachusetts Institute of Technology stressed the necessity for a shift in emphasis in thermionic research. Rather than pour additional funds into thermionic device development, he said, emphasis should be placed on basic research devoted to low work-function materials, plasma characteristics, and techniques for overcoming space-charge effects. After these problems are beaten, he said, device development will achieve performance figures which can make thermionic devices competitive with conventional power sources.

U.S.-Made Replacement Transistors Available for Japanese Radios

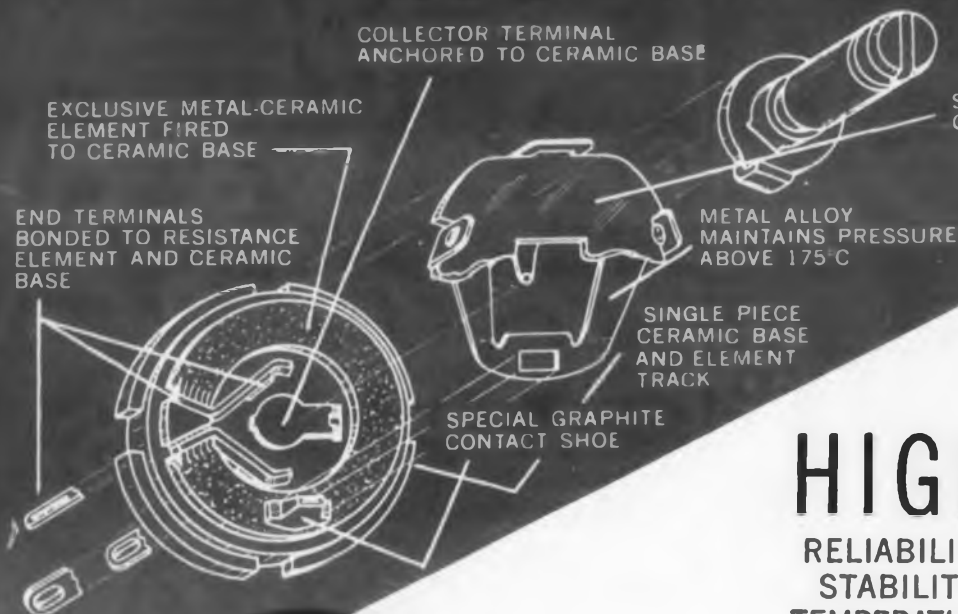
A line of more than 100 U.S.-made replacement transistors for Japanese radios has been announced by Electronic Transistors Corp. of North Bergen, N.J.

The company collected complete interchangeability specifications before announcing production of the transistors, according to its president, Albert Osborne. He said that his company's development of the line required a new set of specifications after analysis and arrangement of the Japanese data.

"This will be the first time," Mr. Osborne said, "that a complete line of U.S.-made transistors, interchangeable with Japanese transistors, will be available to radio service technicians in this country."

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New Series 600 Characteristics:

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- 1/2" diameter; interchangeable with Style RV6 MIL-R-94B.
- Power ratings: 1/4 watt @ 85°C, 1/2 watt @ 125°C, zero load @ 175°C.

CeraTrois' rugged, hard-surfaced metal-ceramic element, having been fired at temperatures exceeding 600°C, meets temperatures up to 500°C with high safety factors at ratings listed below.



COMPARATIVE TEST DATA: No carbonaceous variable resistors (either film or molded) can equal Series 600 performance. Ideal for critical applications requiring high stability and reliability. Far exceeds MIL-R-94B.

Tests	MIL-R-94B (Style RV6, Char. Y) Requirement	Series 600 CTS Maximum	Series 600 CTS Average
Load life 1000 hrs			
1/2 watt @ 125°C, 350 V max.	±10% @ 70°C	±7% @ 125°C	±4% @ 125°C
1/4 watt @ 85°C			
Thermal Stability (1000 hrs. @ 175°C no load)	No test in MIL-R-94B	±5%	±3%
Temperature Co-eff.* (Room to -63°C; room to +175°C)	No test in MIL-R-94B		
25K and over		±250 PPM/°C	±150 PPM/°C
under 25K		±500 PPM/°C	±300 PPM/°C
Moisture Resistance	±5% avg. ±10% max.	±2% avg. ±4% max.	±1.3%
Low Temp. Storage	±2%	±1%	±.5%
Low Temp. Operation	±3%	±2%	±1%
Thermal Cycling	±6%	±3%	±2%
Voltage Co-efficient	No test in MIL-R-94B	±.01%/volt	±.005%/volt
Rotational Life	±10% (after 25,000 cycles)	±10%	±7.5%
Acceleration	±3%	±2%	±1%
High Freq. Vibration	±2%	±2%	±1%
Shock	±2%	±2%	±1%

* Lower temperature coefficient can be developed for specific applications.

Note Exceptional Stability. Note extent that MIL-R-94B is exceeded.

Complete Series 600 CeraTrois electrical and mechanical specs and dimensional drawings will be sent upon request.

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NEWS

Micromin Positioning

Relations Seen Changed Between Makers, Buyers

AS COMPLETELY assembled integrated circuits and molecular building blocks become available in production quantities, the present-day relationship between component supplier and his customer, the equipment manufacturer, faces a drastic revision.

Since microelectronic devices offer complete circuits in a single structure, much of the equipment maker's "contributed value" is lost, claimed Arthur P. Stern, of General Electric's Electronics Laboratory in Syracuse, N.Y., at the National Electronics Conference in Chicago. Should the equipment builder decide to fabricate his own micro-assemblies, the component maker faces a serious loss of business.

Major Policy Decision Seen Within Decade

Thus, in perhaps five to ten years, each will be forced into a major policy decision, according to Mr. Stern. Component suppliers who decide to fabricate and market integrated devices must invest in additional technology and facilities, Mr. Stern stated. Shall "standard" or "custom-made" devices be offered? By fabricating a fixed line of "standard" circuits, the component maker can keep cost at a relatively low level but faces the designer's reluctance to use someone else's ideas, he said. Making "custom-built" devices, at lower production runs, tends to be expensive and thus makes the product less attractive, he added.

Equipment manufacturers entering the integrated-circuit field, Mr. Stern concluded, must likewise expand their facilities and must be assured that their equipment needs can pay for the costs involved. Their microelectronics output will be geared to their equipment with

Business Threat

little, if any, likelihood of sales to competitive equipment concerns.

In addition to size and weight reduction offered by microminiaturization, other factors of key importance must be evaluated by the design engineer, pointed out D. A. McLean of Bell Labs, Murray Hill, N.J. His standards:

Will it work?—The components and connection schemes must be reliable.

Is it small enough?—Objectives must be balanced. Small size can be achieved relatively easily if reliability and cost are overlooked.

How much is it?—In the long run, Mr. McLean believes that the cost factor may be most important to be weighed in deciding what techniques will predominate.

Tantalum Microcircuitry Is One Approach by Bell

Tantalum microcircuitry, starting with the formation of a tantalum pattern on an inorganic substrate, represents one microminimization approach by Bell. The pattern created contains subpatterns for resistors, capacitors, and conductors. Deposition has been performed using sputtering and electron bombardment.

"Thin Circuits" represent GE's present approach to microminiaturization as outlined by J. M. Blank, I. A. Lesk, and J. J. Suran. Active elements are separately packaged in thin, miniature enclosures and then soldered, bonded or welded to a thin wafer containing passive elements, some deposited and others fabricated as discrete components. Although packing density does not approach that of more "exotic" approaches, such advances as the use of high-reliability components, versatility in assembly and current availability make the scheme attractive to design engineers seeking answers to near-future equipment needs. ■ ■

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NEWS

Pattern Recognition Usage

Brooklyn Study Spots Short-Wave From Different Parts of the World

PATTERN recognition is being used to distinguish between signals from different parts of the world in a study program at the Polytechnic Institute of Brooklyn.

Two 15-mc short-wave signals, one from London and the other from Lisbon, have been used by Prof. Arthur Laemmel in the pattern recognition experiments at Brooklyn Poly's Microwave Research Institute. An IBM 650 computer correctly identified the signals in seven out of 10 trials using the initial recognition method developed. The three failures were predictable, according to Mr. Laemmel, because of known ionospheric disturbances occurring at the time the signals were received.

Quantized information about signal strength variations were used in making the computer identifications. Many plots of carrier strength versus time were made for each signal on a pen recorder. Divisions were marked at the maximum signal strength point, and at the $\frac{3}{4}$, $\frac{1}{2}$ and $\frac{1}{4}$ signal strength levels. The curves were then quantized using the numbers of times curves crossed each level, and measuring the time spent between levels. Averages were obtained for the London and Lisbon stations and this information was used in programming the computer to make identifications.

Contract for Signal Study Originated With U.S. Air Force

Mr. Laemmel is continuing the study, being done under contract from the Air Force Cambridge Research Center, by adding more parameters to the identification process. Data on ionospheric conditions, possibly obtained through monitoring WWV, might be used. Further information obtainable from the curves, such as the number of relative minima over some period or patterns of increasing and decreasing maxima and minima, will also be investigated, according to Mr. Laemmel.

Eventually, Mr. Laemmel hopes to be able to have the machine derive the best parameters for making good identifications.

It is too early to predict whether these studies might allow some interpolation between stations of a given frequency to locate another station at this frequency geographically, Mr. Laemmel said. He also pointed out that it is not yet definitely established that geographic differences are ac-

Use to Distinguish Signals

usually the characteristic permitting machine identification. Antenna differences or some unknown factor might actually be involved, with the result that further studies are necessary in order to validate the concept.

Eventually, as the study continues, it may be possible to digitalize the signals to be identified with A-to-D convertes, so that direct computer input can be used. ■ ■

Units Meet 150-Hr MTBF Specs; Equipment Contains 5,600 Parts

Air-navigation equipment containing about 5,600 parts but meeting an AGREE test requirement of 150 Mean Time Between Failure is now being delivered to the Air Force. The TACAN ARN-21C sets are being produced by Hoffman Electronics Corp., Los Angeles, under a \$46 million contract. Earlier TACAN sets were built to a reliability requirement of only 17.5 hr MTBF.

The equipment, first to meet the AGREE reliability specification, was developed by Hoffman under a two-year program. The rigid test program was developed by the Defense Department's Special Advisory Group on Reliability of Electronic Equipment. The TACAN units were temperature cycled between -65 and $+135$ F during a 19-day test in environmental chambers as one part of the evaluation procedure.

Hoffman estimates that the new airborne TACAN units will cost the Air Force only 15 per cent what the previous ones did for maintenance over the life of the sets.



Airborne TACAN units containing 5,600 parts and meeting a 150 hr MTBF AGREE requirement are being delivered to the Air Force by Hoffman Electronics Corp. under a \$46 million contract.

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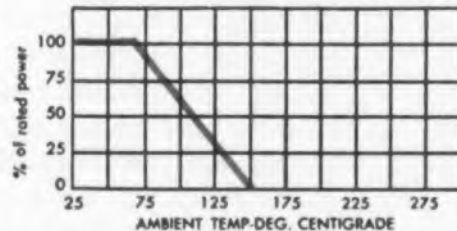
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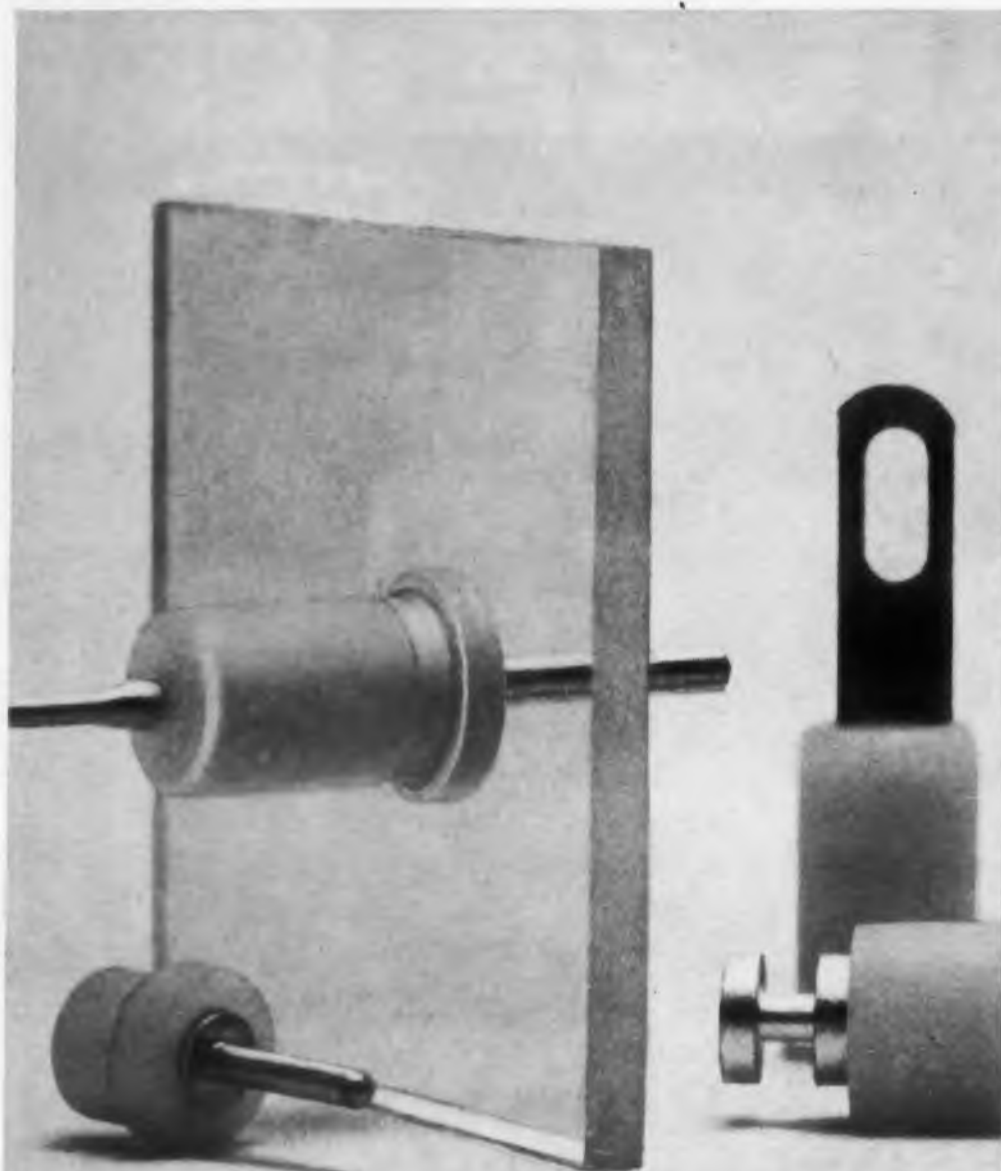
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CIRCLE 21 ON READER-SERVICE CARD

WASHINGTON REPORT



Ephraim Kahn

QUESTIONS OF COST-CUTTING are paramount in the minds of defense planners. Prime areas for reduction of expenses lie in design and in more efficient management. But the military chiefs are not prepared to make compromises in quality in order to achieve dollar savings. The political situation accounts only in part for the heightened stress on cost.

THERE ARE CROSS-CURRENTS, of course, in defense budgeting. Right now, especially, the military is aware that a change in defense spending policies is coming early next year. For this reason, among others, it has ordered a number of different budgets prepared. They range from an unlikely cut of 5 per cent under fiscal 1961's budget to a wishful \$48 billion—which would provide full funding for just about all the projects and programs the military would like. Even the "blue sky" budget presupposes continuing efforts to use money more efficiently.

NEW BUDGET AMOUNT for fiscal 1962 is expected to be at least 5 per cent over the current year. The Chairman of the House Defense Appropriations Subcommittee, Texas Democrat George Mahon, has said he expects a rise of \$1 billion to \$2 billion in defense costs. At the upper limit, this meets the percentage of increase contemplated in one of the alternative defense budgets now being drawn up. Note, however, that there are going to be some technical changes in the statement of the fiscal 1962 budget. A new set of figures—"new obligational availability"—will set forth the sum of carryover funds plus the amount of new obligational authority requested. This will, of course, be a better guide to the actual amounts that will be in the hands of the military for spending. But this will also make proposed increases look a bit larger than they actually are. For example, a hike of 5 per cent over current funds, stated on this basis, would come to about \$45 billion. Actual spending, however, would be lower—about \$43 billion.

HEIGHTENED COST-CONSCIOUSNESS is seen in other areas. The military is smarting under the Congressional tendency to require extensive justifications for all projects along with assurances that efficient purchasing techniques are being employed—and then getting slapped with an across-the-board percentage reduction in procurement funds just in case anything slipped by the Congressional watchdogs. Citing the fiscal 1960 reduction of one-half of 1 per cent and the fiscal 1961 slash of 3 per cent, the head of the Air Materiel Command, General Anderson, noted

that there is "a three-year history of failure" in Air Force relations with Congress. A major problem is the Congressional approach. After the General Accounting Office pointed out a handful of specific cases, the whole military establishment was, in effect, penalized.

CONCRETE RESULTS of this concern are found not only in the Air Force but in other Services. The Navy, for example, is extending to other major programs the computerized Program Evaluation and Review Technique (PERT) that it used in scheduling the Polaris program. The PERT system, when fed data on progress, predicts the sequence of future steps forward. On a technical level, the Navy plans to save money by "more discriminating purchases of drawings" and other technical data. Cecil P. Milne, Assistant Secretary of the Navy (Materiel) wants industry "forcibly" to bring to the attention of appropriate responsible officers any design requirements which seem unnecessary. Milne put it this way: "If we can cut the unit cost of an airplane or a radio or a missile by 20 per cent, we can increase the number we can purchase by 25 per cent." The Navy also plans to cut back drastically its own operation of "uneconomical supporting-type shops as soon as satisfactory arrangements can be made to procure their products and services from commercial sources," according to Rear Adm. R. K. James of the Bureau of Ships.

RELIABILITY IS BEING STRESSED, as well as economy, and the Air Force is trying to make the best of its opportunities. The Pentagon Air Force headquarters has given a green light to broader application of a reliability policy that was originally developed by the Air Materiel and Air Research and Development Commands. In the process, it toughened the policy considerably, making reliability a key factor in contracting. Heretofore, contractors have been allowed "a maximum degree of freedom" in reliability monitoring. From now on, "if contract reliability requirements are not met, or if the contractor's reliability effort is decreased the decision to accept or reject the end item or the revised reliability program will be considered with a view toward monetary penalties, unit price decreases, or other considerations deemed equitable."

UNDERLYING THIS TOUGH POLICY are several years of studies and recommendations concerning the reliability of electronics items. These studies pointed up the importance of achieving a high degree of reliability early in the game—preferably during the earliest system studies and certainly while equipment is being designed. Object is to solve, as soon as possible, the problem that often arises when designs are ready to be put into production. It sometimes—possibly more often than would be cheerfully admitted—then appears that the reliability designed into a system is too costly. At this point, a balance must be struck between cost and reliability. The Air Materiel Command is now under instructions to "monitor reliability functions to minimize the degradation of established reliability programs" when systems are transferred to its executive management from the Air Research and Development Command.

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The design engineers at Victor's Electric-Car Division sought a way of making their Dyna-Powered Maintenance Truck accelerate automatically and smoothly through the three forward speeds. The answer: Two G-V Red/Line Thermal Relays, each providing a two-second delay between steps. This assures smooth, even acceleration every time. A third Red/Line Relay shuts off the dynamic brake after a fixed time interval, conserving battery power. So, at Victor, G-V Red/Line Timing Relays are "paying off".



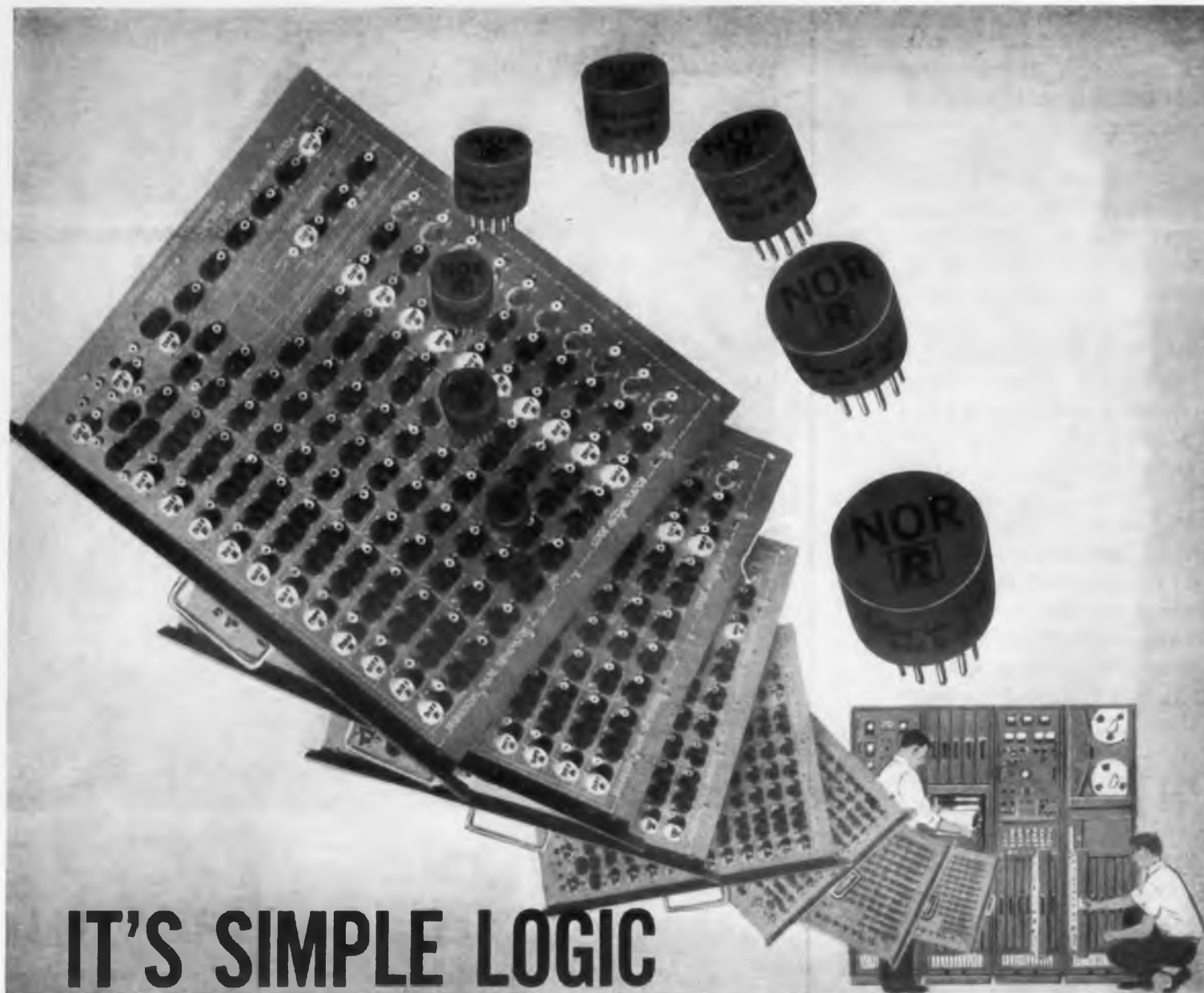
More and more companies are finding the reliable performance of G-V Red/Line Timing Relays makes them best for their products. G-V Red/Line Relays will "pay off" in your product, too. Your customers appreciate the importance of high quality, reliable components. G-V Red/Line Timing Relays are specially designed for industrial applications. They have the precision, reliability and long life needed to "pay off" in industrial use.

Your G-V distributor has them in stock now. Call him or write for Bulletin 131 today.



G-V CONTROLS INC.
Livingston, New Jersey

CIRCLE 22 ON READER-SERVICE CARD >



IT'S SIMPLE LOGIC

...to standardize digital systems...and simplify maintenance
with **RADILOGS**

"Radiologs" are small plug-in logic modules that make possible entire digital systems, using a repetition of as few as two basic circuits. Maintenance involves consideration of only two parameters, saturation and cut-off. Simple rearrangement of a group of "Radiologs" produces entirely new configurations of logic networks. Thus, many a costly system that has served its original purpose is saved from obsolescence. New systems can be designed for greater simplicity and versatility at lower cost.

Radiation developed and presently offers "Radiologs" in three circuit configurations: NOR, Differentiator and Power Driver. Each of these is available in three speed ranges: low, medium and high. Encapsulated and color-coded, they plug into standard 9-pin miniature tube sockets.

For technical information and prices, write to Radiation Inc., Dept. EL-9, Melbourne, Fla.

THE ELECTRONICS FIELD ALSO RELIES ON RADIATION FOR...

TDMS—Telegraph Distortion Monitoring System pin-points type and source of trouble on teletype, data processing and similar communications links without interrupting traffic. Ultra-compact TDMS can replace most test equipment now required for teletype maintenance and monitoring.

RADIPLEX—48-channel low-level multiplexer with broad data processing applications. Features rugged solid-state circuitry, almost unlimited programming flexibility, unique modular construction for compactness and exceptional ease of operation and maintenance.

TELEMETRY TRANSMITTER—Model 3115 is a ruggedized 215-260 MC unit with extremely linear FM output under the most severe environmental conditions. With its record of outstanding performance in many missile programs, Model 3115 is specified by leading missile manufacturers.



RADIATION
INCORPORATED

CIRCLE 23 ON READER-SERVICE CARD

NEWS

Seminar on Technical Writing To Be Offered by ED at NEREM

Four editors of ELECTRONIC DESIGN will conduct a morning seminar on better technical communications in conjunction with the Northeast Electronic and Engineering Meeting in Boston on Wednesday, Nov. 16.

The seminar, which will be held at 9 am in the Oval Room of the Sheraton-Plaza Hotel, will be aimed at improving technical writing of all kinds—articles, letters, reports.

The "Early Bird" session will feature brief talks from ELECTRONIC DESIGN editors on what particular reports should say, selection of material, and organization of that material. The editors will also be available for consultation with interested engineers on writing articles for ELECTRONIC DESIGN. No reservations are required for the meeting, which will last an hour.

Accuracy Is Our Policy . . .

In the July 20 issue, the positions of the pictures on pages 32 and 33 were reversed. The Bell Laboratories computer should have been shown on p 33 and the GE Perceptron should have been on p 32.

■ In the July 20 issue, p 70, Fig. 3, mention was made of noise and field intensity meters to cover 150 kc to 10,000 mc. Omitted from the caption is Empire Devices' NF-112 which covers the 1,000 to 10,000 mc range.

■ In the Signal Corps transistor listing shown on p 50 of the July 6 issue, Table I should refer to silicon types and Table II germanium devices. On Table II, in the 10,000 to 20,000 quantity column of pnp medium speed switching, 2N24 should read 2N428.

CHANGES IN PRICE AND AVAILABILITY

SOLID TANTALUM CAPACITORS will be reduced at an average of 8 per cent by Efcon, Inc. of Garden City, L.I., N.Y. The new price range for Efcon's STP capacitor will be 77 cents to \$11.28 each, compared to the old price range of 85 cents to \$11.88 each. STP's will be available in quantities up to 1,000 on a two-to-four-week delivery basis.

CIRCLE 910 ON CAREER INQUIRY FORM, PAGE 209

ELECTRONIC DESIGN • November 9, 1960

NASA and Grumman In Talks For Orbiting Space Observatory

A \$23 million contract for an orbiting astronomical observatory (OAO) is being negotiated between the National Aeronautics and Space Administration and the Grumman Aircraft Engineering Corp., Bethpage, N.Y. Two flight models, the first to be launched in about two- and one-half years, are called for. The satellites will carry telescopes, spectrometers, and other observation devices into a 500-mile circular orbit to study X-rays, ultraviolet and infrared rays unobscured by the earth's atmosphere.

Grumman's proposal, selected from among 11 other bids, calls for a 3,200-lb satellite approximately 9.5 ft high and 6.5 ft across to carry a 1,000-lb payload. Astronomical equipment with reflecting mirrors up to 36-in. across will be mounted in a cylindrical chamber extending through the length of the vehicle. Each of the vehicles will be a standardized shell containing stabilization, power, and telemetry instruments and accommodating one or more separate experiments for each flight.

The stabilizing system will enable tracking of stars to an accuracy of 0.1 sec of arc. All functions of the satellite and payload will be ground-controlled. The command system will verify commands received and can store them for execution as long as two hours later. Pointing accuracy will be determined by television transmissions to the ground control stations.

The telemetry system will transmit digital data and television signals over a wide-band channel; information on experiments and satellite condition will be carried by a narrow-band channel. More than 100,000 bits of data can be stored within the satellite for readout as the vehicle passes over ground stations. NASA's Minutrack stations will control the OAO and large dishes will be erected at several stations for this purpose.

The observatory will be powered by solar cells arranged on paddles. Approximately 350 w will be required to operate the experiments and satellite equipment.

The groups planning to use the OAO and the proposed experiments include:

- *Smithsonian Astrophysical Observatory*—Several 8-in. telescopes coupled to video tubes to map ultraviolet radiation over the entire sky.

- *Goddard Space-Flight Center*—36-in. mirror and spectrometer to study emissions from a wide range of celestial bodies.

- *Princeton University Observatory*—24-in. mirror and spectrometer to study cosmic gas and dust.

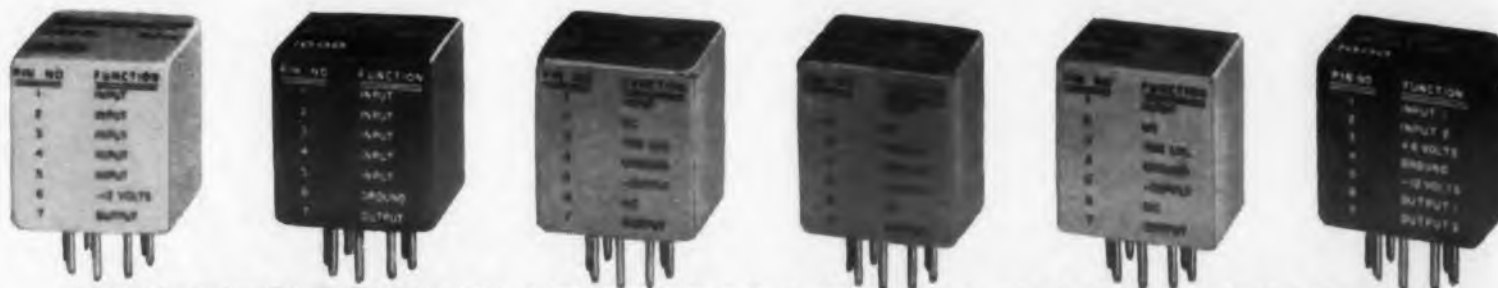
- *Harvard University*—Spectrographic studies of solar radiation.

NOW... Cambion® Guaranteed Quality in Computer Components, Too!

Now you can build extra reliability into electronic data processing systems... with CAMBION Computer Components. These unique, geometrically identical building blocks are manufactured by the new CAMBION Computer Components Division. Like all CAMBION Components, these modules are subjected to rigorous electrical and mechanical tests, bringing you positive dependability. Used in storage or computation circuitry, they provide the positive approach to efficient, trouble-free operations.

All modules incorporate CAMBION advanced design. Compact and lightweight, they're matched to today's ever-shrinking component

space allotments. (For example, a Flip-Flop weighs only 9 grams, and all modules are the same size and shape — .35 cubic inch.) Standard 7-pin design permits easy insertion into socket or printed circuit board work or reliable permanent installation. Bright color-coding makes each module distinctive and distinguishable from all others... particular circuits can be recognized easily. And every module has a high figure of merit for speed and reliability vs. cost and size. Write CAMBION Computer Components Division, 457 Concord Avenue, Cambridge 38, Massachusetts, and get complete specifications for the following CAMBION Computer Components:



FLIP-FLOPS

May be triggered at rates from DC to over 10 million times per second. Output voltages: -11.2 in the "low" state, -0.15 in the "high" state. Operates at temperatures from -55°C to +55°C.

And Gates/Or Gates

Each type accepts 5 separate inputs. Output voltage is same as the (algebraically) lowest input voltage in the And Gate; and same as the highest input voltage in the Or Gate.

Inverters

Superior repetition rate capabilities (DC to 10 MC). Each module contains two independent inverters. Input and output are compatible with all other modules.



Buffer Amplifiers

High output impedance. Low output impedance permits high fan-out. Repetition rates cover the broad range of DC to 10 MC.

Level Triggers

Unique "hold" feature provides storage, so if input is open-circuited output remains at last input level and drop in voltage is prevented.



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CIRCLE 25 ON READER-SERVICE CARD

CIRCLE 910 ON CAREER INQUIRY FORM, PAGE 209

should not be in series with the flow of information through the system, where they might introduce variability or error in the data being processed; and second, that "interfaces" between subsystems should be monitored. As explained by Eric Winkler, of the systems instrumentation and maintainability office of the Electronic Engineering Branch, RADC, interfaces are the problem areas formed by the joining of two subsystems, areas that did not exist before the subsystems were connected and started interacting. An example of interface interaction are data-language changes in flow of information from one subsystem to the next. Noise introduced by one subsystem into the following one is another example.

Interactions can be either good or bad; the good interactions are what makes a system greater than the sum of its parts, according to Mr. Winkler. But good or bad, the interface interactions should be monitored, the Air Force believes.

Basic Method for System Should Be Continuous Loop

The study of dynamic system monitoring submitted to RADC indicates that the basic monitoring method should be continuous-loop testing of operational performance. As shown in the accompanying block diagram, instrumentation loops would be designed to monitor each subsystem in a system from the output of one subsystem to the input of the next, in an overlapping arrangement. A stimuli generator would send a signal through each subsystem for detection by a stimuli detector at the other end of the subsystem, beyond the interface. Suitable instrumentation should be included in the circuit to continuously monitor performance and status of the subsystem and its interfaces.

In turn, several interfaces would be included in other larger loops. These would be called minor loops, and, though larger than subsystem loops, would be less inclusive than major loops, which would be set up to monitor performance from data acquisition, through data transfer, to data display.

The Air Force's study shows how these loops could be coordinated with logic circuitry to indicate easily four levels of subsystem status: fully operational, reduced capability, substandard, and failure. As shown in the accompanying



NEW VA-823

Series Klystrons

VARIAN IS DELIVERING THE HIGHEST CW POWER AT X-BAND

5 kilowatts CW • 7.5 to 10.0 kMc • Noise 160 db below carrier*
50 db gain • 20 Mc bandwidth • Tunable 100 Mc**

Conservatively rated at 5 kilowatts CW in operational environments, the VA-823 has produced over 20 kilowatts CW under test conditions. In system use these tubes are providing extremely low noise performance for pulsed CW radar and communications. They open a new area of design possibilities in microwave radar, communications, and radio astronomy.

To assist you in your particular system design problems, Varian makes available its broad experience in super power tubes at LHF and microwave frequencies. May we work with you or furnish further data?

*AM and FM noise is more than 100 db below the carrier in any 1 Mc channel more than 1 Mc removed from the carrier.
** Tubes in the range from 7.5 to 10.0 kMc have 100 Mc.

Representatives thruout the world



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KLYSTRONS, WAVE TUBES, GAS SWITCHING TUBES, MAGNETRONS, HIGH VACUUM EQUIPMENT, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, NMR & EPR SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

CIRCLE 27 ON READER-SERVICE CARD

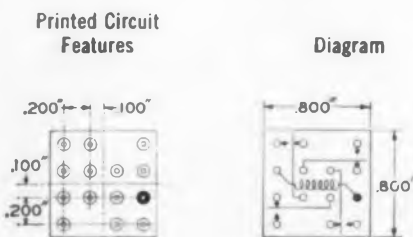


NEW Hi-G 4PDT microminiature relay

First 4-pole microminiature relay incorporating a balanced armature and featuring a pin arrangement readily adaptable to printed circuit applications. This new relay also features improved sensitivity per pole as compared with two 2-pole microminiature relays.

- Type:** Type 4B Microminiature
Size: .800" x .800" x .875" max.
Contacts: 4PDT dry circuit to 2 amps resistive
Dielectric Strength: 1000 VRMS at Sea Level
Insulation Resistance: 1000 megohms min.
Optional Terminals: Long or short leads for printed circuit application or hook type for standard wiring. Bracket, studs or straps also available for mounting.
Construction: Balanced armature construction, proven the best approach available for resistance to extremes of vibration and shock, exceeding all present military specifications.
Environmental Characteristics: To meet all military relay specifications for components of this size.

SEE HI-G AT THE NEREM SHOW—
BOOTHS 209, 210



Printed Circuit Courtesy of The Sibley Co.



THE ONLY COMPLETE LINE OF BALANCED ROTARY RELAYS

Hi-G

INC.

BRADLEY FIELD, WINDSOR LOCKS, CONN.

CIRCLE 28 ON READER-SERVICE CARD

NEWS

schematic, simple AND and OR networks would accept subsystem parameter data and indicate subsystem status.

Dynamic System Monitoring Promises More Effectiveness

As described by the Air Force, dynamic system monitoring, with emphasis on interface interaction and sensing of degradation, is a promising route to increased system effectiveness, which is defined as a function of system reliability, maintainability, and instrumentation. Electronic System Project Offices of various L-systems in operation or under development are already being advised on the basis of the study submitted to the RADC. The Air Force foresees individual monitoring of equipment and sub-systems in a way to integrated monitoring instrumentation that would provide system status reports on a real-time, concurrent basis. Included in the integrated package would be capability for static dynamic and system measurements needed for real-time status reports. Unless this is done, Air Force spokesmen say, the growing number of interactions between subsystems and systems might not be monitored, resulting in too little testing being done, or, as is often the case, too much equipment for each piece of equipment is required, even in large systems using each of several types of equipment, resulting in too much testing.

'Cocooned' Payloads Proposed For Flights to Mars and Venus

A "cocoon" proposal for flights to Mars and Venus is under study at Lockheed Missiles and Space Div. of Sunnyvale, Calif.

Payloads for the flight, including life-support systems, earth-reentry vehicles, and other items would be carried "cocooned" within the booster fuel tanks. They would be supported on a rugged rocket motor structure rather than in a special vehicle.

Two booster rockets for the flights would be fired into earth orbit, carrying crew and other payloads, and would be refueled by other identical boosters to allow them to attain Mars or Venus flight velocity. They would be rotated around a common center to provide artificial gravity. Rotation and maneuvers would be produced by small vernier rockets.

According to Rollin Gillespie, LMSD systems specialist, artificial gravity is essential for crew well-being on the year-long trip to Mars and back. The cable arrangement would allow

long axis of rotation, needed to reduce the effects of coriolis force.

On arrival at Mars, both boosters would be abandoned. Their combined payloads would be slowed down in thin Martian atmosphere by a steel drag parachute to "park" them in orbit around the planet.

Once in Mars orbit, a special glider designed for the Mars atmosphere would land on the surface. A small rocket would be used later to rejoin the return-to-earth vehicle in orbit around the planet. The back-to-earth "ship" would include the basic life-support capsule used by the crew on the way out and a rocket to escape from Mars orbit and return to earth. There would also be a vehicle for reentry into the earth's atmosphere and landing there.

Mr. Gillespie points out that the problems of flight to Mars are enormous. A trip to the moon might be completed in four or five days, but the briefest practical Mars flight would take almost a year. Mr. Gillespie also comments that rocket power for the first Mars flight may be supplied by a nuclear engine. He also stated, however, that a production nuclear engine for space flight is still so difficult that it is likely the first Mars trips will be powered by chemical engines.

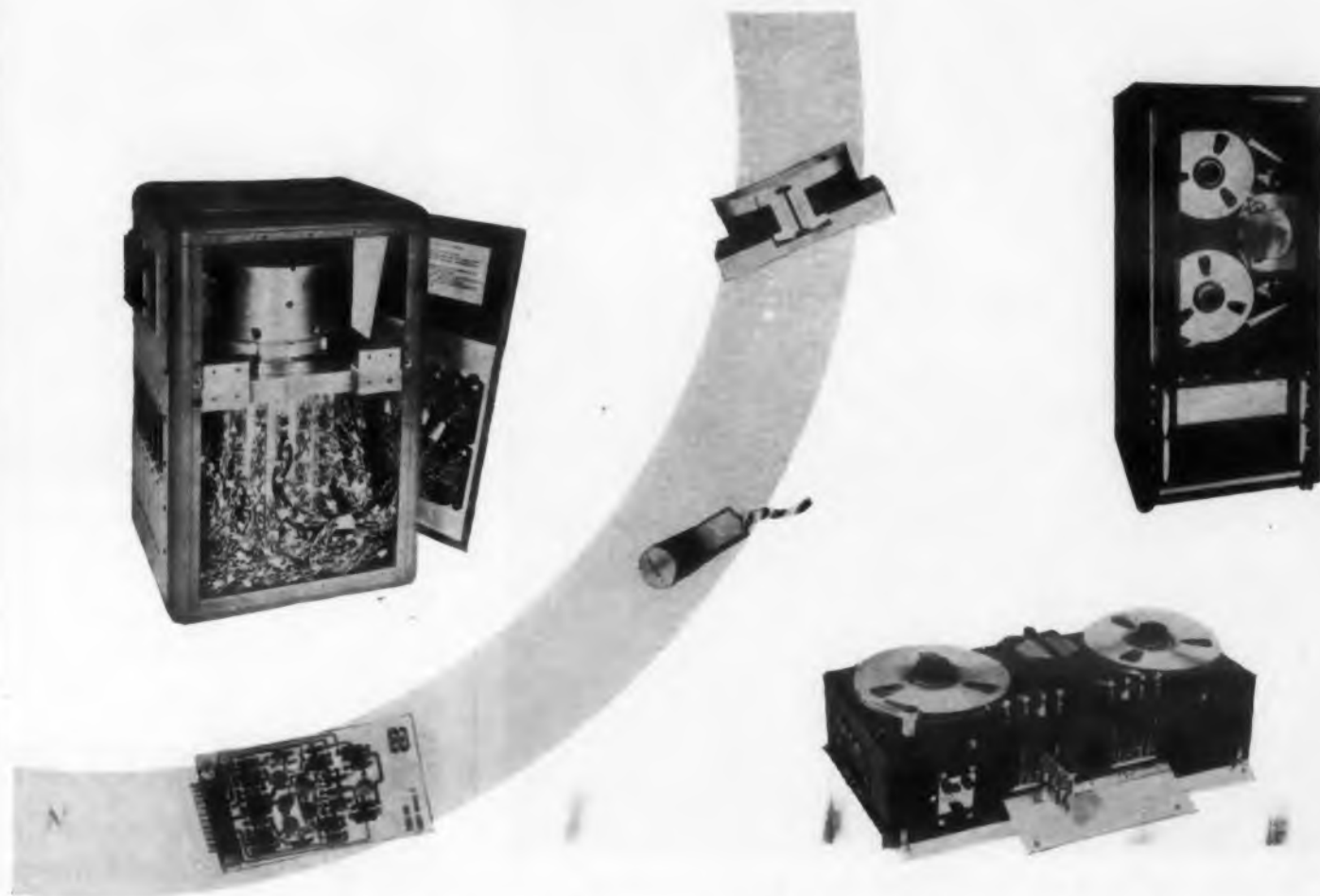
Raytheon, Two Italian Firms Form New Electronics Company

Italy's burgeoning electronics industry has received a shot in the arm with the formation of a new Italian company, 40 per cent of which is owned by Raytheon Co.

Raytheon has invested \$3 million in the new company, to be called SELENIA Spa. Another 40 per cent will be owned by Finmeccanica, an Italian governmental holding company of 27 manufacturing areas, and 20 per cent will be owned by the Italian Societa Edison. The new company is believed to be among the largest electronics companies in Italy.

The new company will use initially the two existing facilities. Manufacturing will be concentrated at Fusaro, in Finmeccanica's electronics plant, and the headquarters and engineering laboratories will be on the outskirts of Rome. The Rome installation was completed by Societa Edison in 1959 and is said to be one of Italy's most modern and well-equipped laboratories.

Emphasis in the new company will be on the development of new electronic commercial products. Initial production assignments include handling the major part of manufacturing the Italian portion of the Hawk missile production for the North Atlantic Treaty Organization.



A NEW CONCEPT

MAGNETIC MEMORY SYSTEMS and COMPONENTS

IF YOUR PROBLEM IS ONE OF A MAGNETIC MEMORY DEVICE OR SYSTEM, WHETHER IT IS AN ANALOG OR DIGITAL SYSTEM, OR A COMBINATION OF THESE---SHEPHERD INDUSTRIES STANDS READY TO PROVIDE YOU THE ENGINEERING AND THE HARDWARE TO MEET YOUR SPECIAL REQUIREMENTS.

TRANSPORTS	MAGNETIC HEADS	DRUMS	TRANSISTORIZED ELECTRONICS
MOBILE DIGITAL ADVANCED DESIGN BIN SLOW SPEED DIGITAL MOBILE ANALOG ANALOG LABORATORY TAPE LOOPS	ANALOG DISC ANALOG TAPE DIGITAL DISC DIGITAL DRUM DIGITAL TAPE STATIC READING	AIRBORNE COMPUTER GENERAL STORAGE ++++ RIGID DISCS MEMBRANE DISCS	READ and WRITE AMPLIFIERS FM/FM RECORD AMPLIFIERS FM/FM PLAYBACK AMPLIFIERS DIODE MATRIX SWITCHES BINARY-DECIMAL CONVERTERS MODULATORS and TRANSLATORS

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CIRCLE 29 ON READER-SERVICE CARD



power alone
is not enough...

it's the ultra low distortion — .005%
in this audio amplifier
that makes the big difference!

Here's a fifty-watt power amplifier with harmonic and intermodulation distortion of less than .005%. Distortion so low — you'd need special equipment to measure it!

That's why the UF-101A is a natural as a reference source, with a suitable oscillator, for low distortion measurement of power components, as well as a highly linear amplifier within the audio band.

The other characteristics of the UF-101A are equally outstanding. Phase distortion is negligible — $\pm 2^\circ$ maximum deviation from linear phase shift. Total hum and noise level less than 10 microvolts input equivalent. Frequency range is from 20 cps to 20 kc. For convenience, the UF-101A has taps for matched load impedances from 1 to 225 ohms.

Some of the applications of this ultra-low distortion amplifier are: checking the residual distortion of distortion-measuring equipment, reproducing non-sinusoidal wave forms faithfully, and as an ultra-low distortion, high power source to supply test benches. Write for full information on the UF-101A.

Other Krohn-Hite amplifiers include the direct-coupled, wide band DCA-10 (10 watts), and DCA-50 (50 watts). Also, *Krohn-Hite Oscillators, Filters and Power Supplies.*



KROHN-HITE CORPORATION

580 Massachusetts Avenue • Cambridge 39, Mass.
Pioneering in Quality Electronic Instruments

CIRCLE 30 ON READER-SERVICE CARD



Compact transistorized receiver package that goes in car and oscillator unit which sends out low-frequency signals from road in GM's Electro Lane.

NEWS

System Alerts Drivers Nearing Road Edge

Car-Mounted Ferrite-Core Sensors Used with Buried Charged Wires

AN ELECTRONIC system designed to alert motorists when their cars are too close to the edge of the pavement is now being tested in Milford, Mich.

The system, called Electro Lane by its designers, General Motors, makes use of roadside-buried, af-charged, electrical wires and pick-up coils in vehicles using the system. It works this way:

A straight wire is installed beneath each edge of the road to warn against straying toward either road edge. To warn against leaving a lane, an additional wire must be buried in the center of the lane.

The road wire carries an audio-frequency current supplied by small oscillators buried at intervals along the road edge. Vehicles using the system are equipped with a pair of electromagnetic, ferrite-core sensing coils mounted on the front bumper. Each coil has a voltage induced in it that is directly proportional to the vehicle's deviation from the center of the road or lane.

When a pair of road wires is used, one at each edge, the coil on either side is virtually unaffected by the opposite road

wire. And because the two sensing coils are mounted on the vehicle so that they straddle the lane-center road wire, the signal in one coil increases while that in the other decreases with lateral vehicle motion. Hence, independent signals are provided for each direction of deviation.

Transistorized Amplifier Used in Cars

The sensing coils are wired as inputs of a two-channel transistorized amplifier located in the passenger compartment of the car. The output of each channel is rectified and compared with a mercury cell reference voltage. When this voltage overrides the reference voltage (corresponding to a certain input level and hence a certain lateral position on the road) an alarm is actuated through a transistor switch to indicate approach to the road or lane edge.

The Electro Lane road wire and oscillators are buried at intervals along the roadside. Use of an audio-frequency (2,000 cps in the prototype) reportedly reduces the transmission-line problem in

controlling a long section of road with each oscillator.

A transistorized oscillator with good frequency stability and relatively low power output is said to be the only component required for installation in the roadbed. In an early installation, a 2.6-mile line was supplied by a single oscillator with a total power dissipation in the wire of reportedly less than 3 w. Even lower power requirements are said to be achievable by using a larger road wire or by increasing the sensitivity of the vehicle-receiving equipment. In an actual installation the roadside oscillators could operate from batteries floated on an ac power line, GM states.

System Designers Faced Dual Problem

Designers of the system were faced with a problem requiring solution by transmission-line theory. The requirements of relatively high frequencies for high-induced voltage in the sensing coils and relatively low frequencies to avoid attenuation along the road wire were incompatible, and a compromise had to be made. Also involved was the selection of road length to be driven by each oscillator. Longer lengths provided efficient use of oscillators on the one hand, but loss of larger parts of the system in the event of failure on the other. The design goal set was a line "flat" from a current standpoint; it was designed to have the same rms value of ac current flowing in the line at every point along the road to provide a constant system sensitivity. These same considerations are applicable to the design of a guidance wire for automatic car control, according to the company.

The vehicle-carried portion of Electro Lane comprises three parts: sensing coils, amplifier and warning lights and buzzers.

High-Q ferrite material is used as a core to obtain a high-voltage output. Layer-winding is said to be permissible because of the low frequencies involved. The coil, which is tuned to the high frequency of the road-wire current, has high output impedance.

System drift, a problem in amplitude and systems, is said to be avoided in the Electro Lane design. Each amplifier channel in the system has high input impedance, stable-gain value, small size, and ruggedness. ■ ■



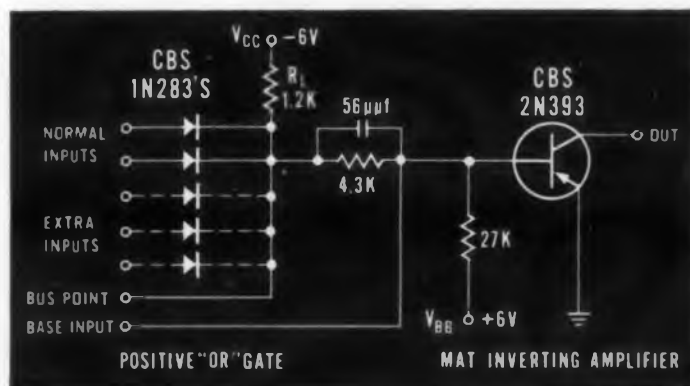
MAT*

TRANSISTOR CUTS COMPUTER COSTS UP TO 25%



The CBS 2N393 MAT transistor cuts computer costs three ways: *Transistor costs* . . . this transistor far outperforms ordinary alloy switching transistors — and at lower cost, since fewer are required. *Component costs* . . . the versatile 2N393 simplifies circuits, eliminates many expensive components. *Manufacturing costs* . . . the high-performance 2N393 makes possible a universal, simplified circuit that permits full exploitation of standardization economies. *Total savings* can easily amount to 25%.

Check the CBS 2N393 features and characteristics . . . and the universal computer circuit shown. Order engineering samples from your local Manufacturers Warehousing Distributor or sales office.



UNIVERSAL MAT CIRCUIT PERFORMS 80% OF COMPUTER FUNCTIONS

This basic NOR circuit provides for more than 80% of the logic and storage functions of moderately fast data processing systems: AND gate, OR gate, inverter, and flip-flop. Advantages include economy, reliability, and ease of replacement. Special features are: minimized noise sensitivity and power dissipation . . . worst-case design . . . operating temperatures to 55°C . . . max. input of 22 collectors and diodes . . . repetition rate up to 1 mc.

CBS ELECTRONICS, Semiconductor Operations, Lowell, Mass. • A Division of Columbia Broadcasting System, Inc.

Sales Offices: Lowell, Mass., 900 Chelmsford St., GLenview 2-8961 • Newark, N. J., 231 Johnson Ave., TA1bot 4-2450 • Melrose Park, Ill., 1990 N. Mannheim Rd., EStebrook 9-2100 • Los Angeles, Calif., 2120 S. Garfield Ave., RAYmond 3-9081 • Atlanta, Ga., Cary Chapman & Co., 600 Trusco Way, S. W., PLaza 8-4508 • Minneapolis, Minn., The Helmann Co., 1711 Hawthorne Ave., FEderal 2-5457 • Toronto, Ont., Canadian General Electric Co., Ltd., LEnnox 4-6311

CBS 2N393 FEATURES

- High gain with high frequency response
- D-c beta linear up to 50 ma
- More efficient high-injection emitter
- Low saturation resistance adaptable to DCTL
- Pyramiding factor of 5 easily attained
- Exceptional uniformity through controlled base width
- Welded TO-24 case hermetically sealed
- Automated production with sequential quality control
- Over-all quality exceeding MIL-S-19500

CHECK THESE DATA

Maximum Ratings

Junction temperature, °C	85
Collector voltage, v	-6.0
Collector current, ma	-50
Dissipation at 45°C, mw	25

Electrical Characteristics (25°C)

Max. I_{CBO} ($V_{CE} = -5v$), μa	5
Min. h_{fe} ($V_{CE} = -3v$, $I_C = 0.5 ma$)	40
Min. h_{FE} ($V_{CE} = -1v$, $I_C = -50 ma$)	20
Max. $V_{CE Sat}$ ($I_C = -8 ma$, $I_B = -1 ma$), v	0.07
Max. $V_{BE (On)}$ ($I_C = -8 ma$, $I_B = -1 ma$), v	0.5
Min. f_{max} (max. frequency of oscillation), mc	40

*Micro Alloy Transistor, trade-mark Philco Corp.

CIRCLE 31 ON READER-SERVICE CARD

New from
Sarkes Tarzian

HIGH VOLTAGE

Silicon Cartridge Rectifiers

Latest in the growing line of Sarkes Tarzian semiconductor devices are High Voltage Silicon Cartridge Rectifiers in two series. Each series includes 18 different types with operating temperatures ranging from -55°C to 150°C ambient. The units feature low voltage drop and low reverse current.

Ferrule Mounted Series (S-5490 thru S-5507)

This high voltage series is equipped with a ferrule type mounting of silver plated brass and is available in both hermetically sealed glass or phenolic tubing. The units range in sizes from $1\frac{13}{16}$ " to $6\frac{1}{16}$ ", have maximum rectified DC output currents varying from 45 to 100 milliamperes, and peak inverse voltage ranging from 1500 to 16,000 volts.

Axial Lead Series (S-5518 thru S-5535)

This high voltage series is equipped with axial leads, with units ranging in size from $\frac{1}{2}$ " to $2\frac{1}{2}$ " and lead lengths varying from 1" to $2\frac{1}{2}$ ". Peak inverse voltage starts at 1000 volts up to 10,000 volts, with maximum RMS input voltage ranging from 420 to 7000 volts. Maximum average rectifying currents at 25 degrees C vary from 70 to 250 MA, and at 100 degrees C, from 25 to 100 MA.

Both series are immediately available in production quantities! For additional information on the new Sarkes Tarzian High Voltage Silicon Cartridge Rectifiers, write Section 5652B.

Sarkes Tarzian is a leading producer of semi-conductor devices in production quantities, including silicon power rectifiers, silicon tube replacement rectifiers, selenium rectifiers, modular silicon rectifiers and zener voltage regulators. Application engineering service is available without cost or obligation.



SARKES TARZIAN, INC.

World's Leading Manufacturers of TV and FM Tuners • Closed Circuit TV Systems • Broadcast Equipment • Air Trimmers • FM Radios • Magnetic Recording Tape • Semiconductor Devices

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(FERRULE MOUNTED SERIES)			
Operating Temperature Range -55°C to 150°C Ambient		Max. Ratings Half Wave Res. Load at 75°C Ambient	
JEDEC TYPE	S. T. TYPE	PEAK INVERSE VOLTS	MAX. RECTIFIED DC OUTPUT MA
1N1133	S-5490	1500	75
1N1134	S-5491	1500	100
1N1135	S-5492	1800	65
1N1136	S-5493	1800	85
1N1137	S-5494	2400	50
1N1138	S-5495	2400	60
1N1139	S-5496	3600	65
1N1140	S-5497	3600	65
1N1141	S-5498	4800	60
1N1142	S-5499	4800	50
1N1143	S-5500	6000	50
1N1143A	S-5501	6000	65
1N1144	S-5502	7200	50
1N1145	S-5503	7200	60
1N1146	S-5504	8000	45
1N1147	S-5505	12000	45
1N1148	S-5506	14000	50
1N1149	S-5507	16000	45

When ordering phenolic tubing as a substitute for glass tubing, add the letter "P" to S. T. Type No.

MAXIMUM RATINGS				
Operating Temperature Range -55°C to 150°C Ambient				
JEDEC TYPE	S. T. TYPE	PEAK INVERSE VOLTS	MAX. RMS INPUT VOLTS*	MAX. RECT. DC OUTPUT (MA) @ 100°C
1N1730	S-5518	1000	700	100
1N1731	S-5519	1500	1050	100
1N1732	S-5520	2000	1400	100
1N1733	S-5521	3000	2100	75
1N1734	S-5522	5000	3500	50
1N2373	S-5523	600	420	100
1N2374	S-5524	1000	700	100
1N2375	S-5525	1500	1050	100
1N2376	S-5526	2000	1400	100
1N2377	S-5527	2400	1680	75
1N2378	S-5528	3000	2100	75
1N2379	S-5529	4000	2800	50
1N2380	S-5530	6000	4200	50
1N2381	S-5531	10000	7000	25
1N2382	S-5532	4000	2800	75
1N2383	S-5533	6000	4200	50
1N2384	S-5534	8000	5600	35
1N2385	S-5535	10000	7000	35

* Derate 50% for capacitive load in half wave circuits.
For capacitive, motor, or battery loads, derate DC current by 20%.

NEWS

General-Purpose Computer

Greater System Efficiency Is Seen Through Automated Equipment

PROGRAMS to direct communications systems with general-purpose computers are being written by at least one company, and other organizations are believed to be far along in efforts to increase system efficiency through use of automatic data processing.

Dr. R. F. J. Filipowsky, Collins Radio Co., Newport Beach, Calif., reported at the Sixteenth National Communications Symposium, held recently in Utica, N.Y., that a team at his company is evaluating general-purpose computers and attempting to program a large general-purpose computer preparatory to using such machine to direct the processing and flow of traffic through a large communications system.

Dr. Filipowski believes that dynamic matching of input devices, transmission links, transmission signals and traffic flow through a large network can increase the utilization index of the network from the present 2 to 5 per cent to 60 or 80 per cent. In addition, states Dr. Filipowski, who delivered, at the symposium, a paper on this subject jointly authored by E. H. Scherer, computer used for control and processing functions may still have sufficient operating capacity left available to perform conventional data-processing services. This would be especially true, Dr. Filipowski believes, in a few years, when telephone-line-linked data systems are in wider use and computers will be commonly talking to other computers in extensive networks. During the several-hour daily traffic-rush period, the general-purpose computer might be fully occupied with speeding message traffic, and during the remaining 16 to 20 hr a day, says Dr. Filipowski, may perform normal DP operations, "probably on a public service basis."

"The enormous advantage of such a hybrid operation, he explains, "is that all communications subscribers would be already connected to the computer with their telephone, and telephone lines and there would be no need for an additional tele-data-processing network."

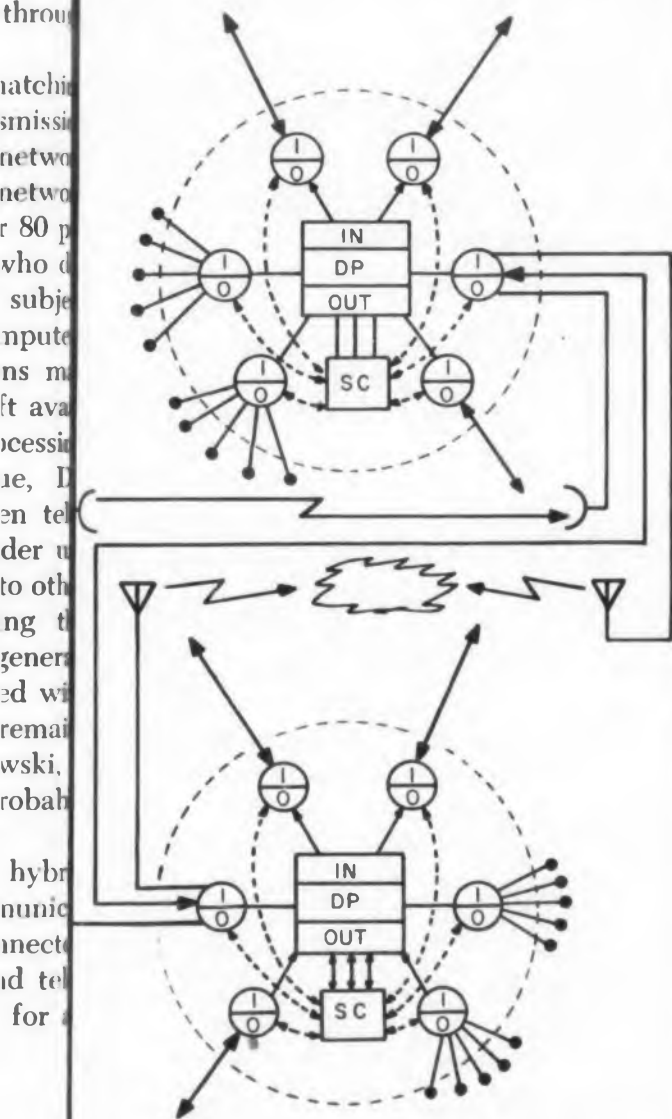
Sophisticated Modes Would Be Possible With Automated Equipment

A further advantage pointed out is that sophisticated modes of operation would be possible using error correction, information loops, signal analysis, channel analysis, and others. These improvements would be made possible through

Computer Direct Communications

After programming and use of some additional peripheral equipment. The sophisticated techniques would aid in achieving the most important single feature of computer-directed networks: dynamic matching. This is defined as the effort to optimize information flow through a network on a practically instantaneous basis, with the greatest flow handled in the shortest interval at the lowest error rate and delay.

The three-main types of facilities in each exchange of a computer-directed communications system would be the computer, an electro-mechanical- or electronic-switching center, and input/output adapters. The adapters make possible connection of circuits to the computer or to



Now computer-directed communication centers could be linked in optimally operated networks. Switching centers, (sc), serve normal switching functions; input/output adapters (i/o), monitor circuit connections and may perform data conversion and concentration functions, the data processors, dp, optimize message flow and network utilization. Black dots at end of lines represent subscribers linked into the network.

NEW CIRCUIT POSSIBILITIES for low impedance, high current applications

SILICON SWITCHING DIODES

Combining high reverse voltage, high forward conductance, fast switching and high temperature operation, these diodes approach the ideal multi-purpose device sought by designers; they open new areas of opportunity for circuit design.

Type CSD-2542, for example, switches from 30 ma to -35v. in 0.5 microseconds in a modified IBM Y circuit and has a forward conductance of 100 ma minimum at 1 volt.

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GENERAL PURPOSE TYPES

Optimum rectification efficiency rather than rate of switching has been built into these silicon diodes. They feature very high forward conductance and low reverse current. These diodes find their principal use in various instrumentation applications where the accuracy or reproducibility of performance of the circuit requires a diode of negligible reverse current. In this line of general purpose types Clevite has available, in addition to the JAN types listed below, commercial diodes of the 1N482 series.

MILITARY TYPES

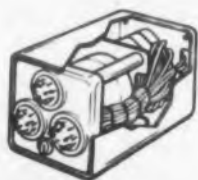
JAN	MILITARY TYPES	SIGNAL CORPS
1N457	MIL-E-1/1026	1N662 MIL-E-1/1139
1N458	MIL-E-1/1027	1N663 MIL-E-1/1140
1N459	MIL-E-1/1028	1N658 MIL-E-1/1160
		1N643 MIL-E-1/1171

Write for Bulletins B217A-1, B217A-2 and B217-4.

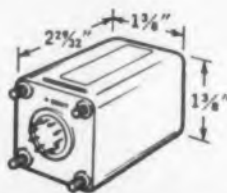


Ledex Hermetically Sealed Rotary Switch

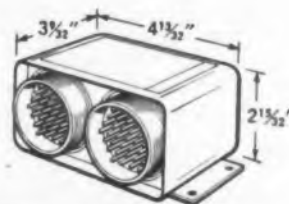
BASIC INFORMATION



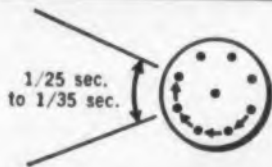
Hermetically sealed switches are permanently protected from moisture, dust, fungus, corrosion and tampering.



Small size 20 Circuit Selector can provide a 1-pole 12-throw, 2-pole 6-throw or 3-pole 4-throw. Weight 3 1/2 oz.



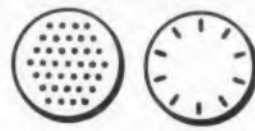
Larger size 3 Circuit Selector is available in many combinations, as 22-pole 2-throw, 12-pole 4-throw, 4-pole 12-throw.



Selectors will stop to any pre-selected position at 25 to 35 steps per second.

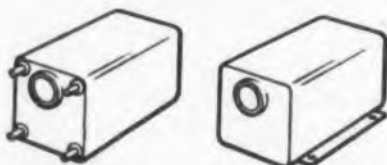


Wiping-type contacts are self-cleaning, remove film problems of "dry" circuits, shorting or mis-shorting contacts.



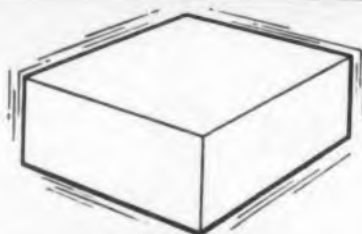
AN Connector Solder Header

Any standard commercial connector can be used.

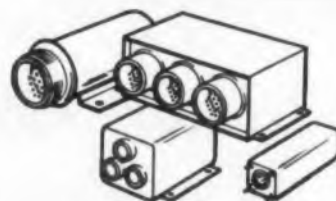


Stud Plate

Switch housings come with stud or plate mounting. Specials on request.



Sealed units to meet missile-age vibration and shock requirements.



Wide selection of stepping switches as well as circuit selectors available in protective housings.

Hermetically Sealed Circuit Selectors and Stepping Switches contain an atmosphere of dry nitrogen which provides a permanent environment for the operation of the switch. They are designed to meet MIL-E-5272A, and will withstand extreme moisture and high altitude conditions in military and industrial installations. Sealed Switches are available in various wire sizes for operation from 6 to 350 VDC. Self-contained plug-in types allow rapid field installation. More than 3000 standard designs are shown in Bulletin D-460.

Other Ledex products include Rotary



CIRCLE 34 ON READER-SERVICE CARD

Solenoid, *Syncremental* Stepping Motor, *Digimotor* Stepping Motor and Indexing Device, Rotary Solenoid Selector Switch, *Digimotor* Selector Switch.

Switching applications include circuit selecting, stepping, counting, programming and sequencing.

Mechanical applications of other Ledex products include actuation of valves, vanes, printers, shafts. Write for literature, mentioning application, to Ledex Inc., Dayton 2, Ohio; Marsland Engineering, Ltd., Kitchener, Ont.; NSF Ltd., 31 Alfred Place, London, Eng.; NSF GmbH, Nurnberg, Germany.

NEWS

the switching center and may even perform some data concentration and conversion functions.

In a hypothetical system investigated by Dr. Filipowski, the data-processing facility might have up to 3-input and 3-output synchronizers which might store up to 16 words or 480 bits. These synchronizers, or associated devices, would automatically translate input data to machine language. Each input and output would go through a terminal box in the input/output adapters that would respond to one or two simple switching signals for connecting the corresponding line to the data-processing facility or to the switching center.

Because electronic switching devices can respond to within a fraction of a millisecond, hybrid operations, such as private connecting (distinguished from private lines) would be possible. Special connections between the computer and the switching centers would permit the computer to communicate on a circuit-switched basis with other computers in the network for such purposes as transferring large stocks of messages in bulk operations to ease traffic bottlenecks.

Batch Systems Fundamental Mode When Computers Are Used

The fundamental mode of operation when computers are used for the control of communication networks is the batch system. Data to be moved would be organized in addressed information packages forming independent messages even if they have their origin in the same information source. All packages would follow a standard format, according to which they would be headed by a data-processing signal, followed by a preamble. The actual message content would constitute the bulk of the package and might be subdivided into items that might also be made up of several fields. Fields would finally be formed by words of the system language, defined by a code. A message would be terminated by a trailer block suffix.

The DP signal has to secure the connection to the data-processing facility and may provide phasing and clocking. The preamble would contain priority indication, a routing indication, the address of the subscriber's and sender's computer, and the addresses of the subscribers themselves.

Local inputs from subscribers might undergo demand-matching processing in the form of translation and redundancy-reducing encoding. Local inputs in analog form might be digitized and submitted to redundancy encoding also. Trunk inputs from computers in other exchanges would arrive in machine language and would be automatically error-checked, with automatic re-

quests for repetition as part of the system.

Radio inputs from computers in other exchanges would usually arrive in special radio-system languages and would probably be submitted to automatic error correction encoding and automatic decoding. It may eventually be feasible to perform highly sophisticated transmission signal analysis on partly mutilated signals, Mr. Filipowsky believes. The detector output of the radio receiver would be forwarded in analog form to an analog-to-digital converter. The converter would be programmed to perform a cross-correlation analysis with the digital version of the clean original signals, which would be stored in data form in the computer memory.

A "link control" capability would be provided. Here, service messages received from other terminals would indicate the quality of transmission as determined from the signal-to-noise ratio, error counts or other observations. From this service data the optimum transmission rates would be computed for instructing the circuit and the rate selector.

Other functions that would probably be desirable in a computer-directed communications systems, Dr. Filipowsky reports, are:

- Network-control function to receive service messages with status reports from all computer exchanges in the system, which would be used to aid a selected computer derive optimum routing instructions.

- Storage function for aiding the classification of messages according to priority and for storing them in groups until transmission facilities become available.

- Master-control function to assign priority to the various computer operations and to determine how the computer capacity can best be used under prevailing conditions. It would decide to what degree the arithmetic facilities may be used for directing communications and to what degree for routine computer operations.

- Output-processing function for local messages would involve any decoding operation to restore original redundant messages.

- Signal-synthesis function might compose analog transmission signals from digital components as they may be computed as optimum signals under given circumstances or as they might be available in the storage facilities of the computer. This function would incorporate any electronic countermeasures or anti-jamming measures that might be necessary.

Such a system, which Dr. Filipowsky calls CODIC (Computer Directed Communications) will soon be not only practical, he believes, but may also be necessary, as pressures rise for communications systems that use less channel space to handle more traffic more reliably than present systems. ■ ■

New Sylvania concept in MICROMINIATURIZATION

wafer thin! feather light!

"PANCAKE" TRANSISTORS

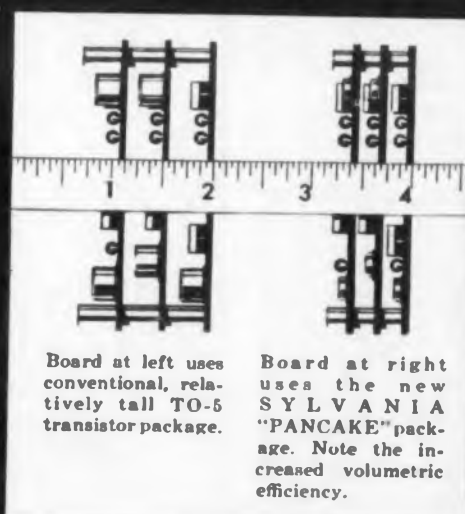
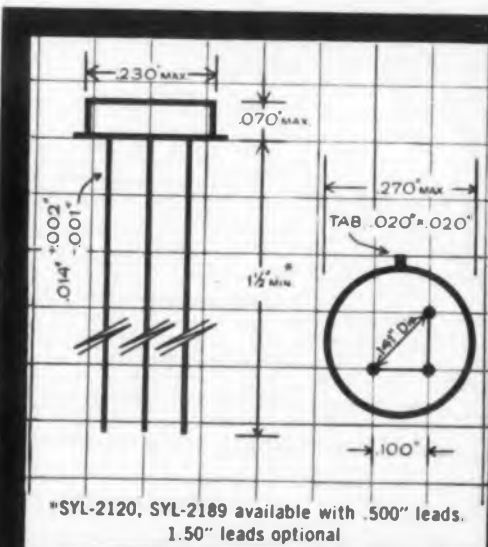
In Germanium Alloy-Junction and Germanium Mesa Structures

... offering exceptional volumetric efficiency (85% smaller, 85% lighter than electrical counterparts)
• increased ruggedness • correct pin-circle geometry for 100-mil automation grid system.

Sylvania announces 10 switching transistors in the new "PANCAKE" package — shorter in height than the diameter of conventional 1/2-watt resistors, flatter than conventional silvered-mica capacitors. All types feature clear glass, stress-free matched seals, true chemical bonds that offer exceptional hermetic reliability and strength, excellent resistance to thermal shock. They with-

stand atmospheric pressure as high as 200 p.s.i., enabling high-pressure leakage tests for military-industrial quality assurance.

For information on these and other "PANCAKE" types under development utilizing mesa and alloy-junction techniques, contact your Sylvania Representative. For technical data, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 1811, Woburn, Mass. Sylvania "PANCAKE" TRANSISTORS also available through Sylvania franchised Semiconductor Distributors.



Sylvania "Pancake" Transistors		Electrically Similar Type
Germanium Alloy-Junction Types		
		(TO-5 package)
2N1684	PNP	2N404
2N1685	NPN	2N388
2N1779	NPN	2N377
2N1780	NPN	2N385
2N1781	NPN	2N1605
2N1782	PNP	2N396
2N1783	PNP	2N414
2N1784	PNP	2N428
Germanium Mesa Types		
		(TO-18 package)
SYL-2120*	PNP	2N705
SYL-2189*	PNP	2N711

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Bendix Bulletin

NEW 25-AMP DAP TRANSISTORS SWITCH IN MICROSECONDS

*High Current—Fast Switching—High Voltage
—give engineers wider design latitude*

The new 25-amp germanium PNP Bendix® Diffused Alloy Power DAP® transistor line—with its microsecond-fast, higher-current switching (typically 5 μ sec at 25 amperes)—frees engineers from the design restrictions set up by ordinary germanium alloy transistors. Only Bendix offers such a high-current, high-speed DAP transistor line.

But high current is by no means the whole story. Bendix DAP transistors make possible increased circuit stability

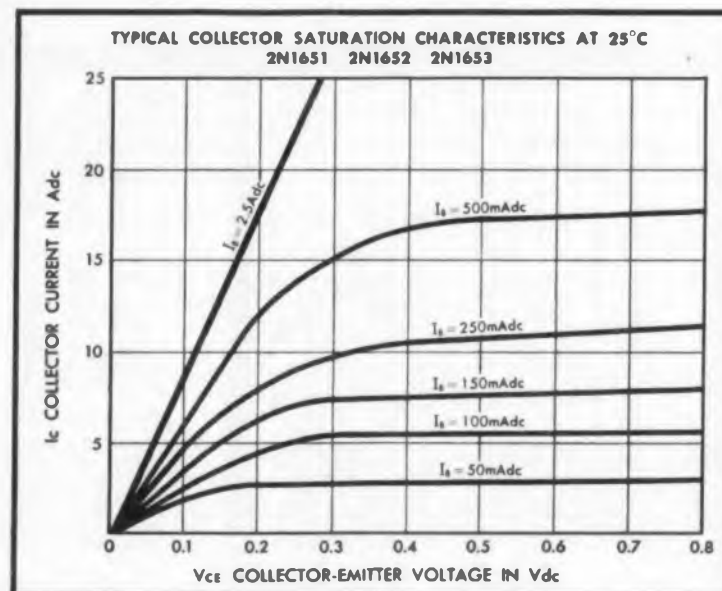
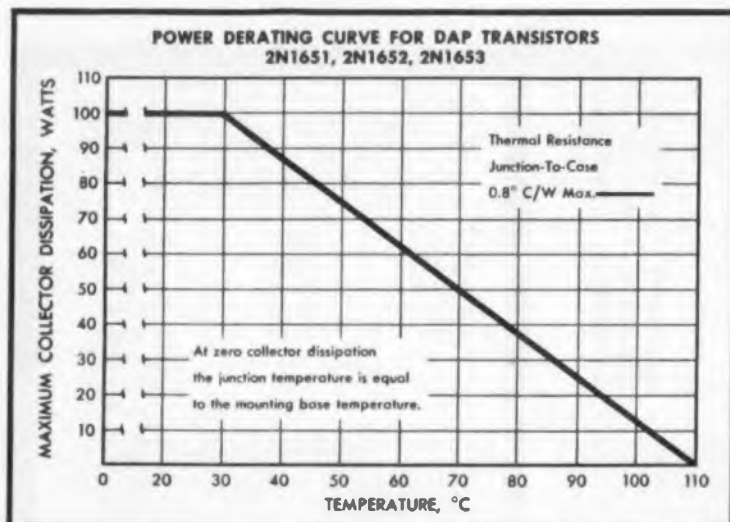
over a wider range of temperatures—from -60°C to $+110^{\circ}\text{C}$. They are also



rated at higher collector-to-emitter breakdown voltages, while providing lower input resistance, controlled current gain, and lower saturation voltages. In short, here is a special high-frequency, high-voltage line that opens the door to many new design ideas and applications.

For details on our complete line of power transistors, power rectifiers, and driver and MIL-type transistors, write on your letterhead for your BENDIX SEMICONDUCTOR CATALOG.

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TYPE NUMBERS	V_{ce} Vdc	V_{cb} Vdc	V_{eb} Vdc	I_c Adc	P_c W	T Storage $^{\circ}\text{C}$	T_j $^{\circ}\text{C}$
2N1651	-60	-60	2.0	25	100	-60 to +110	110
2N1652	-100	-100	2.0	25	100		
2N1653	-120	-120	2.0	25	100		

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NEWS

Two-Thirds Cost Slice

Electro-Logic Strain-Gage System Is Now Measuring Beam Deflection

In fulfillment of the company's first systems contract, Electro-Logic's five-channel strain-gage recorder has been installed for a little more than a third the price of conventional systems. At a cost of \$6,000, a major testing laboratory is now engaged in measuring beam deflection. According to industry sources, a conventional five-channel telemetering system would cost in the neighborhood of \$15,000.

Major savings in the system: elimination of all five low-level amplifiers (about \$1,000 each) and a solid state multiplexer (about \$3,000; a mechanical commutator would cost about \$1,000).

The system works by use of the company's transponders—tiny solid-state devices which transform the low-level outputs from transducers directly to pulse duration information, on command, explains Electro-Logic President Vincent Van Praag. Time duration of the pulse is proportional to the input's amplitude; ranges from 10 to 20 msec. Block diagram of the system is shown in the drawing.

Selection of the transponder channels is made by a ring counter. Its five outputs are sequentially switched to a negative-dc level. As a result the AND gates to the individual channels are opened; an interrogation pulse pair can pass through to operate the transponder.

First of the pulses switches the transponder into the *set mode* where it samples the low-level voltage. The second pulse switches the transponder into *conversion*, where the input is connected to a pulse duration. The interrogation pulse pair has two positive steps placed 40-msec apart.

Transponder output is a positive pulse with a nominal amplitude of 8 v.

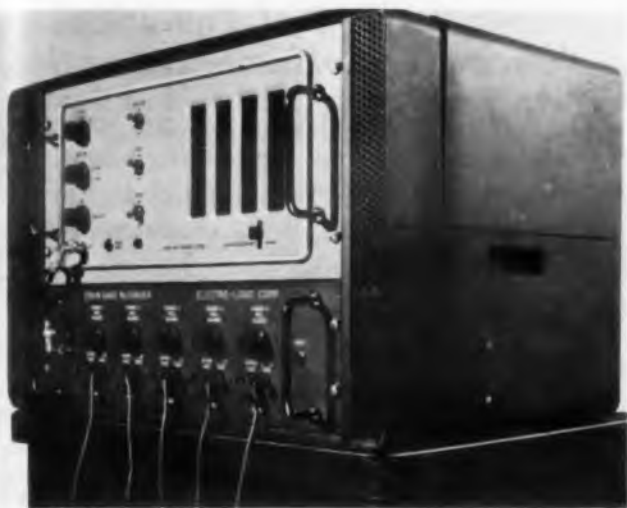
Schmitt Trigger Sets Output, 100-Kc Clock Gates Pulses

Pulse amplitude of the transponder output decreases gradually at a constant slope until it reaches a knee, at which time an abrupt decay in amplitude is observed. The position of this knee, according to the company, is accurately determined with a Schmitt trigger. Pulse outputs from all transponders are multiplexed with a common output circuit as shown in the drawing. Transponder outputs are sequentially passed through an OR gate into the Schmitt trigger which shapes the output pulse.

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CIRCLE 36 ON READER-SERVICE CARD

Slit Claimed for Recorder



Strain-gage recorder system sold to major testing installation for \$6,000—slightly more than one-third of conventional system.

Resulting pulse has a negative step-to-ground with a 2- μ sec fall time at the position of the knee. This pulse is then inhibited for its initial 10 msec. Duration of the remaining pulse is precisely measured, the company asserts, by gating it with a 100-kc clock pulses and using the counter to count and display the resulting number of clock pulses.

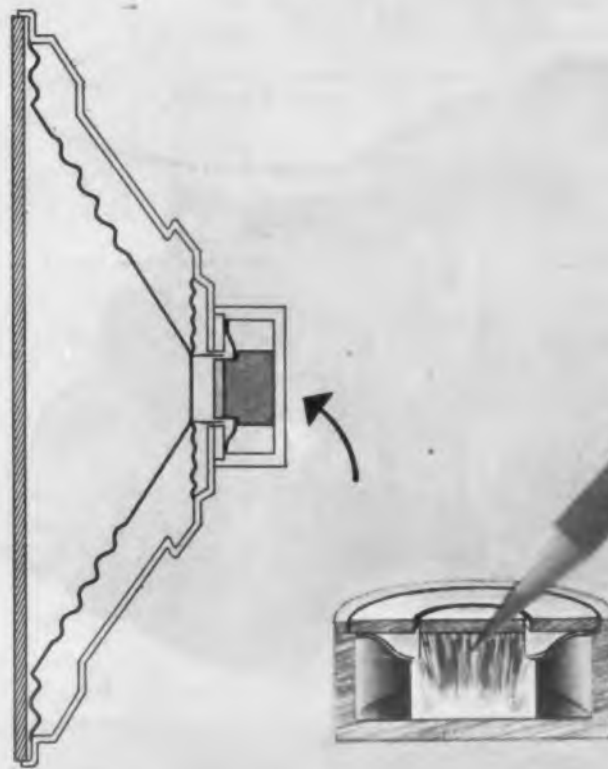
Recorder Reputed To Give More Accuracy Than Needed

Accuracy of Electro-Logic's strain-gage recorder in measuring the output of the strain-gage bridge circuit is within 0.2 per cent of full scale. This accuracy is about an order of magnitude greater than the SR-4 strain gages used in the system—they have a basic accuracy of about one per cent of full scale.

Installation of the new strain-gage record system for telemetering beam-deflection information is the first step in a kind of telemetering revolution, one industry source predicted. Amplifiers are a labor expense in multi-channel telemetering installations; elimination of this expense marks an appreciable cut in systems cost.

Mr. Van Praag points out other advantages to his system. "We are able to sample and hold, interrogate automatically or manually—choosing any channel of interest at any time, and set up limit alarms at little or no extra cost. A system using transponders is basically more reliable too: there is no multiplexer to malfunction and if one or more of the transducers gets out of whack, it is easy to detect and ignore. This is difficult with a multiplexer system." ■ ■

Magnetic Materials from General Electric



Compact G-E dual-diameter d.g. magnets give you a free hand in speaker design

General Electric dual-diameter, directional grain magnets clearly demonstrate that magnet size and weight are no longer any criterion of speaker performance. And, the reason is simple.

G-E engineers have purposely designed weight and size out of dual-diameter, directional grain Alnico 5 magnets by concentrating magnetic field energy within the area of voice coil travel. By combining the outstanding properties resulting from the G-E patented d.g. process with a design integrated to use these properties, a new level of efficiency at the higher levels of gap energy has been achieved.

In addition, smaller, lower cost pole pieces and return paths of powdered iron are now feasible in larger speaker sizes. Send for full technical information on G-E directional grain Alnico 5. And, for a freer hand on any magnetic design, turn first to: *Magnetic Materials Section, General Electric Company, 7820 N. Neff Blvd., Edmore, Michigan.*

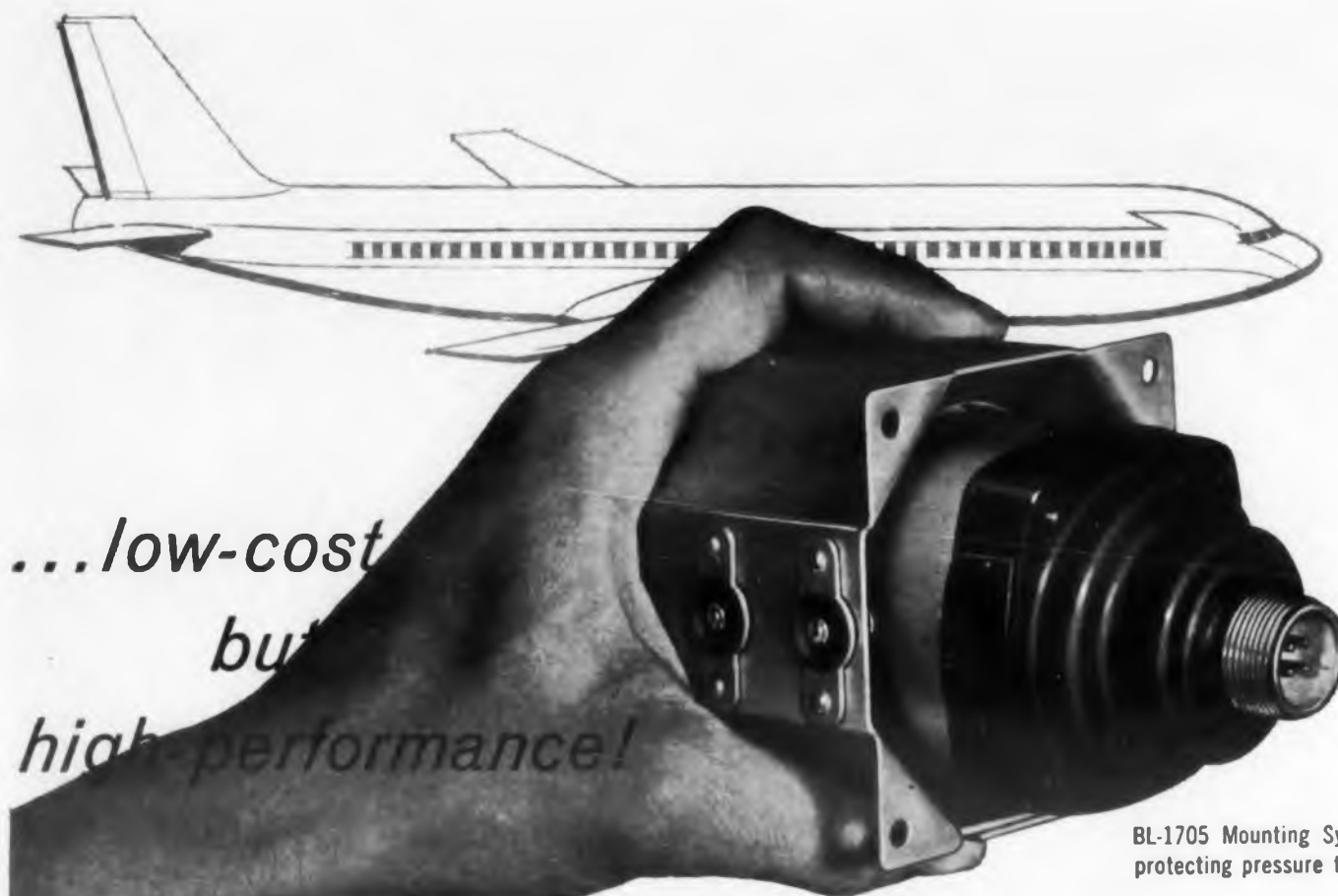


Compare these two Alnico 5 magnets for size. The smaller G-E directional grain Alnico 5 magnet at the right establishes air gap energy equal to that produced by the conventional Alnico 5 magnet at the left. Note the crystal orientation over the dual-diameter magnet volume.

MAGNETIC MATERIALS SECTION

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BL-1705 Mounting System — shown protecting pressure transducer.

vibration control for aircraft instruments

Here's a new Lord mounting system for small equipment or instruments on jet aircraft that offers big advantages!

It's versatile. Basic design is adaptable to a variety of units: transducers, indicators, electronic tubes, gages, warning and timing devices, baroswitches. Mounting arrangements permit use in instrument panel, nacelle or other airframe locations.

It's high-performance. Lightweight system provides excellent all-attitude control of high-frequency excitations plus attenuation of shock and structure-borne noise.

BTR® Elastomeric Mountings possess extreme environmental resistance, excellent damping, superior endurance, consistent performance over -65° to $+300^{\circ}$ F. range.

It's economical. Simplified design gives you Lord quality at a lower price than competitive bases. Long service life means your maintenance costs will be lower, too.

It's proved. The advanced design and performance of this Lord system have been thoroughly proved in actual service on today's jet airliners.

This mounting system is an example of Lord ingenuity. It indicates why you can continue to expect Lord to produce the best in vibration/shock/noise control for the aerospace environment. To put this ingenuity to work on your project, or to get further data on the BL-1705 base, contact the nearest Field Engineering Office or the Home Office, Erie, Pa.

FIELD ENGINEERING OFFICES

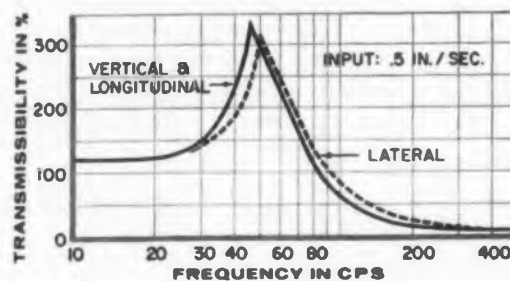
ATLANTA, GEORGIA - Cedar 7-9247
BOSTON, MASS. - Hancock 6-9135
CHICAGO, ILL. - Michigan 2-6010
DALLAS, TEXAS - Riverside 1-3392
DAYTON, OHIO - Baldwin 4-0351
DETROIT, MICH. - Diamond 1-4340
KANSAS CITY, MO. - Westport 1-0138

LOS ANGELES, CAL. - Hollywood 4-7593
NEW YORK, N. Y. (Paramus, N. J.)
New York City - Bryant 9-8042
Paramus, N. J. - Diamond 3-5333
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SAN FRANCISCO, CAL. - EXbrook 7-6280
WINTER PARK, FLA. - Midway 7-5501

"In Canada—Railway & Power Engineering Corporation Limited"

typical specifications

Application: pressure transducer. Weight: equipment — 1.2 lbs., base — .38 lbs. Shock/vibration protection: all-attitude. Isolators: four Special BTR Multiplane Mountings. System natural frequency: 45 cps. Operating temperature range: -65° to $+300^{\circ}$ F. Environmental resistance: unaffected by fungi, dust, sand, salt atmosphere, oil, ozone. Construction: center-of-gravity suspension, fail-safe. Mounting arrangements: clearance holes or clinch nuts for base, bulkhead or overhead attachment.



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CIRCLE 38 ON READER-SERVICE CARD

NEWS

Analog Computer Helps In

Simulates Kind of Equipment Which Needs Human Attention

A "PROBLEM-MAKING" analog computer and a control panel are helping scientists at Battelle Memorial Institute, Columbus, Ohio, to understand better the effects of automation on men who supply the necessary human element in complex man-machine systems.

The computer-fed control board is designed to simulate the kind of equipment which requires constant human attention in a man-machine system, according to Battelle technologists. For instance, the control board can simulate the conditions facing the operator of a radar alert system or of the complex controls used in a chemical-processing plant.

The control panel, in effect, demands that the operator remain constantly alert to answer three questions:

- Is the system operating as it should be?
- If it isn't, what correction should be made?
- Was action taken effective in correcting the system?

Capsule to Test Radiations

NASA-Launched NERV Capsule Traveled to 1,200-Mile Height

THE UNIQUE space radiation measurement vehicle launched by the National Aeronautics and Space Administration returned to earth with the record of going to a higher altitude than any other vehicle known in the free world to have been recovered from space.

The nuclear emulsion recovery vehicle (NERV), designed and developed by the General Electric Co.'s Missile and Space Vehicle Dept. of Philadelphia, traveled to an altitude of about 1,200 miles. It was launched on an Argo D-8 research rocket.

The vehicle was designed for measuring radiation intensity at various altitudes and for returning these measurements in physical form back to earth for study. The measurements were obtained by extending and exposing a nuclear emulsion package shortly after take-off and retracting it before the vehicle impacted.

The emulsion package registered the amount

Helps In Man-Machine Study

According to Battelle technologists, these questions are basic to automation problems, and they will have to be answered in the control of systems no matter how sophisticated machines become.

A man may be overworked with too many decisions and unable to do his part in a man-machine system, thus making the whole system ineffective. It is also pointed out that the man may not have enough to do. That is, the machine may require human decisions so infrequently that the operator becomes inattentive and fails to respond promptly when human action is required.

It is hoped that continued research may in time make it possible to understand what the desirable balance is between the work load of the machine and the man.

This equipment has been used for more than a year at the research center in a study sponsored by Wright Air Development Div.'s Aerospace Medical Laboratories—a component of the Air Force's Air Research and Development Command. ■ ■

Antennas Recovered from Space

of radiation in a manner similar to a photographic negative. The package contained a stack of 25 layers of a special emulsion 3-in. in diameter and 1/2-in. long. This was exposed from 300 miles above the earth to an altitude of approximately 1,200 miles and downward to about 600 miles above the ground.

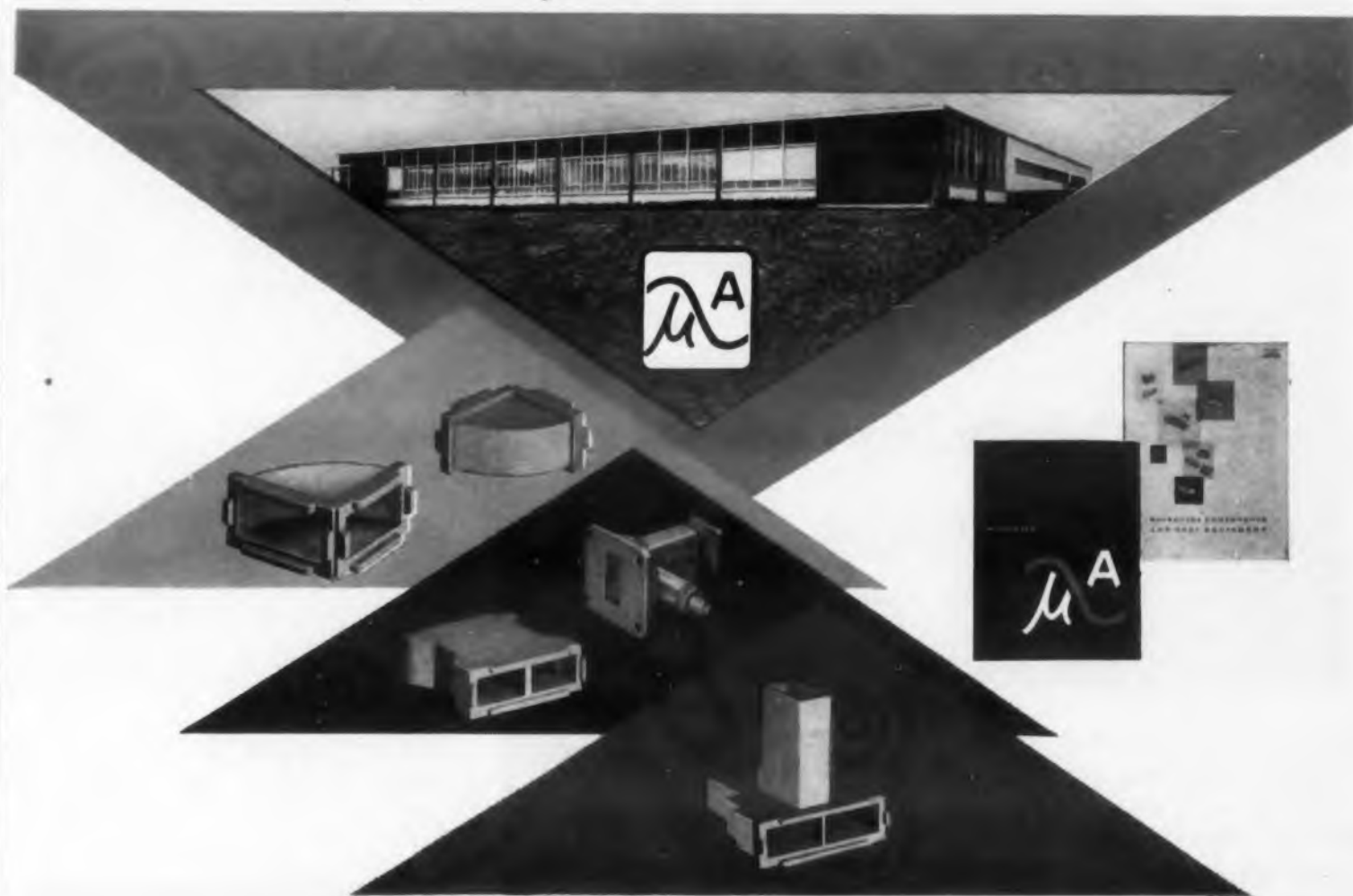
The nose cone housing the package and recovery system weighs 83.6 lb and has a diameter of 19 in. and a length of almost 17 in. The vehicle has a plastic ablation-type shield which protects its contents during re-entry by absorbing heat and vaporizing.

Measurements obtained of the Van Allen radiation belts surrounding the earth may help determine design factors involved in protecting man from radiation hazards in deep space flights.

NERV was developed for providing more accurate and more complete information than it has been possible to obtain with other types of radiation probes. Measurements made on the emulsion package cannot be read electronically and telemetered back to earth. ■ ■



COMPREHENSIVE
MICROWAVE COMPONENT
CAPABILITIES



This modern three-quarter-acre plant has significantly expanded the services and production capabilities of Microwave Associates' experienced Waveguide Components Division. This new research and production facility is one of the most completely equipped on the east coast. A large 3' x 2' capacity dip-brazing unit as well as complete plating and other shop facilities are now handling both large volume and custom-engineered orders. Components are precision-machined and produced in beryllium-copper, cast and fabricated aluminum, and cast magnesium.

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New High-Power Varactor Harmonic Generators — excellent suppression of unwanted harmonics and record power levels are available from these solid-state harmonic generators.

New Cast Bends — Zero bend radius — 90° E and H plane bends in S through Ka bands... Each bend is compensated to a VSWR of 1.05 over its entire waveguide band.

Sidewall Hybrid Couplers (3db) and H-Plane Folded Hybrid Tees — Cast in aluminum and beryllium-copper are available in S through Ka-band models.

Two New Catalogs — Waveguide Components Short-form Catalog (CSF-60) gives data on over 500 items of waveguide components and test equipment.

Pressure Window Catalog (12 pages) contains electrical and mechanical data on a complete line of glass-kovar, mica, and special pressure windows plus valuable installation and testing tips.

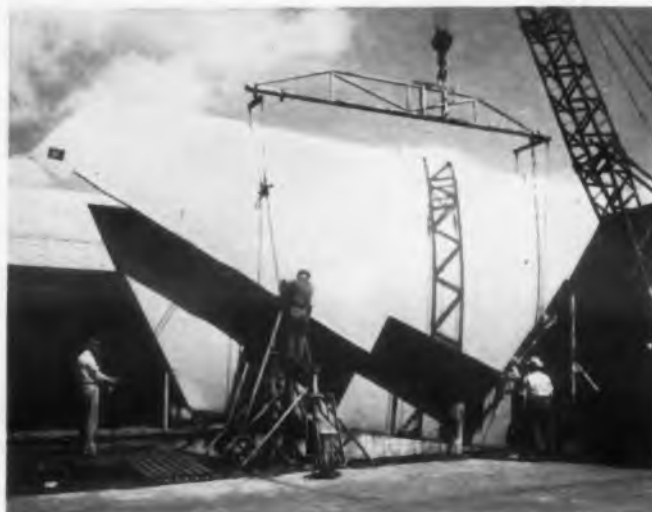
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The Fairchild Aircraft & Missiles Division's design and construction capabilities were acquired through long experience in successfully completing varied projects for industry. Just one of the many areas where Fairchild's proved abilities are at work is the production of major assemblies for the Boeing B-52 intercontinental jet bomber. Fairchild utilizes its diverse experience in bonding, plastics and metals to con-



struct honeycomb sandwich wing panels, magnesium laminated wing skins, tapered honeycomb trailing edges and honeycomb wheel and strut doors—many to critical tolerances.

Fairchild's broad facilities, its modern equipment and personnel experienced in the on-time design

and fabrication of systems, sub-assemblies and products, are available to you. Write today for detailed information.



Representative of Fairchild's diverse production capabilities are: VTOL/STOL projects • High flotation gear • Boeing B-52 assemblies • SD-5 surveillance system • Antenna and installation housing for Project Defender Pincushion radar • F-27 propjet • Aluminum boats, lampposts and bridges.



NEWS

Data-Processing Systems

New Unit Matches Human Operator To High-Speed Computers

An electronic unit which provides a display and control link between the human being and the high-speed data-processing or communications systems, has been developed by the Electrada Corp. of Beverly Hills, Calif.

Called the Electrada Datacom, the system accepts digital information at line speed, automatically translates it to ordinary alpha-numeric characters and presents a clear display on the screen of a cathode-ray tube. As the information is being displayed, the operator may approve its contents, or he may alter them in part or in total by striking a standard typewriter keyboard.

Both incoming and outgoing records are held in the Datacom display until the operator punches the send button, causing the unit to retranslate the information to coded form and transmit it automatically to the associated communication network or computer.

The unit is reported capable of receiving and sending digital data at speeds of approximately 3,600 characters per second. Datacom allows the operator to perform selective monitoring, correcting, editing, or rerouting of data. The operator may also compose, transmit, receive, correct and expand incoming messages, or send messages from prerecorded internally stored forms.

Unit Is Packaged In Desk-Size Console

The complete unit is packaged in a desk-size console. Display of incoming and outgoing data takes place in a high-brightness cathode-ray tube, the upper part of which shows the incoming information or message, while the lower part displays the revised or approved version which is to be transmitted. A magnetic storage drum with a capacity of 3,072 bits provides a display memory which stores the information for the upper and lower halves of the screen and holds them ready for editing or transmittal.

The drum uses transistor read-write circuits and contains an engraved clock track to prevent accidental clock erasure. Larger size storage memory drums can be provided to fit any specific application.

Circuit design is flexible in order to allow incorporation of the Datacom in any existing data-processing or communications system. The

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Fairchild Engine & Airplane Corp. • Hagerstown, Maryland

CIRCLE 40 ON READER-SERVICE CARD

Edited With Datacom

following auxiliary devices will greatly extend its range of application:

- A photographic printer for high-speed automatic photographic recording of all messages received and transmitted.
- A high speed Electronic Printer to provide instantaneous hard copy of received and transmitted messages.
- A buffer memory which accumulates messages during periods of peak activity and then automatically releases these messages to the operator.
- A Buffer Storage Adapter which changes the reception and transmission rate from the normal rate of the Datacom to the rate of the external equipment. ■ ■

Ultrasensitive Ranger Altimeter To Detach Capsule for Moon Landing

An altimeter to tell the projected Ranger space craft when it is within 20 to 25 miles of the moon is being built by Ryan Electronics Co., San Diego.

At this distance from the moon, a signal from the altimeter will cause a capsule to be detached from the rocket. The detached capsule will be slowed by retro-rockets to a speed of less than 300 mph before it hits the moon's surface.

The altimeter, its antenna, and support structure, will be in the main body of the space craft, and will be destroyed with it upon impact with the moon at more than 5,000 mph.

Photo-Control System Developed



This automatic photo-control system for use in reconnaissance aircraft or drones has been developed by U.S. Science Corp., Los Angeles. An operator or pilot can give remote control to photography with the system, which weighs under 25 lbs. Computer inputs are ground speed, altitude, camera constants, and depression angle. Outputs make corrections, set the lens, and take exposures from up to 50,000-ft altitude.



The Avnet System

creates a new Concept of Supply

Avnet's supply of electronic components is vast. At this moment, for example, Avnet's total inventory of connectors is somewhere over 4 $\frac{3}{4}$ million. The Manufacturers whose lines Avnet assembles and/or makes available are in constant awareness of your present and future requirements. The Avnet System is geared to meet your demands of tomorrow, next month, next season, because unique Customer-Avnet-Manufacturer planning goes on daily.

This new Concept of an overwhelming Supply is one of many advantages in The Avnet System. Avnet maintains a network of Sales Engineers traveling the U.S. Each engineer has his counterpart in a Service Center Expediter. Tremendous stocking facilities are maintained strategically throughout the country. Avnet maintains and operates complete assembly facilities for Connector Prototype requirements. For the most reliable, most constant, steadiest source of Supply, contact your nearest Service Center in The Avnet System.

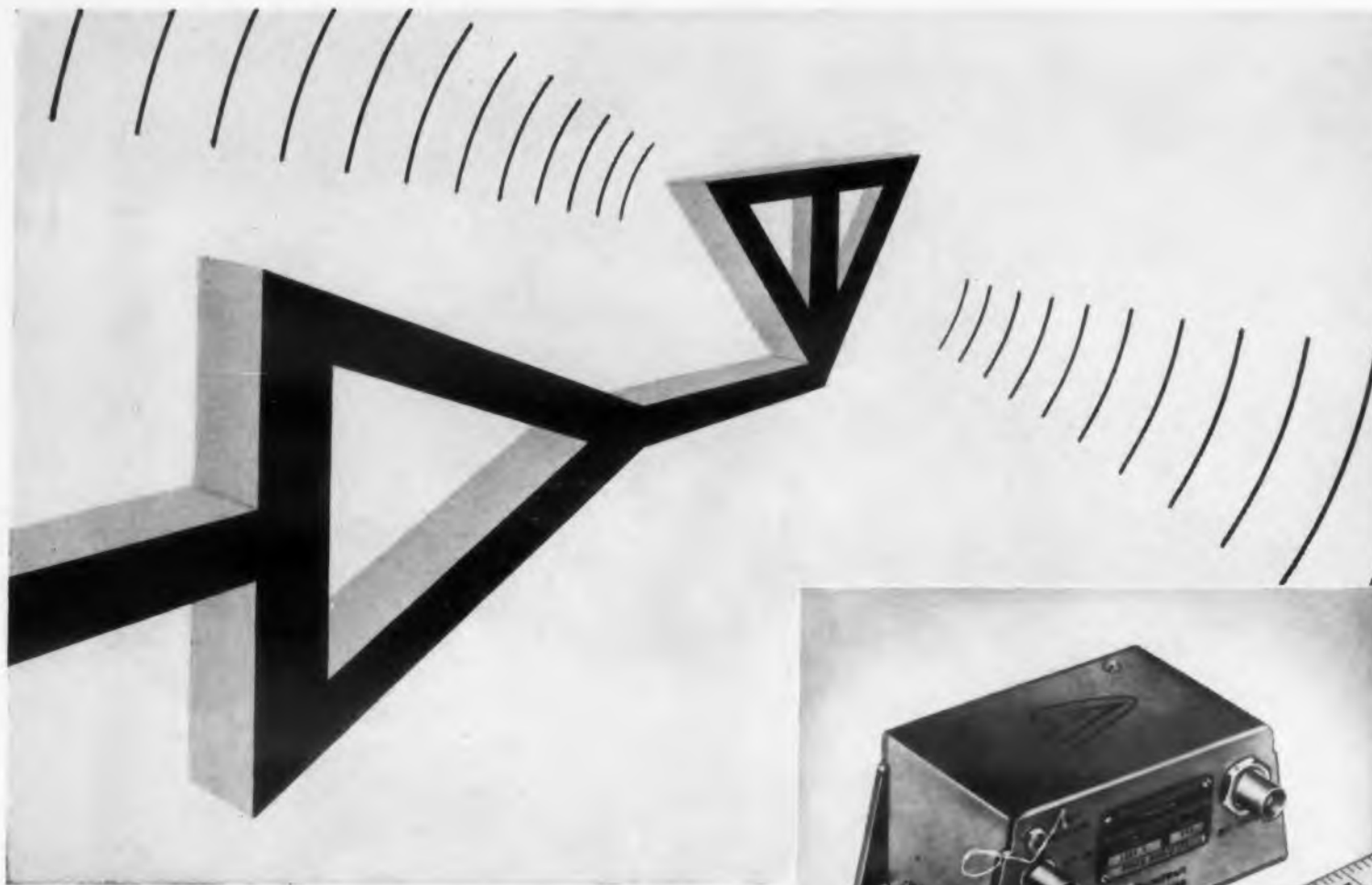
AVNET



THE AVNET SYSTEM
Men / Methods / Materials / Management
AVNET ELECTRONICS CORP.

Avnet Service Centers and Stocking Facilities are located in Los Angeles, Cal.; Sunnyvale, Cal.; Chicago, Ill.; Dayton, Ohio; Westbury, L. I.; Burlington, Mass.

Avnet distributes from its stocking facilities: BENDIX SCINTILLA CONNECTORS, SPERRY SEMICONDUCTORS, RHEEM SEMICONDUCTORS, ELECTROSNAP AND HETHERINGTON SWITCHES, GREMAR CONNECTORS, CLARE RELAYS, ROBERTSON SPLICE & CONNECTOR CASES, BABCOCK RELAYS, KING SUBMINIATURE HI-TEMP CERAMIC CAPACITORS, TIC PRECISION TRIMMERS, VIBREX FASTENERS by GENERAL TIRE & RUBBER CO., U. S. SEMCOR SEMICONDUCTORS, SANGAMO CAPACITORS, SPRAGUE CAPACITORS
CIRCLE 41 ON READER-SERVICE CARD



OPERATION BIG BOOST

Here is *the* amplifier when distance is a critical factor in obtaining usable signal levels at the receiving station. It is Tele-Dynamics' Type 1114—a new compact rf power amplifier weighing only 14 ounces, for missile, probe or satellite transmitters to give the final boost for good signal reception.

Performance of Type 1114 is reliable and impressive. When used in conjunction with Tele-Dynamics' 1004 transmitter it delivers 15 watts power output with 250 volts at the plate. It is easy to drive and requires no auxiliary cooling system.

This miniaturized model is completely shielded, provides tuned input and output, has excellent heat-sink characteristics and is ruggedly built throughout to operate with complete reliability under severe environmental conditions.

You can get this new amplifier in two models, for

either 6.3 or 28 volt filament—each available with either integral output filter . . . integral output filter plus integral line filter . . . or without any filters.

The 1114 is ready for immediate delivery. Detailed technical bulletins and evaluation models are available. Please call the American Bosch Arma sales office in Washington, Dayton or Los Angeles. Or contact Tele-Dynamics Division, American Bosch Arma Corporation, 5000 Parkside Avenue, Philadelphia.

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Commutators—Mechanical and Electric • Pulse-Width Modulators • Subcarrier Oscillators • Wideband Amplifiers • Transmitters • Power Amplifiers • Receivers • Discriminators • Decommunators • Receiving Systems Accessories • Guidance Receivers

7005

TELE-DYNAMICS

AMERICAN BOSCH ARMA CORPORATION

CIRCLE 42 ON READER-SERVICE CARD

NEWS

Continuous Operation of Machines Monitored by New German Device

A German designed device recently introduced here continuously monitors the operation of factory machines. The device, called Productograph, indicates whether a machine is operating and how many parts it handles. It does this by recording pulses from a transducer on the machine.

The type of transducer employed in the operation—microswitch, relay, flow-meter, photoelectric cell, etc.—depends on the type of machinery being monitored.

Failure of the machine to operate—whether due to mechanical malfunction, lack of items for processing, or necessity to change tools—is automatically displayed as a colored light and as a blank interval in the graph of the pulse train as recorded by a pen-writer.

The machine operator then pushes a button to describe the cause of machine shut-down. There are five buttons for five common causes. The production-control operator is then in a position to determine the cause from the color and position of a light actuated through relays by the button.

The number of parts handled by each machine is a function of the number of mechanical cycles the machine goes through. Hence, the transducer-produced pulses are fed to binary counters and an electrically-driven bar graph to indicate production.

The production monitor is being marketed in the United States by Farrington Manufacturing Co., Needham Heights, Mass. It was invented and developed by Josef Mayr, president of Mayr Electrotechnische Fabrik, Erlangen, West Germany.



Microswitch at center produces pulses in accordance with movements of the machine. Pulses indicate how many mechanical cycles machine goes through and hence how many pieces it handles. Absences of pulses indicates machine has stopped.

Six Manufacturers Kick Off Traveling Show on Long Island

Trends towards higher accuracy, better reliability, easier operation, and lower prices are among the key features that instrument users will look for, according to Ivan Easton, vice president of General Radio Co. Speaking at the first Electronic Instrument Manufacturers' Exhibit, at Roosevelt Field, Garden City, N.Y., Mr. Easton highlighted the strong appeal of digital-readout instruments but warned against the tendency to mistake higher readability for higher accuracy.

The most emphatic need, which was stressed by all six speakers at the exhibit on Long Island, is for greater and greater reliability in instrumentation. But another need—for approaching "ultimate" accuracy—was brought to light by H. Russell Brownell of Sensitive Research Instrument Corp.

Though in many fields of measurement the National Bureau of Standards has made rapid strides, he told the meeting, NBS has made no important advances in the basic measurement of voltage for 40 years.

Though comparison techniques in measuring voltage have improved greatly, Mr. Brownell said, the agency has no real prospect of major advances now. NBS is working hard on today's measurements. Because of this pressure, it has little time or manpower to devote to tomorrow's measurements.

The traveling exhibit is sponsored by six manufacturers: FXR, General Radio, Lambda Electronics, Panoramic Radio, Sensitive Research, and Tektronix. During October, the exhibit moved from Garden City to Norwalk, Conn. to Poughkeepsie, N.Y., to Cedar Grove, N.J. and finally to Moorestown, N.J.



Easton meets Weston at Electronic Instrument Manufacturers' Exhibit. Ivan Easton (vice president of General Radio Co.) and Simeon Weston (executive vice president of Lambda Electronics Corp.) discussed problems in reliability. Both manufacturers were pioneers in long-term instrument guarantees—General Radio with its two-year guarantee, and Lambda with its five-year guarantee.



NEW Corning wafer capacitors run from 1 to 10,000 uuf

Uuf for uuf the smallest, most stable capacitors you can get for printed circuits and high reliability components.

Never has so much capacitance been crammed into so little space with so much ruggedness and reliability.

The smallest gives from 1 to 560 uuf while resting in a space only 0.00204 cubic inch in volume.

The largest runs from 4301 to 10,000 uuf and takes up only 0.02106 cubic inch.

You sacrifice nothing for size. The flat shape gives you more options in mounting, e.g., slot or flat mounting in printed circuits.

When you need leads we can provide those too, in $\frac{3}{16}$ -inch lengths, in the WL series.

These capacitors are rugged and reliable. The dielectric and conductor layers are fused at high temperatures and need no encasement. You'd almost have to smash one completely to stop its operation. Meets or exceeds the performance requirements of MIL-C-11272A.

For complete specs write for a new 4-page bulletin to Corning Glass Works, Dept. 540, Bradford, Pa.

Capacitor	Capacitance (uuf)	Volume (approx.)
W, WL-5	1 to 560	0.00204 in. ³
W, WL-4	561 to 1000	0.00327
W, WL-3	1001 to 2700	0.00702
W, WL-2	2701 to 4300	0.01951
W, WL-1	4301 to 10,000	0.02106



CORNING ELECTRONIC COMPONENTS

CORNING GLASS WORKS, BRADFORD, PA.

CIRCLE 43 ON READER-SERVICE CARD

NEWS

Teachers Go Back To School To Learn Computer Techniques

Some 70 professors and deans of engineering colleges have been hard at work learning how best to present computer techniques to undergraduate engineering students. The studies have been conducted at the Ford Foundation Computer Workshop at the University of Michigan.

Last fall the Ford Foundation granted \$900,000 to the university for a three-year study of the use of computers in undergraduate engineering instruction. Under the direction of Prof. D. L. Katz, the workshop for engineering professors is one of many scheduled during the program.

During these workshops, the professors are introduced to high-speed computers, the procedural languages used in computers, how to write equations in computer language, and how to present problems to computers. They also have to solve problems with computers to demonstrate what they have learned and to "get the feel" of computer solution of engineering problems.

Detectors Count Space Radiation



How much radiation man will meet in space will be measured by cigar-size detectors in an experiment conducted by the Air Force. The detectors, packaged with signal-amplification units in small cylinders, will be carried in simulated space-crew cabins in high-altitude balloon ascents and in Atlas ICBM space flights. The detector, developed by Hughes Aircraft Co. of Culver City, Calif., is essentially a thin slice of silicon. When struck by charged nuclear particles, it emits pulses which are fed to a telemeter system inside the space vehicle by the detector package's amplifier. The telemeter system transmits the signals to receiving stations on earth as the vehicle moves through space.

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1.5 to 1.8 amps, basic Model VT2



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Fixed, VT2, VT4, VT8



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Portable, VT4, VT8



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SPECIAL FEATURES

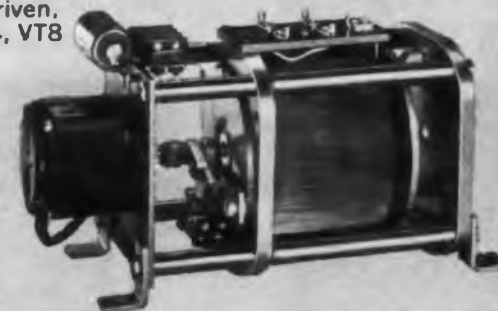
Tandem Combinations, VT2, VT4, VT8



Multi-Tap, VT2, VT4, VT8



Motor Driven, VT2, VT4, VT8



IMMEDIATE DELIVERY

From Distributor and Factory Stocks



Thirty-eight different types, including individual transformers, two-in-tandem, three-in-tandem, cased, low-voltage, single-phase, three-phase, fixed mounting, portable and accessories.

VARIABLE TRANSFORMERS

FROM 1.5 TO 10 AMPS

LOW VOLTAGE High Current

36 volts,
5 amps,
basic Model
VT2LN



36 volts,
12 amps,
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VT4LN



36 volts,
22 amps,
basic Model
VT8LN



UL APPROVED



At the present time, Model VT8 carries the UL label. Model VT4 is undergoing final tests, and VT2 will be submitted soon.

CUSTOM ENGINEERED

Double Track
Transformer



With
Rheostat



Motor-driven tandem
assembly with
reciprocating motion



Whether your special needs are mechanical or electrical, simple or complex, Ohmite can engineer and manufacture the job in any quantity you desire. Units shown above are typical examples.

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Rheostats • Power Resistors • Precision Resistors
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OHMITE



Swiss Surveillance Radar System Uses Remote Microwave Relays

Two new air-traffic control radar systems now being installed to cover Switzerland's major air routes will mark the country's first use of microwave relay links for remote control of all operating functions.

Radar transmitter-receivers for Geneva-Cointrin airport will be located atop 5,500-ft Mt. La Dole 16 miles away. The radar pedestal weighing several thousand pounds, the giant 40-ft-wide antenna, and the microwave relay equipment will be taken up the last 1,500 ft of the mountain by cable car. For the Zurich-Kloten airport installation, a concrete structure 60-ft high will be erected on a hill about 7 miles away.

These long-range radars, produced by Raytheon Canada, Ltd., are similar to those used in the nation-wide networks in Canada and the U.S. They provide a number of features suited to meet Switzerland's needs. Moving target indication will overcome the problem of ground clutter encountered in mountainous terrain.

Other features available to the operator include circular polarization to reduce the signal return from rain, and a video integrator which strengthens weak signals while suppressing interference from other radars operating on similar frequencies. Additional means available for reducing ground return and other types of interference are FTC, STC and IAGC.

Another aid to the flight controller is electronic video mapping. The map displayed on the PPI changes automatically so as to maintain correct relationship with the radar targets when the range is changed or the display is decentered.

Data gathered by the radars will be relayed to scopes located in control centers at both airports. Of particular interest is the fact that the relays will permit remote control of the radars from the airports. At each of the control centers, 7 and 16 miles from their respective radar sites, operators will remotely monitor and control more than 70 radar functions with a time lag of less than 0.1 sec.

Remote Computer Control Planned At Carnegie Computation Center

Remote control of a central computer unit from various laboratories of Carnegie Institute of Technology will be provided by a Bendix G-20 computer now being installed.

Output equipment will also be available in various buildings on the campus. The Carnegie Computation Center is used by science and engineering students.

CIRCLE 44 ON READER-SERVICE CARD



BANDOLUG®

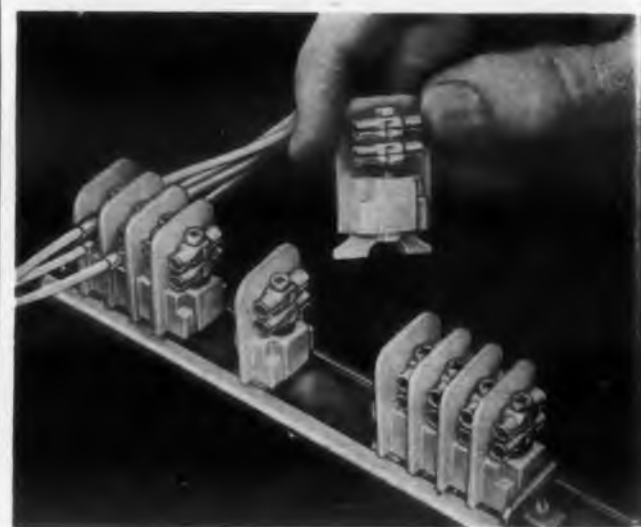
high speed automatic
harness fabrications

high production rate—up to
1000 per hour...one machine
installs all size and tongue
variations on wire sizes #26-#12
...stud holes from 2 thru 3/8"...
minimum operator training
and maintenance

*Burndy INSULUG® is insulated, pure
electrolytic copper...meets or exceeds
requirements of MIL-T-7928C...
accommodates full range from #26-2/0*

NEW PRODUCT

Modular Terminal Block



The Burndy Corporation, Omaton Division, has available for immediate delivery its terminal block development, MODULOK®, which employs the principle of crimp-type, snap-in contacts, combined with the convenience and versatility of modular design. Individual modules, molded of Zytel 31, a nylon compound having extremely low water absorption characteristics, can be snapped together or apart. These modules are inserted into separate steel tracks up to 32 inches in length, and are secured in place by end locks. MODULOK has found wide application in early warning systems, missile ground control systems, and associated fields.

Modules are available with either 2- or 4-tier spring-loaded sockets which may be set for quick-disconnect for rapid ring-out, bussing, or circuit changes. A twist of a screwdriver transforms the quick-disconnect into a permanent connection. Up to 30 modules per foot of track can be accommodated. The unique spring-loaded, cup-shaped sockets exert continuous, uniform pressure in either position. Contact tips are the solderless crimp-type applied to wire ends.

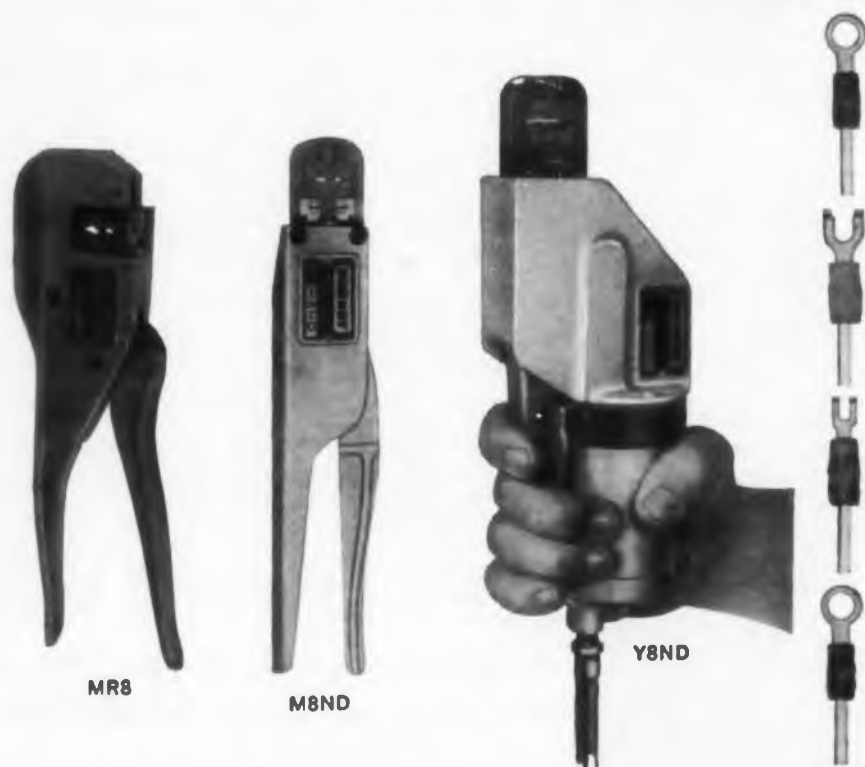
The Burndy tool-installed solderless crimp-type connection provides reliable compression connections with quality control built into the tooling. Since no fluxes or dissimilar metals are involved, the Burndy connection provides high corrosion resistance.

Burndy Corporation, Norwalk, Connect.

CIRCLE 46 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

HYDENT® TERMINALS with MATCHING INSTALLATION TOOLING



HYTOOL®

bench-mounted and
manually-operated

ratchet or full cycling control
guarantees uniform, complete
crimp on each installation...
on MR8, one die set with
multiple grooves designed for
conductor sizes #26-#10...
M8ND & Y8ND have remov-
able and interchangeable dies
and same basic tool may also be
used for HYFEN®, STAPIN®,
and MODULOK® contacts.

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CIRCLE 45 ON READER-SERVICE CARD

EDITORIAL

Growing Up to Scaling Down

In a few short years, considerable gains have been achieved in reducing the size of electronic packages. Even more remarkable gains are to be expected as functional blocks, rather than discrete components, become available to the design engineer.

Unfortunately, many optimistic promises for the future have been heralded with a deceptive timetable. It is inaccurate to consider availability of a single wafer or block as a final step towards the realization of a gain in microminiaturization. Far too few touted schemes are concrete in terms of a practical working system.

During interviews with physicists, scientists, and engineers responsible for many leading approaches, a trend to underestimate serious problems was apparent. Heat dissipation, structural soundness, and cross coupling effects were regarded as problems for the customer or systems engineer to overcome.

Cost of micromin assemblies will obviously depend on the degree of mechanization which can be applied during fabrication. Yet, approaches with poor automation potential continue to appear. To gain acceptance for industrial and consumer applications, price must be reduced by automation.

Interconnections between tiny blocks or wafers represent a most serious stumbling-block to the entire micromin effort. For this reason, it is common to see pictures of individual assemblies placed near paper clips, pencils, or coins; complete system photos are rather rare indeed.

At a panel discussion on microminiaturization at WESCON this year, this question was offered from the audience—"How will interconnections be solved?"

After a short huddle, a spokesman for the device manufacturers replied—"It's up to the systems engineer to work out the answer."

"But I'm one of the many systems engineers depending on you people to guide us!" came the disgruntled reply from the floor. Polite smiles and shrugs ended the point under discussion.

Heat dissipation is another factor which is rarely discussed when high packing-density figures are presented. Yet, Arthur P. Stern of GE's Electronic Laboratory, at a recent NEC session, pointed out how a component packing-density figure was reduced from 150,000 to 90 components per cubic inch when temperature rise was considered.

To bring the wonders of microelectronics closer to reality, key problems must be faced and overcome, not ignored. Reducing the size of electronic assemblies cannot be accomplished by thinking small.

Howard Bierman

**0.1% Accuracy—
thousands of units
now in use!**



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UNIVERSAL IMPEDANCE BRIDGE

First choice of leading companies and laboratories—thousands of units now in use. A self-contained, line-operated portable that measures impedance elements at dc and audio frequencies with laboratory accuracy. Resistance to 0.1%, seven ranges; Capacitance to 0.2%, seven ranges; Inductance to 0.3%, seven ranges. Simple in-line readout and 12,005 dials of resolution at your fingertips with the exclusive ESI DEKADIAL®. This is the bridge that has been the industry pacesetter since introduction—probably the most imitated portable on the market today. Write for Catalog C-16.

Model 250-DA, \$565. Model 250-C1, battery-operated, \$375 (ac detector \$200 additional). Immediate delivery. Prices f.o.b. factory.



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CIRCLE 47 ON READER-SERVICE CARD

Choosing Optimum DC Supply Voltage Minimizes Power Dissipation



The additional design step of calculating an optimum supply voltage, rather than merely an adequate one, pays off in minimal power dissipation in resistors through which the supply voltage is fed. Richard W. Hofheimer describes here how a simple formula can help one select the optimum supply voltage.

Richard W. Hofheimer
Non-Linear Systems, Inc.
Del Mar, Calif.

THE PROPER CHOICE of dc power supply voltage minimizes power dissipation in many circuits, such as flip-flops, logic circuits, and oscillators. This optimum supply voltage will be shown to depend only on the level, amplitude, and duty cycle of the associated signal voltages.

The general formulas used in designing for

minimum power dissipation are conveniently developed with the typical AND circuit shown in Fig. 1a. The circuit's output waveform, shown in Fig. 1b, has a voltage amplitude V , and upper voltage level E_1 with respect to ground, and a duty cycle K , defined by the equation.

$$K = \frac{t_1}{t_1 + t_2} \quad (1)$$

If the current, i , through resistor R has a value

I whenever the output voltage is E_1 , then one can readily see that

$$R = \frac{E - E_1}{I} \quad (2)$$

Power Equation is Starting Point

What are optimum values for E and R corresponding to minimum power dissipation in R ? To answer this, consider first an equation for the average power P dissipated in resistor R .

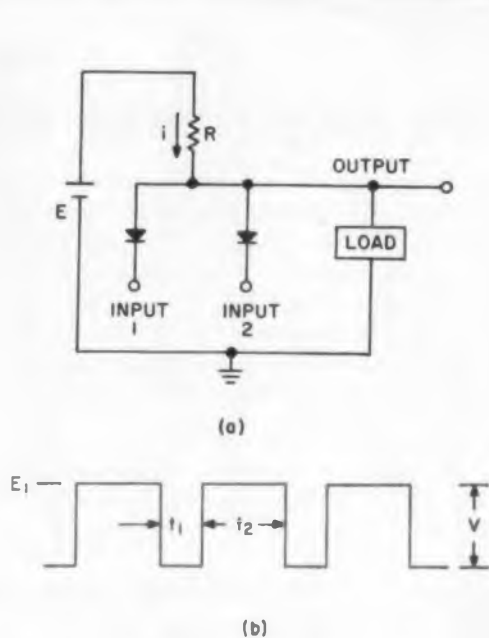


Fig. 1. (a) The typical AND circuit used to derive formula for optimum supply voltage. (b) Output waveform of the AND circuit.

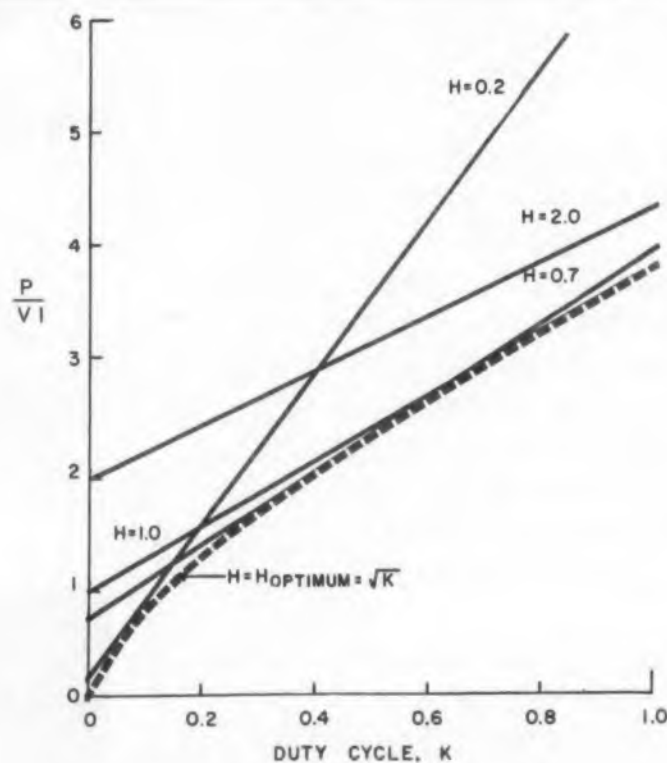


Fig. 2. Plots of P/VI vs duty cycle of signal waveform, for various values of a parameter H that reflects difference between supply voltage and maximum signal level.

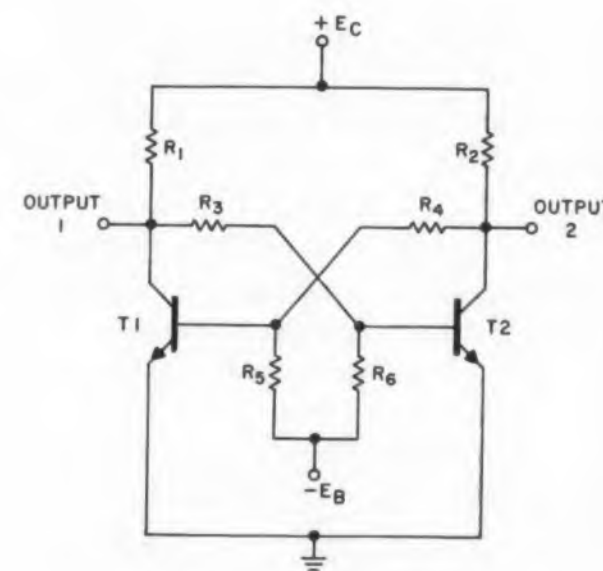


Fig. 3. The typical flip-flop circuit used as an exam of how to choose optimum supply voltage, E_c .

$$P = K \frac{[E - (E_1 - V)]^2}{R} + (1 - K) \frac{(E - E_1)^2}{R} \quad (3)$$

Substituting Eq. 2 in Eq. 3 gives

$$P = KI \frac{(E - E_1 + V)^2}{E - E_1} + I(1 - K)(E - E_1) \quad (4)$$

Eq. 4 can be written

$$\frac{P}{VI} = K \left[\frac{E - E_1 + V}{E - E_1} \right]^2 + (1 - K) \frac{E - E_1}{V} \quad (5)$$

$$\text{Define } H = \frac{E - E_1}{V} \quad (6)$$

and substitute in Eq. 5. Then

$$\frac{P}{VI} = K \frac{(H + 1)^2}{H} + (1 - K)H \quad (7)$$

This simplifies to

$$\frac{P}{VI} = 2K + \frac{K}{H} + H \quad (8)$$

If Eq. 8 is differentiated with respect to H , and set equal to zero, H for minimum power dissipation is found to be

$$H_{\text{optimum}} = \sqrt{K} \quad (9)$$

The optimum value for E is then

$$E_{\text{optimum}} = E_1 + V\sqrt{K} \quad (10)$$

Optimum Voltage Independent of I and R

Eq. 10 is the desired formula, relating the optimum value of supply voltage to the level, amplitude, and duty cycle of the signal waveform, independent of the values of I and R .

By substituting Eq. 9 in Eq. 8, the minimum value of the ratio P/VI is found to be

$$\frac{P_{\text{min}}}{VI} = 2(K + \sqrt{K}) \quad (11)$$

The corresponding value for R is found by substituting E_{optimum} in Eq. 2.

In circuits with varying duty cycle, as in computers, a compromise value for E must be used. Fortunately, compromise values can be found that yield near-minimum dissipations no matter how the duty cycle varies. These values can be determined graphically.

Fig. 2 is a plot of P/VI versus K for various values of H (Eq. 8). Also on the same graph is a plot of P_{min}/VI versus K (Eq. 11). The curve for P_{min}/VI is the lowest and only non-linear curve on the graph.

Several H Values Acceptable

The problem, then, is to find the value of H in Eq. 10 that yields the best straight line approxi-

In Arctic cold...

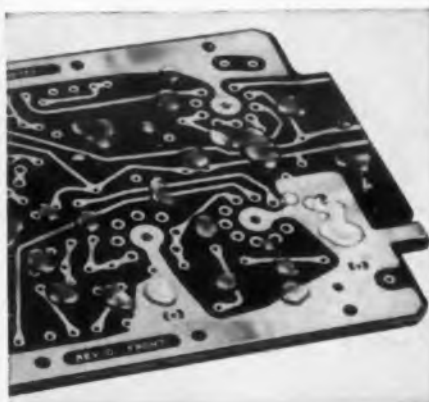


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mation to the curve of Eq. 11. One can use Fig. 2 to select an appropriate value of H .

Inspection of Fig. 2 shows that all values of H between about 0.7 and 1.0 yield satisfactory approximations. It is also apparent from the curves that values of H outside this range produce a waste of power.

As an example, consider the AND circuit of Fig. 1. Assume the logic levels of the input signals are -3 and $+7$ referred to ground. The swing V is, therefore, 10 v and the level E_1 is $+7$ v. From Eq. 6 then,

$$E_{optimum} = 10H_{optimum} + 7 \quad (12)$$

But we have determined from Fig. 2 that any value for H between 0.7 and 1.0 is satisfactory. Therefore $E_{optimum}$ to give minimum power dissipation in R can be any voltage between $+14$ and $+17$ v.

The foregoing considerations also apply to the design of OR circuits.

Equation Useful for Flip-Flops

One of the most elegant and useful applications of Eq. 10 is in the design of flip-flops.

Refer to Fig. 3 and assume, for a moment, that the flip-flop is triggered so the transistors have equal on-and-off-times. In this case the duty cycle K , which applies to the output waveforms, is 0.5.

However, if R_1 and R_2 are equal, the power dissipated in both of them is constant, no matter how the flip-flop is triggered.

Therefore, if R_1 and R_2 are considered together, the value of K to be used in Eq. 10 is precisely 0.5, even if triggering of the flip-flop is random in time.

If the flip-flop of Fig. 4 is saturated, and the amplitude of the output swing is V , the E_1 in Eq. 10 also equals V because the emitters are grounded. Eq. 10 now is written

$$E_{o\ optimum} = V + V \sqrt{0.5} = 1.707 V \quad (13)$$

Note that this value for $E_{o\ optimum}$ is independent of any values of resistance.

Base Supply Voltage Not Optimized

Similar consideration can be applied to determining $E_{b\ optimum}$. However, this is not usually

STORAGE TIME:

done because the power dissipated in resistors R_5 and R_6 generally is much less than that in R_1 and R_2 . Also, other flip-flop design considerations often preclude the use of the optimum value for E_b .

If E_c optimum is used, the corresponding minimum power dissipated in both resistors R_1 and R_2 is

$$P_{min} = 3.414 \frac{V^2}{R_1} = 3.414 \frac{V^2}{R_2} \quad (14)$$

It might seem that substituting a sine wave for the rectangular wave in Fig. 1 would require nothing more than choosing the value 0.5 for duty cycle K , and using the formulas already developed. This, however, is not the case.

Get Different Equation for Sine Wave

Referring to Fig. 1, but assuming the output to be a sine wave the instantaneous power dissipated in R is

$$P_{inst} = \frac{\left[E - \left(E_1 - \frac{V}{2} + V \sin \omega t \right) \right]^2}{R} \quad (15)$$

where E_1 is the voltage level of the top of the sine wave, and V is the peak-to-peak amplitude.

Combining Eq. 15 with Eqs. 2 and 6 gives

$$\frac{P_{inst}}{VI} = \frac{\left(H + \frac{1}{2} - \frac{1}{2} \sin \omega t \right)^2}{H} \quad (16)$$

Integrating Eq. 16 over one cycle of the sine wave, and dividing by 2π gives

$$\frac{P_{average}}{VI} = 1 + H + \frac{3}{8H} \quad (17)$$

Differentiating Eq. 17 with respect to H and setting it equal to zero gives

$$H_{optimum} = \frac{1}{2} \sqrt{\frac{3}{2}} \quad (18)$$

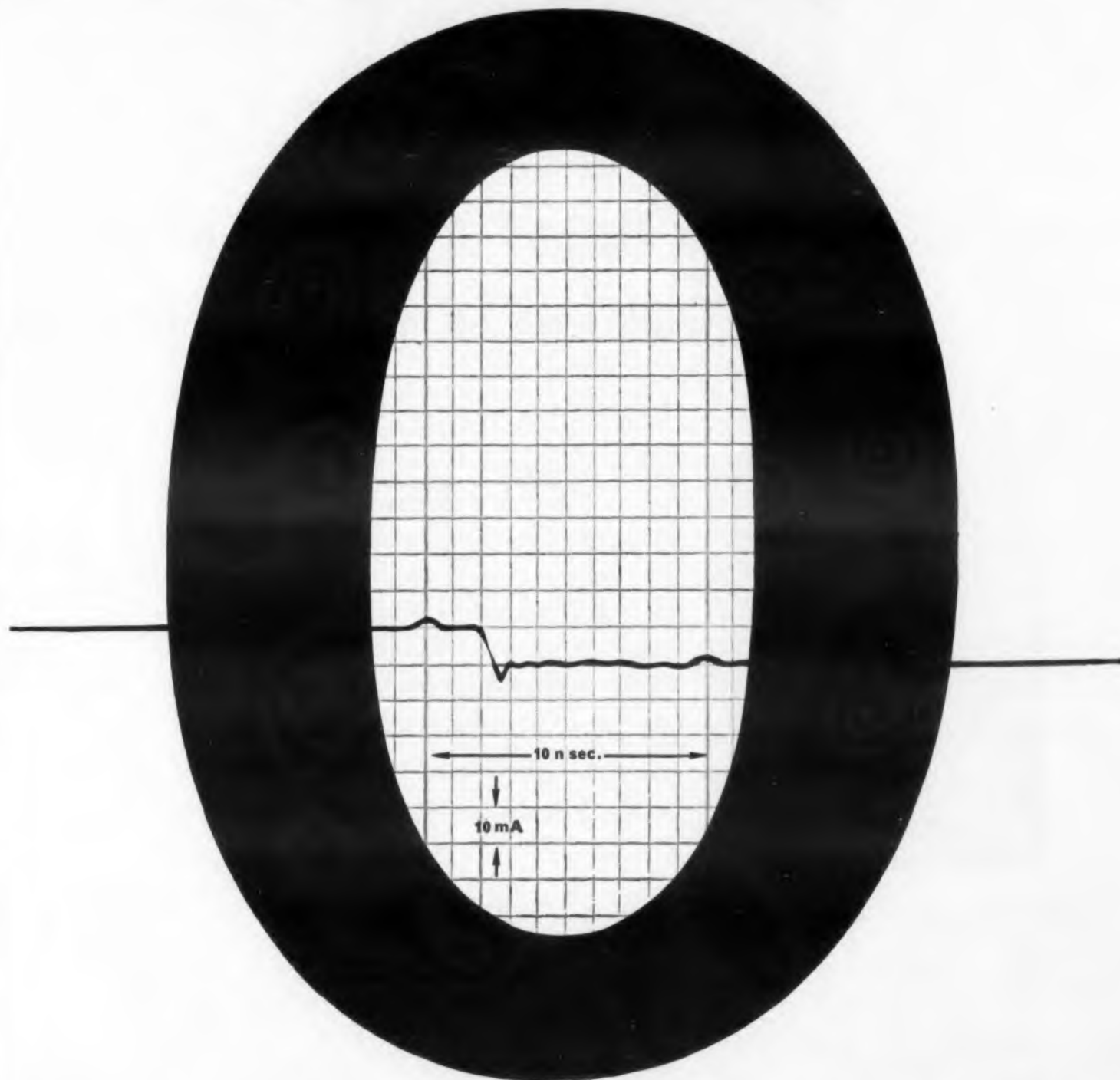
from which

$$E_{optimum} = E_1 + \frac{V}{2} \sqrt{\frac{3}{2}} \quad (19)$$

Eq. 19 should be useful in the design of oscillators and other circuits in which the sine-wave amplitude is constant or nearly so.

The minimum value of $P_{average}/VI$ can be found by substituting Eq. 18 in Eq. 17. This gives

$$\frac{(P_{average})_{min}}{VI} = 1 + \sqrt{\frac{3}{2}} \quad (20)$$



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Type	$I_F @ 1V$ (mA)	$E_S @ 100\mu A$ (volts)	$I_S (\mu A)$ @ 25°C	$I_S (\mu A)$ @ 100°C	Recovery n sec.
HD 5000	5	20	0.2	2.0	<0.5
HD 5001	5	20	1.0	10.0	<0.5
HD 5002	2	20	0.2	2.0	<0.5
HD 5003	2	20	1.0	10.0	<0.5
HD 5004	2	15	1.0	20.0	<0.5

The recovery circuit uses a high-speed sampling scope and attachments. The switching is 10 mA forward to 6V reverse; recover to 1mA reverse. Loop impedance is 100 ohms. Typical capacitance: 0.8 pf. Typical rectification efficiency: 80% at 100 Mc.

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$$V = V(1 - e^{-t/T})$$

A Quick Method of Selecting Minimum Time Constants for Time Base Functions



When is a segment of an exponential function a ramp? Never! But it can come very close if the time constant of the circuit used to approximate the ramp is chosen correctly. William Wagner describes here how the minimum time constant may be chosen in a few simple, swift steps. The author systematized a normally tedious process while designing airborne test instruments for recording various quantitative data.

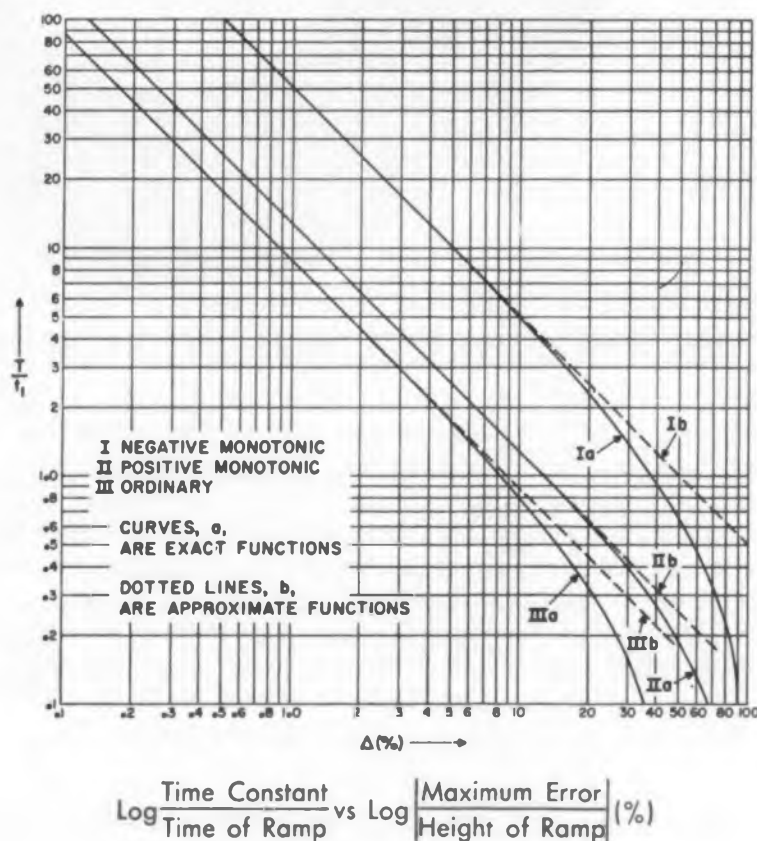
William Wagner
Hazeltine Corp.
Little Neck, N. Y.

BY USING two graphs, one can determine swiftly the minimum time constant of an exponential function for a specified deviation from an ideally linear time base.

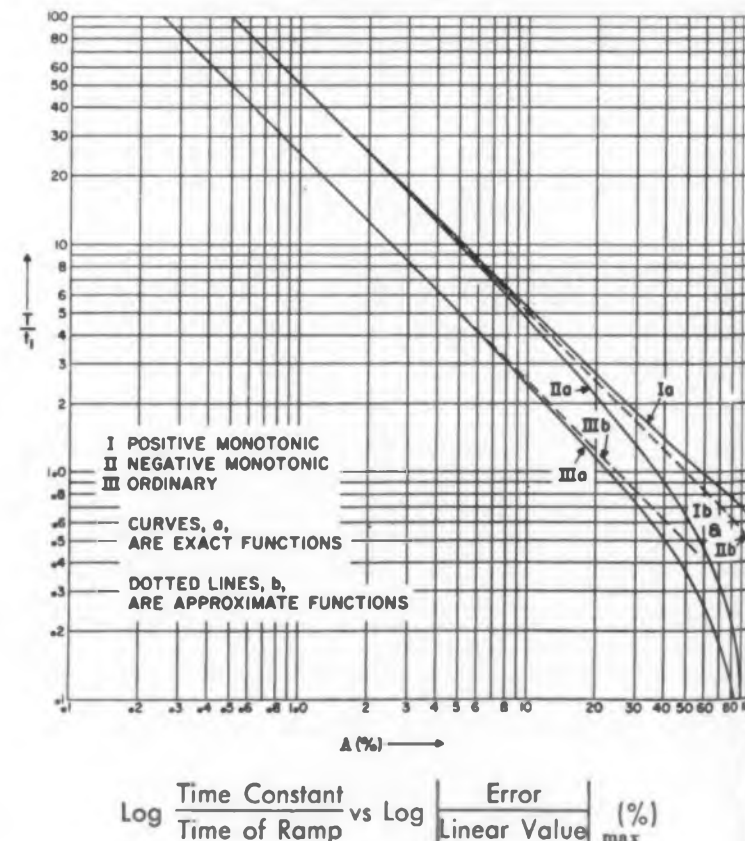
Two Types of Linearity Error Defined

The rising portion of the exponential ($v = V[1 - e^{-t/T}]$) is required to approximate an ideal

Graph for Absolute Nonlinearity



Graph for Relative Nonlinearity



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ramp ($v = kt$) only for a time interval t_1 , which, practically, may be considered the duration of the ramp.

Relative linearity error is the ratio of the instantaneous difference between the exponential curve and the ramp it approximates, to the instantaneous value of the ramp.

Relative linearity error, λ , is defined by the following equation:

$$\lambda = \frac{\text{error}}{\text{linear value}} = \frac{1 - e^{-kt} - kt}{kt} = \frac{1 - e^{-kt}}{kt} - 1$$

Absolute linearity error (sometimes called "displacement error") is the ratio of the instantaneous difference between the exponential curve and the ramp to the final value of the ramp.

Absolute linearity error, δ , is defined by the following equation:

$$\delta = \frac{\text{error}}{\text{ramp height}} = \frac{1 - e^{-kt} - kt}{kt_1}$$

$$= \frac{1 - e^{-kt}}{kt_1} - \frac{t}{t_1}$$

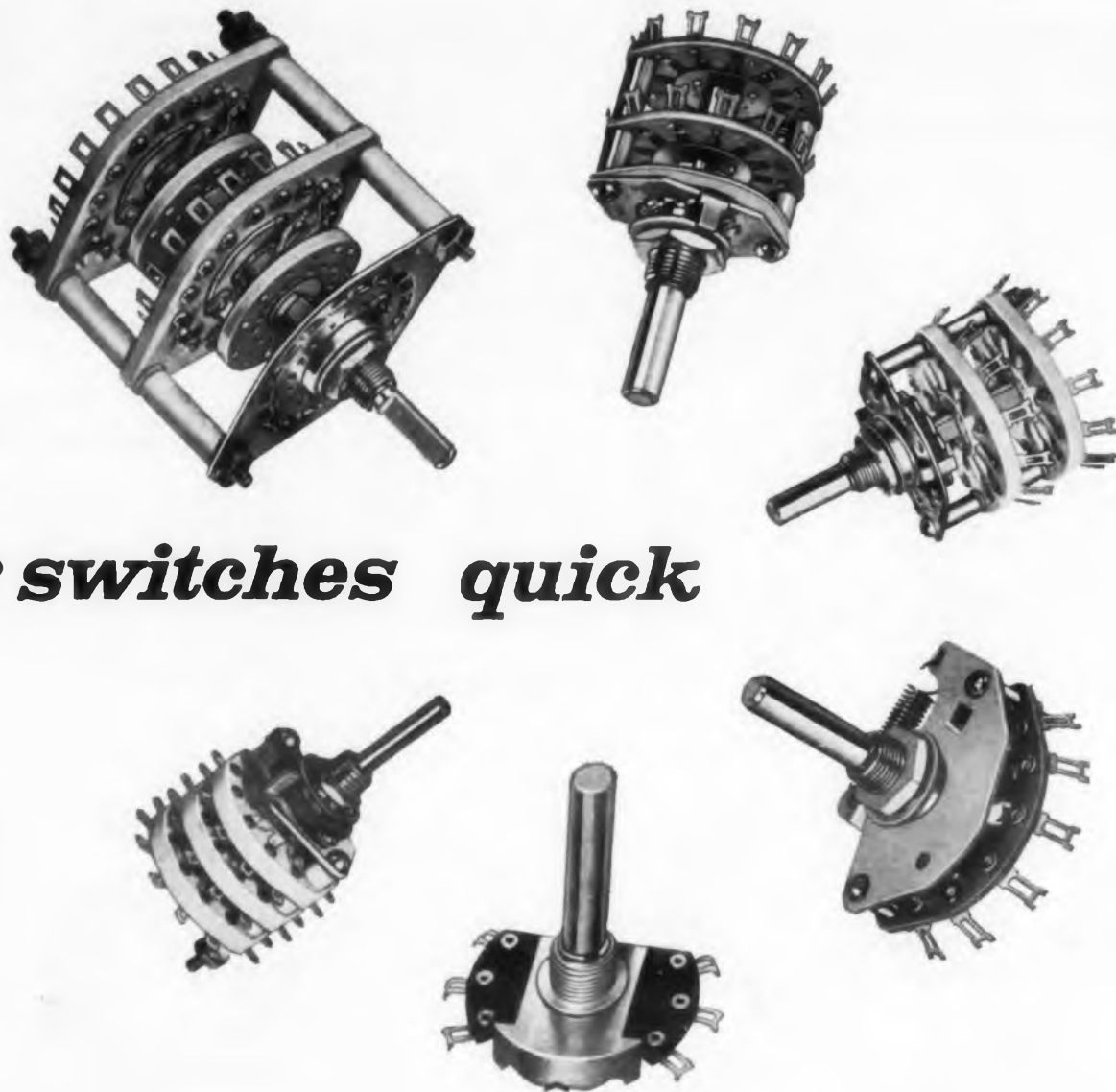
When the error is always positive, (that is, the exponential curve is always above the ideal ramp, except for the intersection at the end points) the error is monotonically positive. Similarly, when the error is always negative it is said to be monotonically negative.

Ordinary nonlinearity means the error at various points may be either positive or negative, (that is, the exponential intersects the ideal ramp at the initial point and somewhere before the ramp's end).

Graphs Cover All Nonlinearities

The two graphs, one for each type of linearity error (relative or absolute), contain curves for all

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$$V = V_0(1 - e^{-t/T})$$

three types of nonlinearity (positive monotonic, negative monotonic, and ordinary).

The ratio of the circuit time-constant, T , to the time duration of the ideal ramp, t_1 , is plotted as a function of the maximum linearity error:

$$\Delta = |\lambda|_{\max} \quad \Delta = |\delta|_{\max}$$

The dotted lines on each graph are plots of simple functions listed later that closely approximate the curves for small values of linearity error.

Graphs Give Solution Quickly

If the time base of the ramp voltage is to be expanded, (for example in radar sweeps), and the linearity is to remain essentially unaffected by the expansion, then a time-constant must be chosen according to a pre-specified relative linearity error.

If the ramp is to remain fixed, as in television sweeps, the time constant is chosen according to a pre-specified absolute linearity error.

Use the graph that gives the time-constant ratio as a function of the appropriate linearity error—relative or absolute.

Choose the curve on that graph according to whether the error must be always positive, negative, or either. (Note that the time-constant for the ordinary nonlinearity case is the smallest of the three for both absolute and relative linearity error.)

Locate the per cent error on the abscissa, and from the curve, find the time-constant ratio on the ordinate axis. Multiply this ratio by the time duration of the ideal ramp. The product is the optimum circuit time constant.

Note that the optimum time constant (for any specified error) is the same for approximations to all ideal ramps of time duration t_1 , regardless of their slopes. Once the optimum time constant is determined, the slope is a function of the source voltage V .

Linear Approximations Useful

The functions described by all the curves in both graphs can be approximated by certain inverse relationships. These approximations (plotted as straight, dotted lines on the log-log graphs) and the accuracy of each are as follows:

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trial-and-error matching of fixed units to the system. Savings also carry over to maintenance because the technician can adjust equipment quickly in the field—no time and dollars spent to replace components.

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Relative nonlinearity:

Positive monotonic: $T/t_1 = 1/2 \Delta$

Less than 2-1/2 per cent low for Δ less than 5 per cent

Negative monotonic: $T/t_1 = 1/2 \Delta$

Less than 2-1/2 per cent high for Δ less than 5 per cent

Ordinary: $T/t_1 = 1/4 \Delta$

Less than 2 per cent high for Δ less than 6 per cent

Absolute nonlinearity:

Negative monotonic $T/t_1 = 1/2 \Delta$

Less than 2-1/2 per cent high for Δ less than 5 per cent

Positive monotonic $T/t_1 = 1/8 \Delta$

Exact Solutions Possible

If more accuracy is desired than is provided by the graphs or the approximate relationships, the reader may subject any of the following relationships to a trial-and-error solution.

These relationships are the ones plotted in

Less than 2 per cent high for Δ less than

Less than 2-1/2 per cent high for Δ less than 15 per cent

Ordinary: $T/t = (1.5 - \sqrt{2})/\Delta$

than 4 per cent

solid lines on the graphs.

Relative nonlinearity:

Positive monotonic

$$\Lambda(n) = \frac{1}{n(1 - e^{-1/n})} - 1, \text{ where } n = T/t_1$$

Negative monotonic

$$\Lambda(n) = 1 - n(1 - e^{-1/n})$$

Ordinary

$$\Lambda(n) = \frac{1}{p(1 - e^{-1/p})} - 1$$

where p is the solution of

$$n(1 - e^{-1/n}) = 2p(1 - e^{-1/p}) - 1$$

Absolute nonlinearity:

Negative monotonic

$$\Delta(n) = 1 - n(1 - e^{-1/n})$$

Positive monotonic

$$\Delta(n) = \frac{1}{1 - e^{-1/n}} - n \left[1 + \ln \frac{1}{n(1 - e^{-1/n})} \right]$$

Ordinary

$$\Delta(n) = \frac{n}{p(1 - e^{-1/p})} - n \left[1 + \ln \frac{1}{p(1 - e^{-1/p})} \right]$$

where p is the solution of

$$n(2 - e^{-1/n}) - pn [1 - e^{-1/p}]$$

$$\left[1 + \ln \frac{1}{p(1 - e^{-1/p})} \right]$$

$$- p(1 - e^{-1/p}) = 0 \blacksquare$$

Test Equipment:



Types and Characteristics

The Characteristics of Oscillographs & Oscilloscopes

In this second article of an ELECTRONIC DESIGN series, A. J. Reynolds, general manager of Technical Information Corp., describes oscilloscopes and oscillographs. His next article will deal with frequency meters.

A. J. Reynolds

Technical Information Corp.
New York, N.Y.

OSCILLOGRAPHS and oscilloscopes often are swept into the same category. For practical purposes, however, they may be distinguished as follows:

An oscillograph is a device that produces a permanent record.

An oscilloscope is a device that is primarily observed.

This, of course, puts oscilloscopes with attached cameras into the class of oscillographs. To anyone who feels this is perhaps stretching the terminology, we offer the opinion that the terminology is long past redemption.

Frequency Responses Overlap

However, the two classes are by no means neatly separated. There are regions at the lowest and highest ends of the frequency spectrum where technical considerations dictate the choice, but there is an enormous intermediate region where either type can be used. The factors that usually determine choice in this region are the number of channels required, the size and the cost.

Where many channels are required, direct writing recorders generally are easier to handle. Where the number of channels becomes very large, say greater than 20, the galvanometer type becomes about the only practical one.

The choice between the various stylus types is largely a matter of cost and individual preference. Ink-writing pens are the cheapest to oper-

continued on p 58

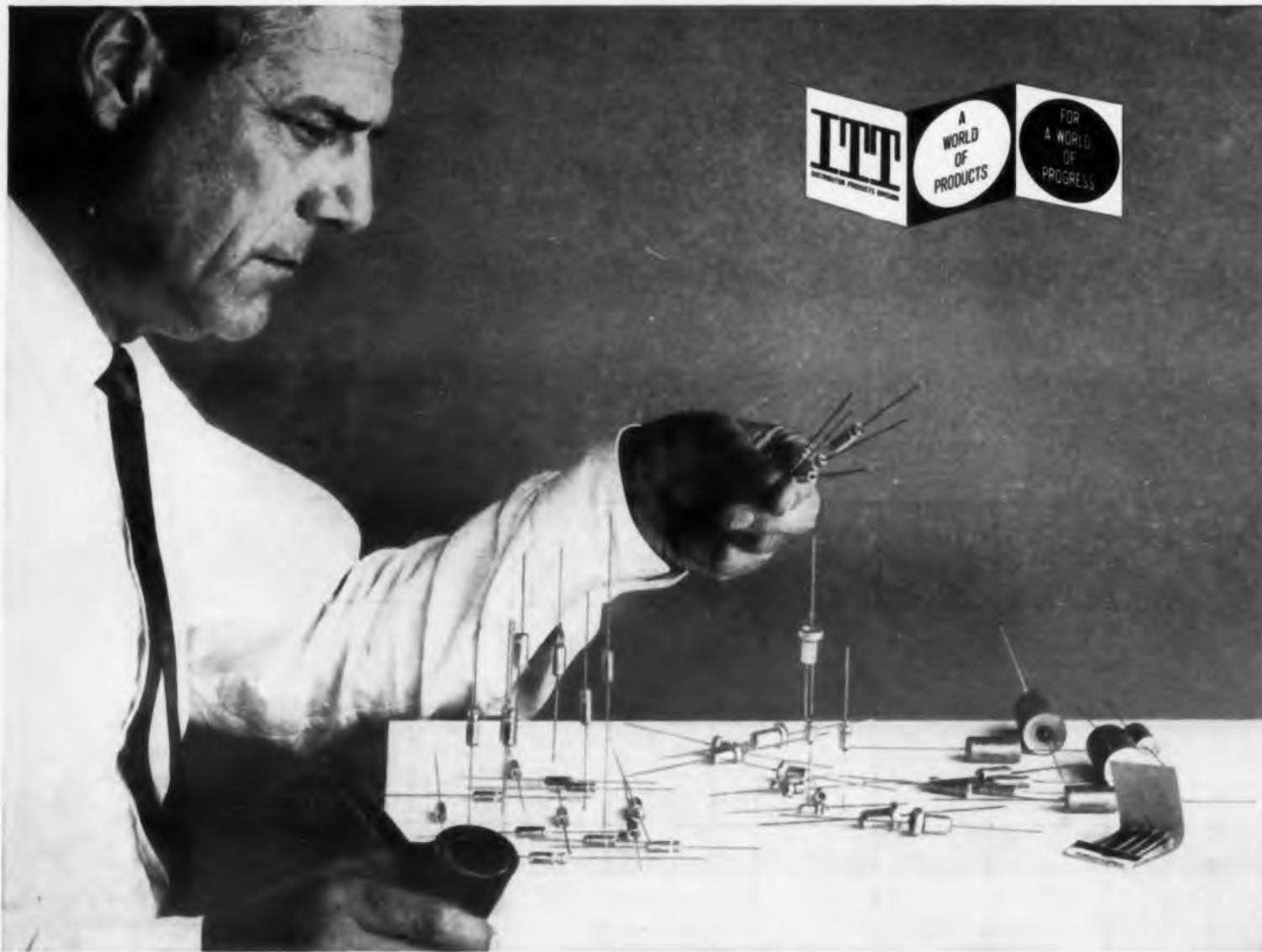
Type	Ultimate Sensitivity	Type of Coordinates	Time Base Speed	Cost of Record	Max. No. of Channels	Availability of Record	Vulnerability of Record
Recording Ammeter Chopper Type	100 μ a full scale	Rectilinear	in./min to in./week	low	10	immediate	low
Recording Ammeter Pen Type	100 μ a full scale	Curvilinear	in./min to in./week	low	2	immediate	low
Oscillograph Ink Writing	μ v	Curvilinear	in./sec max	low	10	immediate	low
Oscillograph Heat or Current Sensitive Paper	μ v	Curvilinear	in./sec max	med/high	10	immediate	fair
Oscillograph Wax Paper	μ v	Curvilinear	10's of in./sec max	med/high	2-4	immediate	high
Oscillograph Liquid Ink Stylus (Mingograph)	μ v	Rectilinear	in./sec max	low	2	immediate	low
Oscillograph Light-Spot Galvanometers	μ v	Rectilinear	100's of in./sec	medium	100's	may require processing	fair
Oscillograph Multiple Crt	10's of μ v	Rectilinear	1000's of in./sec	high	10's	requires processing	fair
Oscilloscope Memory Tube with Camera	10's of μ v	Rectilinear	μ sec/cm	medium	2 by beamswitch	requires processing	fair
Oscilloscope With Moving Film as Time Base	10's of μ v	Rectilinear	10,000's of in./sec	high	8-16 by beamswitch	requires processing	fair
Oscilloscope With Camera	10's μ v low BW 10's mv wide BW	Rectilinear	10's of nsec/cm	medium	8-16 by beamswitch	requires processing	fair
Oscilloscope Advanced Techniques	mv	Rectilinear	nsec/cm	medium	1	req. proc.	fair
Oscilloscope With Camera	Volts	Rectilinear	10's nsec/cm	medium	1	req. proc.	fair

*Technical Information Corp.

Part 2—Oscilloscopes and Oscillographs

Bars indicating frequency range are divided into three sections. Solid lines indicate commercially available frequency range; broken lines indicate frequency coverage available on special order; dotted lines indicate that covering these frequencies would be too expensive and difficult for a practical instrument of the designated type.

Ability Record	10cps	100cps	1kc	10kc	100kc	1mc	10mc	100mc	1kmc	10kmc	Size Range	Price \$ Min	Price \$ Max	Remarks
w	Accuracy 2% Commercial 0.5% max										In. ³ to 0.5 ft ³	Hi 10's	Lo 100's	A few samples per second possible.
w	Accuracy 2% Commercial 0.5% max										0.5 to 1 ft ³	Hi 10's	Lo 100's	Speed across scale 100's of msec.
w	Accuracy 2% Commercial 0.5% max										1 ft ³ to 10 ft ³	Lo 100's	Mid 1000's	Pens require careful maintenance. Rectilinear co-ordinates possible by ingenious design.
r	Accuracy 1-2% Commercial 0.5% max										1 ft ³ to 10 ft ³	Lo 100's	Mid 1000's	Rectilinear co-ordinates possible by ingenious design.
h	Accuracy 1-2% Commercial 0.5% max										1 ft ³ to 10 ft ³	Hi 100's	Mid 1000's	Rectilinear co-ordinates possible by ingenious design.
v	Accuracy 1-2% Commercial ? max										1 ft ³		Lo 1000's	Jets require extremely careful maintenance.
r	Accuracy 0.5% 3% Commercial 0.5% max										1 ft ³ to 10's ft ³	Hi 100's	Hi 1000's	Direct writing records sensitive to bright light.
	Accuracy 3-5% Commercial 1-2% max										ft ³ to 10's ft ³	Hi 100's	Mid 10,000's	
	Accuracy 3% Commercial 1% max										ft ³	Lo 1000's	Mid 1000's	
	Accuracy 3% Commercial 1% max										ft ³	Hi 100's	Mid 1000's	
	Accuracy 3% Commercial 1% max										ft ³	Hi 100's	Hi 1000's	
											ft ³	Lo 1000's	Hi 1,000's	Sampling technique
														Helical deflector plate crt.



TEST EQUIPMENT

ate, requiring only plain paper; even so, the newcomer to this field will be a little shocked by his first invoice for paper.

Ink Oscillogram Can be Costly

The low cost of paper must be equated against the value placed on time spent unblocking pens and on ink-stained shirt fronts. The display put on by an ink oscillograph when a clip lead falls off and all pens have a full scale deflection from stray 60-cps pick-up is impressive.

The mingograph is an interesting type. Originally developed in Europe for cardiology, it works as follows: A galvo coil carries a small jet connected to an ink reservoir by a flexible tube; pressure is maintained by a pump coupled to the chart motor. The resultant ink jet is deflected by the galvo before impinging on the chart. As unlikely as this sounds as the principle behind an instrument, the net result is a direct writing ink recorder with a response up to 1,200 cps.

A less exotic instrument is the recording ammeter. Its meter movement simply has an ink-writing pen instead of pointer. It writes on a circular or roll-type chart and has low-response speed. A 1-ma recording meter typically requires 1 sec to go from zero to full scale.

Chopper Gives Dot Pattern

The chopper type of recording ammeter has a knife-edge actuated periodically to push the paper against a marking stylus. The stylus moves in response to a slowly varying signal, and the record is in the form of a pattern of dots.

The technique of using a crt display with film movement as the time base is limited in speed only by the mechanical considerations of film drive. With readily attainable film speed, the cost of records can soar to amazing heights.

The chart column headed "Vulnerability of Record" is a commentary on the likelihood that the record may be unusable when required. Wax paper, for example, will not survive much rough handling if data on it are to be reproduced. Film is, of course, heir to all the general hazards of film processing. Vulnerability is graded in three divisions: high, easily subject to damage; fair,

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will survive with normal care; and low, not easily damaged.

The oscilloscope shares with the voltmeter the distinction of being the most ubiquitous instrument we have. Although in recent years there has been a tendency to make oscilloscopes quantitative measuring instruments, their fundamental job remains one of display.

No Scope is Perfect

If an oscilloscope is defined as "an instrument that displays on its screen a picture of the waveform applied to the input terminals," no practical instrument can live up to it.

At best, a fast-rising waveform will be degraded in terms of rise time by the finite amplifier bandwidth. Unfortunately, convention appears to have arisen that the value of an oscilloscope varies directly with its Y amplifier bandwidth. As a result, methods of specifying this bandwidth and even methods of aligning the amplifiers have been dictated by the desire of manufacturers to present a strong claim on paper.

In this field, we strongly recommend that for general-purpose instruments, only a critically-damped amplifier be used. This implies square-wave alignment and quoting the measured rise time for zero overshoot. The resultant figure is a meaningful one completely describing upper frequency response of the amplifier.

Bandwidth Can Be Deceiving

In oscilloscopes there has been a school, worshipping bandwidth *per se*, that has aligned vertical amplifiers sinusoidally, resorting to peaking and other devices to raise the frequency of the upper 3-db point.

In extreme cases the claimed bandwidth has been based on a reference point not 3 db down, but variously 5 per cent, 10 per cent, 0.5 db, 1 db, 3 db, 30 per cent, 50 per cent, 6 db or 10 db down. From one of these claimed bandwidths, the rise time is then derived arithmetically. The only figure this practice produces can be called "Sales Bandwidth."

When buying oscilloscopes, perhaps more than any other instrument, there is no substitute for a careful bench investigation. ■ ■

Succeeding articles of this series on test equipment will deal with frequency meters, wattmeters, phase meters, sweep generators, signal generators, pulse and function generators, filters, and wave analyzers and distortion meters. A chart summarizing electrical and physical features of the equipment will accompany each article.

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V	BL-221	69,000-70,500	10	UG385/U

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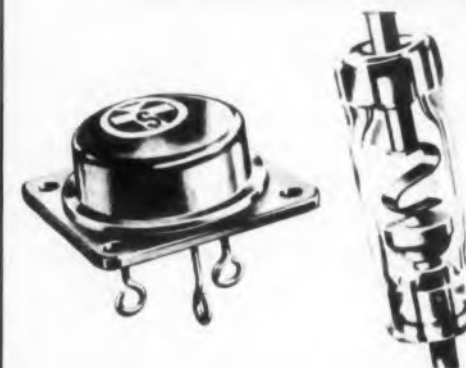
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GUIDELINES TO MICROMINIATURE DESIGNS

An *ELECTRONIC DESIGN* Staff Report

Howard Bierman and Robert Haavind
Associate Editor Assistant Editor

TABLE OF CONTENTS

Five Major Approaches Pursued	62
High-Density Packaging	62
2-D Circuits	66
Micromodules	78
Integrated Circuits	80
Molecular Electronics	82
Interconnections Lag Device Development	84
Comparing Key Characteristics of Major Microminiaturization Approaches	94
Looking at Microminiaturization in Perspective	96

DEMANDS of outer space and floor space are responsible for the highly-active microminiaturization programs under development.

Budget-minded military chiefs want more electronics per payload-dollar packed into each orbiting vehicle. Scientists yearn for more data than present instrumentation weight-limitations allow.

On the ground, computer designers seek an escape from giant-size equipment requiring elaborate air-conditioning. Desk-size units are the targets of their size-reduction programs.

Reliability-conscious engineers seek a means to apply redundancy without excessively increasing weight and volume.

In space and on the ground, microminiaturization seems to be the answer.

Many approaches have been devised and widely publicized. Unfortunately the positive aspects of each have been emphasized and the negative side has been ignored.

This report presents a more realistic view of the field to equip the design engineer with the background and insight necessary to make valid decisions on microminiature designs. Where drawbacks exist, they are presented along with the advantages of each technique.

To present an over-all picture of the micromin effort, various approaches are grouped into five major categories: high-density packaging (p 62), 2-D circuits (p 66), micromodules (p 78), integrated circuits (p 80), and molecular electronics (p 82). Problem areas and advantages of each approach are included in these descriptions.

Interconnections, a major stumbling block to effective progress, are discussed with some promising solutions (p 84).

To permit a comparative evaluation of the various approaches, *ELECTRONIC DESIGN* has prepared a comprehensive chart of key factors and considerations (p 94). A systems designer's viewpoint, along with the editors' conclusions, close the report (p 96).

Five Major Approaches Pursued

Although many variations in microminiaturization concepts exist, it is possible to separate individual approaches into five major categories:

- **High-Density Packaging.** Packaging miniature components into a "cordwood" type assembly using soldering or welding techniques for connections.
- **2-D.** Achieving a flat circuitry form factor through use of microcomponents or by imbedding or depositing components. Conventional 2-D approaches include use of miniature elements and screened or deposited resistors, capacitors and conductors. More advanced thin-film 2-D circuits consist of metallic films which are generally

vacuum or chemically deposited in Angstrom thicknesses.

- **Micromodule.** Placing one or a few components on a single flat substrate and then vertically stacking a group of substrates to form a complete circuit.
- **Integrated circuitry.** Fabricating a complete circuit on a thin semiconductor substrate. Both active and passive components are formed by a series of alloying, diffusion, deposition, and etching steps.
- **Functional circuitry.** Achieving reduction in size by a new circuit philosophy. In the functional, or molecular, approach, input-output demands are met by modifying the properties of a single semiconductor crystal.

High-Density Packaging

Packaging conventional small components into clusters, cordwood packs, or similar closely spaced modules aims to achieve maximum density through reduction of interconnection volume. Vertical stacking of components between printed-circuit boards, forming a sandwich module, and welded packages make up the two major approaches within this category.

THE PRESS of time has not permitted designers to wait for exotic approaches to feed the armed forces' insatiable hunger for miniaturized hardware.

Making the best of the situation, design engineers have clustered components as close as possible and have advanced the industry's printed board and have termination methods in order to achieve remarkably high packaging densities employing miniature components of proven reliability.

Initial efforts have centered on the sandwich-board approach. Components are stacked vertically and leads are attached to printed boards at each end of the cluster. Because of the potential danger of heat damage to semiconductors when leads are soldered, a short lead is left

between the components and the board. Sometimes heat sinking is used, but the soldering operation has been performed successfully without it.

Bendix Corp.'s Radio Div. in Baltimore has been turning out some 2,000 of these modules daily under a classified digital production contract. Dip-soldering is used to join leads to the printed boards, and a 6-sec dip at 480 to 490 F has not appeared to harm components.

Another sandwich-board approach is illustrated by Republic Aviation Corp.'s Dice program. Encapsulated sandwich-board modules are being used in the guidance computer for the Swallow drone being built by Republic for the Army Signal Corps. Up to 50 Dice are attached to a printed-circuit mother board which

is plugged into the main computer frame.

Double-sided redundant circuit boards with plated-through holes are used at each end of a component cluster. The boards are made by laminating together two single-sided boards back-to-back, lining up the lead holes.

A fountain solder technique is used to join leads to boards. Solder bubbles up through a line-type orifice, and the boards with leads in



Fig. 1. Republic Aviation's Dice, encapsulated sandwich-board miniature component modules, are mounted on plug-in printed-circuit boards.



Fig. 2. A model of a welded package showing component arrangement and interconnecting ribbon used to tie components together.

place are passed over the bead strip so that the molten solder bubbles up into the plated-through holes.

The modules are then encapsulated with a filled epoxy of good heat-transfer characteristics.

Welded Approach Adds Strength

The promise for stronger, more reliable joints and even denser packaging has encouraged the

Welded Module

ADVANTAGES (compared to soldering):

- Greater reliability for following reasons:
 - (a) short heat cycle does not damage closely packed components.
 - (b) less bending of leads is necessary than with wiring boards or conventional chassis work.
 - (c) resistance spot-welding has been checked with up to 10^7 welds between undetected failures.
- Package form, using tightly grouped components, has high strength. Due to the ability to weld close to each component body without damage, lead length is short and component flexing is reduced. Thus, the stiffness-to-weight ratio is high for resistance to vibration.
- Solder flux is eliminated, preventing contamination and allowing closely spaced wire matrices to be used.
- Conventional high-reliability parts can be used.
- Welding techniques well advanced compared to newer connection approaches.

PROBLEM AREAS:

- Non-standard component-lead materials, coatings, and diameters require special weld cycles to be determined for a great number of possible joints.
- Sharp angular projections lower resistance to thermal shock in encapsulating material.
- Maintenance is difficult.
- Skilled workers are required.

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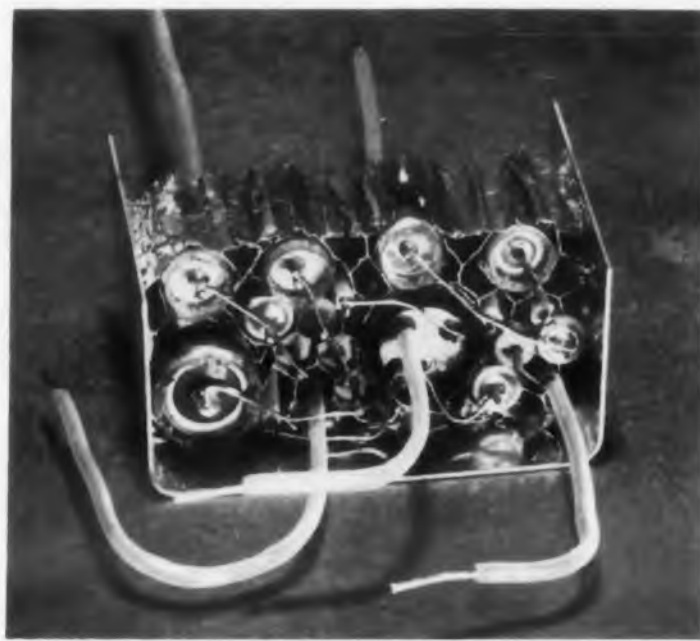


Fig. 3. An experimental module showing the use of a honeycomb structure which will result in improved heat transfer and rigidity.

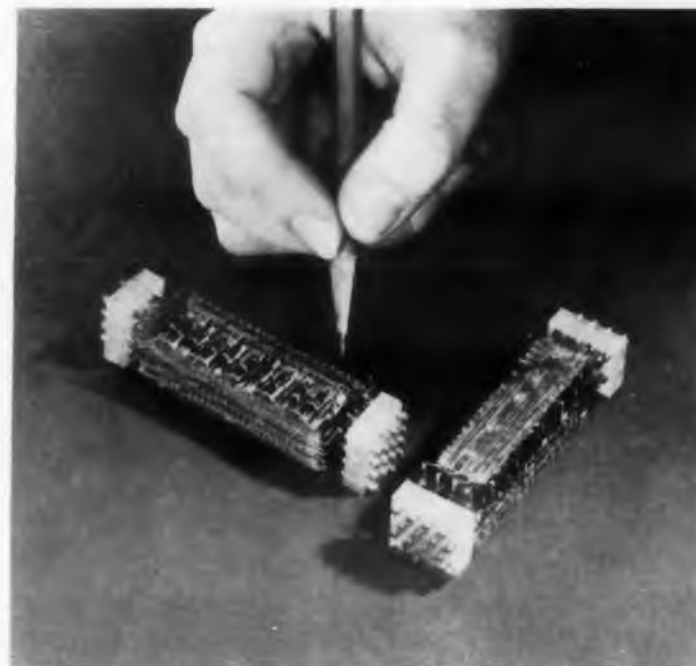


Fig. 4. Cordwood approach is illustrated by these high-density Raytheon Weld-Paks.

swing from the soldered to the welded component cluster (*ED*, Sept. 28, p 4).

Extremely short leads can be used in this approach because weld cycles are very short—on the order of a few milliseconds with a capacitor discharge machine. At the same time, no flux is involved, eliminating the possibility of contamination and allowing use of a closely spaced wire matrix.

In this approach, leads are interconnected by means of metal ribbon—usually nickel. When many connections are required, joints may be made on each side of a Mylar film placed at each end of components. After welding, the modules formed are usually encapsulated.

Pioneering work in this field was done by Francis Associates and Sippican Corp., Marion, Mass., and Massachusetts Institute of Technology. The Francis-Sippican alliance has teamed with Engineered Electronics Co. and Electronic Engineering Co., Santa Ana, Calif., to do systems work and to market welded “sticks” under the MiniWeld trade name.

More than 30 companies have joined an industry-wide committee which is attempting standardization of component leads and setting of military specifications for welded circuitry.

Raytheon Co., which is producing Weld-Paks for the Polaris program, is applying welding skills gained during years of tube manufacturing to the problems of making welded packages with varied lead materials and lead diameters. Optimum weld cycles and control settings are necessary for each type joint, so that a good deal more skill is required than that which is necessary to make solder connections.

AC Spark Plug Div. of General Motors Corp., Milwaukee, has developed its own techniques for producing welded modules for an advanced Titan inertial-guidance system. Rather than Mylar films, for example, AC is using a special epoxy board at each end of component clusters, and the modules are then encapsulated in the same proprietary epoxy compound.

Some automation is being applied to the welded approach at General Electric Co.’s Light

Military Electronics Div., Utica, N. Y. Spot welds are made along standardized terminal strips, as shown in Fig. 5. GE shapes modules into various special configurations necessary for classified applications.

Delco Building Digital Modules

Delco Radio Div., General Motors Corp., is currently offering delivery of 15 different digital modules fabricated by resistance welding techniques. Individual modules have protruding pins to permit dip-soldering to printed boards or welding to interconnection wiring. Input characteristics are identical and each module can drive five additional modules; a power inverter block is available for driving 30 modules when dictated by load requirements. Modules are standard in height (0.8 in.) and length (1.0 in.); width varies for different blocks from 0.4 to 1.0 in. in steps of 0.2 in. Included among the module types are a crystal oscillator, 80 to 150 kc, series gates, a squaring amplifier, and a group of multivibrators. ■ ■

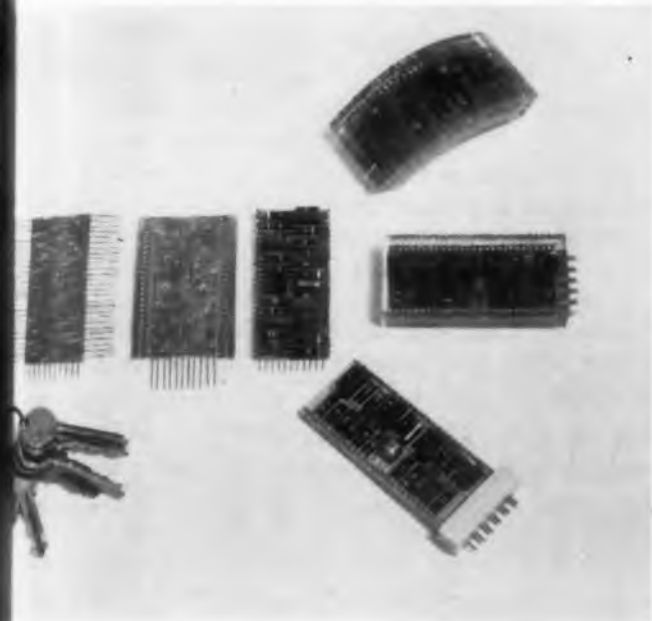


Fig. 5. GE has automated production of welded modules by using standard termination strips. Odd shapes possible with welded approach are illustrated by curved module, upper right.

EIA Subcommittee on Micromin Formed

To accelerate microminiature component standardization, a Microminiature Electronic Components Subcommittee of the EIA has been established. According to Edward Keonjian of Arma, chairman of the group, recommendations for electrical and mechanical requirements will be offered for active and passive components used in digital computers. At present, only discrete components will be considered; complete modules will not be included.

Form factors of components, their lead configuration, environmental test conditions and mechanization requirements are initial targets of the group's efforts. Manufacturers interested in participating should contact Mr. Keonjian at Arma, a Division of American Bosch Arma Corp., Garden City, N. Y.



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2-D Circuits

Conventional or miniature-size active components are assembled on tiny wafers to achieve a flat-form factor. Screened resistors and conductors can be used, capacitors can be formed with the wafer acting as dielectric, or thin films can be employed as passive elements. All of these variations, except for the thin films, are here considered "conventional 2-D." Thin films are considered separately.

Conventional 2-D Circuits

THE ORIGIN of the 2-D concept of micro-miniaturization is generally attributed to Diamond Ordnance Fuze Laboratories, Washington, D.C. This approach, described in detail in "Microminiaturization of Electronic Assemblies," Hayden Book Co., Inc., New York, has been directed at depositing components for a complete circuit or stage on a single wafer with apertures for insertion of non-deposited components. DOFL has worked closely with Sprague Electric Co., North Adams, Mass., on this approach, and Sprague has provided about 200 binary counters

and 200 NOR circuits for development work at the Fuze Laboratories.

Most DOFL Components Deposited

It is too early to use these 2-D circuits in operating equipment, according to Norman Doctor, research supervisor of DOFL's microminiaturization laboratory, because reliability has not yet reached suitable levels. Studies now in progress should lead to increasing reliability as the program advances.

Conductive adhesives are being used for interconnection of microcomponents to conducting paths on the wafers. Non-deposited components have included transistors, diodes, inductors, and large-valued capacitors and resistors. Size of the wafers is not standardized, but is chosen for individual applications.

Binary-counter wafers for a program timer have nickel-ribbon leads suitable for welded joining to a connecting rod. Count-down timer modules, made up of several wafers stacked in an epoxy package, are completely epoxy-encapsulated.

A five-stage if amplifier is also being made by DOFL using the 2-D wafers. This unit, to be packaged in a copper shielding box which has proved adequate for isolating stages, will operate at 30 mc with 100-db gain and 2-mc bandwidth. The rectangular package is 0.7-in. high, 0.7-in. wide and 0.45-in. long; the unit will be non-tunable. Both this unit and the count-down timer are throw-away-type packages, designed especially for fuze applications.

DOFL is now beginning to explore the possi-

bilities of applying thin films to the 2-D concept. Silver films are being chemically deposited on a substrate, and copper is electro-deposited on top of this. These layers are then selectively etched to form passive elements and a conductive network. This work is in the early research stage, however.

Industry Served Early by Centralab

During World War II, Centralab produced miniature printed circuits to the military for the self-powered complete mortar fuze. Following this effort, Centralab, a division of Globe-Union, supplied the radio and TV industry with PEC's—Packaged Electronic Circuits.

The basic PEC technique involves placing a silver pattern on each side of a ceramic plate to form capacitor plates and also create conductor paths. Resistors are then screened on the wafer, leads are soldered in position, and the entire unit is encapsulated. In addition, flat ceramic disc capacitors can be soldered to the

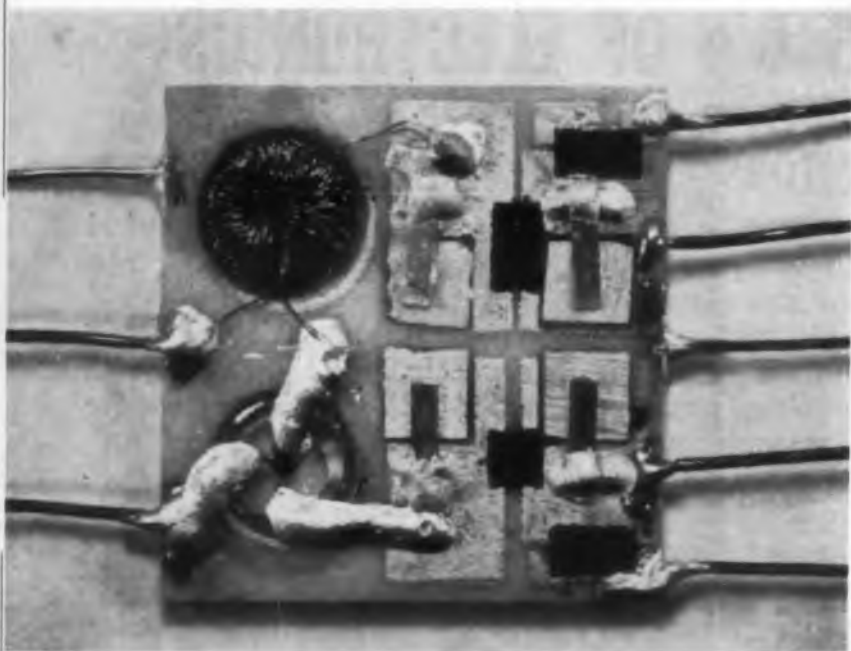


Fig. 6. One stage of five used in DOFL 30-mc amplifier. Transistor element, lower left is potted in epoxy.



Fig. 7. Centralab, with PECs, was an early supplier of packaged components to replace conventional parts in miniaturization programs.

Conventional 2-D

ADVANTAGES:

- Timeliness—systems can be built now.
- Currently available, high-reliability components can be used.
- Wafer replacement can be incorporated in design.

PROBLEM AREAS:

- Parts density is poor compared to more exotic schemes.
- Many interconnections are required. Reliability is potentially degraded each time a hot soldering iron is placed close to delicate components.
- Little is known about tolerances maintainable in multiwafer assemblies.

wafer before encapsulation if required.

In addition to printing passive components and leads to a ceramic plate, Centralab is producing a four-stage amplifier, in a hermetically sealed case, containing 12 resistors, five capacitors and four transistors. The device is 0.5-in. in diameter, 0.25-in. high and 1/16 oz in weight.

Sprague Microcircuits Use Ceramic Substrate

A ceramic substrate is used both as a base and as a capacitor dielectric in the approach by Sprague Electric Co., North Adams, Mass. Coupled with screened resistors and uncased semiconductors imbedded in cavities cut in the substrate, a complete circuit or group of stages can be prepared. As many as 120 components have been included on a single plate. A 2-in. x 3.7-in. ceramic plate, containing four independent memory and delay circuits, has been supplied with 64 resistors, 8 capacitors, 16 cased transistors and 32 conventional diodes.

Miniature Boards in CBS Microdeck

A 1.25-in. x 0.6-in. x 0.555-in. Fotoceram substrate, Fig. 8, acts as the miniature-mounting

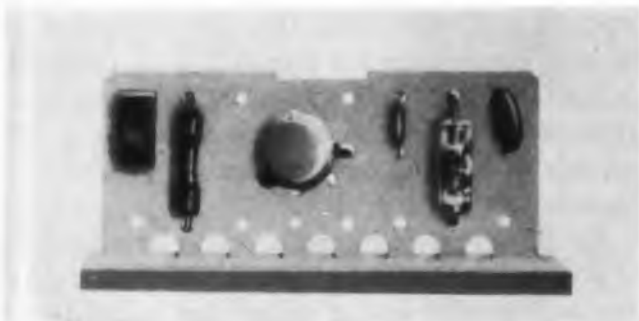
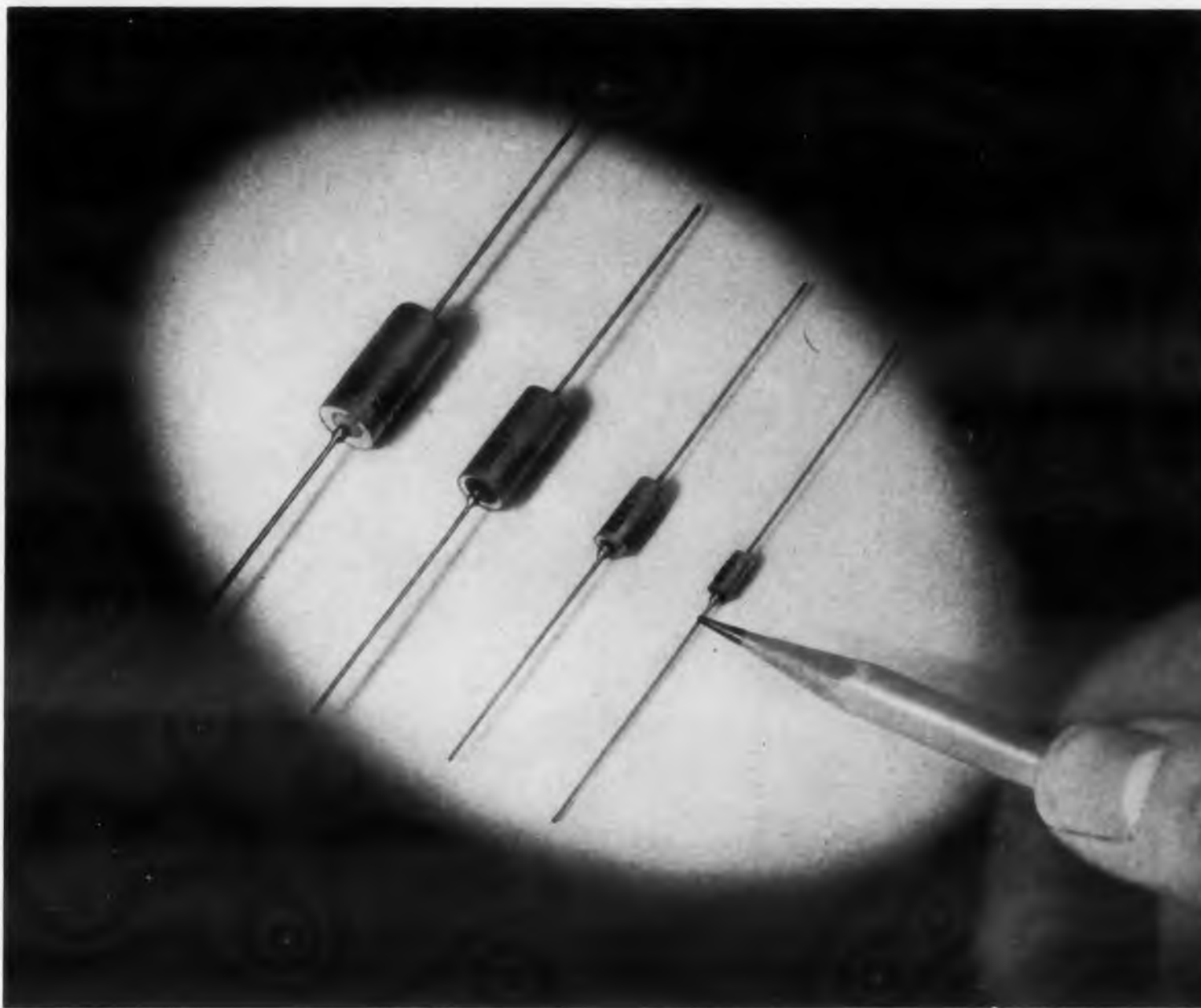


Fig. 8. Microdeck, by CBS Electronics, is adaptable to deposited conductor runs, deposited or standard resistors and TO-9, TO-18 or micro-transistors.



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leakage current characteristics associated with the H-series line, even though they occupy about 1/3 of the space of the earlier types.

These new capacitor designs are made possible by the advanced research facilities available at Union Carbide Corporation, plus the fact that "Kemet" is not dependent on other suppliers for the mining or processing of tantalum.

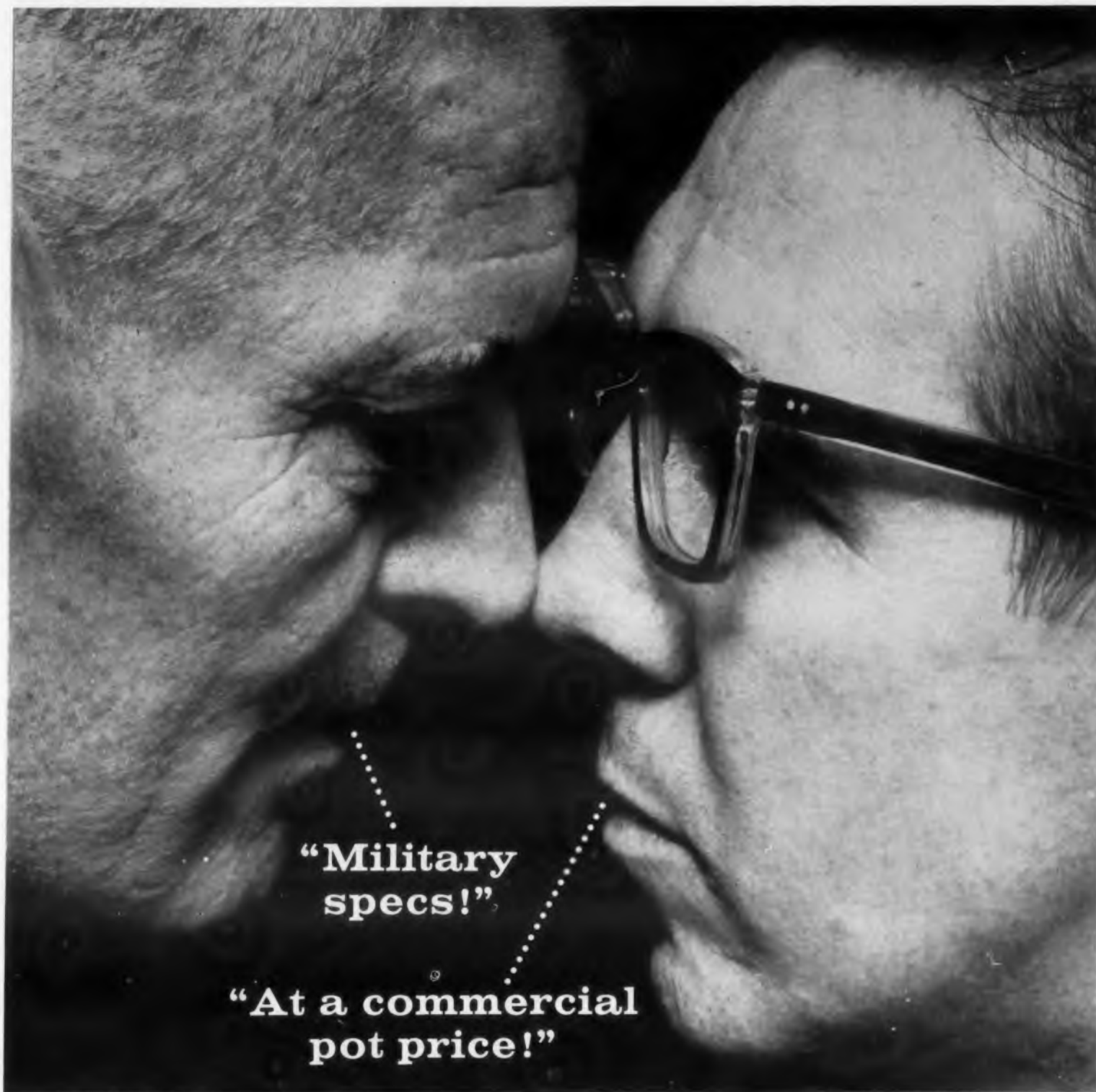
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APPROACHES

MICROMINIATURIZATION

2-D CIRCUITS

board for deposited conductors, as well as standard- or thin-film resistors and capacitors; TO-9, TO-18, microtransistors, or unencapsulated semiconductors can be mounted as active elements.

Although the approach does not achieve the packing density of more exotic schemes, the Microdeck permits the use of presently available, high-reliability components with the ability to accommodate newer devices and techniques as they become accepted by the industry and military. Microdecks, made by CBS Electronics, Danvers, Mass., are interconnected by means of printed-circuit panels in order to form complete assemblies.

Sylvania Hermetically Seals Wafers

In contrast to the RCA Micromodule approach which limits the number of components per wafer, Sylvania's 0.5-in. square wafers can accommodate five or more components per wafer; the design approach is to house a complete function on each wafer. As integrated or molecular techniques become feasible, they may be incorporated to provide several stages per wafer.

Vacuum-deposited conductors, resistors and capacitors plus unencapsulated or micro-size semiconductors are applied to each wafer. After the necessary individual wafers are completed, they are tested and hermetically sealed. Each wafer, as shown in Fig. 9, contains 12 tabs uniformly spaced around its edge. Spacers, sufficiently high to clear any wafer component, are glazed to the wafer edge. Then wafers are stacked vertically until the necessary number of individual stages are attained. Four rectangular printed-circuit boards, containing rows of slots, accept the tabs of each wafer to permit electrical and mechanical mating of the total assembly.

By clever use of interconnection boards, there is no need for wiring within the assembly. After the individually sealed wafers are linked by interconnecting boards, the assembly, except for the protruding tabs, is covered with a plastic film as additional protection against environ-

Fig.
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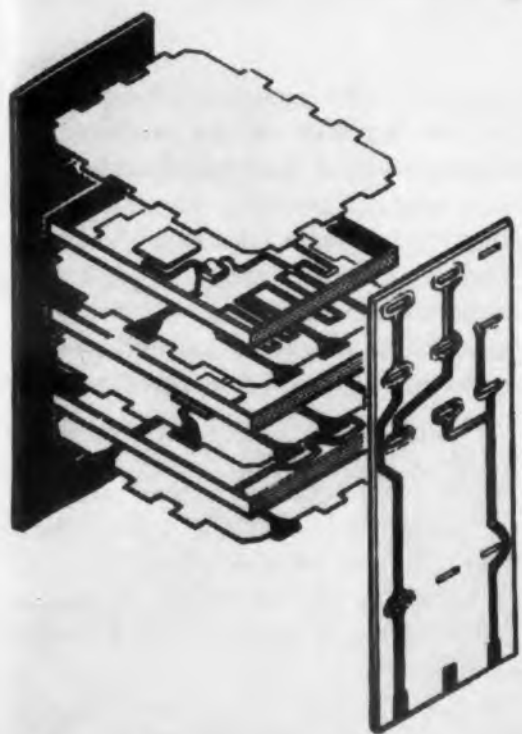


Fig. 9. An exploded view of Sylvania's module assembly showing individual wafers, spacer elements and the silk-screened interconnection boards which electrically and physically interlock wafers.

mental damage. Modules can be interconnected to a printed-circuit board by spring connectors or by soldering.

In addition to digital circuits, Sylvania has demonstrated a single-wafer broadcast-band transmitter and a 60-mc if strip using silicon transistors. These devices illustrate the feasibility of the approach to communication equipment as well as computer applications.

Microweld by Hamilton Standard

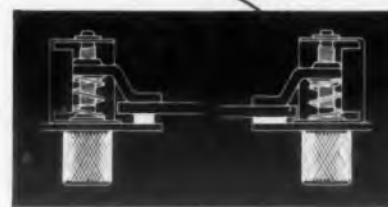
Electron-beam welding, offering high-beam accuracy and controllability, is a key factor in the approach being followed by Hamilton Standard, Windsor Locks, Conn., a division of United Aircraft Corp.

In contrast with soldering and welding techniques which result in hot electrodes adjacent to critical components and thin films, the Hamilton-Zeiss electron-beam welding unit is reported to achieve highly reliable welds with minimum component damage due to its narrow fusion zone, short-cycle pulsing, and close control of penetration. Temperature at the weld can be as high as 11,000 F, yet 0.01 in. away, the component lead will be at ambient.

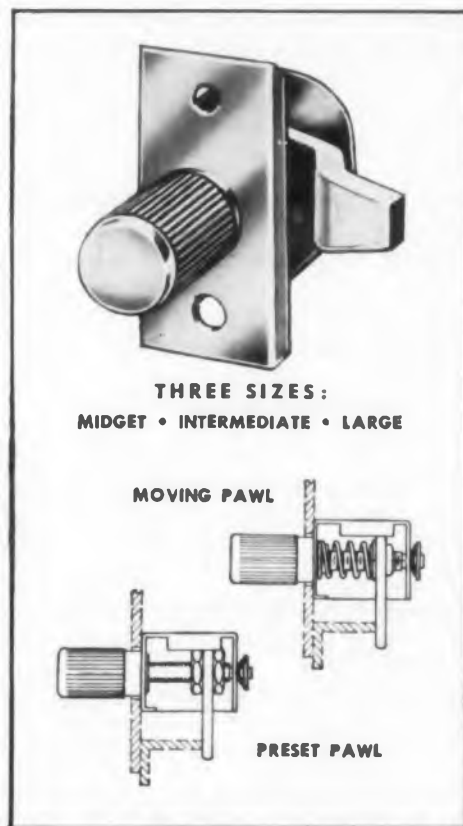
The basic wafer, a 0.75 x 0.50 x 0.025-in. ceramic slab, contains a complete flip-flop, as

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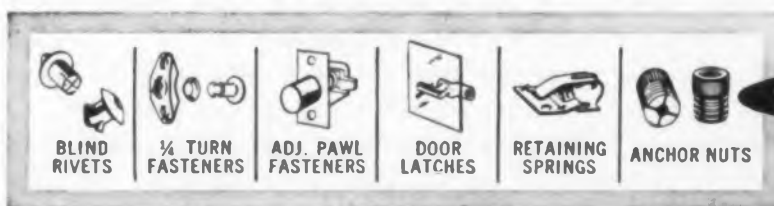
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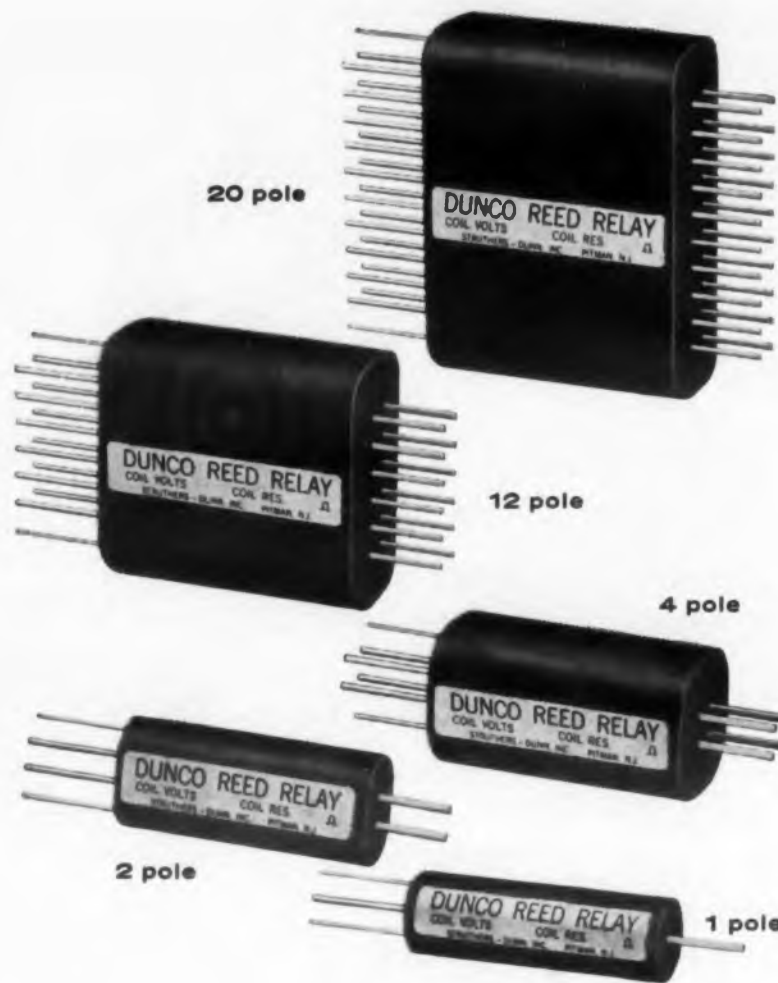
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APPROACHES

MICROMINIATURIZATION

2-D CIRCUITS

shown in Fig. 10. Deposited conductors and components are applied to the wafer and then welded to connector pins placed along one edge. A basic computer module, Fig. 11, consists of 25 wafers stacked on a Fotoceram header board, a printed-circuit board containing the necessary interconnections between wafers.

To facilitate wafer insertion and also to supply structural support, a plastic spacer is inserted between wafers and the header board. Wafer pins which convey signals for the main equipment circuit board extend through the header, while the remaining wafer pins, used for wafer interconnections, terminate within the header board. A plastic spacer to support the top of the wafers is inserted and a metal cover is then placed over the assembly and welded to a metalized edge around the edge of the header board. Following the cover-seal welding, which is done in a vacuum, the module is pierced, filled with dry helium, and resealed. This step is taken to eliminate a pressure dif-

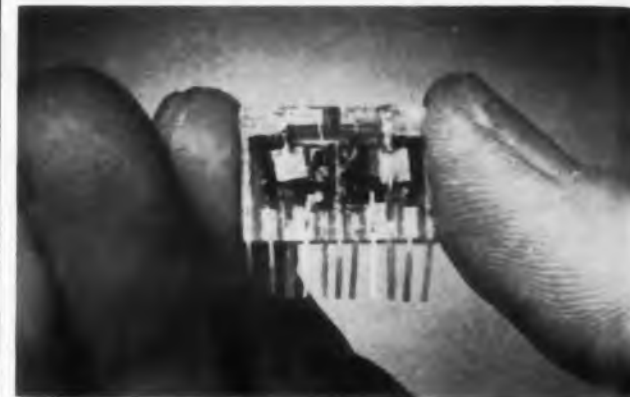


Fig. 10. Hamilton Standard's wafer, containing a complete flip-flop, is assembled by electron-beam welding techniques.

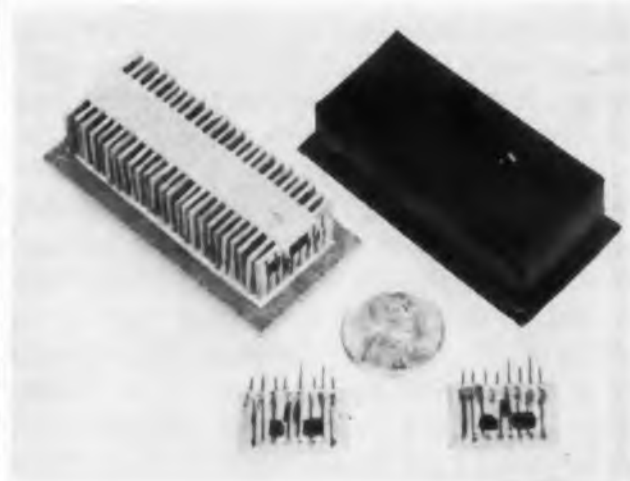


Fig. 11. A complete computer module, containing 25 wafers assembled with the Hamilton-Zeiss electron beam welding machine. (Could this package be tagged a "Zeiss cube"?)

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ference across the sealed junctions which could lead to moisture entry; helium also serves to efficiently transfer wafer heat to the module cover.

Extensive efforts are underway to mechanize wafer assembly. Various schemes include loading of adhesive reels with components and connectors, and feeding arrangements to route the adhesive spools to the welding machinery.

Conventional Components in MICRAM

Infrared devices, electronic timing and fuzing systems plus miniature receivers are being produced for the Army by a group of firms engaged in the MICRAM program (Microminiature Individual Component Reliable Assembled Modules). Using standard microcomponents, wafers are assembled using tweezers, microscopes and soldering irons with 1/16-in. tips. Cleveland Metal Specialties Co. is coordinating the program with Aerovox Corp., Pacific Semiconductors, Inc., Raytheon Co., Formica Corp., Wilrite Products, Inc. and Sylvania Electric Prod., Inc. among the firms which are engaged in supplying microcomponents.

Paktron Automates Wafer Assembly

Automated assembly of wafer modules has been developed by Paktron Div., Illinois Tool Works, Alexandria, Va.

Two to seven ceramic wafers are stacked with three riser wires used on each side of the wafers, which are 7/8-in. sq. A surge of current through the riser wires for about 0.5 sec is used to make six joints simultaneously, and another surge completes the soldering process for a module. When encapsulated, the modules are about 15/16-in. sq.

Paktron, which was founded by the key personnel from the Bureau of Standards who managed the Navy's Project Tinkertoy, is attempting to market modules to radio and television broadcasting companies.

At least six components are placed on a single wafer in the standard Paktron modules, cutting down on interconnections. A later version of this approach, known as the Mini-module using a 0.5-in. sq wafer, is under development.

Microcomponents are soldered or attached to wafers by a conductive adhesive. Several types of encapsulents are used, depending on their applications.

Arma Combines Component Types

A guidance computer for space vehicles, based on the 2-D approach, is to be completed in early



Fig. 12. Electric weld heads, inset, flow solder on heavily pretinned riser wires to make joints to wafer notches in this automated module assembly machine designed by Paktron. Wafers are fed from vertical magazine, in front of operator, and wires from spools at left.

1962 by American Bosch Arma Corp., Garden City, N. Y. A complete circuit is to be contained on a 1.0 x 1.0 x 0.03-in. wafer using deposited resistors, miniature capacitors and sealed microtransistors. Interconnection between wafers is to be accomplished through an epoxy glass board.

Aerovox Corp., Hi-Q Div. has been fabricating 2-D wafers on ceramic substrates using conventional components. A full adder for Arma's computer program was supplied for evaluation containing 85 components in a 0.5 x 0.625 x 1.0-in. package.

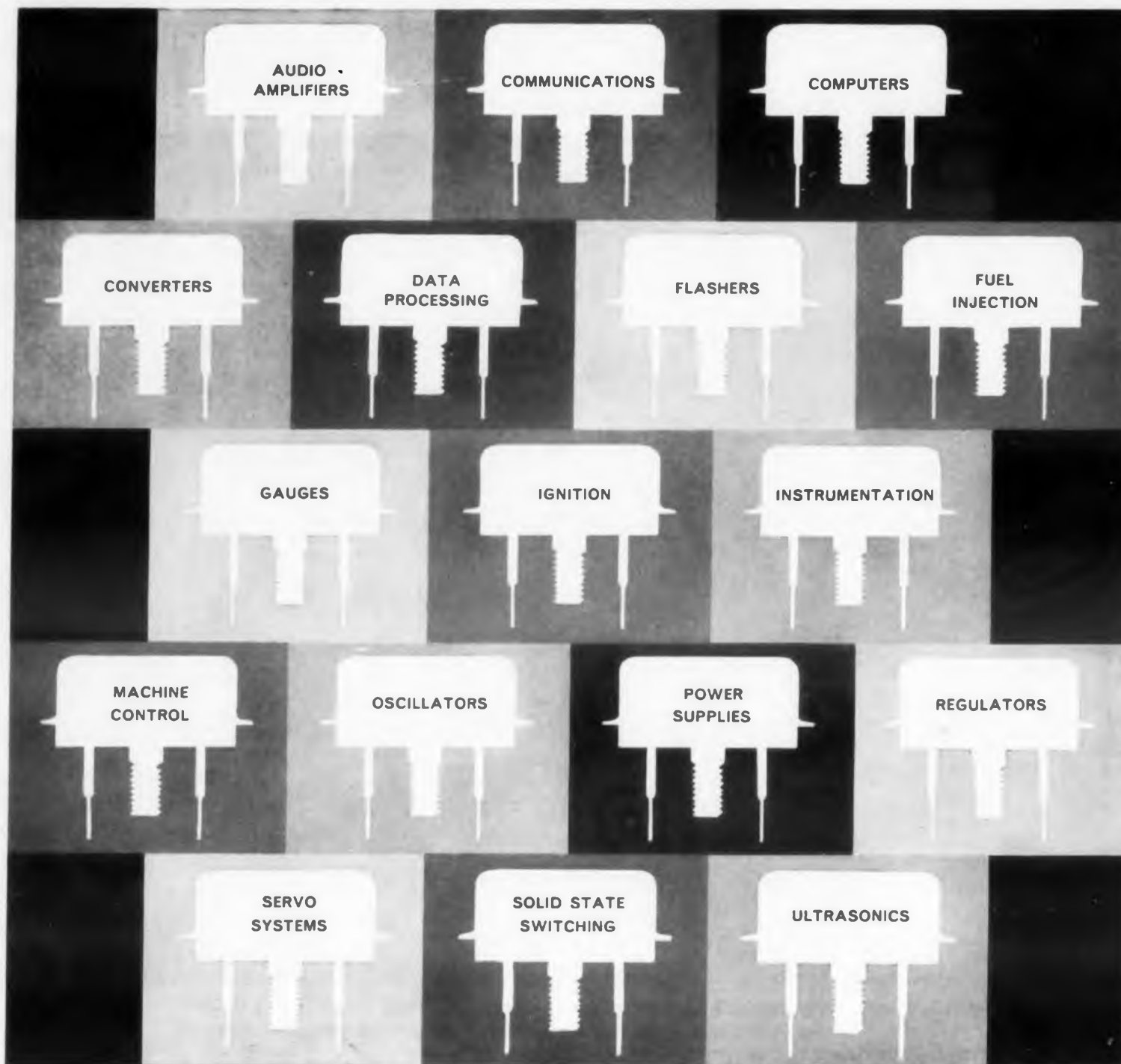
Standard RC Boards by Haloid Xerox

A micromin scheme which does not require designers to send proprietary circuit diagrams to the micromin manufacturer has been devel-

oped by Haloid Xerox, Inc., Rochester, N. Y.

RC Circuit Plates provided by Haloid Xerox consist of ceramic wafers on which conductive, resistive, and dielectric films have been deposited by vacuum evaporation. Each layer covers preceding layers, with no masking used to form component geometry. Deposition of dielectric films is the one exception to this general plan. These films are masked onto required areas of the wafers in thicknesses depending on necessary capacitance values which are specified by the user.

Equipment producers selectively etch these circuit boards to form the desired pattern. Xerographic stenciling and etching has been used by Haloid Xerox in forming this type of passive network, allowing resist images to be formed



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APPROACHES

MICROMINIATURIZATION

2-D CIRCUITS

in about two minutes. This process allows some degree of automation, but if resolution better than 100 lines per inch is required, it is better to use photoresist methods.

Materials selected for the Haloid Xerox program are capable of operation up to 200 C. Alsi-mag 614 is used for the base wafer, chromium for resistors, silicon monoxide for capacitor dielectrics, and aluminum and nickel for conductors. This approach provides resistance values from a few ohms to a megohm, and capacitor values to about 0.02 μ f.

Standard plates will be specified by the ohm per square value of the resistive film and the capacitance per square inch value of the dielectric film.

Since high temperature operation is limited by the silicon monoxide dielectrics, the company, under Air Force contract, has been studying the possible use of refractory materials such as aluminum oxide, boron nitride, silicon carbide and rare earth oxides for dielectric films. These are being deposited by electron bombardment rather than vacuum deposition techniques.

Tabs on the ends of the circuit boards are placed through slots in interconnecting boards, which also contain holes for insertion of semiconductors. Leads and tabs are attached by a dip soldering operation.

Imbedded Circuits in Hughes Concept

Insertion of components into a thin circuit board, with printed circuitry on both the top and bottom of the boards, is the approach being developed by Hughes Aircraft Co.'s Semiconductor Div., Newport Beach, Calif. (ED, May 11, p 8).

Circuit boards made of Fotoceram, produced by Corning Glass Works, Corning, N. Y., have holes prepared according to a drawing of the required configuration by chemical and photographic techniques. Copper printed circuitry, along with plated-through holes, can be laid down in 2- to 6-mil thickness on both sides of the boards. Methods of contacting between the ends of leadless or pellet components and the copper stripes are still being studied. An ultrasonic welding process with tabs extending over the holes is presently favored, although a silk-screening metallic paste and firing process also may prove suitable.

The plated-through holes are used only to

CIRCLE 66 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

join the top and bottom circuit patterns, and device holes do not require plating. Stripes on each side of the board are directed in general at right angles to each other, so that cross-over problems are eliminated.

Hermetically sealed leadless diodes 0.030-in. deep and 0.050-in. in diameter have already been produced, and experimental transistors in pellet form were shown by Hughes at WESCON. All Hughes diodes and transistors should be adaptable to the new form, except for coaxial types.

Handling of such small components has received attention during the study program. A special magnetic tip has been designed to pick up the diodes by one end, and additional plating has been added over the gold contact surface on one end so that visual identification is possible. Magnetic handling may be used in automating this system.

Many possible component shapes can be adapted to the Hughes approach, and flat lead components of the proper depth might also be used.

Very complex circuit groups might be implanted in a single-circuit board, so that only basic input-output and supply connections must be made. Some attention has been given to this interconnection area, such as use of flexible wiring, however, Hughes prefers to work out this scheme with individual users.

Pellet Components Mallory Aim

Pellet components which can be plugged into holes in circuit boards are being developed by P. R. Mallory & Co., Inc., Indianapolis, Ind., under a Unitized Component Assembly concept.

Mallory's components differ from the dimensions planned by Hughes. Standard-size units, including resistors, various types of capacitors, and silicon rectifiers, will be 1/16-in. thick, and 0.1-in. in diameter. A more easily handled 0.25-in. package will also be available, either 30-mil or 1/16-in. thick.

Low-cost components will be possible with this approach. "We can keep the penny resistor this way," a company spokesman said.

At the same time, designers can assemble circuits in their own plant and not have to send circuit designs to the device producer. Standard printed-circuitry techniques apply to this pellet approach, except for the connection between printed conductors and the ends of components. This problem is still being investigated by designers at Mallory. ■ ■

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CIRCLE 907 ON CAREER INQUIRY FORM, PAGE 209

Thin-Film 2-D Circuits

THIN Metallic films, with thickness measured not in inches but Angstroms, are of interest since their characteristics are quite different than those of bulk metals. Resistivities of thin films of metal can be 10 to 25 times greater than that of bulk metal depending on the roughness of the substrate surface and type of process used in film application. Films can be made from conducting, insulating or semiconductor material.

Thin-film resistors have low residual-noise level, high stability, plus excellent temperature-coefficient and high-frequency characteristics. Values, however, are limited to several hundred kilohms. Although vacuum-evaporated capacitors have been produced, efforts are still underway to develop controlled techniques for low-loss, high quality components on a large scale.

In circuitry employing thin films, various deposition techniques are being investigated. An important process step involves the cutting of a desired pattern or separation of a deposited pattern from other circuit regions. Among the more promising methods are the electron beam and electric probe which are considered flexible, highly efficient, and also are well suited to high-yield production.

By including multiple layers on a single substrate, interconnections can be reduced with a subsequent increase in reliability and assembly simplicity. However, extremely thin layers of film are difficult to connect to and may be partially destroyed or undergo a change in parameters during the process of connection to other sections of a system.

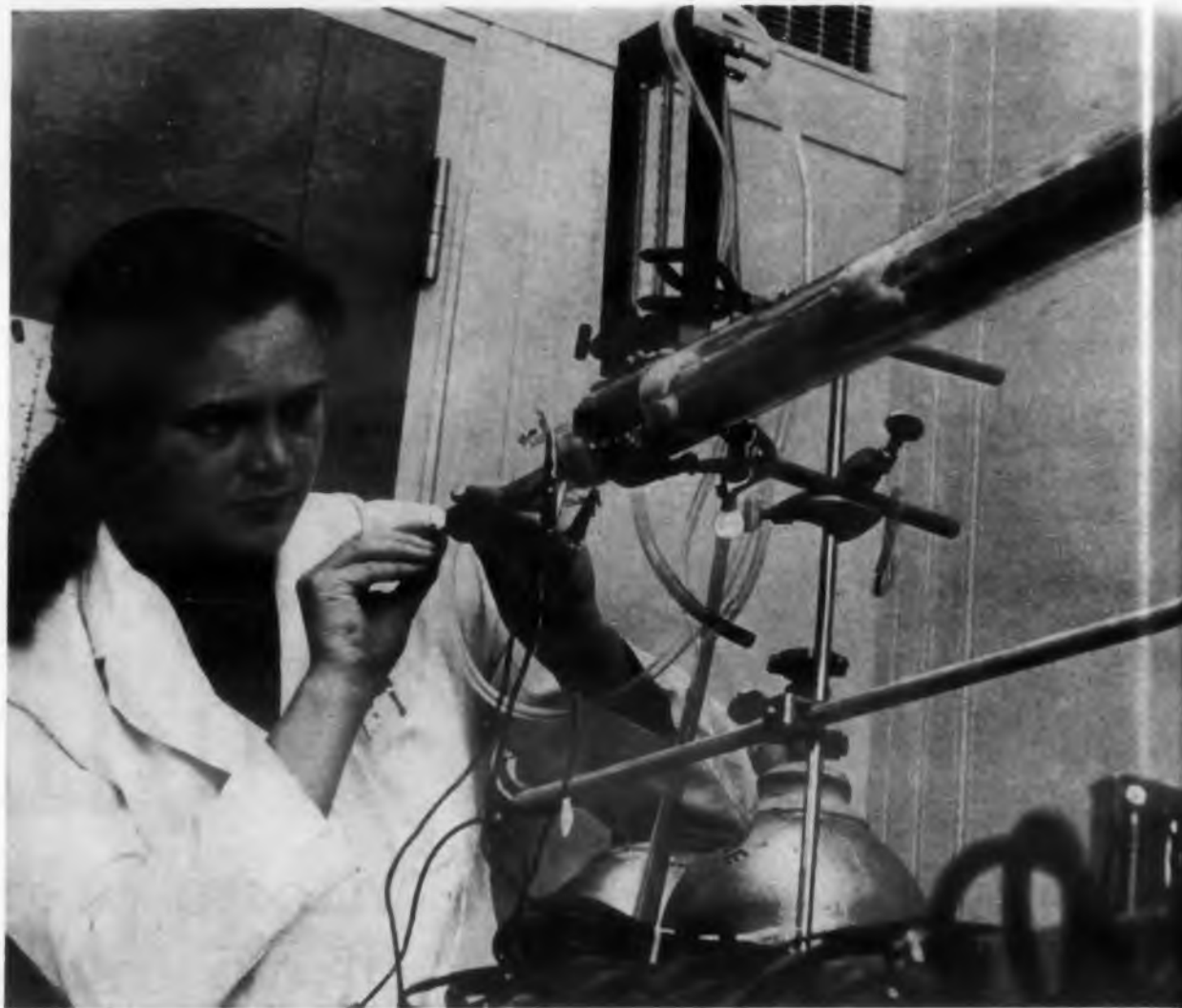


Fig. 13. Epitaxial semiconductor growth—vapor deposition of material on a seed crystal so as to continue the single crystal structure of the seed—experiments at IBM may lead to methods of depositing active as well as passive elements in thin film form (*ED*, July 6, p 4). Here associate researcher Patricia J. McDade unloads furnace after vapor-growth run.

IBM Automating Thin-Film Work

Advanced automation equipment has already been constructed for production of layered thin-film networks by International Business Machines Corp. Up to 18 layers have been deposited, one on top of the other, using the IBM approach to produce the passive elements in an OR circuit (see Fig. 14).

Glass substrates with an undercoating layer

of silicon monoxide have been used in most IBM work. Aluminum has been found to be most compatible with SiO₂ as a conductive material, Nichrome is used for resistors, and insulators are layers of silicon monoxide or dioxide. A final SiO₂ protective film is deposited on the top of the circuit, leaving land areas exposed for external connection.

Typical resistance values obtained with the

2-D Thin Films

ADVANTAGES:

- Use of thin-film conductors and insulators reduces wafer or plate thickness.
- Interconnection is reduced by at least two to one; a conventional component requires two internal and two external connections while a film resistor, for example, needs only two external contacts.
- Metal films should be more stable than organic types.
- Higher resistivity values should result with metal films compared to screened approaches due to finer line widths.

PROBLEM AREAS:

- Deposition must take place on a flat, smooth surface free of discontinuities.
- Techniques for trimming resistors are still in the experimental stage.
- Component tolerance and reliability figures must be evaluated.
- Deposition in a vacuum poses a production challenge. Cleanliness is important.
- Components must meet the circuit requirements from the first step on.
- Pin holes are easily developed and hard to control.

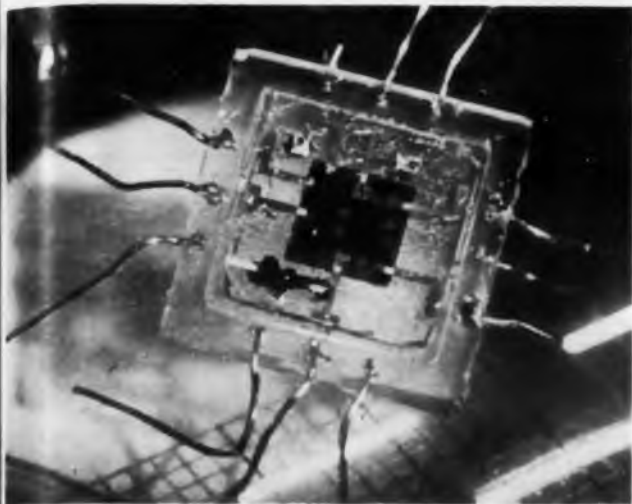


Fig. 14. IBM produced this 18-layer thin film OR circuit under an Army Signal Corps contract.

IBM approach are 200 ohms per sq. and typical capacitance is 0.045 μ f per sq in. using a 10,000-A-thick insulator. Voltage breakdown is about 65 v for this thickness. The thinness of insulators is one of the drawbacks to this approach. Breadboarding of new circuit designs is also a difficult process.

Connections to semiconductors or to other circuitry are made using soldering, conducting cements or thermal compression bonds.

IRC Selling Mu-Circuits

First on the market with thin film circuits was International Resistance Co., Philadelphia, with a \$46 NOR unit. Passive elements are vacuum-deposited on both sides of a 0.4 x 0.4-in. glass wafer which has an aperture for the single transistor in the circuit. Two transistor leads are soldered to one side of the plate, and one on the other.

Films are applied by IRC in a single layer, and crossings are avoided. Depth of the wafer is presently fixed by the diameter of the transistor—a Raytheon CK67A audio type is being used to demonstrate feasibility rather than to provide fast switching. Micro-transistors can be adapted to this approach and IRC is planning to go into the semiconductor field in order to supply its own requirements for thin film circuits. Emphasis is being placed on types amenable to microcircuitry, such as planars.

Power dissipation is limited to about 2 w per sq in. on glass, although this could be boosted to 4.5 w per sq in. if ceramic was used according to IRC's Dr. Benjamin J. Patton, manager, microcircuitry research. A self-imposed limit of 300 to 1,000 ohms per sq in. has been set by IRC on resistance, and capacitance is limited to 0.01 μ f per sq in. Tolerances start at about 5 per cent—it is too early in the development of this technology to expect 1 per cent



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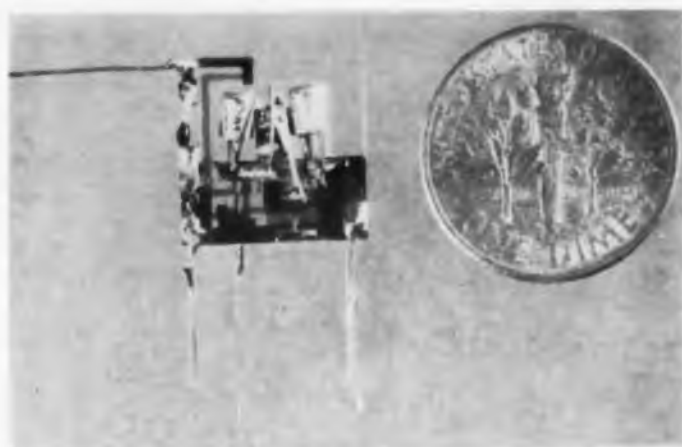


Fig. 15. This IRC 3-stage audio preamplifier has thin-film resistors combined with miniature components connected by solder joints to pack 3 transistors, 4 resistors and a diode onto a 1/2-in. square glass wafer.

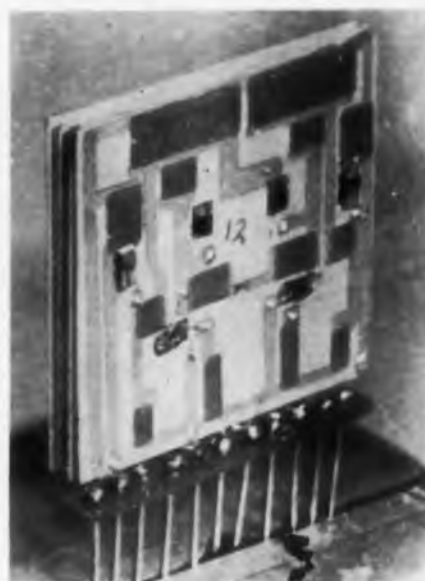


Fig. 16. Varo's thin-film assembly, containing four flip-flop circuits, shown prior to encapsulation.

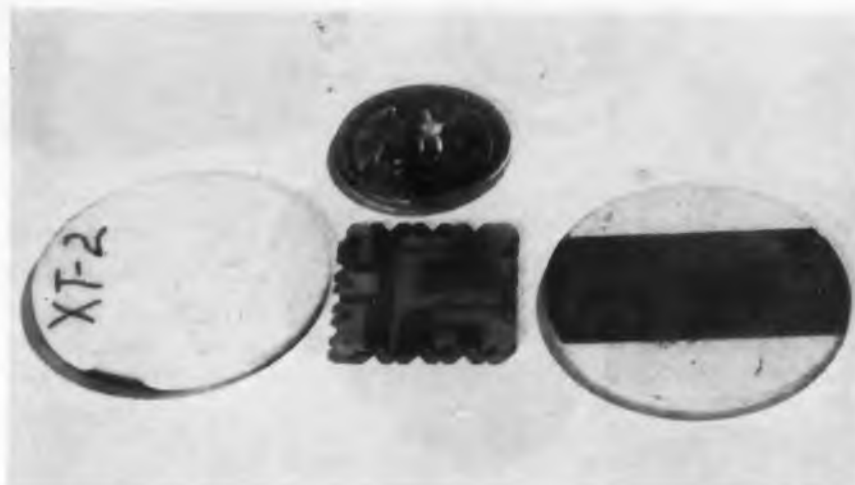


Fig. 17. A chemical process for thin-film deposition, developed by Lockheed Missile and Space Div., Sunnyvale, Calif., is cheaper than vacuum techniques. The process of circuit fabrication includes the formation of the ceramic substrate with titanium film by electrochemical conversion followed by attachment of active elements.

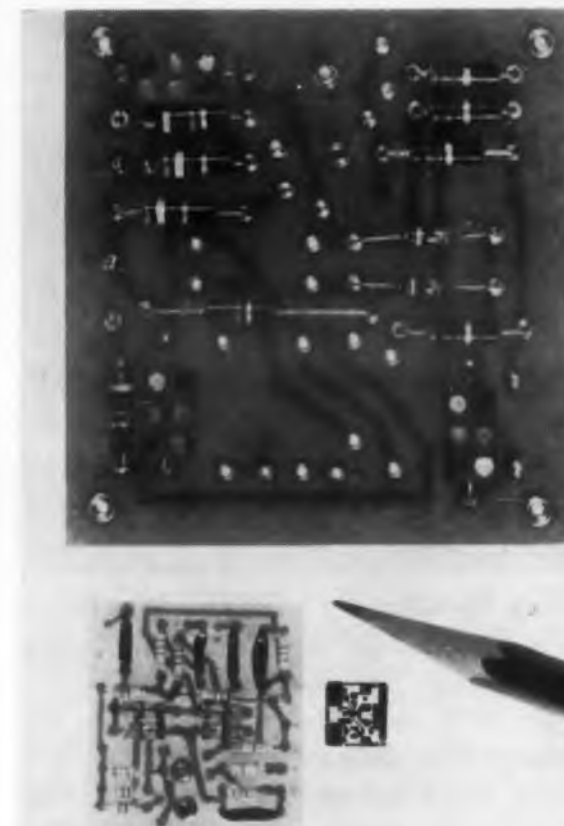


Fig. 18. Three versions of the same flip-flop circuit fabricated by Servomechanisms, Inc., illustrate size reduction.

tolerance, Dr. Patton says. Price levels in the \$2 to 50-cent range for vacuum-deposited resistors are the object of the IRC development program.

Designers must be careful in derating of components in specifying for micromin equipment, Dr. Patton feels. Calling for the 0.5-w resistor out of force of habit must go by the wayside in micromin designs because of the costs involved. Fig. 15 shows a thin-film, 3-stage amplifier produced by IRC.

Thin-Film FM Transmitters Built by Varo

Microcircuitry, as developed by Varo Manufacturing Co., Garland, Tex., is a two-dimensional thin-metal film technique using vacuum deposition of passive circuit elements. Micro-

diodes and transistors are presently inserted in the substrate; as soon as reliable deposited semiconductor techniques are realized, they will replace the micro-semiconductors.

Although it is possible to deposit multiple layers of circuitry on a single substrate and offer exceptional package density and outstanding interconnection ease, more efficient circuits must be designed to permit lower voltage levels to be applied, according to Fred Granger, director of Varo's program. The process is not limited by the number of deposited layers which can be deposited, he insists, but by the heat-dissipation factor. Varo specifies a limit of 1 w on a 1-in. sq substrate (without special cooling); by designing more efficient circuitry, more compon-

ents can be accepted before the 1-w figure is reached.

In addition to computer blocks, Varo has fabricated audio preamplifiers, fm transmitters and receivers, using the vacuum evaporated technique. A thin-film circuit package, consisting of 104 components, contains four high-speed flip-flop circuits in a 0.125-cu in. space, see Fig. 16.

Servomechanisms Use Microsoldering

Servomechanisms, Inc., Goleta, Calif., has fabricated vacuum-deposited wafers using nickel-iron for the conductor areas and nichrome as the resistance element. Using uncased transistors and microdiodes, circuit configurations have been built. It is interesting to note that the sol-

Micromin Literature Available

A survey of microminiaturization work along with details of the DOFL 2-D approach is presented in the book "Microminiaturization of Electronic Assemblies," available from Hayden Book Co., 830 Third Ave., New York 22, N.Y., \$11.50 per copy.

A status report on the field, prepared by Norman Doctor, who heads DOFL's program, is available from the Office of Technical Services in Washington. Titled "Status of Electronic Microminiaturization," PB 161674, it is priced at 75 cents.

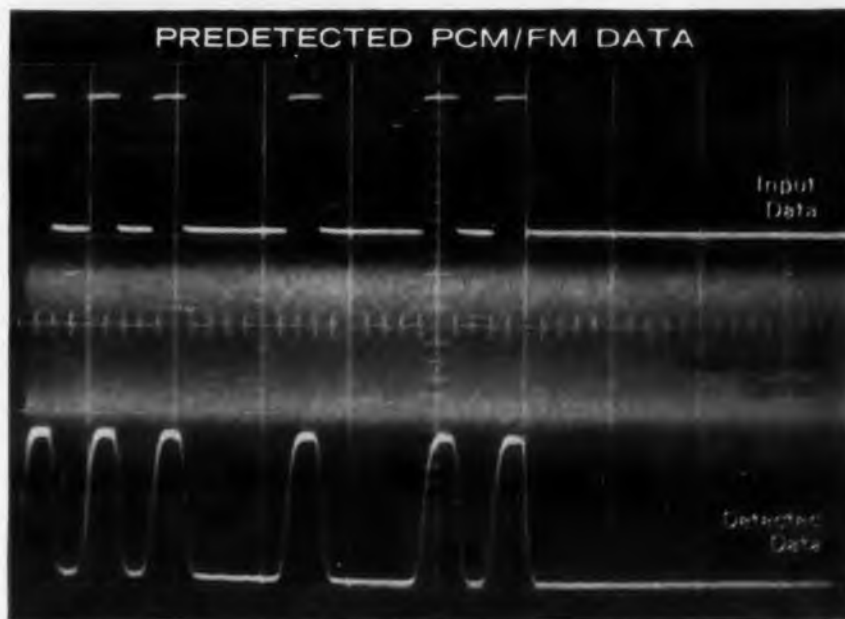
dering-iron tip, for transistor lead connections, consists of a single strand of 3-mil wire. A thermo-compression bonding scheme is being investigated for fusing the gold lead wires of the transistor to the substrate material.

In Fig. 18 are shown three generations of bistable multivibrators constructed at SMI; the first measures 2.75 x 2.75 x 0.25 in., the second is 1.25 x 1.0 x 0.25 in. and the vacuum-deposited version is only 0.35 x 0.35 in.

Motorola Shows Thin-Film IF Amplifier

At the 1960 Western Electronic Show and Convention (WESCON), Motorola revealed details of a two-stage RC amplifier resulting from its microelectronic efforts.

Basically, the approach involves the use of thin-film conductors and insulators with uncased semiconductors serving as the active elements. Motorola claims a method for deposition of a pinhole-free thin-film dielectric has been developed. This results in extremely low leakage and permits the glass-like dielectric to be used as electrical insulation for conductors which must cross each other. The circuit demonstrated was a section of a 5-mc if amplifier using filter techniques to achieve the bandpass characteristic. Distributed capacity problems are minimized by virtue of the small components; distributed capacity can be calculated when simple geometrical patterns are used. ■ ■



5.0-mc IF carrier heterodyned down to 750 kc. Random-spaced pulses, 20 μ s on-20 μ s off-type information. Sweep rate: 50 μ s/cm.

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CIRCLE 68 ON READER-SERVICE CARD

Micromodules

A standardized approach to microminiaturization is being sought by the Army Signal Corps under its Micromodule program. Radio Corp. of America, Camden, N. J., has been prime contractor on the project since the first quarter, 1957. Three development phases were set, each to run for two years with a one-year overlap. Phase I, 1957-59, was microelements and micromodules; Phase II, 1958-60, equipment subassemblies; and Phase III, 1959-61, originally called mechanization, is now termed production engineering measures.

MICROMODULES are encapsulated wafer stacks, with individual components either deposited or mounted on a single ceramic wafer.

The wafers, called microelements, measure 0.310 x 0.310-in. sq and usually about 0.010-in. thick, with three notches for lead attachment on each edge. Notches are metalized and solder pads attached for solder connection of riser wires. Wafers inside the module are metalized with silk-screened silver paint and end wafers are gold-platinum metalized because of the possibility of silver migration due to moisture. Four corner blocks on each module give 12-to-15 mil spacing underneath so that air circulation prevents collection of moisture.

Riser wires are soldered to at least three notches on each wafer, and at least six risers are connected to terminal pins for structural rigidity.

A wide range of deposited and attached components have been developed for the program, although definite limitations on values exist as shown in the table. Wirewound ferrite cores

now used for inductors are not compatible with the over-all form factor, but do not appear to seriously enlarge the over-all module height—which is variable.

Inter coupling effects within modules are an important consideration in linear circuitry—a small inductor, for example, might provide 60- to 80-db gain. Positioning of wafers, control of spacing, and elimination or removal of riser wires is sometimes necessary to overcome these effects. Faraday shielding could be used but has not yet proved necessary.

The module is usually a throw-away package for maintenance purposes. Module costs are currently high, but RCA indicates that they will be radically lower with automation.

In some cases, component manufacturers participating in the program indicate, however, that costs may be hard to bring down. Putting a component onto the ceramic wafer brought yield down to one-third of that obtained for the component without the ceramic, because of the brittleness of the wafer, according to one manufac-

Micromodules

ADVANTAGES:

- Standard geometry.
- Automation of parts production and assembly.
- Reliability data should be available.
- Many component makers contribute skills to an over-all industry program.

PROBLEM AREAS:

- Less flexibility for the design engineer.
- Many tiny solder connections required.
- New component technology necessary.
- Some engineers feel that costs will always be comparatively high even with automation.
- Some 3-D approaches already in production have close to the same parts density.
- Hermetic sealing of transistors to wafers difficult.

turer. The use of deposition and non-reversible adhesives for attachment means that if wafers break the component is lost.

A source of premetalized wafers could save costs considerably, one manufacturer commented, since it is difficult to set up adequate metalizing operations for small output in each components plant.

RCA spokesmen expect that when operations are mechanized, however, yield will be above 90 per cent for all components except semiconductors, which should be in the 50-per-cent range.

As for price an RCA spokesman said, "We are striving for the \$10 micromodule by 1965." ■

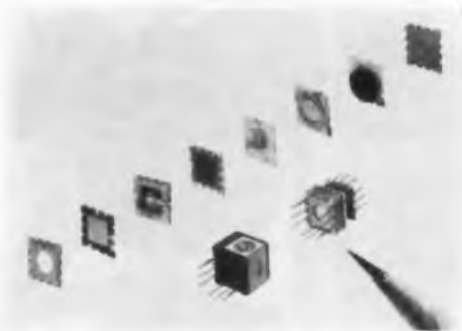


Fig. 19. RCA Micromodule, showing several microelements developed for the program. Left to right are: end wafer; ceramic capacitor; electrolytic capacitor; resistor; diode; transistor; inductor and end wafer.

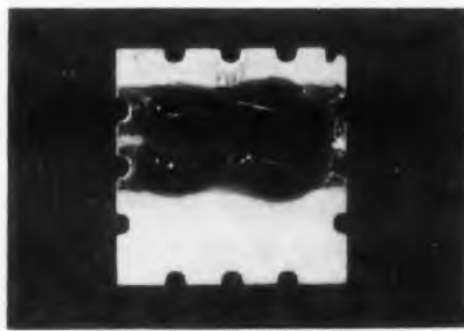


Fig. 20. Four PSI diodes are mounted on a single wafer, indicating the trend toward putting more than one part of a particular kind on a single wafer. Later RCA and the Signal Corps plan to integrate thin film and more exotic advances into the Micromodule program.

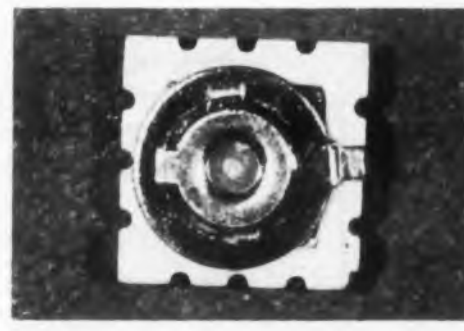


Fig. 21. Transistor package with radial leads built for the Micromodule program by Hermetic Pacific, Inc. Hermetic sealing is accomplished by glass-to-metal seals and resistance welding. Because of high yields for welded seals, such as those supplied to the program by Hermetic Pacific and Rheem Semiconductor, these will probably replace the ultrasonic solder hermetic seals in the program.

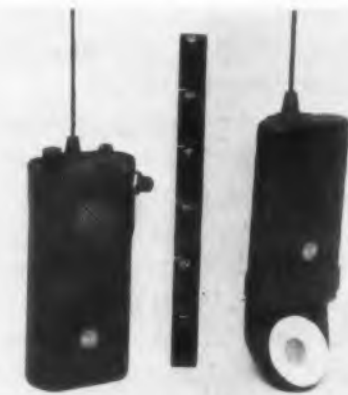


Fig. 22. Models of 50-mc fm hand transmitter, left, and helmet receiver, right, being built by RCA for the Signal Corps under the Micromodule program.

Micromodule Components and Limitations

Transistors 3 germanium—2N404; 2N-384; 2N140. (11 additional silicon and germanium transistors to be added in sample quantities in next few months, expect to have essentially all types in next two years).

Diodes 1N277 gold-bonded; 1N643 silicon junction and Varicap.

Resistors 10 to 100 K with up to four per wafer. 1% tolerance, 1% over-all lifetime stability, maximum dissipation 1/8 w per resistor and up to 1/2 w per wafer.
In development: GP (5 to 10% tolerance), 10 to 1 meg, "several" per cent over-all lifetime stability.

Capacitors Single layer ceramic, all common temperature compensating and dielectric bodies.

- 0 deg temperature coefficient—40 μf max.
- High K, general purpose—0.005 μf max.

Sprague monolithic up to 10 layers.

- 0.030 ppm negative temperature coefficient—up to 1400 μf max.
- GP material—0.3 μf

(all temperature-compensating and high K bodies should be available in next several years).

Tantalum electrolytic — 60 μf (expect this to go to 500 to 1,000 μf in next several years).

Variable ceramic trimmer for tuned if circuits still in development, in few μf range.

Inductors 10 mh for chokes and larger transformers.
 Precision transformers used at 4.3 mc.

Quartz Crystals 7 to 70 mc.



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CIRCLE 69 ON READER-SERVICE CARD

Integrated Circuits

By applying to the manufacturing process such techniques as oxide masking, alloying, diffusion, metal deposition and surface shaping, complete circuits can be fabricated on or within one semiconductor slab.

TEXAS Instruments, Dallas, first to announce commercially available "Solid Circuits," creates resistances from bulk properties of the semiconductor crystal and by oxide-mask or mesa-etch diffusion techniques. Capacitors are formed by using a reverse-biased pn junction with the depletion region of the junction acting as the dielectric. Where reverse bias cannot be applied, a silicon-oxide capacitor is constructed using the crystal as one plate, silicon-oxide as the dielectric and a deposited metal layer as the upper plate. Inductors pose a serious design challenge; at present, the problem has been avoided since computer blocks, requiring no coils, have been the target for much of the integrated circuit work. Transistors and diodes can be fabricated by alloying or diffusion processes.

In the completed device, it is difficult to distinguish individual components on the crystal substrate. By careful layout and topology, the number of connections can be considerably reduced compared with conventional component approaches. Contacts to the diffused layers are performed through thermal compression bonding, similar to techniques used in mesa transistor manufacturing. The final assembly steps produce a glass-to-metal hermetically sealed package.



Fig. 23. Seven solid-circuit multivibrators, made by TI, can sit on a dime, with room to spare.

Early in 1960, TI announced commercial availability of a Type 502, 200-kc binary flip-flop measuring 0.125 x 0.25 x 0.003 in. The single silicon wafer contains the equivalent of 8 resistors, 2 capacitors and 2 transistors, see Fig. 23.

Other efforts in integrated circuitry include RCA, using the unipolar transistor as a key element within design. Diamond Ordnance Fuze Labs is experimenting with germanium substrates. England's Royal Radar Establishment has successfully constructed a "proof-of-principle" solid-silicon circuit, but mass assembly is not expected for some time, due to the low yield rates expected from their complex process.

Silicon Micrologic From Fairchild

Silicon integrated digital circuits packaged in 8-lead transistor cans are being sampled by Fairchild Semiconductor Corp., Mountain View, Calif. (See Fig. 25.)

The techniques used by Fairchild for these Micrologic building blocks are similar to those applied in the TI Solid Circuit approach, but the marketing concept is much different. By packaging in TO-5 and TO-18 cans, which will soon be halved in height, the company hopes to

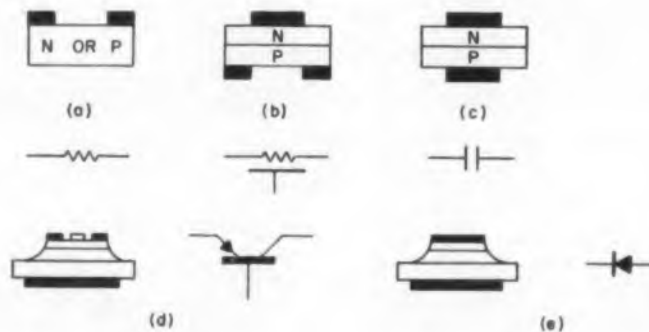


Fig. 24. Silicon circuit elements used in TI Solid Circuits include (a) resistors, (b) distributed capacitance, (c) capacitors, (d) transistors, and (e) diodes.

attract more designer interest because of the adaptability to present packaging methods.

Present samples, using thermal-compression, bonded, fine-wire connections between active areas, do not represent the commercial product, Fairchild says. The commercial version will have vacuum-deposited thin-film interconnections inside the packages—a much cheaper solution than thermal-compression bonding because all connections can be deposited at once. Since thin-film deposition requires a specially prepared, flat surface and offers many other problem areas, it has been troublesome in the past.

Average power dissipation for the blocks is 30 mw, speed is over 1 mc, and temperature range is from -55 to +125 C.

Raytheon Stresses Alloying

Integrated silicon circuits produced primarily by alloying and post-alloy-diffusion methods, rather than straight diffusion, are being investigated by Raytheon Co., Waltham, Mass.

Admittedly diffusion and photoevaporation techniques give more control of geometry, according to Dr. W. T. Eriksen, manager of advanced development, but the alloying approach should offer more reliability, lower cost, and higher yield. An added possibility, he said, is that more extraneous conductances can be eliminated with this method so that operation at extremely low currents will be easier to achieve because of high current efficiency. Raytheon hopes to reach input current levels of 5 to 10 μ amp for digital circuits. (See Fig. 26.)

A multivibrator has been produced on a silicon chip to prove feasibility of the concept. This unit operates on 20-ma input, but this is necessary because output must be high enough to drive present type gates.

Severe technical problems face low-input solid-block development. Surface recombination effects which are temperature-dependent, for example, cause gain to vary with temperature. The serious effects of even monomolecular contaminating layers on the surface are also a problem,



Fig. 25. Silicon Micrologic blocks packaged in miniature transistor cans with eight leads are under development at Fairchild Semiconductor Corp.

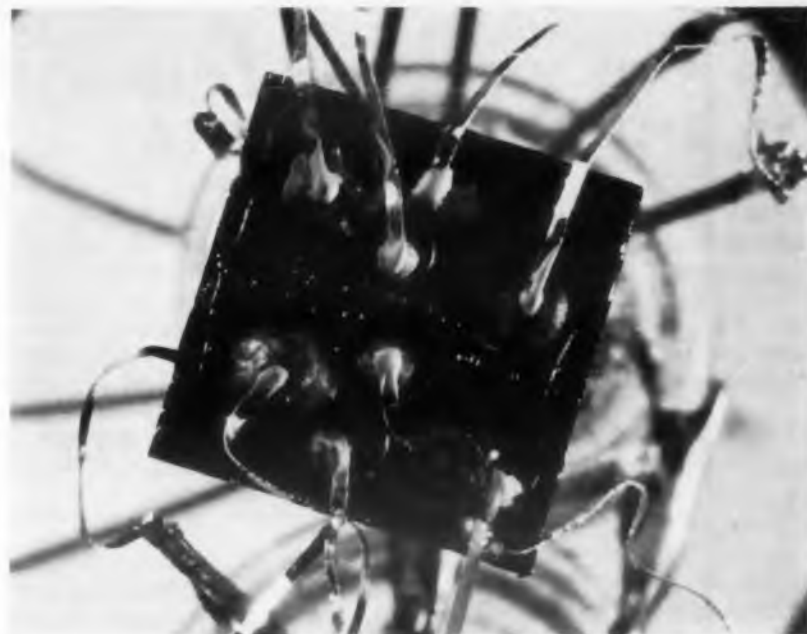


Fig. 26. This flip-flop on a 1/4-in. silicon chip was made by Raytheon Co. using primarily alloying and post-alloy diffusion methods.



Fig. 27. Sperry-manufactured integrated "Semi-Nets" are encased in TO-5 transistor cans.

and it is too early to be sure that surface passivation techniques are a solution to this, according to Dr. Eriksen.

Sperry "Semi-Nets" Use Redundancy

Also engaged in the single solid block, integrated-circuit approach is the Sperry Semiconductor Div. of Sperry Rand Corp., South Norwalk, Conn. The initial devices, to be made available in about eight months, will be silicon computer circuits suitable for 10-mc repetition rate applications. By careful design, Sperry engineers have minimized the use of internal thermal compression bonds to link various elements; in their flip-flop circuit, for example, no internal compression bonds are used, only tie points to external leads are bonded. A backing plate is used as a heat sink to achieve a maximum dissipation rating of approximately 150 mw per circuit.

An important feature of the Sperry approach lies in the decision to incorporate redundancy in individual blocks; reliability, yield and cost are expected to be reduced compared to a straightforward, non-redundant scheme. Initially, the "Semi-Nets" will be mounted in a TO-5 transistor package; the package is being redesigned to a flat form. (See Fig. 27.) ■ ■

Integrated Circuits

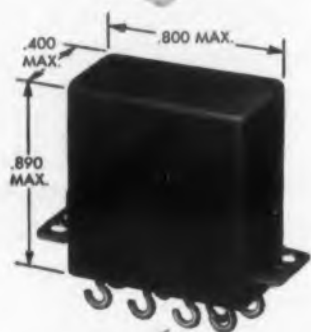
ADVANTAGES:

- Extremely high packing density possible.
- Lead wires and interconnections are markedly reduced.
- Fabrication of difficult circuit designs may be simple since, in many cases, masking apertures could be interchanged.
- Inherent reliability is high due to:
 - (a) use of a carefully controlled material whose characteristics can be closely checked.
 - (b) reduction in connections between components.
 - (c) low thermal expansion mismatch between continuous regions of a single material.
 - (d) relatively few process steps involved as compared to conventional component fabrication and assembly.
 - (e) low mass of the package, reducing the hazards of shock and vibration fatigue.

PROBLEM AREAS:

- Component values are restricted.
- Tolerance of individual elements are difficult (or economically impossible) to check. This, of course, eliminates the use of worst-case design analysis.
- Components, active and passive, are temperature-dependent.
- Thermal-compression bonding is relatively difficult and time consuming.
- Yield figures, although not publicly released, would be expected to be rather low due to the number of elements involved. This, in turn, results in high initial production cost figures.
- Application to analog circuits, where cross-coupling and higher power dissipation are serious problems, might become involved; the use of special shielding and heat sink arrangements could represent substantial size and weight increases.

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APPROACHES
 MICROMINIATURIZATION
 MOLECULAR ELECTRONICS

Molecular Electronics

Functional blocks, rather than conventional circuitry, are employed to satisfy a given input-output function. This approach to the concept of microminiaturization is dependent on phenomena occurring within or between domains of molecules in the solid state.

UNDER a \$2 million Air Force contract, Westinghouse Electric Corp. has concentrated efforts on molecular electronics, the science of merging a function with a material. In contrast to conventional size-reduction programs where a one-to-one replacement of small for large components is made, the molecular program seeks to modify the properties of a single crystal to achieve a given transfer function. Thus, miniaturization by circuit redesign, rather than "shrinking parts," becomes the ultimate goal to be achieved by the designer. Functional blocks, rather than complete circuits, are produced.

Molecular electronic blocks are prepared by forming a number of distinct domains, generally in a single crystal. Domain boundaries, or interfaces, can create effects different from those occurring in adjacent domains.

As an example of the functional block as compared to the conventional approach, consider a 110-v ac to 9-v dc converter, see Fig. 29. The conventional circuit requires a transformer, rectifier and three filter components. With the molecular approach, the ac is applied to the resistive domain, heat is passed through the center domain which is an electrical insulator but thermal conductor, and then converted to dc by a thermoelectric domain. Ripple elimination is inherent since the heat flow to the thermoelectric domain is uniform.

An important process in fabrication involves "dendritic" growth, a technique for producing semiconductor crystals in long, uniform ribbons with optically flat surfaces. The ribbon, which can be made as long as several hundred feet, can

Functional Blocks

ADVANTAGES:

- Individual component and connection reduction by means of circuit redesign should markedly improve reliability.
- Parts densities of enormous proportions are feasible.
- Power requirement can be reduced.
- Low mass offers higher resistance to shock and vibration.

PROBLEM AREAS:

- Extensive time may be required to redesign molecular blocks meeting a wide range of transfer functions.
- As with integrated circuits, the devices are temperature-dependent, require new fabrication approaches and will be expensive until high yield is achieved.
- Attachment of leads to sections within a multi-function block poses unique problems.
- Reliability must be proved.
- Heat dissipation is difficult to handle, and may necessitate bulky cooling devices.

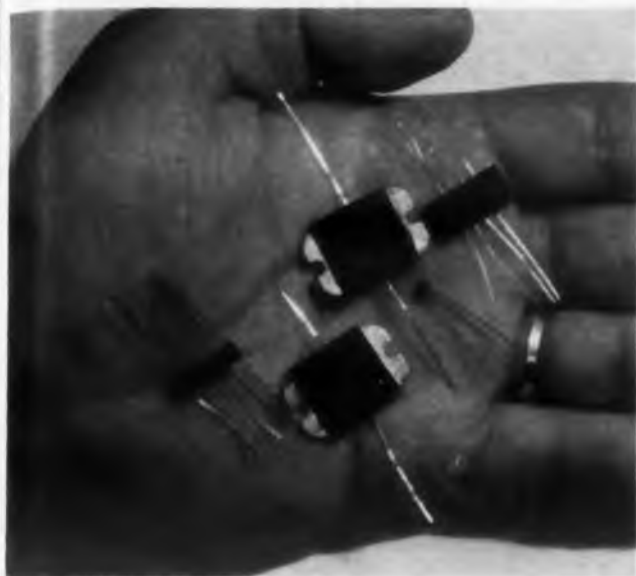


Fig. 28. Functional blocks recently announced as available from Westinghouse include (left to right) a multiple switch, two-stage amplifier, three-stage amplifier, pulse generator and multivibrator. Prices range from \$300 to \$400 each.

have diffusion, evaporation, and plating processes applied as it is grown in the furnace. Thus, completed semiconductors, requiring only leads to be attached, can be obtained. In addition, techniques have been developed for growing multi-zoned crystals as dendrites; this, in turn, eliminates the need for separate steps in creating multizone elements in conventional crystals. At WESCON, Westinghouse announced sample availability of five types of functional blocks. ■ ■

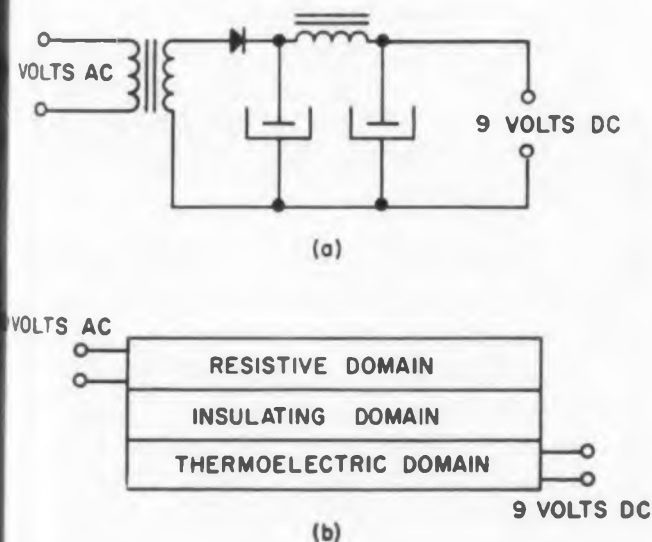


Fig. 29. A conventional ac-to-dc converter (a) requires a transformer, diode and filter elements compared to the simpler three-domain molecular block (b).

vernistat[®] design report

Information on Vernistat a.c. potentiometers for design engineers

TERMINAL LINEARITY—THE RAINBOW AT THE END OF THE POT

Let's run with the basic facts: the Vernistat is a precision a.c. potentiometer. It differs from the ordinary pot, because the input voltage is spread across an autotransformer. An interpolating pot which operates between adjacent taps of the autotransformer acts as the voltage pick-off; it pulls out a smoothly-rising, precisely linear voltage.

IMPEDANCE

Now let's focus on the autotransformer: The voltage looks into a **very high impedance**, because the autotransformer consists of many turns of wire around a high-permeability core. The output impedance of the transformer is very low. Now, the load looks back into a **very low impedance**, because output impedance of the Vernistat is determined mainly by the **resistance of the interpolating pot**. As far as the load is concerned, the impedance of the autotransformer itself never goes above a few ohms.

"Now what," you may ask "has this high Z_1 — low Z_0 ratio got to do with linearity?"

Simply this: **Vernistats may be cascaded and loaded without appreciable loading error. Output voltages remain linear and accurate!**

To give it in figures: if a 500 K load is applied to an ordinary 50 K pot, a maximum loading error of about 1.4%

will result. This obviously is ruinous to system accuracies requiring a linearity of about .1%—not uncommon in analog computer and servo work. With the same 500 K load, Vernistat goes to the head of the class with loaded linearities no greater than 0.07%.

PHASE SHIFT

What's more, if phase shift is a problem, Vernistat may well be the answer. The tapped autotransformer acts as an almost perfect voltage divider. That is, tap voltages remain almost exactly in phase with input voltage! (Take a look at the phase diagram below.) Unlike many voltage dividers, the Vernistat does not develop excessive phase shift at higher frequencies. Operation at 5 KC is not uncommon.

In sum: the Vernistat provides high linearity and multiturn operation — a direct result of its high angular resolution of 0.002%. Its other inborn features include: continuous mechanical rotation and operation with essentially no energy losses.

Paradoxically, the Vernistat can be made into a useful nonlinear device simply by varying tap distances on the autotransformer. We sell other nonlinear variants of Vernistat, too. Ask us about our Adjustable Function Generators.



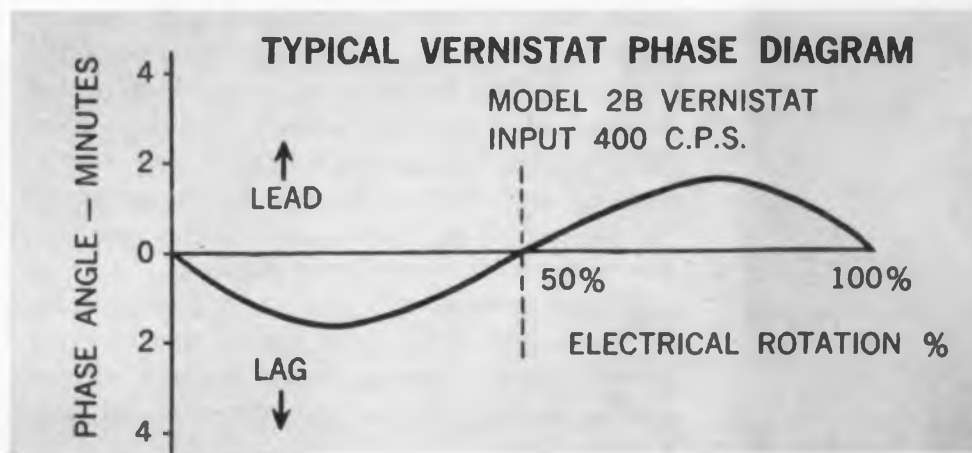
SIZE II VERNISTAT AC POTENTIOMETERS

These miniature components are approximately $1\frac{2}{3}$ inches long, a little over an inch in diameter and weigh 2 ounces. The Series 4 operates on 400 cycle power at 17-40 volts maximum input. Minimum input impedance is 2,500 ohms; maximum output impedance — 40 to 200 ohms. Terminal linearity is $\pm 0.05\%$. Rotates continuously through a ten-turn electrical cycle.

Four Series 4 Vernistats are available in numerous sizes and ratings. Vernistats are useful not only as a.c. potentiometers, but in data transmission, mathematical operations, as computer elements, as driving elements for resolvers, as servo follow-up elements, for voltage step-up and phase reversal.

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CIRCLE 71 ON READER-SERVICE CARD

Interconnections Lag Device Development

Packaging has reached a different level of development in each area of microminiaturization, depending on the stage of advancement of the particular concept.

Three-dimensional form factors have been carefully worked out, as indicated in the discussion of sandwich-type and welded modules. The earlier 2-D approaches have received some attention, and in some cases excellent packaging schemes have been developed.

The greatest promise for micromin, however, remains with the most advanced concepts—thin-film and integrated circuits and functional or molecular electronics. Here is where the greatest novelty in form factor is feasible, but also where the fewest detailed schemes have been worked out.

A tendency throughout the industry, evident at a WESCON micromin session this summer, is to pass off packaging problems as someone else's headache. Component producers want the systems designers to come forward with packaging approaches. Systems men feel that to be sold on micromin, they must be offered space- and weight-saving connection techniques along with small lumps of circuitry.

A great deal of imagination has gone into the new concepts under development in the laboratory. Now is the time for the same kind of forward thinking to be applied to interconnecting these novel circuits to prove that these concepts are ready to move toward the hardware stage.

Some of the advances are illustrated in this section.

THE MICROMINIATURIZATION trend has led to exploration of many basically new approaches to interconnections. Several drawbacks to the solder joint, long standard in the industry, have caused this move.

Micromin solder joints, by necessity, consist of minute bits of solder, inherently reducing strength

of a joint. Hot flux can splash or flow during operations, contaminating open-type deposited components or circuits, or making undesired joints between closely spaced fine wires. Heat cycles for soldering are relatively long, and heat, highly localized in some of the newer approaches, can damage components.

Despite these defects, microsoldering methods are improving and many of these disadvantages are being minimized. Consciousness of the problems that exist are leading to more rigid training of workers, which is undoubtedly leading to improvements in soldering techniques.

Ultrasonic soldering is one of the methods under study. Pretinned lands and lead wires or fillets can be joined by ultrasonic vibration, without using flux. Surfaces are cleaned of oxides because of migration through molten solder. RCA is using this approach to produce hermetic seals for transistors on ceramic wafers, for use in the Micromodule program and further possibilities of the method are being explored.

Ultrasonic welding is also under investigation, as it has proved ideal for joining thin to thick pieces. Again vibration breaks through surface oxides, making the method attractive for aluminum joints.

Some of the drawbacks to this approach are the large electrodes required, the induced heat which in effect gives a long-weld cycle, and the heavy vibration stresses applied to leads.

Electron-beam welding, using the Zeiss process licensed by Hamilton Standard, appears to have potential because of the extreme localization of the beam, concentrating heat within a minute area so that higher temperatures can be used.

Some of the advantages and problem areas for welded joints have been described previously. Two basic types of resistance welding machines, one using stored energy and the other an ac type, are being used in the industry for welded modules. The ac machines, which give longer weld cycles, include a Raytheon 5-kva slope welder and a Taylor Windfield Model EB-1, which has a half-cycle switch for somewhat shorter weld times. Capacitor discharge welders provide a surge of current over a few milliseconds. Machines commonly used include Raytheon's 225 w-sec model and Unitek's Weldmatic 250 w-sec machine.

Clever Interconnection Features AMP's MECA

To facilitate maintenance and provide means for an economically feasible "throw-away," a new and radically different interconnection scheme has been developed by AMP, Inc., Harrisburg, Pa. Studies of maintenance costs associated with electronic equipment have revealed that 10 to 15 times original cost was spent to keep systems in operation; with expensive modules, this figure may increase by an order of magnitude unless maintenance, preferably by semi-skilled techni-



Fig. 30. Electron beam welder developed by NRC Equipment Corp., Newton Highlands, Mass., produces welded joints in vacuum. This machine costs about \$17,000.

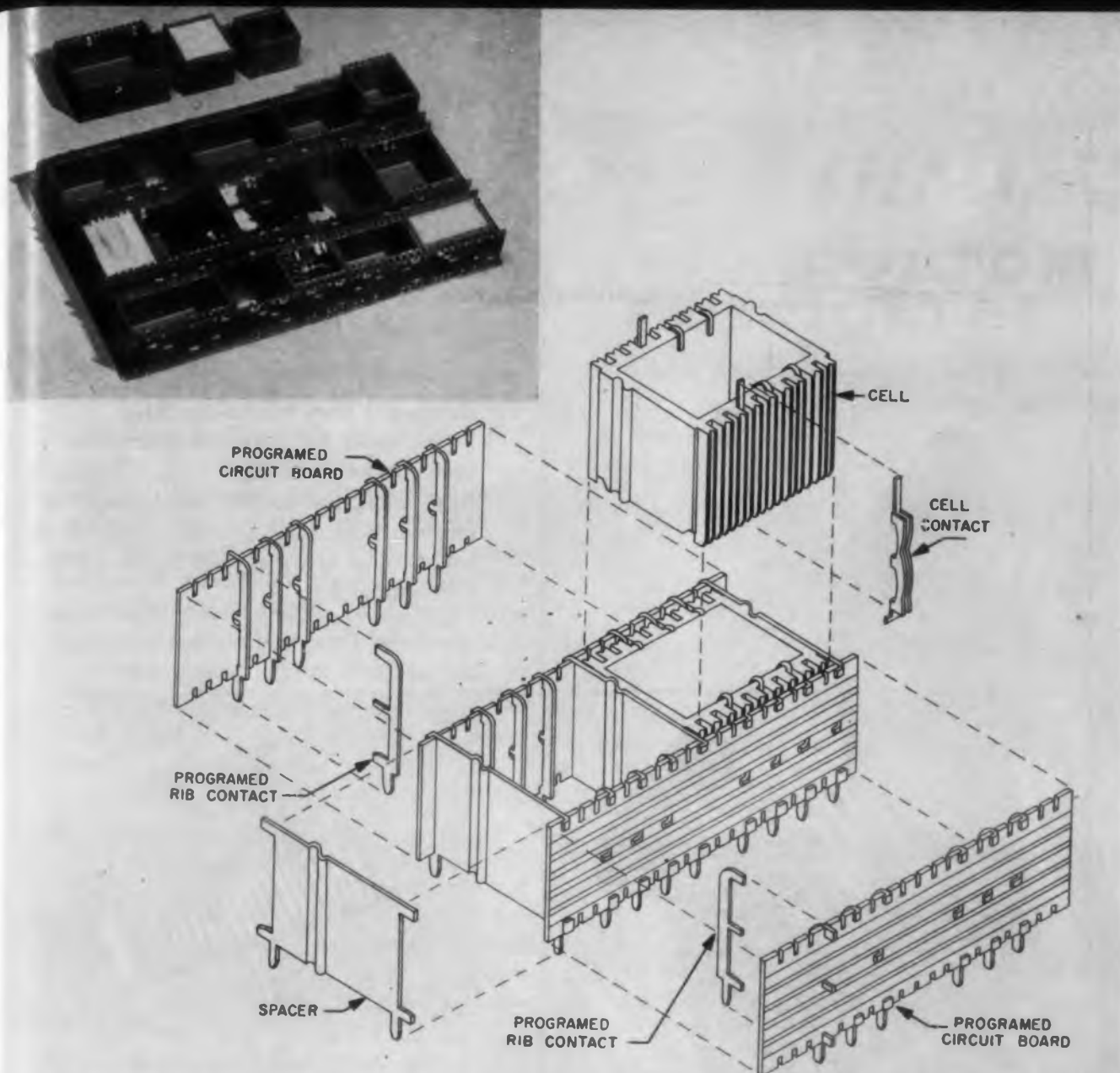


Fig. 31. An exploded view of the Amp MECA assembly showing cells, contacts and programed circuit boards. If an individual cell is removed for repair, associated cell contacts are replaced to avoid a drop in reliability. An assembly of MECA cells mounted on a mother board is also illustrated.

icians, is considered during initial system design.

The MECA (Maintainable Electronic Component Assemblies) assembly, shown in Fig. 31, begins with a cell to house the necessary electronic components, integrated circuits or functional devices. For applications where servicing of components is desired, an open bottom cell is used and parts are stacked vertically for lead accessibility. For "throw-away" use, the completed cell can be encapsulated. Cell contacts, the active spring members of the assembly, are shaped so as to provide four points of contact between cell and external connections to achieve high reliability even under extreme shock and vibration conditions.

Two parallel programed circuit boards, each capable of carrying as many as nine horizontal conductor lines, are mechanically held together by spacers to form a rigid three-dimensional structure to house one or a group of cells. Pro-

gramed rib contacts are selected, depending on the interconnection needs, to establish firm and positive contact between each cell contact and the proper horizontal conductor on the programed board; solder tines on the rib contacts enable connection between rib and board. Each rib contact has a solder tine which can project down into a base or "mother" board and then be bent and soldered to the wiring pattern at the underside of the mother board; this technique permits interconnection between cells and external circuitry.

In the event of failure of a cell, the defective unit is nudged out of its fitting, and a replacement, complete with new cell contacts, is inserted into the assembly. All solder connections, between rib contacts and circuit, and mother boards, are undisturbed. Thus, maintenance, even by semi-skilled personnel, does not degrade reliability and performance.

(Continued on p 86)

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**Q. E. D. = Quod erat demonstrandum
(what was to be proved)*

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INTERCONNECTIONS

MICROMINIATURIZATION

Burroughs Uses Macro-Modules

The need for microminiaturization packaging concepts led Burroughs Corp.'s Research Laboratory, Paoli, Pa., to the development of a highly efficient packaging approach, suitable for today's microcomponents as well as later 2-D and 3-D film approaches.

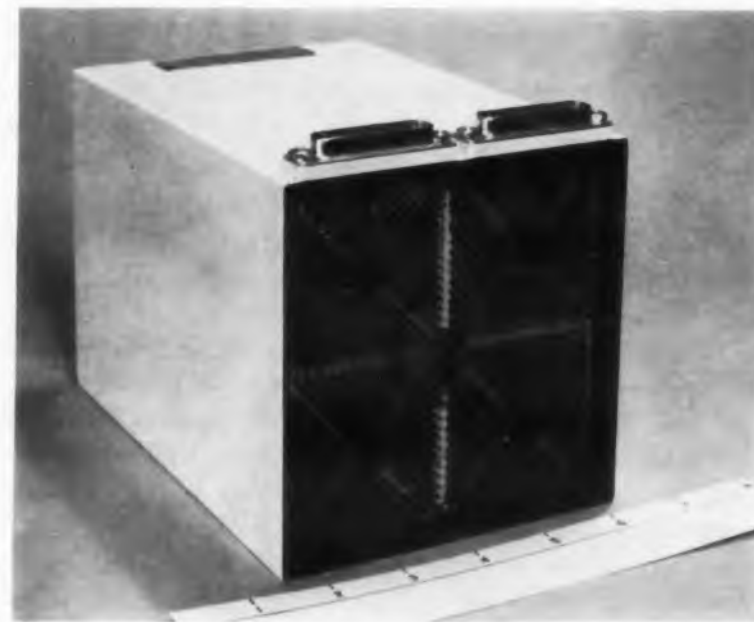
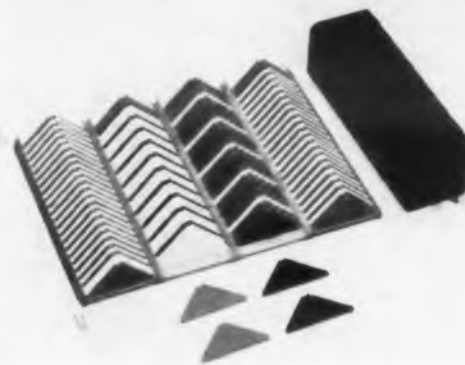


Fig. 32. Macro-Module approach developed by Burroughs provides high volumetric efficiency for airborne computer. Circuitry is mounted on plastic chips, which are tucked into plastic or metal pockets and encapsulated. Pins on chips are held firmly in sockets when package is folded into a rectangular box, so that soldering is not necessary and chip replacement is easily performed. Coolant from external supply flows through hollow core.

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Because of the packaging rather than component viewpoint on micromin, Burroughs tabbed its project the "Macro-Module" program.

Circuits are mounted on triangular plastic chips, with 24 pins along one edge, see Fig. 32. The chips are inserted into a plastic or metal sleeve, which is then filled with an encapsulant. This sheathed chip becomes the basic throw-away unit for maintenance. The mechanical strength added by the sleeve allows consideration of encapsulation materials other than epoxy, so that either heat transfer or easy removal for maintenance can be stressed.

The chips are plugged into a master plug-board unit, which consists of four-hinged boards side-by-side. When all chips are in place the board is folded to form a rectangular box. A metal fin heat exchanger leads to a cold plate or external coolant source with cooling fluid flowing through a central core of the fin assembly. If dissipation is limited to 2.5 w per chip, heat removal with this exchanger should keep component-temperature rise under 100 F over the coolant temperature.

Solder joints are now being used as the primary connection method, and dip soldering techniques are being studied. Deposited conductors join the parts on each chip. Provision for ribbon connections between chips are being made so that printed wiring is not the only joining method. Pin and chip spacing is now sufficient to allow one conductor path between pin sockets, and two paths between socket columns.

To demonstrate the concept, Burroughs is building an airborne digital differential analyzer using about 3,000 components. Dissipation is being held to 0.5 w per chip for this demonstration model, and an average of about 38 components per chip is being used. Five different circuit boards, identified by individual colors, are required. The DDA will be a 20-bit parallel machine with a 1.3-mc clock.

Greater miniaturization, using recently introduced microcomponents, is being achieved in a more advanced chip design now under study. Two flip-flops, containing 54 components, are mounted on a single chip.

As the amount of circuitry on each chip increases, the number of connections between chips decreases. In initial Macro-Module designs

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INTERCONNECTIONS

MICROMINIATURIZATION

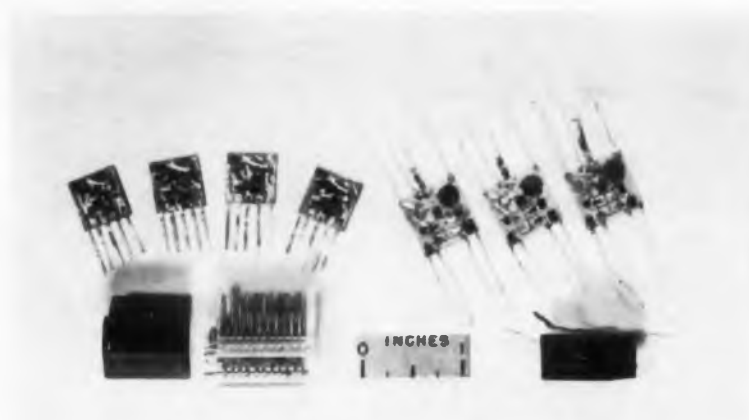


Fig. 33. Countdown timer, left, and 30-mc amplifier, right, being made using DOFL 2-D approach. Two interconnections schemes are shown for the 11-stage timer at lower left, illustrated on these pages and the packaging of the 5-stage amplifier in a copper shielding cabinet is illustrated at lower right.

it was necessary to use some jumper wires between chips, and in some cases on the chips themselves, but this requirement is being eliminated as parts density increases. To further decrease thickness of the boards, imbedded pellet components will probably be used on future chip designs.

An advantage of the box design being used by Burroughs is the pressure automatically exerted on chips, so that pins remain firmly seated in sockets without being soldered in. This allows quick and easy repair to be affected when such is required.

DOFL Packages 2-D Circuits

Packaging approaches for 2-D circuitry are being developed by the Army's Diamond Ord-

nance Fuze Laboratory. Four basic interconnection methods are being studied, and it is possible that each of them might find use in specific applications.

The four techniques are soldering, welding, deposited metal, and micromin connectors—which up to now have been Elco 5-pin 8100 series types.

Solder joints made in "hearing-aid" type circuitry, made by Cleveland Metal Specialties Co., have given excellent results, according to DOFL. Cleveland Metal, which also handles assembly of Micram 2-D circuits, applies microsoldering skills developed for jewelry manufacture to microcircuitry.

Another connection method developed by DOFL is a deposited metal approach. 2-D wafers

Fig. 34. Deposited silver joins exposed lead wire cross-sections in epoxy block containing several circuit wafers in this interconnection approach used by DOFL (*ED*, April 29, p 32). This method has been troublesome because of failure of stages after machining operation—probably due to cracking of wafers.

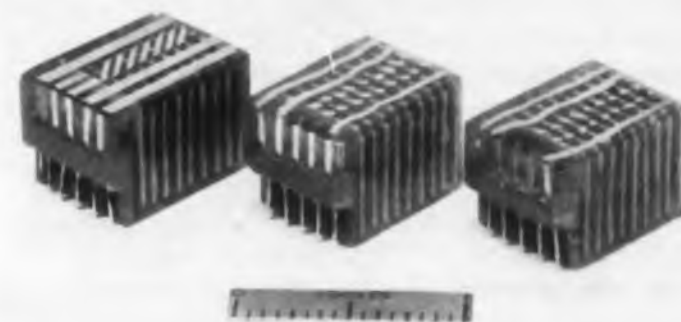




Fig. 35. Wafer interconnection scheme developed by Diamond Ordnance Fuze Laboratories makes use of nickel ribbons from wafers, which are spot-welded to various interconnecting rods. The rods are then rolled down flush with the back of the plastic block and fastened. Wafers are replaced easily by unrolling the rods, right, and clipping the ribbon leads. Blocks are about 1-in. long. Assembled unit shown below.



with wire leads soldered to an edge are epoxy encapsulated and then the side with the wires is machined off exposing the wire cross-sections. These wire tips are then connected by deposited metal stripes. So far this technique has not proved successful because of the failure of circuit stages after machining. The circuits survive encapsulation at 85 C, and do not appear to suffer from resin shrinkage, however waveforms after machining indicate cracking—probably caused by chucking pressure according to Norman Doctor, research director of DOFL's micro-miniaturization laboratory. This problem is now under investigation and may be solved.

A drawback to encapsulation is the resulting high priced throw-away package, therefore DOFL is also developing unencapsulated type packaging. Ribbon leads protrude through the back of an epoxy container for 2-D circuits. These nickel ribbons are spot-welded to a connecting bar, which is then rolled down tight against the back of the container and fastened. If a circuit stage fails, it can be removed, repaired, and then replaced by clipping the end of the ribbon and rewelding with the remaining portion. If replacement of the 2-D wafer is required, this is also easily accomplished with the spot welding approach.

For linear circuits with cross-coupling problems, DOFL is using a copper shielding cabinet, with slots for inserting 2-D circuit stages. So far the copper cabinet has proved effective in providing isolation. ■ ■

1. Series 42—Over 2,000,000 produced since 1942—The standard of reliability.

2. Series SC42-970—Sine-Cosine potentiometer version of famous Series 42.

3. Series 55—10 turn potentiometer—available in 3 sizes— $\frac{7}{8}$ " dia., $1\frac{1}{2}$ " dia., and 2" dia.—winding molded to housing—shock-proof construction.

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5. Series 57— $\frac{1}{2}$ " precision trimming potentiometer— $\frac{1}{2}$ " dia.—available with glass seal back cover.

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Many Packaging Plans Favor Solder Joint

These Flat-Circuit Interconnection Schemes Use Simultaneous Soldering of Several Joints



Fig. 36. Two basic interconnections approaches are being explored by IRC for its Mu Circuits. The vertical approach makes use of 3-layer Lamoflex flexible printed wiring to interconnect thin-film circuits deposited on glass wafers. Riser wires along the opposite edge of the package are also used for connections. In the horizontal approach to interconnections, encapsulated circuits are interconnected by means of plated-through holes and solder joints.

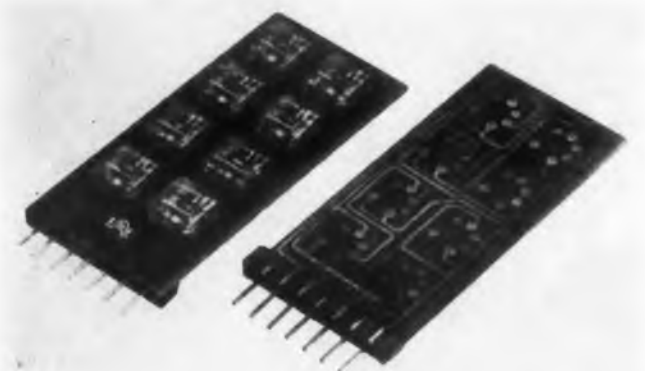


Fig. 37. Prototype receiver being built by RCA using micromodules has shielding compartments for stage isolation; interconnection is accomplished by means of a printed board, plated-through holes, and solder joints. Dimensions are 2-5/16 x 7/8 x 23/32-in., without batteries. Stacking of wafers, end-to-end, is also being considered because of the isolation provided.



Fig. 38. Mock-up of Micromodule digital differential analyzer designed for use with an inertial guidance system by RCA's Missile Electronics and Controls Div. Corrugated metal sleeves surrounding each module serve as shock isolators and also are used to provide heat transfer to the frame.

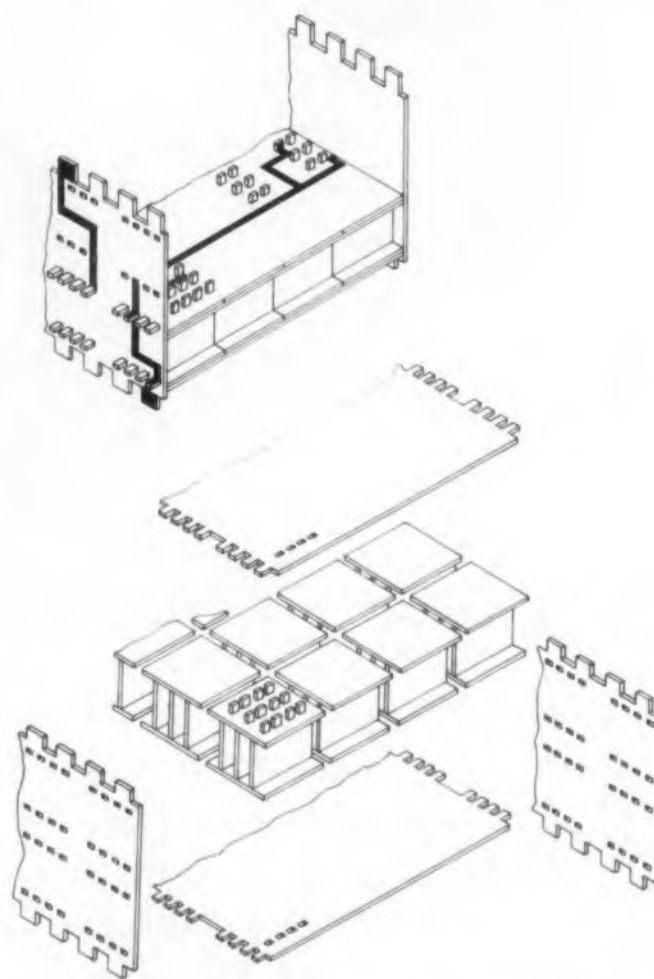


Fig. 39. Tabs at the edges of Haloid Xerox's etched circuit boards are inserted into holes in connecting printed circuit boards. These boards also contain slots for insertion of active element leads. The tabs and leads are fastened by dip soldering. Tabs on the connecting boards are used to join groups of circuits.

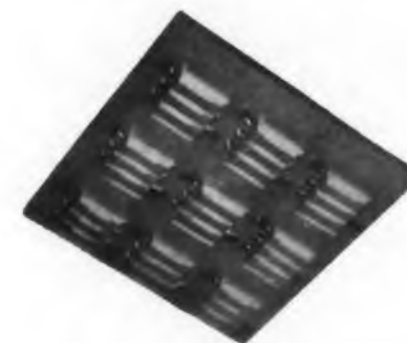
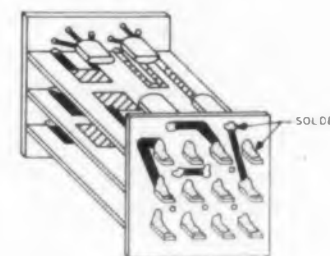


Fig. 40. Possible interconnection scheme under investigation by IBM shows cubes, representing multi-layer thin film circuits, attached to interconnecting base plate by a solder reflow process. Pretinned lands on the base and on the circuits are put in contact and heated to the flow temperature in a vacuum oven to make joints. This approach gives a moderate cost throw-away unit for maintenance purposes.





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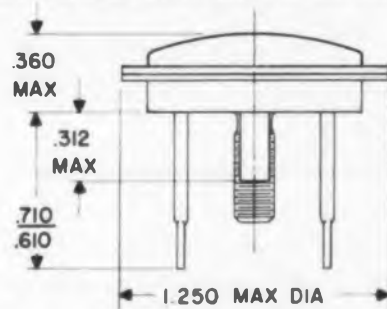
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						min	max	amps
2N441	150	100	40	40	15	20	40	5
2N442	150	100	50	45	15	20	40	5
2N443	150	100	60	50	15	20	40	5
2N174	150	100	80	70	15	25	50	5
2N135B	150	100	80	70	15	25	50	5
2N1100	150	100	100	80	15	25	50	5
2N1412	150	100	100	80	15	25	50	5
2N277	150	100	40	40	15	35	70	5
2N278	150	100	50	45	15	35	70	5
2N173	150	100	60	50	15	35	70	5
2N1099	150	100	80	70	15	35	70	5



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Micromin Connectors Making an Appearance

*First Designs Already Being Used in Equipment,
More Advanced Connectors Under Development*

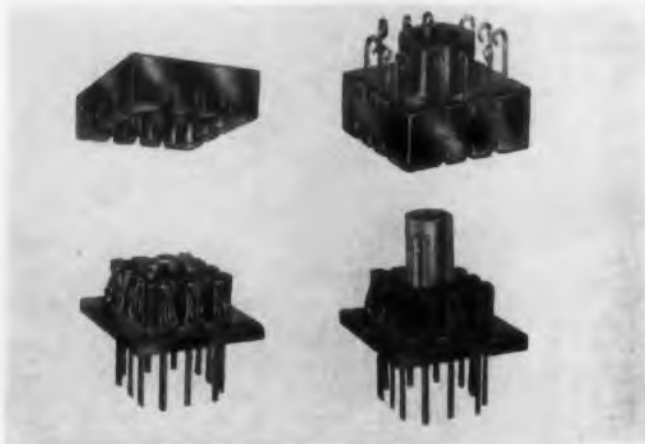


Fig. 41. Designed specifically for the Micro-module program these Amphenol-Borg Micro-Mod connectors are 3/8-in. square and have 12 contacts on a 0.075-in. center. Polarizing key and keyway used on unit at right for cable-to-cable termination.

Views on Interconnections

Following are statements reflecting the concern of some of the most knowledgeable men in the industry over the microminiature packaging problem.

"Millions have been spent on new systems of components with no serious effort or thought placed on methods of interconnection that will allow realization of their potential in reducing system size and weight. The claims in terms of system density of some of these programs are in fact little better than is being achieved with conventional components. And more important, what of connection reliability? Little is documented—yet one of the most common causes of electronic system malfunction is the failure of a wire or a connection."

THAYER FRANCIS, JR.
The Sippican Corp.

"Only by reducing the number of interconnections, which will lead to equipment of less complexity, can higher reliability be attained."

E. KEONJIAN
American Bosch Arma Corp.

"We are already approaching a limit for complexity with an acceptable degree of reliability. Continuing this line of development will lead us to the ultimate catastrophe—a system of maximum complexity which will never work."

DR. D. E. NOBLE
Motorola, Inc.

"The Dynamics driving the electronic packaging state of the art towards microelectronics will be stalled at the last hurdle . . . unless it gathers the forces required for its final leap: Reliability, Production and Price."

LEO BERNSTEIN
Kearfott, Div. of G.P.I., Inc.

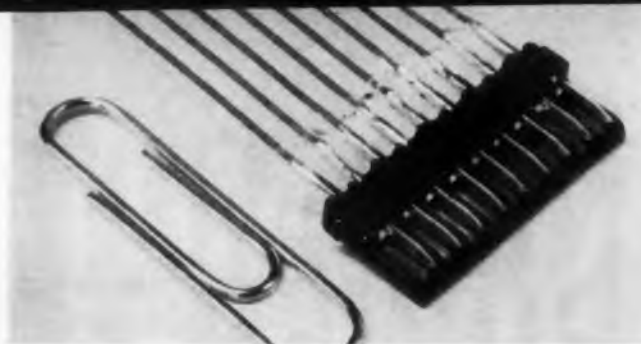
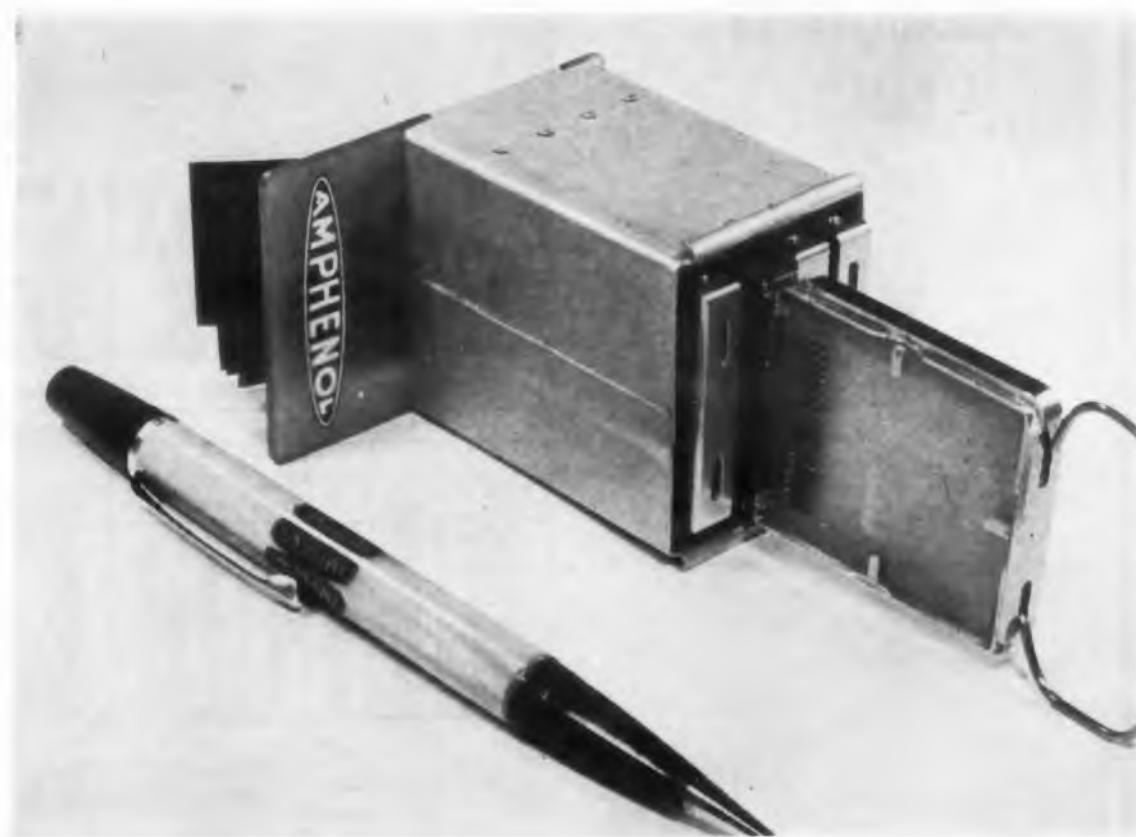
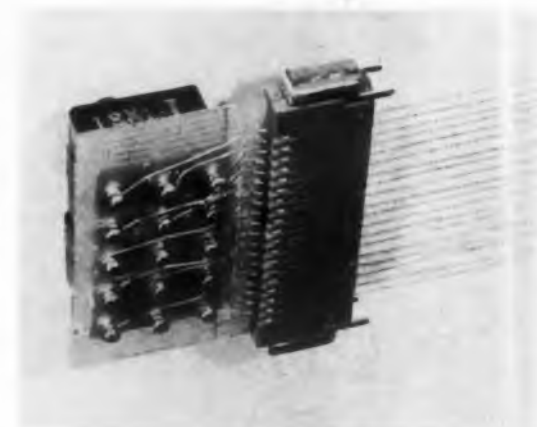


Fig. 42. Diminutive connectors enable designers to work micromin developments into new equipment. These Elco Corp. 8100 series units are 0.14-in. thick, with conductors soldered to stripped leads from flexible cable.



Fig. 43. Various micromin connector configurations are illustrated with these Elco connector units. Potting strengthens joints.

Fig. 44. Micro-Min connector series, either in single-sided 19-contact or double-sided 38-contact configurations are available from Amphenol-Borg Electronics Corp., Broadview, Ill. Center spacing is 0.050 in. for these units, shown with a series of microswitches and in a modular package design. Voltage rating is 350 v, current rating 1/2 amp, breakdown 1,500 v, and temperature range -55 to $+125$ C.



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29F2200	200	85C	0.35	P	32	5715	1/8"	1/8"
29F2105	300	85C	25.0	P	500	82	3/8"	2 3/4"
29F2108	300	85C	2.0	NP	150	1010	3/8"	2 1/8"
29F2207	200	85C	0.15	NP	32	13330	1/8"	1/8"
29F2161	250	125C	2.5	P	100	830	3/8"	1 1/8"
29F2164	250	125C	13.0	P	325	160	1/2"	2 3/4"

These units are supplied in tubular form, in lightweight aluminum cases, with axial leads, and are available with insulating sleeve in 7 case sizes.

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ELECTRONIC DESIGN • November 9, 1960

Comparing Key Characteristics of Major M

ALTHOUGH more than two dozen microminiaturization approaches are presently under development, each can be fitted into one of the five broad categories listed in the accompanying chart.







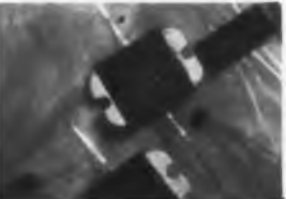
Each approach offers distinct merit when compared to another. However, the systems engineer should also be aware of problem areas, cost considerations and availability before reaching a decision. This chart summarizes the major points to be considered.

No one particular scheme represents the "ultimate" for all requirements. For those design engineers having an immediate need for size reduction involving a complete system, the high-density and 2-D approaches are available now. Engineers with long-range programs in mind can experiment with the thin-film, Micromodule, integrated circuit and molecular electronic techniques which are now becoming available in sample quantities.

If the factor of urgency is discounted, such items as relative cost, reliability, performance, "throw-away" potential and complexity of interconnections must be carefully considered by the design engineer preparing a comprehensive evaluation.

The accompanying chart has been prepared to provide a thumb-nail summary of the relative merits and characteristics of the leading approaches. Heat dissipation and reliability, both involving detailed study programs, have been deliberately omitted, since an accurate appraisal is not possible at this time.

Conspicuously absent in the chart is a listing of component-density figures. There is little value in playing the "numbers game" until interconnection and heat-sink configurations are realistically evaluated. ■ ■

Basic Approach		Representative Companies	Key Features	Major Problem Areas
High-Density Packaging (Sandwich Board)		Republic Aviation, Bendix.	<ol style="list-style-type: none"> 1. Available now using high reliability components. 2. Maintenance and replacement possible. 3. Relatively easy to automate. 	<ol style="list-style-type: none"> 1. Many solder joints required. 2. Packing density relatively poor.
		AC Spark Plug, American Bosch Arma, Delco, Francis Associates, GE, Kearfott, MIT, Raytheon, Sippican, EECo.	<ol style="list-style-type: none"> 1. Available now. 2. High reliability due to short-heat cycle and less lead bending compared with soldering. 3. Tightly grouped components provide a high stiffness-to-weight package. 4. Conventional high-reliability components can be used. 	<ol style="list-style-type: none"> 1. Non-standard component lead materials require special weld cycles. 2. Maintenance is difficult to impossible. 3. Skilled workers are needed. 4. Mechanization is difficult. 5. Encapsulation still poses problem.
2-D (Conventional)		Aerovox, Arma, CBS, Centralab, Hamilton-Standard, Sylvania, Sprague, DOFL, Cleveland Metal, Haloid Xerox, Hughes, Mallory, Paktron.	<ol style="list-style-type: none"> 1. Available now. 2. Presently available, high-reliability components can be used. 3. Replaceable, repairable wafers can be designed into a system. 	<ol style="list-style-type: none"> 1. Many interconnections are required with reliability potentially reduced. 2. Parts density limited.
		IRC, IBM, Varo, Servomechanisms, Motorola, Lockheed.	<ol style="list-style-type: none"> 1. Higher density than above. 2. Reduced interconnections. 	<ol style="list-style-type: none"> 1. Limited to smooth, flat surfaces. 2. Technique leaves little room for error. 3. Connections to thin films difficult.
Micromodule		RCA	<ol style="list-style-type: none"> 1. Standard geometry. 2. Automation of components and assembly possible. 3. Reliability data in process. 	<ol style="list-style-type: none"> 1. Many tiny solder connections needed. 2. Parts density limited. 3. Lacks flexibility.
Integrated Circuits		TI, Sperry, Fairchild, Raytheon.	<ol style="list-style-type: none"> 1. Reduction in internal connections. 2. High inherent reliability due to the use of a carefully controlled material, low mass of the package and low thermal expansion mismatch. 3. Relatively few process steps. 	<ol style="list-style-type: none"> 1. Component values are restricted. 2. Tolerance difficult to check. 3. High cost. 4. Circuits temperature-dependent.
Molecular Electronics		Westinghouse	<ol style="list-style-type: none"> 1. Circuit redesign minimizes components. 2. Power requirement low. 3. High inherent reliability. 	<ol style="list-style-type: none"> 1. Redesign of circuits to molecular blocks may require extensive time. 2. Devices are temperature-dependent. 3. High cost.

Major Microminiaturization Approaches

Availability	Repairability	Estimated Price (Flip-Flop)	Complexity of Process	Relative Packaging Density	Ease of Interconnections
Now	Good	\$25-35	Relatively simple	Moderate	Good
Now	Poor. Throw-away concept seems practical	\$25-35	Original set-up requires considerable effort. Production is not complex but, nevertheless, is difficult to mechanize.	Moderate	Good
Now	Good at circuit level	\$25-35	Not too complex—a scaling-down of printed-circuit wiring techniques.	Fair	Fair
Limited at present	Poor	\$50-150	Vacuum deposition difficult to control. Chemical deposition seems more suitable for higher yield, greater output.	High	Difficult
Limited availability	Good at circuit level	\$193.10 (\$96.55 for each half of binary divider)	Soldering riser wires for interconnections presents a production problem. Fabrication of components well established by now.	Fair	Fair
In small quantity	Poor	\$300-400	Semiconductor manufacturers claim that fabrication, although complex, will pose no serious problem since transistor techniques are well known and can be directly applied.	Very high	Difficult
Limited devices available in sample quantity	None	\$300-400	Complex	Extremely high	Difficult

Looking at Microminiaturization in Perspective

Knowledge of the approaches available and packaging factors is not sufficient in selecting the optimum method for microminiaturizing a system. Systems perspective must be applied, and some judgement must be reached about the status and usefulness of each of the possible alternative micromin concepts. To satisfy the first requirement Walter J. Prise, Supervisor of Electronic Methods Group Production Engineering, Lockheed Missiles and

Space Div., Sunnyvale, Calif., presents an approach to the problem from the systems designer's viewpoint. To help engineers reach some judgment on alternatives, *ELECTRONIC DESIGN's* editors conclude with a summary of the conclusions drawn from the information in this report and the consensus of the opinion of many engineers and scientists whom they interviewed in the course of preparing this Staff Report.

Packaging Must be Compatible with System Design – Walter J. Prise

FROM A REVIEW of the state of the art in miniaturization it becomes evident that high-density packaging assemblies are with us today. High-density welded electronics units are being developed very rapidly although some difficulties still exist. Ultimate success of the welded electronics technique will depend on the introduction and maintenance of production-control techniques in the manufacturing process.

High-density packaging can be successfully applied with size reductions up to 10 to 1. If density of higher degree is anticipated, other methods should be investigated. Fundamentally, potted high-density construction is not repairable without a great deal of difficulty. Design concepts must be adjusted to the rigid demands of high-density construction, and necessary changes should be made in such a fashion that all adjustable components are located near the outside of a package. The use of modules and the

possibility of dividing a package into a number of small sub-assemblies should be given serious consideration as a fundamental part of the "throw-away" concept.

A combination of methods using devices belonging to different concepts is feasible and practical. Printed circuitry, with the introduction of landless plated-through holes, multiple-layer patterns, flexible dielectrics and smaller, more durable conductive traces are compatible with high-density packaging methods and should be considered. Printed-circuit techniques have become the basis for the development of advanced microminiaturization processes.

The thin-film concept is being used in limited quantity but will be in greater use in the near future. Additional work is required for the establishment of improved repeatability, simplification of manufacturing processes and consistent reliability. The chemical deposition of films as far

as can be seen at the moment seems to be a very promising process.

The availability of modules using integrated circuits is dependent upon the state of development of the thin-film concept and the perfection of fabrication techniques. Standardized devices, such as Amp Corp.'s MECA, for holding and interconnecting modules, show promise of reducing designers' effort. Interconnection between individual wafers and modules is a very serious problem affecting the reliability of the finished product. This problem exists in all methods of microminiaturization and will require additional effort for a satisfactory solution.

Molecular electronics is primarily a field of the future. Predictions are being made that greatly improved and reliable molecular electronic packages may be available in larger quantities and with more definite and stable characteristics within the next four or five years. In the mean-

time their cost is high and their use is justifiable only in exceptional cases.

The establishment of design parameters in all fields of microminiaturization is needed and should be expedited by the combined efforts of manufacturers and system-design engineers. A first step might be to provide a common terminology and list of definitions.

In years past, electronic packaging was the realm of the mechanical designer who assembled conventional components onto a metallic chassis in accordance with the requirements of the schematic diagram. The complexity of the new field of microminiaturization requires a much higher and more diversified knowledge on the part of the electronic-packaging engineer. He must possess sound engineering knowledge to visualize the complexities of present and future electronic

packaging and the interrelation of the various fields of engineering, including chemistry and atomic physics.

If the characteristics of new and often intricate manufacturing processes are taken into consideration at the conception of a design, and modifications to the design are anticipated to take care of these producibility aspects, reliable products can be produced. Even if all the characteristics of the selected method are fairly well defined, some adjustments will be necessary; and it is advisable to perform an evaluation test on prototype units.

Producibility considerations and value engineering will play an important role in the application of microminiaturized electronic-packaging methods to the design of complete systems. The packaging design engineer must be skilled in the

various aspects of producibility or have access to a group of competent producibility specialists. A number of processes such as photography, etching, welding, vacuum evaporation, chemical deposition, electronic-beam and electronic-probe techniques are used in the new packaging techniques. A variety of metals, dielectrics and semiconductors are being used. Shop processes should be modified and adjusted to the requirements of miniaturized electronic packages.

Problems associated with miniaturization can be solved only by investigation of all the variables connected with new processes. It will require continuous coordinated effort of specialists in development, design, production engineering and manufacturing to produce simplified and reliable products well adjusted to the requirement of a particular system. ■ ■

Transition Will Take Place Through Mixed Approach Systems — The Editors

THE LEVEL of development of various approaches indicate a gradual evolution toward the most advanced methods. Rather than progressing from one approach to another in distinct steps, however, the transition will take place through "mixed approach" systems—combining various concepts. Combined circuits are already beginning to appear—thin-film and 2-D circuits with microcomponents for example. At the present time relatively few "circuit functions" have been achieved with semiconductor slabs. However, as reliability is demonstrated, as reasonable costs are achieved, and as interconnection schemes are developed, it is reasonable to expect some mixed approach systems to make use of this developing technology.

In this light, it is reasonable to pursue development of many concepts in order to gain understanding of basic characteristics. Future systems can then benefit from designs uniting the best contributions of each approach.

■ **High-Density Packaging.** This approach is already well established in the industry and will undoubtedly be used for several years. Although generally considered a miniaturization rather than micromin approach, the advent of microcomponents permits an order of magnitude increase in packaging density compared to today's standard printed-circuit designs.

■ **2-D Circuits.** Reliability must be proved and better interconnection schemes established before this approach is ready for widespread use. The initial phase for one particular approach, in which pellet components are imbedded in circuit boards, has attracted much interest and because it is not such a long step beyond present technology it will probably find some application within the next year. The more advanced deposited circuit approach will probably take longer to gain acceptance.

■ **2-D Thin Films.** This is the most advanced step in the 2-D approach. Because of the special properties of thin metal films, a great deal of applied research, improved production methods and interconnection techniques must be developed. Due to the limitations of this approach, such as restricted component values and inability to add semiconductor thin films, other approaches will probably be combined with thin films in actual applications.

■ **Micromodules.** This approach should be in limited use within the next year, and when adequate reliability data and lower cost have been achieved, may become attractive because of the confidence level offered. Since many parts of this program are frozen until reliability is established, some flexibility is lost and parts density is not too far beyond that achieved with high-

density packaging. At the same time, however, reliable micromodules will have a great advantage over much more advanced but unproven microcircuitry concepts. After initial reliability is established, some of these newer approaches can be adapted to the micromodule format—adding both flexibility and high parts density.

■ **Integrated, Molecular, and Functional Circuits.** The majority of experienced workers in the field agree that these approaches promise the greatest parts density and best potential reliability, through minimizing interconnections, of any of the approaches discussed. Because of the fundamental change in philosophy required by the functional or molecular approach, in which semiconductor interface and domain interactions are used to provide circuit functions, the integrated approach will probably come first.

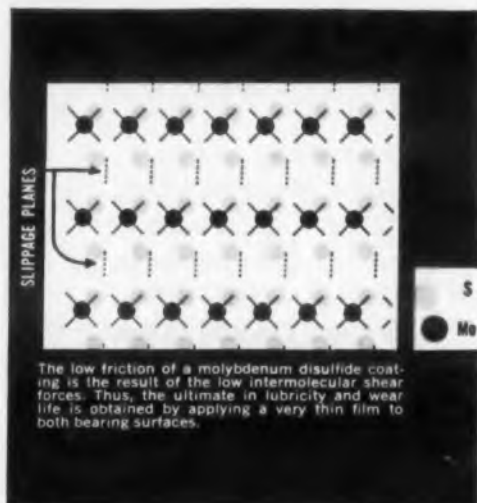
Cost reduction through improved production methods and higher yield is a requirement for both approaches. Heat dissipation and external connections also need much attention. For the functional and molecular concepts, a much greater understanding of basic semiconductor phenomena is needed before the potential of the approach can be exploited.

The concepts have been proved, but it is a matter of time before the industry can put this developing technology to work. ■ ■



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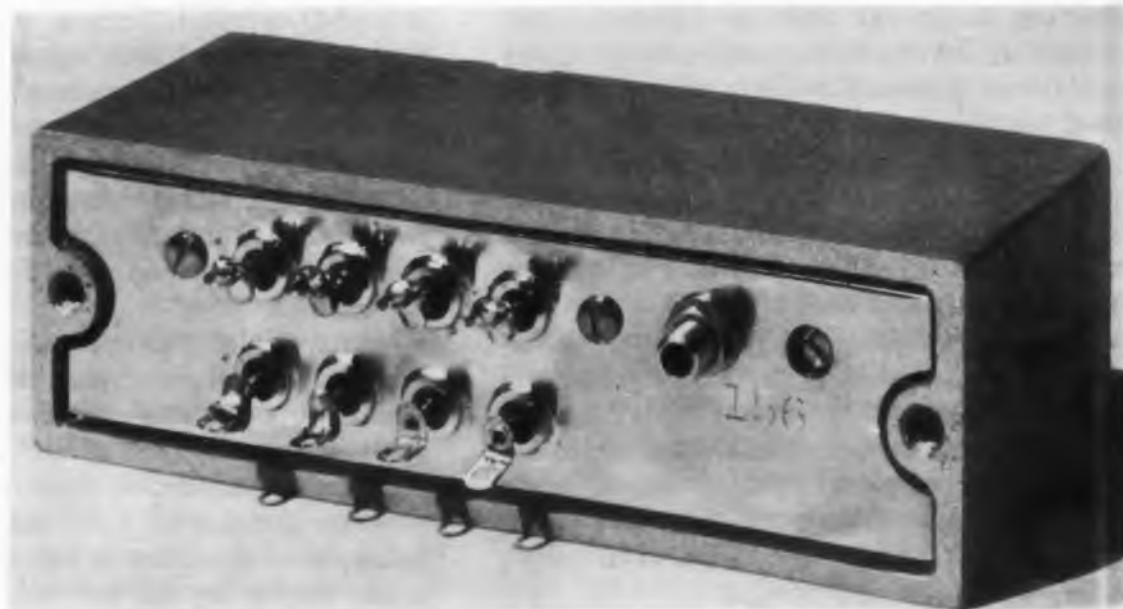
A VACUUM-TUBE operational amplifier drawing no more than 10^{-10} amp at its input would be quite impressive. A solid-state, fully floating, differential-input, dc amplifier with that low an input current is doubly impressive.

Without the help of choppers, this highly stable operational amplifier offers a long-term drift stability of less than $100 \mu\text{v}$ at constant temperature. Its ultra-high input resistance (not really a measurable resistance at all but merely a way of expressing the minuscule input "uncertainty" current), allows the use of large input resistors. Thus, for a 1-sec integrator, one can use a 10-meg resistor with a $0.1\text{-}\mu\text{f}$ capacitor.

To be shown for the first time at NEREM in Boston next week, the model P2 amplifier is a product of George A. Philbrick Researches, Inc. of 285 Columbus Ave., Boston.

Even with its high open-loop gain of 30,000, the P2 features a very wide frequency response which rolls off smoothly to unity gain above 75 kc for small signals. For large signals, the output is amplitude limited at 1 kc.

Its low power dissipation, less than a third of a watt for a full load of 10 v at 1 ma, encourages its application in portable, low-noise, battery-powered instrumentation. Its thick, cast-aluminum housing provides thermal as well as electrical



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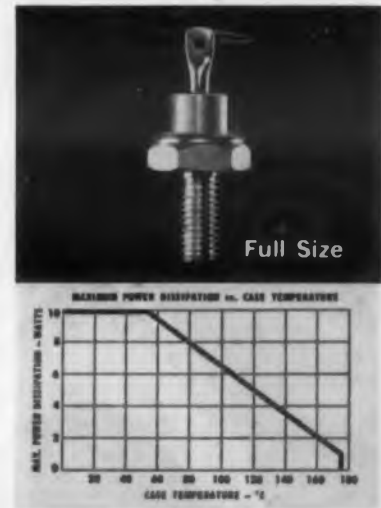
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<small>(Standard types supplied ± 10% of stated value; ± 5% tolerances available except as indicated.)</small> <small>*Supplied with ± 10% tolerance only</small> <small>†Intermediate values supplied with ± 5% tolerances on order</small>	1N1808	9.1	500	1	1N1588	3.6-4.3	150	2.6	1N1518	3.6-4.3	50	9	1N708	5.6	25	3.6
	1N1351	10	500	2	1N1589	4.3-5.1	125	2.3	1N1519	4.3-5.1	40	8.5	1N714	10	12	8
	1N1352	11	500	2	1N1590	5.1-6.2	110	1.4	1N1520	5.1-6.2	35	5.5	1N718	15	12	13
	1N1353	12	500	2	1N1591	6.2-7.5	100	.58	1N1521	6.2-7.5	30	1.6	1N721	20	4	20
	1N1355	15	500	2	1N1592	7.5-9.1	80	.5	1N1522	7.5-9.1	25	1.1	1N723	24	4	28
	1N1357	18	150	3	1N1593	9.1-11	70	.7	1N1523	9.1-11	20	1.5	1N731	51	4	115
	1N1358	20	150	3	1N1594	11-13	50	1.4	1N1524	11-13	15	2.4	1N735*	75	2	240
	1N1359	22	150	3	1N1595	13-16	40	3.4	1N1525	13-16	13	5.4	1N738*	100	1	400
	1N1360	24	150	3	1N1596	16-20	35	6	1N1526	16-20	10	11	1N742*	150	1	860
	1N1361	27	150	3	1N1597	20-24	30	9	1N1527	20-24	9	18	1N744*	180	1	1200
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shielding. It serves, with the novel circuitry, to prevent any violent changes in the output.

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Common-mode errors which plague many conventional amplifiers are absent in the P2. In fact, the amplitude of the common-mode signal which the P2 can accept is limited only by the dielectric strength of the encapsulant—more than 200 v.

The P2 can play all the roles of conventional operational amplifiers; it can add, integrate, differentiate, scale, and invert. But in addition, its differential input allows high-impedance voltage following and amplification, direct subtraction (in one stage), and precise current driving to grounded loads.

With its true-differential input and its single-ended output, a single P2 can provide many functions which would normally require two conventional operational amplifiers. It can be used, for example, for many monostable, bistable, unstable, and conditionally stable applications.

Though the P2 is not likely to find extensive use in large, general purpose computers, its small size (4 x 1-1/4 x 1-11/16 in.), together with its low power dissipation and other unusual features, suggest its use in process-control computers and simulators, in complex production test equipment, and in many other electronic instruments.

In lots of 25, the P2 costs \$185. The price per amplifier is \$210 for smaller quantities. Small samples will be available from stock by the end of this month. Larger orders will require six weeks for delivery.

For more information on this operational amplifier, turn to the Reader-Service Card and circle 251.

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True Rms Vtvm Gives High Accuracy With Clean or Distorted Waveshapes

A NEW, true-rms vtvm brings the accuracy of the standards laboratory to the general laboratory or even to the production line for a wide range of voltages and frequencies. The instrument provides accuracy as high as 0.25 per cent for sinusoids which may have as much as 50 per cent harmonic distortion.

Conventional, peak- or average-reading voltmeters can deviate from true-rms re-

sponse by as much as 3.3 per cent with as little as 10 per cent harmonic distortion in the waveform to be measured.

The model 350 Precision rms vtvm, manufactured by Ballantine Laboratories, Inc. of Boonton, N.J. combines simplicity of operation, clarity of readout, and ruggedness with its high accuracy.

An operator needs merely to select the correct voltage range, set four knobs to



True rms vtvm used to check frequency response of precision dynamometer.

bring a meter pointer to midscale, and depress and reset the knobs for minimum indication on the meter. A 2-sec. time-delay relay prevents the needle from swinging to midscale while the operator moves from knob to knob to null the meter.

When the indicating meter is nulled, the input voltage appears on an in-line, 5-digit, Nixie display. Over the fundamental-frequency range of 100 cps to 10 kc, the accuracy is within 0.25 per cent of the actual voltage reading from 0.1 to 300 v.

When the fundamental-frequency range of the voltage to be measured is extended to 50 cps or 20 kc, or when the maximum voltage is extended to 1,000 v, the accuracy drops slightly to 0.5 per cent. The instrument handles harmonics as high as 50 kc with no loss in accuracy.

Drift due to ambient-temperature variations in the "350" is less than a low, 0.005 per cent per deg C. Changes due to line-voltage variations have less than 0.025 per cent effect.

The instrument operates from 105- to 125-v or 210- to 250-v power lines with frequencies of 50 to 400 cps. Its input impedance is 2 meg in parallel with a capacitance which varies from 15 pf for the 10 to 1,000-v ranges to 45 pf for the most sensitive range.

Though the push-button range switches indicate maximum ranges of 1, 10, 100, and 1,000 v, each range can measure about 20 per cent higher.

Input Nulls Ac Standard After Suitable Amplification

To provide its high accuracy and stability, the "350" features a barretter bridge as an ac-voltage standard. The input voltage, after suitable amplification, is attenuated by the four-resistance decades on the front panel which control the Nixie readouts. Output from the attenuators is amplified and compared with the ac-voltage standard. The attenuators are adjusted till the comparison of their output with that of the ac voltage standard yields a null on the panel meter.

The Ballantine 350 is available on 30- to 60-day delivery at \$720.

For more information on this rms vtvm, turn to the Reader-Service card and circle 252.

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Built and tested to meet MIL-T-27A, Class R, Grade 5 Specifications, the type TT miniaturized transformers are ideally suited for transistor circuits. In addition, frequency response ratings are based on military specifications.

The exceptional reliability, low distortion and high efficiency of these units combine for excellent performance.

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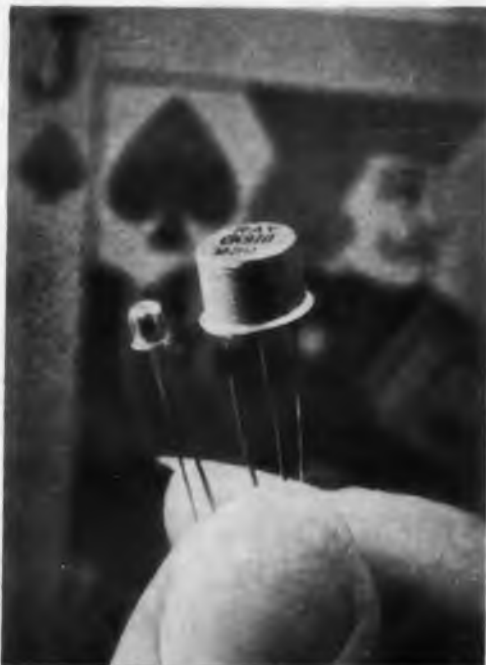
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Germanium Transistors Are 21 Times Smaller Than Comparable Units 553

These germanium subminiature transistors are 21 times smaller than presently available transistors with the same characteristics, according to the manufacturer. The units' maximum outside dimensions are 0.130 x 0.130 in. They are the electrical equivalents of: pnp types 2N404, 2N428, 2N416, and 2N417; npn types 2N388 and 2N440. The new subminiatures, all in TO-5 packages, are respectively: 2N799, 2N805, 2N811, 2N813, 2N815, and 2N821. Collector dissipation of the new units is 70 mw at 25 C.

Raytheon Co., Semiconductor Div., Dept. ED, 200 First Ave., Needham, Mass.
Price: From \$1.90 to \$5.50 in 100 to 999 lots.
Availability: From distributors.



Crossbar Scanner Offers Enhanced Flexibility 554

Series SD-6 Crossbar Scanners are designed to provide high-capacity scanning for data-logging systems. It has a 100-channel, six-pole-per-channel capacity which can be readily altered to a 200-channel, three-pole, a 300-channel, two-pole, or a 600-channel, one-pole array through a "level-scanning" option. The crossbar scanner is rated at 20,000,000 operations per crosspoint, continuous duty at full load. Twin-contact, gold closures are used throughout. Crosstalk, noise and thermals are negligible. Scanning speeds range from 0 to 50 closures per second per pole. The basic assembly consists of a six-level, 10 x 10 crossbar switch, a regulated power supply, and a logic chassis to provide commands of: start, step, stop, return to off, reset to zero, designate channel N as first, designate channel X as last, and scan continuously.

James Cunningham, Son and Co., Dept. ED, Rochester 8, N.Y.
Price: \$2,000 to \$4,000, depending on options.
Availability: 8 to 12 weeks after order.

Closed Circuit TV System For Transmission of Microfilm 555

This closed-circuit TV system is especially designed for the transmission of microfilm, and can be used for the retrieval of blueprints and other data from microfilm libraries. Aperture cards or film reels are manually inserted into the transmitter at the library. The 945-line, high-resolution system gives the viewer considerable control over the transmitted image. He may select any portion of the microfilm frame for examination and then electronically enlarge that portion up to 60 diameters. Several screens, at different locations, may be given to any one of the several viewers. The viewing console includes push-button magnification control and a "joy-stick" for selecting the area to be scanned.

Nord Photocopy and Electronics Co., Dept. ED, New Hyde Park, N.Y.

Price: \$12,000 for the basic transmitter, \$2,000 for the basic receiver.
Availability: On a custom-built basis.

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 2, No. 5



Waveform Generator 557 Features Low Frequency

The SG88 VLF function generator provides waveforms at repetition rates down to one cycle every 200 sec. The type waveshapes that can be generated only require the function from which each is derived to be single-valued and repetitive. Specifications are: frequency range, 0.005 to 50 cps; frequency calibration accuracy, $\pm 1\%$; output voltage, 200 μv to 20 v; output impedance, 300 to 3,000 ohms depending on frequency.

General Measurements Co., Inc., Dept. ED, 1108 Beacon St., Newton Highlands 61, Mass.

Price: \$2,580, fob Newton Highlands.

Availability: 90 days.

Automatic Checkout 556 Uses Intelligence Units

This compact system, known as "Speed-Tronik," not only checks ordinary voltages and current, but tests modulated and unmodulated frequencies up to the 3,000 mc range as well as pulses with very low rise time and duration. Complex waveform analysis is also possible from a minimum amplitude of 30 μv . Intelligence units are "plugged-in" in sufficient number for the program required. It is possible to check up to 9,999 different points with an accuracy of $\pm 0.5\%$ or better, in a single system. The system can be used for fully automatic, semi-automatic or manual operation, displaying results as visual readout, go-no go.

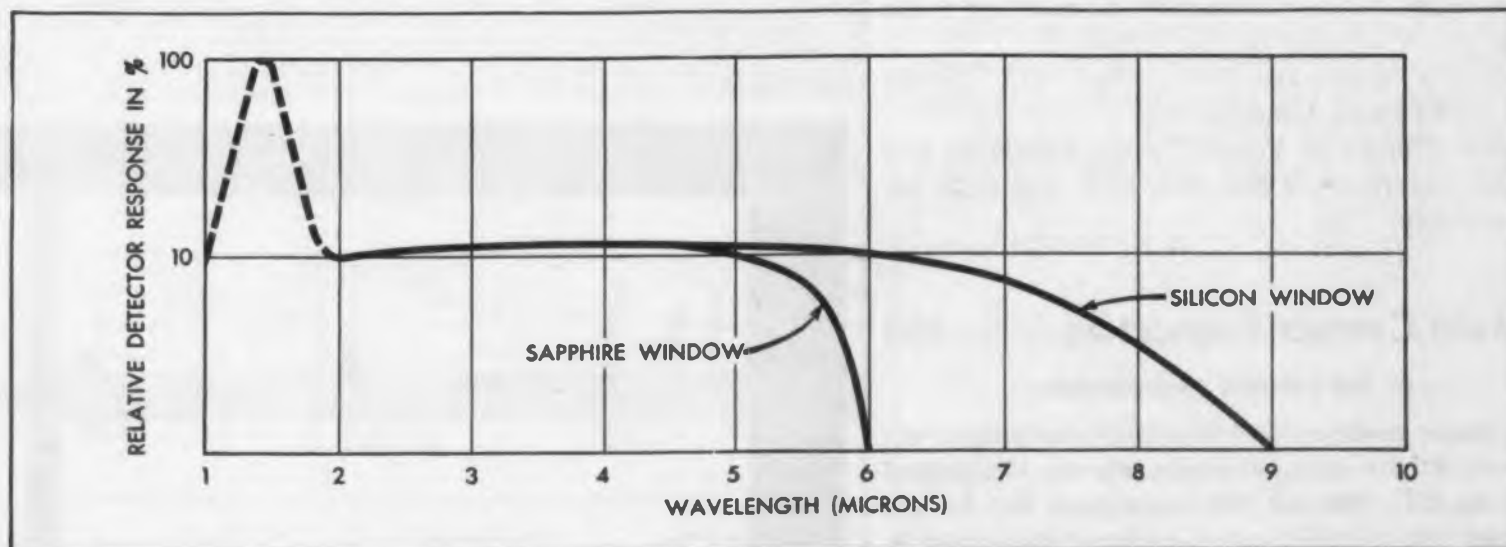
Audiotronics Co., Dept. ED, P.O. Box 2187, Dayton 29, Ohio.

CIRCLE 84 ON READER-SERVICE CARD

NEW RAYTHEON MINIATURE, ALL-METAL INFRARED DETECTORS

Specially designed and constructed to resist shock and vibration in airborne applications

Raytheon's QKN748 and QKN884 are highly sensitive, compact, P-type infrared detectors. These gold-doped germanium devices feature all-metal construction and hermetically sealed windows of sapphire barium fluoride or anti-reflection coated silicon. They are ideally suited for airborne applications, including passive missile guidance and air traffic control systems, where resistance to shock, vibration and other extreme environmental conditions is required. Their detecting element has a spectral sensitivity ranging from 2 to 9 microns at an operating temperature of about -195°C . The standard effective detector area is 2.0 x 2.0 millimeters. Larger or smaller effective detector areas can be manufactured to meet specific requirements. The impedance range is 50,000 ohms to 1 megohm. The acceptance angle is dependent upon the effective detector area and can be as large as 150 degrees. The time constant is less than 1 microsecond.



Excellence in Electronics



You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Co., Waltham 54, Mass. In Canada: E. Waterloo, Ontario. In Europe: Zurich, Switzerland

WORLD'S LEADING PRODUCER OF MICROWAVE TUBES

NEW PRODUCTS

Pulse Programmer

354

Four-channel type

Type RD15-101 tape programmer, using polyester tape, eliminates the use of clutches, rewind mechanisms, take-up drums and take-up drum drives. The tape is stored on a removable cartridge. A maximum of 1,200 inputs may be punched in each channel. The four channels can be extended to control up to 16 events. Data spacing can be 0.1-in. apart. The unit operates at 30 pps with automatic resetting. It weighs 2.5 lb and measures 4-3/4 x 4 x 3-1/2 in.

Lundy Manufacturing Corp., Dept. ED, Glen Head, L.I., N.Y.

Availability: 15 to 30 day delivery on small orders.

Klystron Tube Mounts

358

Have forced-air cooling



These klystron tube mounts simplify klystron mounting for tests and for operation. Free access to tuning adjustments, forced-air cooling, and type AN connectors is provided. The mounts are made of cast aluminum. Connecting cable for power supplies can be furnished.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, N.Y.

Price: Mounts for Varian, Sperry, Raytheon, and EMI klystrons are \$60, \$85, \$100 and \$125, respectively.

Multi-Contact Connectors

360

For extreme environments

These multi-contact electrical connectors are designed for extreme environments. Designated series 600, 700 and 800 connectors, the devices meet MIL-C-26500 specs covering high-altitude, temperature and shock requirements of rockets, missiles and space vehicles. They are immersion-resistant, withstand 50 hr of salt spray, 50-g shock and 500 F for 1,000 hr and handle 1,500 v rms potentials at sea level. Configurations with 24, 31 and 55 contacts, and tools for crimping, inserting and removing contacts are available.

General Electric 2N396A and 2N526 transistors feature guaranteed maximum high temperature I_{CO} and minimum low temperature h_{FE}

A WELL-CHARACTERIZED SWITCH AND AMPLIFIER FOR MILITARY USE WITH EXTREME STABILITY PROVED BY 10,000-HOUR LIFE TESTS

These two do the tough jobs—a fact demonstrated by their use in dozens of different missiles. Reliability and uniformity of parameters are enhanced by a 100°C bake on 100% of all manufactured product. All units also undergo a hydraulic pressure test to insure against leaks. Gettering guards against entrapped moisture and provides unusual stability of parameters.

USN 2N396A

Method B life-test of MIL-S-19500 assures exceptional reliability for General Electric's USN 2N396A. Life-test reliability is the highest for any transistor now covered by military specifications. The G-E USN 2N396A is guaranteed to have extremely low failure rates,

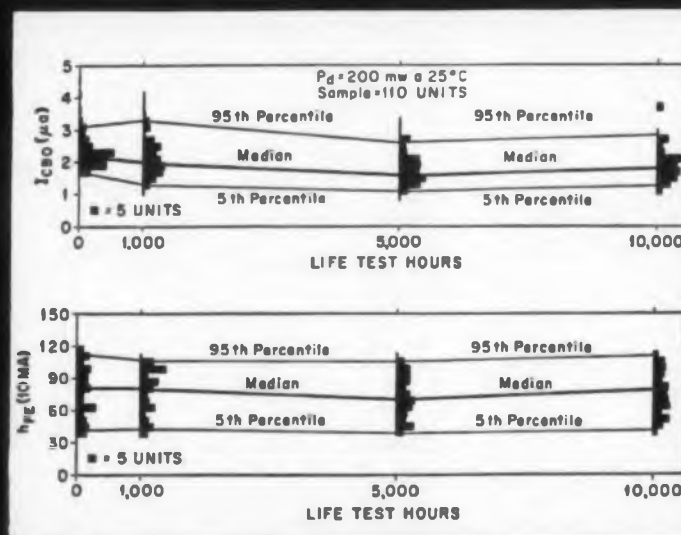
being required to meet acceptance criteria roughly equivalent to 0.65 AQL. Compare this with the AQL's of 4.0 and 6.5 generally used for life assurance in MIL specs.

USN 2N526

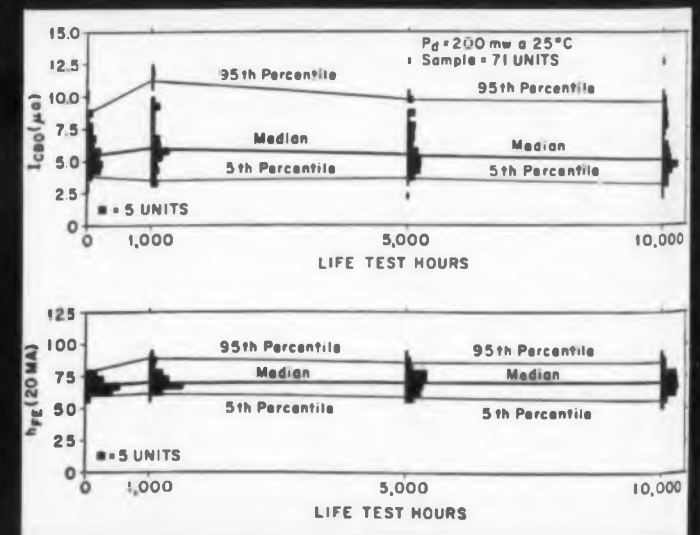
The Navy specification for General Electric's 2N526 reflects the outstanding characteristics of this transistor type. Among the features which contribute to its superiority are high dissipation (225 mw), 100°C maximum storage temperature and h_{FE} from 53 to 90.

See your General Electric Semiconductor District Sales Manager for complete specifications. General Electric Company, Semiconductor Products Dept., Electronics Park, Syracuse, New York.

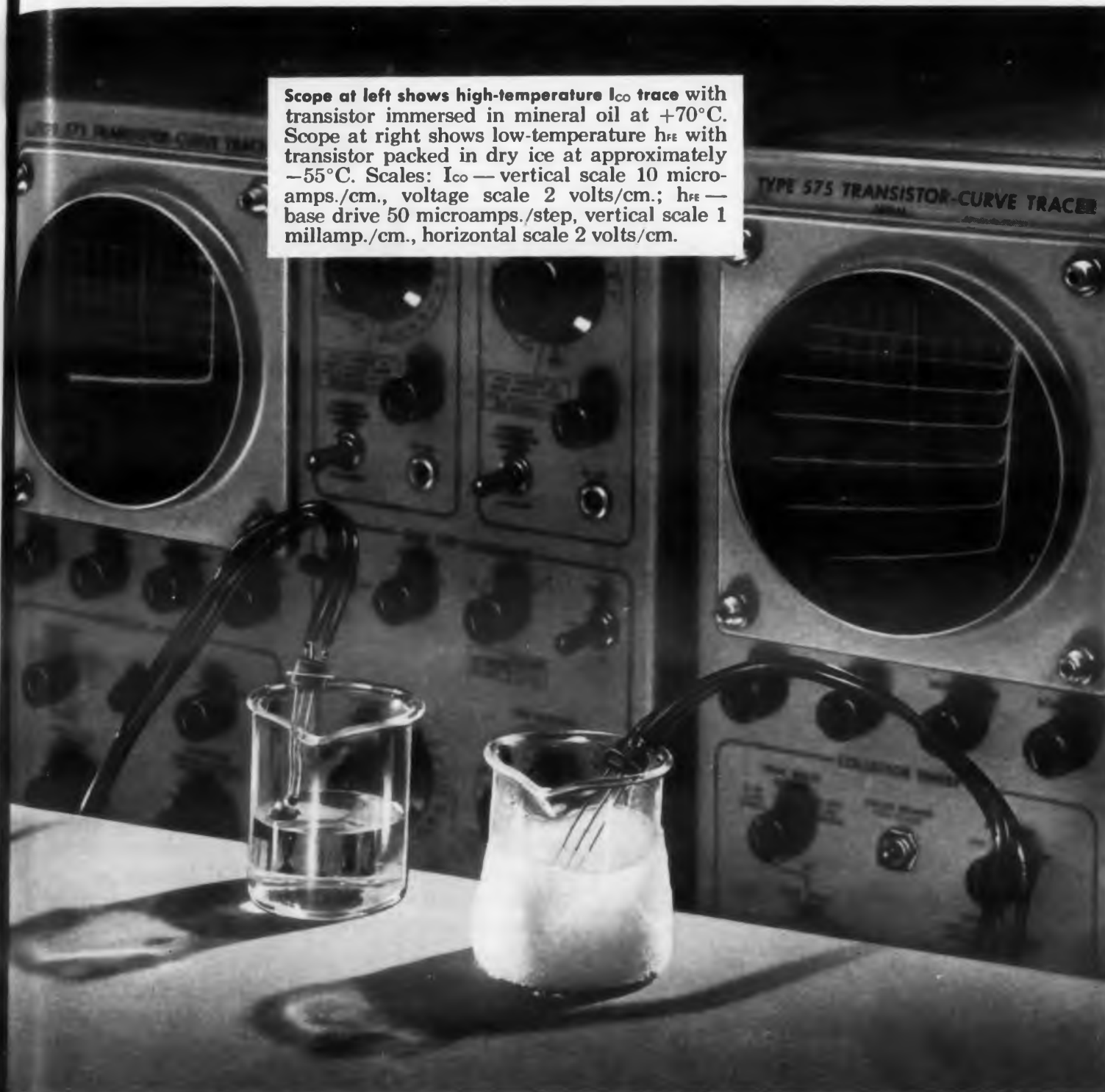
2N396 EXTENDED LIFE TEST STABILITY



2N526 EXTENDED LIFE TEST STABILITY



Scope at left shows high-temperature I_{CO} trace with transistor immersed in mineral oil at $+70^{\circ}\text{C}$. Scope at right shows low-temperature h_{FE} with transistor packed in dry ice at approximately -55°C . Scales: I_{CO} — vertical scale 10 microamps./cm., voltage scale 2 volts/cm.; h_{FE} — base drive 50 microamps./step, vertical scale 1 millamp./cm., horizontal scale 2 volts/cm.



TYPE	MAXIMUM RATINGS (25°C)				ELECTRICAL CHARACTERISTICS				
	V_{CBO}	V_{CER}	V_{EBO}	P_T	25°C Max. I_{CO}	70°C Max. I_{CO}	25°C h_{FE}		h_{FE}
					min.	max.	min.	max.	min.
2N526	-45***	-30	-15	225 mw	-10 μA @ -30V	-220 μA @ -30V	53	90	27 (-25°C)
2N396A	-30	-20*	-20	200 mw**	-6 μA @ -20V	-120 μA @ -20V	30	150	20 (-55°C)

* V_{CEO}
 Mil Version 150 mw *Mil Version -30V

For fast delivery at factory low prices, call your authorized General Electric Distributor.

GENERAL ELECTRIC

CIRCLE 85 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

Insulator blocks are of glass-filled diallyl phthalate.

Consolidated Electrodynamics Corp., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

Price: On request.

Availability: 15 days.

Delay-Line Coil Forms 362

For distributed constant delay lines

These delay-line coil forms are made of low expansion, low-loss glass. They are designed for use in distributed constant delay lines. The silver conductor fired into the glass is scribed with three to forty lines as specified by the user. Scribe gaps are 0.004-in. wide ± 0.001 -in. Dielectric constant of the glass is 4.6 at 1 mc and 20 C, power factor is 0.46, expansion coefficient is 32.5×10^{-7} per degree C.

Corning Glass Works, Dept. ED, Bradford, Pa.

Amplitude Distribution Analyzer 363

Sensitivity is 0.1 v



Model 200 analyzer provides a direct reading of the amplitude probability distribution of complex or random signals. Sensitivity is 0.1 v; bandwidth is 0.1 to 15,000 cps. The unit requires 117 v ± 10 v, 60 cps, and is accurate within 1%. Input dynamic range is greater than 50 v peak-to-peak. Applications include radar and infrared systems.

Automation Laboratories, Inc., Dept. ED, 80 Urban Ave., Westbury, L.I., N.Y.

Price: \$795.

Availability: 60 days.

Axial-Lead Power Resistors 364

Available in 3, 5, and 10 w sizes

These axial-lead, vitreous-enamel power resistors come in three sizes, 3, 5, and 10 w. The axial-lead design is suited to printed-circuit, terminal-board and point-to-point wiring applications. The elimination of terminal lugs permits space saving in assemblies. Standard resistance tolerance is $\pm 5\%$ for one ohm and higher, while tolerance for values below one ohm is $\pm 10\%$.

Clarostat Manufacturing Co., Inc., Dept. ED, Dover, N.H.

NEW PRODUCTS

Adjustable Temperature Resistor 365

Temperature coefficient can be adjusted

The temperature coefficient of the model 760 resistor can be adjusted externally without affecting the fixed resistance value. Units may be used to temperature compensate electronic circuits, printed-circuit modules or individual components such as transistor and solid-state devices. Specifications are: temperature-coefficient adjustment range, from 10 ppm per degree C to 4,500 ppm per degree C; resistance range, from 100 ohms to 10,000 ohms; temperature range, from -55 to $+150$ C; resistance tolerance, 1% at 25 C; power rating, 1 w.

Conrad-Carson, Inc., Dept. ED, 3110 Goddard Way, San Diego, Calif.

Price: \$15 ea in sample quantities.

Silicon Zener Regulators 366

Are rated at 400 mw



Types 1N746 through 1N759 silicon Zener regulators have glass packages and axial-lead construction. Voltage range is 3.3 to 12 v at 20 ma and 25 C. Reverse-current ranges from 10 μ a for the 3.3-v unit to 0.1 μ a for the 12 v unit. Operating temperature range is -65 to $+175$ C and Zener voltage tolerance is $\pm 10\%$ or $\pm 5\%$.

Hoffman Electronics Corp., Dept. ED, 3761 S. Hill St., Los Angeles, Calif.

Price: \$3.76 in lots of 1 to 99; \$3.16, 100 to 999.

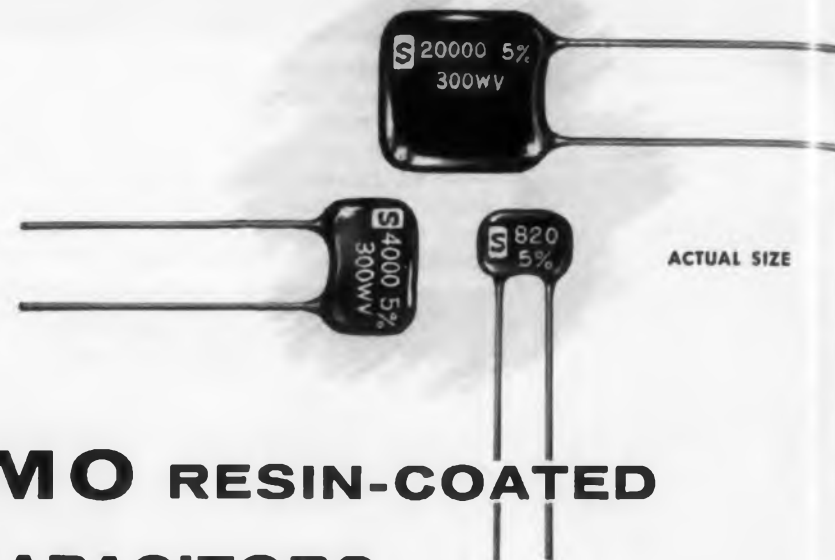
Availability: Immediate.

Printed-Circuit Board Puncher 367

Machine is tape-programmed

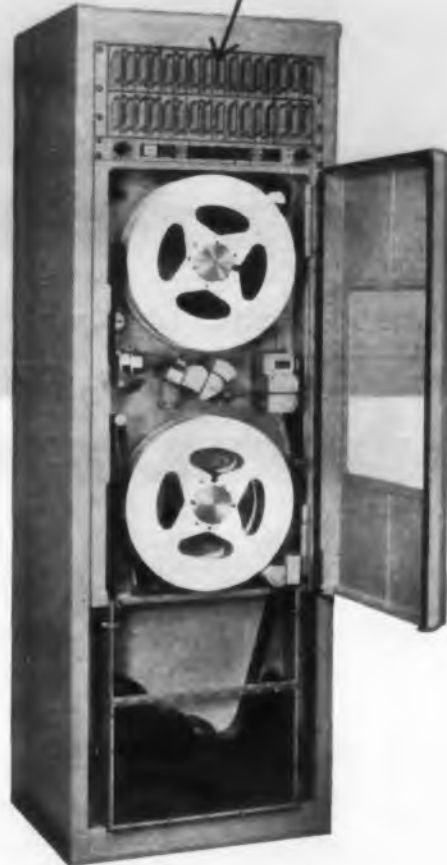
This high-speed tape-controlled unit is capable of punching up to 10,000 holes per hour in boards up to 6 x 18-1/4 in. All holes are accurately punched on 1/10-in. coordinates without breakout. Punch diameters are 0.052 and 0.105 in. The unit is self-contained in a 56 x 45 x 43 in. cabinet.

Radio Corp. of America, Industrial and Automation Div., Dept. ED, 12605 Arnold Ave., Detroit 39, Mich.



NEW SANGAMO RESIN-COATED SILVERED-MICA CAPACITORS...

are significantly smaller... operate to $+150^{\circ}$ C... exceed proposed dipped-mica capacitor military specifications



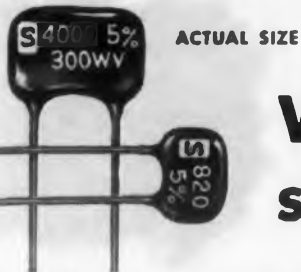
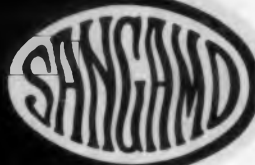
Sangamo experience with mica capacitors and years of engineering know-how and quality development underline two new Type D Resin-Coated Silvered-Mica Capacitors. Designed for operation at temperatures of $+125^{\circ}$ C and $+150^{\circ}$ C, both offer the advantages of radial leads, small size, full rated working voltage without derating, and a clean, moisture-sealed protective resin coating. Physical and electrical features of the Type D capacitor are ideal for etched circuits, high component-density equipments, missiles, computers, and instrumentation devices. Type D capacitors are available with characteristics C, D, E, or F, in nearly all capacitance values.

Test these new Sangamo Type D Resin-Coated Silvered-Mica Capacitors — they more than meet proposed military specifications. Try them in your own circuits — they will fulfill all expectations of today's most critical applications. Those who know capacitors choose Sangamo for outstanding performance and long life.

... Type D Resin-Coated Silvered-Mica Capacitors are an important part of the transistorized circuitry of this Sangamo Type 460 Tape Transport System. Their small size, high-temperature performance, and reliability contribute materially to the transport's recording uniformity and play-back accuracy —

SC60-7

SANGAMO ELECTRIC COMPANY, Springfield, Illinois
— designing toward the promise of tomorrow



ACTUAL SIZE

What constitutes a superior dipped-mica capacitor?

Silvered-mica capacitors have achieved a reputation over many years of use for high stability and high reliability. Mica's inherent low power factor, high dielectric strength, low dielectric absorption and high insulation resistance have made mica capacitors most desirable in electronic circuits where good stability with respect to temperature, frequency, and aging are required.

But refinements of mechanical features were required for today's high component-density equipment utilizing etched-circuit construction. Some of the requirements that led to development of the dipped mica capacitor were:

1. A protective covering, that is thermally and mechanically rugged, impervious to moisture, and non inflammable.
2. Radial leads for rapid assembly, rigid mounting, and cool operation.
3. Small size and dimensional uniformity for more compact and standardized assemblies.
4. A glossy surface to which dirt does not adhere and which also enhances appearance.
5. Lower cost through improved automated manufacturing techniques.

Considering these requirements, Sangamo has designed two new Type D resin-coated, silvered-mica capacitors. They have a better coating resulting from finer materials used in the dipping process, and also possess the excellent performance characteristics previously established by other types of Sangamo silvered-mica capacitors.

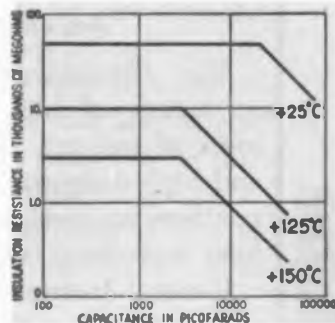
MECHANICAL DESCRIPTION: The mica is carefully selected for electrical excellence and dimensional uniformity. The silver is screened on the mica and fired to effect a positive bond. A positive low-resistance connection is assured by clips and leads of tinned brass pressure clamped to the section.

Good thermal shock characteristics, moisture resistance, and a glossy surface are provided by five separate resin coatings that do not appreciably alter the electrical characteristics of the silvered-mica section.

OPERATIONAL PERFORMANCE:

Type D capacitors are available in two maximum temperature ratings, +125° C or +150° C. Both can be operated at rated voltage without derating.

The insulation resistance for capacitance values is shown in Figure I for +25° C, +125° C, and +150° C.



These capacitors are available in C, D, E, or F characteristics over the temperature range of -55° C to +125° C or +150° C as shown in the following table:

TABLE I			
Characteristics Available in Type D Resin-Coated, Silvered-Mica Capacitors			
Characteristic	Temperature Coefficient ppm/° C	Capacitance Drift Per Cent	Availability of Characteristic
C	±200	±0.5	All Values
D	±100	±0.3	All Values
E	-20 to +100	±(0.1 + 0.1 pf.)	Above 20 pf.
F	0 to +70	±(0.05 + 0.1 pf.)	Above 50 pf.

The moisture resistance is given as an insulation resistance greater than 10,000 megohms after a ten day cycle outlined in Method 106A, Figure 106-1 of Mil-Std-202B.

Thermal and immersion cycling is given as an insulation resistance greater than 10,000 megohms when subjected to temperatures between -55° C and +125° C or +150° C as outlined in Method 102A, test condition D and Method 104A, test condition B of Mil-Std-202B.

These capacitors will withstand a constant acceleration of 20 G's in accordance with Mil-Std-202B, Method 204A, test condition D.

Values of Q at various frequencies are shown in Figure II.

Type D capacitors can be stored at -55° C without injury. Case insulation strength is 200 per cent of rated voltage.

They will have an insulation resistance of 10,000 megohms at +25° C after an accelerated life test of 2,000 hours duration at 150 per cent of rated voltage, at high ambient test temperatures of +125° C or +150° C.

Acceptable Quality Levels (AQL) of completed units are fully met using the sampling plan set forth in Mil-Std-105A. This limits visual and mechanical AQL to 1.5%; Electrical AQL to 0.65%; and environmental AQL to 2.5%.

Sangamo also supplies the Type D as a non-standard capacitor in accordance with special requirements. Where maximum dimensions are critical and military humidity specifications do not apply, Type D capacitors are available with fewer resin coats. If circuit design requires a lower temperature coefficient, it can be provided when specified. Where improved reliability is an important factor, Type D capacitors can be 100 per cent short-term, accelerated life tested. In addition to straight lead design, Type D is also available with crimped leads which provide a positive stop when capacitors are mounted on etched-circuit boards.

SC60-B

SANGAMO ELECTRIC COMPANY, Springfield, Illinois
— designing toward the promise of tomorrow

Wirewound Resistor

368

For printed circuits



Measuring 17/64 in. in diameter and 27/64-in. long, type P-2W resistor exceeds the requirements of MIL-R-93B and MIL-R-9444 for operation at 125 C. Non-inductively wound and sealed in epoxy resin, the unit is temperature cycled and subjected to short term overloads to insure reliability. Resistances to 1 meg and tolerances as close as 0.05% are offered. Power rating for 1% tolerance is up to 0.5 w.

Shallcross Manufacturing Co., Dept. ED, Salem, N.C.

Availability: 15-day delivery.

Sensitive Relay

369

Is 4pdt

The HS-400 series relay operates on 100 mw of dc power, switching four, 5-amp resistive circuits. A choice of 16 coil resistances is offered; the range is 100 to 100,000 ohms. The unit is suited for plate-circuit applications as well as nominal-voltage ratings from 6 to 120 v dc. It is designed to stand environmental extremes.

Hi-Spec Corp., Dept. ED, 7328 Ethel Ave., North Hollywood, Calif.

Price: \$36.80 in lots of 1 to 9.

Availability: 30 days.

Fixed Coaxial Attenuators

370

Impedance is 50 ohms



Series 180 fixed coaxial attenuators are available with a nominal attenuation of 3, 6, 10 and 20 db. Frequency range is 1 to 12.4 kmc for 3, 6 and 10 db and 2 to 12.4 kmc for 20 db. Impedance is 50 ohms. The units are designed to withstand appreciable overloads, temperature cycling, and shock and vibration.

FXR, Inc., Dept. ED, 25-26 50th St., Woodside 77, N.Y.

Price & Availability: \$40; from stock.

CIRCLE 86 ON READER-SERVICE CARD



The Fusite Quality Control Director said,

" 1×10^{-10} STD CC/SEC"



The Advertising Man said,

"SPEAK AMERICAN, BOY!"

The Fusite quality control director was explaining a testing procedure for Fusite solid glass hermetic terminals.

It seems that every batch of this type (and practically all Fusite Terminals) is given a heat shock treatment to simulate the condition encountered when the customer solders or welds them in his production.

Fusite Terminals have this unique V-24 glass that actually fuses with the metal parts. When the terminal is heated to 500° F in 20 seconds this is supposed to be sheer murder. If the glass is ever going to leak, now is the time.

Well sir, now they put the test terminal on a Veeco Mass Spectrometer which tries to pass helium through the terminal and into the innards of the machine. This thing is so sensitive that it can detect one part of helium in 10 million parts of air and according to this long hair, that's the same as 1×10^{-10} std. cc/sec.

If Mr. Veeco gets even a sniff of helium, no terminal from that run ever sees the shipping department.

You can decide for yourself whether or not this is as big a deal as the lab boys make out, by the simple expedient of asking for samples of Fusite Terminals to test in your own way.

They are yours for the asking. Write Fusite Dept. C-6.



THE **FUSITE** CORPORATION

6000 FERNVIEW AVE., CINCINNATI 13, OHIO

Woodford Mfg. Co., Versailles, Kentucky.

In Europe: FUSITE N. V. Königsweg 16, Almere, Holland

CIRCLE 87 ON READER-SERVICE CARD

NEW PRODUCTS

RF Power Amplifiers

371

Range is 220 to 2,600 mc

These rf power amplifiers have ranges starting at 220 to 2,600 mc in nominal increments of 10%. They consist of 10 cavities packaged in cascade. The units deliver a minimum of 15 w of rf power and have a 100-mw input. An external 600-v dc power supply with 6.3 v ac forced-air cooling of approximately 12.5 cfm is required. A provision for blower mounting is included.

J-V-M Microwave Co., Dept. ED, Brookfield, Ill.

Price: \$895 to \$1,095.

Availability: 30 days.

Incandescent Indicator

372

Operates on less than 1 ma



The Type 1TDF3 miniature, transistor-driven incandescent indicator is designed to operate on less than 1 ma input. The unit operates on 12 v, using a T-1-3/4 lamp. It measures 1.76 in. long and has a diameter of 1/2 in. behind the panel. The transistor is an industrial-type germanium unit with a typical beta of 100, and a maximum power dissipation of 250 mw. Mil specs are met.

Eldema Corp., Dept. 7ED, 1805 Belcroft Ave., El Monte, Calif.

Silicon Power Rectifiers

373

Are encapsulated in alkyd

The alkyd-encapsulation process offers the advantage of high-speed molding to produce units of uniform size, high moisture resistance and high dielectric performance. The PA Series rectifiers are designed for high volume use and have a piv from 50 to 600 v.

General Instrument Corp., Dept. ED, Semiconductor Div., 65 Gouveneur St., Newark 4, N.J.

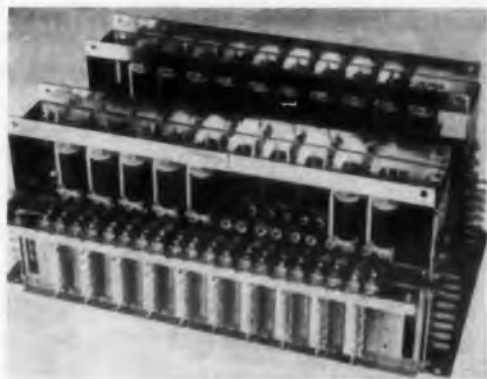
Price: \$0.35 to \$1.66.

Availability: From stock.

Crossbar Switch

378

High-frequency type



Type P high-frequency crossbar switch is for video, audio and sync switching, and can also be used in radar, sonar, and low-level signal distribution. It can switch sequentially or at random up to 120 circuits. The twin gold contacts carry 100-ma non-inductive load at 50 v dc for 20,000,000 operations. The unit weighs 4.5 lb.

James Cunningham, Son & Co., Inc., Dept. ED, 104 Litchfield St., Rochester 8, N. Y.

Availability: Delivery time is four to six weeks.

Thermocouple

379

With sensing tip extension to 4 in.

This miniature thermocouple has a sensing tip extension of up to 4 in. Designated model E, the unit has a response time of less than 10 μ sec, a continuous service temperature of 2,000 F, an operating pressure range to 25,000 psi, and a sensing tip with unlimited life.

Nanmac Corp., Dept. ED, P. O. Box 8, Indian Head, Md.

Price: \$95 to \$115.

Availability: From stock.

Analog Data Storage System

380

Stores up to 28 channels

The model MSS-100 multi-trace electrostatic storage system accumulates repetitive or non-repetitive analogue data on 28 channels and provides continuous visual readout on a 17-in. TV-type monitor. Data can be stored for 20 min. Electronic circuits are housed in two upright cabinets. Seven horizontal sweep rates from 100 msec to 6 sec are available at a vertical sampling rate of 2,500 cps. Storage sweep can be delayed up to 9.99 sec. Vertical timing lines can be displayed on the output tube at 1/100-sec intervals. Input is 150 mv across 100 K; frequency response is 0.5 to 250 cps; each cabinet measures 21 x 22 x 62-3/4 in.

Electrodynamic Instrument Corp., Dept. ED, 1841 Old Spanish Trail, Houston 25, Tex.

Price: \$12,500 ea.

Availability: 60 days.

Announcing...

the NEW Franklin Model 500A Digital Multimeter

all-electronic operation ... 0.1% d-c accuracy

From its extra-heavy-duty case (0.090" aluminum) to its improved all-electronic circuitry... the Model 500A offers more advantages than any other digital multimeter available today. No idle boast! The effectively infinite d-c input resistance (on ranges below 1200 V) permits accurate readings across resistive loads that would be disturbed by the best conventional instrument. Then again, there's the conservative 0.1% d-c accuracy... better than some bridges. Yes—the 500A has the usual features too; like the automatic polarity indication that lets you read negative or positive d-c without reversing leads. The brief specs tell more...



request
data sheet 2013

brief specifications

RANGES	DC: 0.000 to 1.200, 12.00, 120.0, 1200 V positive or negative (automatic polarity indication). AC: Same as dc ranges (rms value of 30 to 10,000 cps sine wave). OHMS: 0.001 to 1,000 K ohms.	POWER REQUIREMENTS	105 to 125 V, 60 cps, 250 W.
ACCURACY	DC: Better than $\pm 0.1\%$ of full scale. AC: Better than $\pm 0.2\%$ of full scale up to 120 V and 200 cps. Better than $\pm 0.5\%$ of full scale above 120 V and 200 cps. OHMS: Better than $\pm 0.2\%$ of full scale.	DIMENSIONS	Portable model (illustrated): 11 $\frac{3}{4}$ " H x 11 $\frac{1}{2}$ " W x 18 $\frac{1}{2}$ " D. Rack mounting model 19" W.
INPUT IMPEDANCE	DC: 20 megohms nominal. (Effective input impedance on other than 1200 V range approaches infinity.) AC: 20 megohms shunted by 400 mmf.	WEIGHT	45 pounds.
		FINISH	Smooth gray baked enamel. White engraved panel designations.
		SPECIAL FEATURES	Printer output provisions. Static parallel; binary coded 1-2-2-4 decimal output. (Other codes optional extra.)



FRANKLIN
electronics, inc.

BRIDGEPORT
PENNSYLVANIA

VAN NUYS
CALIFORNIA

You count best when you count on FRANKLIN

CIRCLE 88 ON READER-SERVICE CARD

Instruments that Stay Accurate



After More Than 600 Separate Inspections — One Panel Instrument

Sounds like a lot of inspecting, but it's one of the things that makes possible Simpson's fine panel instruments.

Take pivots, for example, which support the rotating armature of a meter movement. Because Simpson quality standards are so high, Simpson makes its own pivots which require more than 60 separate inspections during manufacture. Among these are 100% inspection under a 100X microscope and sampling inspection under a 400X microscope to check radius, cone angle, finish and other characteristics. One result is pivot points with a radius tolerance maintained to within .000010". Moreover, Simpson inspects each and every group of pivots for correct hardness so they won't deform under rough use.

Through such meticulous care as this, Simpson is able to offer you panel instruments with accuracy limits that are 100% guaranteed . . . instruments with conservative ratings on which you can rely . . . instruments that *stay accurate* . . . instruments you can specify with confidence.

Write for Catalog 2059A.

Simpson

ELECTRIC COMPANY

5202 West Kinzie Street • Chicago 44, Illinois
Phone: EStebrook 9-1121
In Canada: Bach-Simpson Ltd., London, Ont.

NEW PRODUCTS

High-Voltage Silicon Rectifiers 381

Temperature range is -55 to $+150$ C

Two series of high-voltage silicon cartridge rectifiers, series S-5490 through S-5507 and S-5518 through S-5535 have operating temperatures from -55 to $+150$ C. Series S-5490 to S-5507 have maximum rectified dc-output currents from 45 to 100 ma and piv ranging from 1,500 to 16,000 v. Series S-5518 to S-5535 have piv from 1,000 to 10,000 v, with maximum rms-input voltage ranging from 420 to 7,000 v. Maximum average rectifying currents at 25 C vary from 75 to 250 ma and at 100 C, from 25 to 100 ma.

Sarkes-Tarzian, Inc., Dept. ED, Bloomington, Ind.

Price: From \$7.90 to \$44.80 ea in sample quantities.

Relay And Capacitor Kit 382

For prototype and engineering labs

This kit consists of relays, capacitors and a compact container. There are 20 standard, micro-miniature relays which meet MIL-R-5757 and MIL-C-25018. The relays have four-mounting and three-header configurations. 160 high-temperature ceramic capacitors range from 39 μ mf to 10,000 μ mf and meet the specs of MIL-C-11015. Purchaser is placed on a technical data mailing list to receive application notes on use of relays and capacitors and current news in microminimization.

Telecomputing Corp., Electronic Components Div., Dept. ED, 14704 Arminta St., Van Nuys, Calif.

Price: \$295.

Panel Meters 386

Available in 276 standard models

These panel meters are available in 92 standard models in each of three sizes, and include voltmeters and ammeters. They offer standard accuracies of 2% full-scale value for dc meters and 3% for ac-rectifier types. All standard ac meters are calibrated for 60 cps. Special calibration accuracies of $\pm 1\%$ at a specific temperature, 0.5% at any point, and up to 0.5% full-scale value are readily available.

Beckman Instruments Inc., Helipot Div., Dept. ED, 2500 Fullerton Road, Fullerton, Calif.

Price: \$12.50 to \$26.50, depending on type and quantity.

Availability: 30-day delivery.

CIRCLE 89 ON READER-SERVICE CARD

UHF-Bandpass Filters 384

Frequency range is 200 to 1,500 mc

These uhf bandpass filters are available in the frequency range of 200 to 1,500 mc. They use both conventional and printed circuit techniques, occupy less than 13 cu in., and weigh only 4 oz. Multistage filters have either maximally flat or Tschebycheff response characteristics and provide signal rejection up to 35 db at one bandwidth from center frequency. Insertion loss at pass band is 1 db max. Filters meet military specifications.

Melpar, Inc., Special Products Dept., Dept. ED, 3000 Arlington Blvd., Falls Church, Va.

Price: \$95 ea below 1,000 mc, \$105 ea above 1,000 mc.

Availability: From stock.

Synchro Inspector 387

Tests according to MIL-S-20708A

This synchro tester measures the major synchro characteristics described in MIL-S-20708A specifications. These include electrical zero, electrical error, fundamental null, and total null. The device has semi-automatic operation and direct-reading, recordable outputs. Specifications include: electrical error, 0 through 360 deg in 5-deg steps; null range, 0 through 360 deg in 60 deg steps.

Theta Instrument Corp., Dept. ED, 520 Victor St., Saddle Brook, N.J.

Price & Availability: \$4,500, delivered from stock.

Portable Frequency Standard 434

Supplies 100 kc and 1 mc

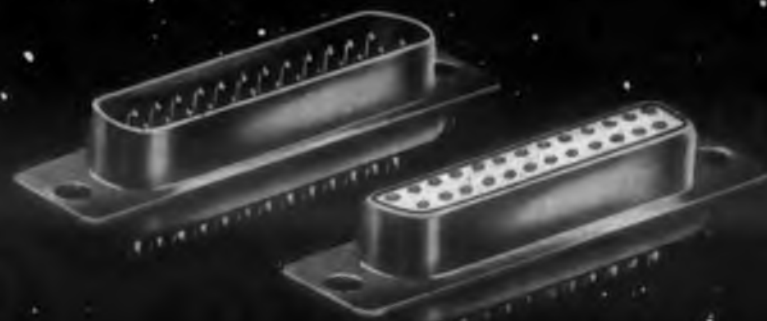
Outputs of 1 mc, 100 kc, and 100 kc with 10-kc synchronous pulses, are available from the model FS-195 portable frequency standard. The device is stable within 0.002% at 50 C. A modulating signal of 400 cps is provided. Harmonic content is usable beyond 150 mc.

Van Norman Industries, Inc., Transistron Electronics Div., Dept. ED, 186 Granite St., Manchester, N.H.

Price & Availability: \$185.95, from stock.

For protection against

PROBE DAMAGE



the NEW CINCH GOLDEN "D"*

designed for high performance, reliability... in aircraft, missiles and electronic equipment.

FEATURES:

- Closed Entry Contacts For Protection Against Probe Damage.
- Monobloc Insulators
- Low Engagement/Separation Forces
- Golden Iridite Finish to Meet MIL Q Q-P-416A, Type II Class 2.
- Insulators to Meet MIL-M 19833 Type GDI-30 Or MIL-M-14E Type MDG.
- Fully Interchangeable With Standard "D"

CINCH "D" SUB-MINIATURE CONNECTORS*

For Commercial Requirements

The CINCH STANDARD "D"*

designed to withstand rigid environmental conditions imposed by Military Specs—



*Manufactured by agreement with Cannon Electric Company

AVAILABLE NOW!

Complete engineering data on both the Golden D Connector and the Standard D Connector is yours for the asking. Specification sheets and Catalog 100, cover Cinch Connectors, D Sub-Miniature, DPX and DPA types. Phone NE 2-2000 today or write/wire.



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CIRCLE 90 ON READER-SERVICE CARD ➤

THE A.W.E. ANALOGUE TO DIGITAL CONVERTER

For fast
accurate
transmission
of data...



- ★ Extremely High Speed
- ★ Flexible and Reliable
- ★ Low Power Consumption
- ★ Fully Transistorized
- ★ Suitable for Rack Mounting
- ★ Easy Servicing

The A.W.E. Analogue to Digital Converter, type A.D.C.1., by performing up to 55,000 conversions a second, prevents bottlenecks caused by lack of speed—the main drawback in incorporating such converters in a system. An 8-bit binary converter, the A.D.C.1. provides a reliable link between the two forms of signal. Transistors are used throughout the unit to ensure resistance to shock and vibration, and plug-in boards allow rapid and easy servicing.

Specifications include provision for both serial and parallel digit outputs and for external sample and digit drive. The accuracy of the unit is $\pm \frac{1}{2}$ the least significant digit $\pm 0.25\%$ over a temperature range of 0-40°C. Units can be supplied to accept analogue inputs whose scale factors range from 0-6V to 0-60V. Total power consumption is only 11 watts from a nominal 230V supply. Overall dimensions of the unit are 19 ins. x 10.5 ins. x 12 ins.

ARMSTRONG WHITWORTH EQUIPMENT TEL: GLOUCESTER 86781 TELEX 4313
SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LIMITED., A MEMBER OF THE HAWKER SIDDELEY GROUP

CIRCLE 91 ON READER-SERVICE CARD

NEW PRODUCTS

Tape Recorder

450

For digital data



The Perfograph digital data-recorder records information in a visually readable and machine sensible form. The information is stored in digital form on paper tape by electronic perforation. Up to eight channels and any digital coding may be accommodated. The data can be interpreted by a photoelectric tape reader. The recorder is portable and operates on dry batteries.

Avinco, Dept. ED, 700 S. 4th St., Richmond, Calif.

Price & Availability: \$400 ea; delivery is in 30 to 60 days.

Accelerometer

458

Dynamic band error is $\pm 0.45\%$

Having a range of 0 to 2 g through 0 to 100 g, model 608 accelerometer is designed for use in missile and aircraft systems. Resolution is 0.3% with 7,500 ohms, total resistance. Power rating is 0.5 w at 165 F and damping is 0.5 to 0.8 of critical from -65 to +165 F. The unit stands severe shock and acceleration overloads.

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

Availability: 60- to 75-day delivery.

Voltage-Reference Standards

459

Operate directly from unregulated dc

Series 230 voltage-reference standards are designed to operate directly from unregulated dc-power sources. They provide dc output-reference voltages having a temperature coefficient of $\pm 0.001\%$ per degree C from -25 to +75 C, with a regulation of $\pm 0.001\%$ for $\pm 10\%$ input changes. Output voltages of 5, 7, 8.5 and 10.5 v dc are available.

Viking Industries, Inc., Dept. ED, 21343 Roscoe Blvd., Canoga Park, Calif.

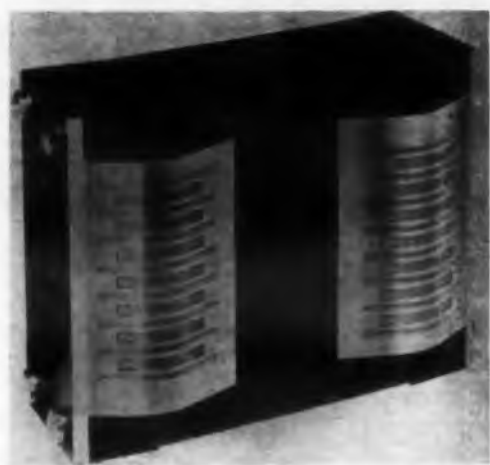
Price: From \$80 to \$90.

Availability: 2 to 3 week delivery.

Magnetic Heads

460

For analog and digital recording



Series 2000 integral interlace magnetic heads for analog and digital recording provide efficient use of tape, maintaining critical relative azimuth and spacing between two gap lines. The interlace feature nearly doubles the number of channels which can be recorded on a given tape width.

Clevite Electronic Components, Dept. ED, 3405 Perkins Ave., Cleveland 14, Ohio.
Availability: Delivery time is 60 days.

Induction Torque Motor

403

For gyro applications

The model 103 motor is an inside-out induction torque unit. Intended for gyro applications, the device is 1-5/8 in. in diameter and 1/2-in. long. It will produce 3.1 oz-in. of torque when supplied with 10-1/2 w per phase of 400-cps, 2-phase power. Class-B insulation is used throughout, and the windings are completely encapsulated in epoxy.

Curvin Development Co., Inc., Dept. ED, 13740 Saticoy St., Van Nuys, Calif.

Price: \$150 ea; \$125, 10 to 50; \$110, 50 to 1,000.
Availability: 30 days.

Code Transmitter-Receiver

483

Has eight channels

Model 8C code transmitter-receiver, eight channels, transmits a single, continuous tape alternately over two transmission channels, each operating at 75 bits per sec. All features of the standard Tele-data are retained. The half-duplex system transmits 850 characters per min in either direction; the full-duplex system transmits 850 characters per min in both directions, or 1700 characters per min.

Friden, Inc., Dept. ED, San Leandro, Calif.

Price: \$2650.

Availability: 60 to 90 days.

COUNTEREM

35 SILICON DIODES

JOIN THE GROWING

RAYTHEON FAMILY

FOR HIGH TEMPERATURE SERVICE—RELIABLE OPERATION UP TO 200°C

General Purpose		High Conductance, General Purpose	
1N456	1N461	1N456A	1N461A
1N457	1N462	1N457A	1N462A
1N458	1N463	1N458A	1N463A
1N459	1N464	1N459A	1N464A

High Conductance		High Conductance, High Resistance	
1N482	1N485	1N482A, B	1N485A, B
1N483	1N486	1N483A, B	1N486A, B
1N484	1N487	1N484A, B	1N487A
	1N488		1N488A

Compare These Advantages!

Low Cost—available in large quantities. Mass production results in large savings to customers.

Subminiature—actual size only 0.265" x 0.105" max.

Hermetically Sealed—fusion sealed glass package is impervious to moisture and contaminants.

Rugged—designed to meet and exceed mechanical and environmental requirements of military standard MIL-S-19500 B.

Tested—100% units tested to rigid electrical specifications.

Proven—devices of this design have been in operation for several years in critical applications.

FOR GENERAL SERVICE—CONSIDER THESE VERSATILE GERMANIUM DIODES

POINT CONTACT

General Purpose		High Resistance		Computer
1N558	1N95	1N127	1N63A	1N191
1N66A	1N97	*1N127A	1N67A	1N192
1N68A	1N116	1N294A	1N99	1N198B
1N89	1N117	1N297A	*1N128	
1N90	1N126	1N298A	1N128A	
	*1N126A		*1N198	

GOLD BONDED DIODES

1N34A	*1N270	*1N281
1N38A	1N273	1N283
1N100	*1N276	1N292
1N108	*1N277	1N695

*Also available to JAN specifications

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RAYTHEON COMPANY

SEMICONDUCTOR DIVISION

SILICON AND GERMANIUM DIODES AND TRANSISTORS • SILICON RECTIFIERS • CIRCUIT-PAKS
ENGLWOOD CLIFFS, N. J., Lowell 7-4911 (Manhattan, Wisconsin 7-6400) • BOSTON, MASS., Hillcrest 4-8700 • CHICAGO, ILL., National 5-4000 • LOS ANGELES, CAL., Plymouth 7-3151
ORLANDO, FLA., Garden 3-0618 • SYRACUSE, N. Y., Howard 3-9141 • PHILADELPHIA, PA., (Haddonfield, N. J.), Hazel 8-1272 • BALTIMORE, MD., Southfield 1-0450
CLEVELAND, OHIO, Winton 1-7716 • DETROIT, MICH., Trinity 1-1710 • SAN FRANCISCO, CAL., (Redwood City), Emerson 9-5588 • CANADA: Waterloo, Ont., Sherwood 5-8831
GOVERNMENT RELATIONS: Washington, D. C., Metropolitan 8-8208

CIRCLE 92 ON READER-SERVICE CARD

RAYTHEON

NEW PRODUCTS

Extender-Counter Timer 476

Measures frequencies to 220 mc

The model 1290 extender and model 1039 counter-timer, mounted in the same cabinet, measure frequencies to 220 mc when used with existing plug-in units. The counter-timer, a solid-state device, has 0.1-v rms sensitivity, 1-meg input impedance on three dc amplifiers, and Nixie readout.

Systron-Donner Corp., Dept. ED, 950 Galindo St., Concord, Calif.
Price & Availability: Model 1290, \$250; model 1039, \$3300. Delivery from stock by November, 1960.

Synchro Transmitter Units 477

Supply linear or angular position information

The series PX-1 synchro transmission units supply linear or angular position information to a remote location from electro-mechanical devices such as industrial control systems, automatic machinery, and missile or satellite tracking systems.

Scientific-Atlanta, Inc., Dept. ED, 2162 Piedmont Road, N. E., Atlanta 9, Ga.

Price: \$360 to \$500.

Availability: 7 to 56 days.

Miniature Magnetic Clutch 478

Rates 10 oz-in. at 1,000 rpm

Torques of 10 oz-in. at speeds up to 1,000 rpm are provided by the model 162 magnetic clutch. The device, occupying 1 cu in., operates at 2.5 v in voltage ranges of 6, 12, 28, and 90 v. Torque loss is less than 0.3 oz-in. The unit operates to 85 C and withstands severe humidity, shock, and air-pressure conditions.

Ultronix, Inc., Dept. ED, 111 E. 20th Ave., San Mateo, Calif.

Price & Availability: \$27.50 for 1 to 10 units; small quantities available from stock.

NEW! CONTROLLED RECTIFIERS

4 TRANSITRON TYPES AUGMENTING

Silicon Controlled Rectifiers / Switches



NEW! CONTROLLED SWITCHES

TSW31S · TSW201S PNP bistable switching devices in TO-18 packages, with maximum holding current of 1 ma.

- High gate sensitivity 20 μ A to fire
- Covers current range from 1 ma to 200 ma @ 75°C ambient
- Voltage ratings up to 200 volts available
- Temperature range: -65°C to +150°C

CIRCLE 781 ON READER-SERVICE CARD



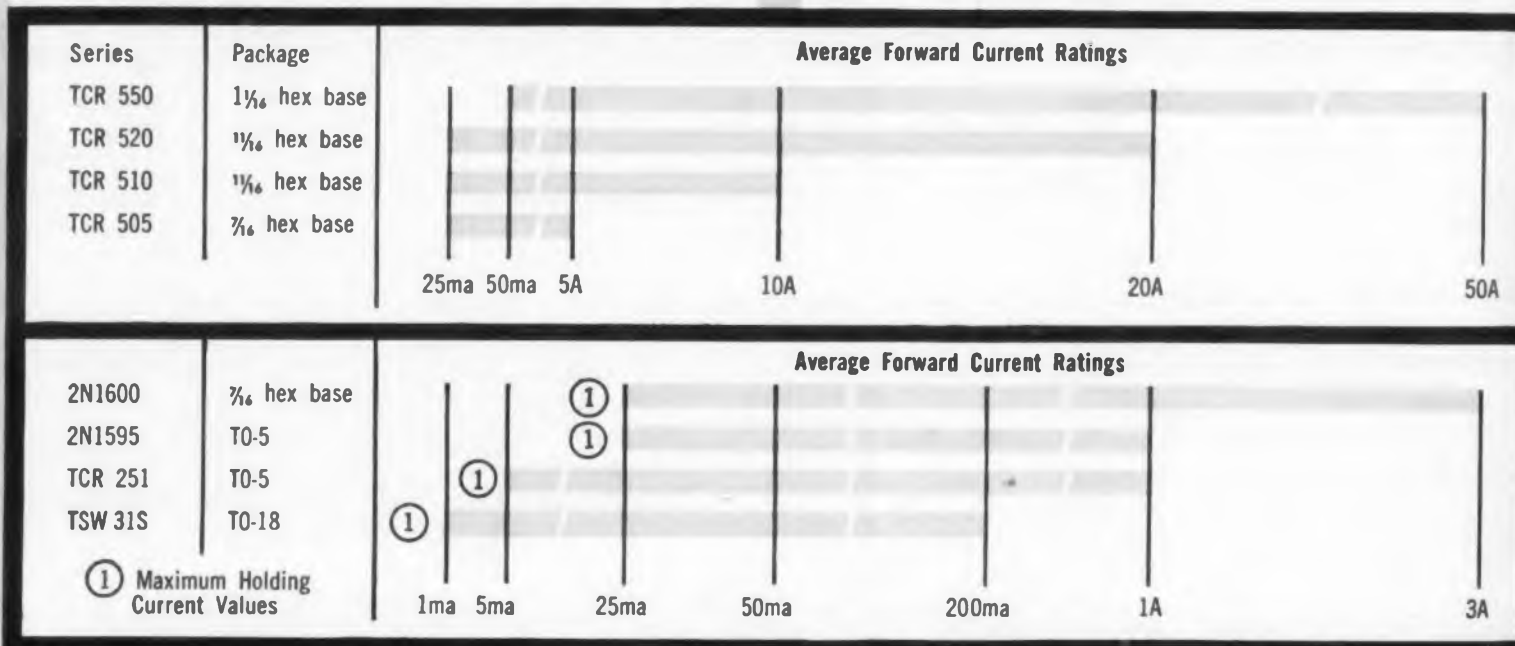
NEW! TO-5 PACKAGE CONTROLLED RECTIFIERS

Two series of diffused silicon PNP bistable switching devices with very low triggering requirements and micro-second switching.

TCR251-TCR4001 series featuring:

- Low leakage: 100 μ A @ 125°C case
 - High gate sensitivity: 200 μ A @ 25°C
 - Low Holding Current: 5 mA maximum @ 25°C
 - Current rating: 1 amp at 80°C case or 600 ma at 25°C ambient
 - Voltage ratings: Up to 400 volts
- Plus 2N1595-2N1599 series with same current and voltage ratings

CIRCLE 782 ON READER-SERVICE CARD



The complete Transitron line of Controlled Rectifiers and Controlled Switches includes the following higher current types:



NEW! 2N1600-2N1604 and TCR505-TCR4005 series diffused Silicon Controlled Rectifiers

- Current ratings: 3 amps at 80°C case; 1 amp @ 125°C case
- Voltage ratings: Up to 400 volts
- Package: 3/4" hex base

CIRCLE 783 ON READER-SERVICE CARD



10 Amp Series

- Current ratings: 10 amps @ 25°C case; 5 amps at 100°C case
- Voltage ratings: Up to 400 volts
- Package: 1 1/4" hex base

CIRCLE 784 ON READER-SERVICE CARD



NEW!

50 Amp Series

- Current ratings: 50 amps at 100°C case
- Voltage ratings: Up to 400 volts
- Package: 1 1/4" hex base

CIRCLE 785 ON READER-SERVICE CARD

RECTIFIERS & SWITCHES

INDUSTRY'S BROADEST LINE!

Binistors / Transwitches



THE BINISTOR (by-nis-tor)

Transitron's new silicon NPN Tetrode offers simpler, more reliable, more economical switching and storage circuitry. The key parameters of this bistable, negative resistance device are determined by external circuitry, providing remarkable stability and uniformity over wide temperature ranges. The signal and output swings are compatible with present transistor and diode circuits. Two series are available: The wide temperature range or military types and the commercial and industrial computer types. The stability and uniformity of each unit in the military series is absolutely guaranteed by the method of specification at critical temperatures (-65°C and +150°C).

CIRCLE 786 ON READER-SERVICE CARD
ABSOLUTE MAXIMUM RATINGS

	3N56	3N57
Collector to Emitter Voltage (V_{CE})	15 Volts	15 Volts
Collector Current @ 25°C (I_C)	30 mA	30 mA
Storage & Operating Ambient Temp. Range	-65°C to +150°C	-55°C to +100°C

3N56 MILITARY TYPE SPECIFICATIONS & TYPICAL CHARACTERISTICS (At Noted Ambient Temp.)

TURN-ON	AMBIENT TEMP	MIN.	TYPICAL	MAX.	TEST CONDITIONS
D.C. Collector Saturation Voltage (V_{CE})	-65°C	—	0.46	1.0 V	$I_C = 10\text{mA}, I_b = +.5\text{mA}^*$ $V_J = 4\text{V}, R_J = 3\text{K}$ supply
	+25°C	—	0.7	1.0 V	
	+150°C	—	1.2	1.5 V	
Critical Injector Current ($I_{j\text{crit}}$)	-65°C	0	.38	.5 mA	$I_C = 10\text{mA}, I_b = -50\mu\text{a}$
	+25°C	0	.28	.5 mA	
	+150°C	0	.21	.5 mA	
TURN-OFF Base Cutoff Current (I_{bo})	-65°C	—	—	—	$V_{CE} = 15\text{volts}, V_{JE} = +13\text{volts}$ $V_{BE} = -.6\text{volts}$
	+25°C	—	.020	0.2 μA	
	+150°C	—	2.0	10.0 μA	

3N57 COMPUTER TYPE SPECIFICATIONS & TYPICAL CHARACTERISTICS @ 25°C

TURN-ON	MIN.	TYPICAL	MAX.	TEST CONDITIONS
D.C. Collector Saturation Voltage (V_{CE})	—	0.7	1.0 V	$I_C = 10\text{mA}, I_b = +.5\text{mA}^*$ $V_J = 4\text{V}, R_J = 3\text{K}$ supply
Critical Injector Current ($I_{j\text{crit}}$)	0	.28	0.5 mA	
TURN-OFF Base Cutoff Current (I_{bo})	—	.020	.2 μA	$V_{CE} = 15\text{volts}, V_{JE} = +13\text{volts}$ $V_{BE} = -.6\text{volts}$
	—	—	—	

*Unit must switch on under the above conditions; however, actual V_{CE} measurement is made with $I_b = -50\mu\text{a}$



THE TRANSWITCH

A PNPN bistable silicon computer element that can be turned on and off with gate current. The device is available in the T0-18 package, and is designed for miniaturized memory circuits, ring counters, shift registers, controlled rectifier drivers, and flip flop equivalents. A 100 ma series (TSW-31A-TSW-201A) has been added to the Transwitch series. Both series (50mA and 100mA) are available in voltage ratings up to 200 volts. For commercial and industrial applications, the SW-30 type is now available. This unit, especially designed for lower temperature applications, features maximum collector current rating of 30mA and maximum voltage rating 30 volts.

CIRCLE 787 ON READER-SERVICE CARD
ABSOLUTE MAXIMUM RATINGS

	SW-30	TSW-31 thru TSW-201	TSW-31A thru TSW-201A
Forward current I_f	30 mA	50 mA	100 mA
Operating temp. range	-55°C to +85°C	-55°C to +125°C	-55°C to +125°C

SPECIFICATIONS (AT 25°C)

	SW-30	TSW-31 thru TSW-201	TSW-31A thru TSW-201A
Max. Saturation Voltage (V_s)	1.5 V @ 30 mA	1.5 V @ 50 mA	2 V @ 100 mA
Max. Forward "OFF" Current (I_{CGO})	10 μA	10 μA	10 μA
Max. Reverse Current (I_R)	10 μA	10 μA	10 μA
Max. Forward "OFF" Current (I_{CGO})	50 μA @ 85°C	50 μA @ 125°C	50 μA @ 125°C
Max. Reverse Current (I_R)	50 μA @ 85°C	50 μA @ 125°C	50 μA @ 125°C
Max. Gate Voltage to Switch "ON" ($V_{G\text{ON}}$)	1.0 V	1.0 V	1.0 V
Max. Gate Current to Switch "ON" ($I_{G\text{ON}}$)	1.5 mA	1.0 mA	1.0 mA
Max. Gate Voltage to Switch "OFF" ($V_{G\text{OFF}}$)	-5.0 V	-4.0 V	-6 V
Max. Gate Current to Switch "OFF" ($I_{G\text{OFF}}$)	-8.0 mA	-10 mA	-20 mA
Max. Holding Current (I_H)	10.0 mA	5.0 mA	7.0 mA

In writing for further information on all these devices, refer to the following bulletin numbers:

Controlled Rectifiers & Switches		Binistor & Transwitch	
TSW-31S series	Bulletin # TE-1356E	TSW-31A	Bulletin # TE-1357B-1
TCR-251 series	Bulletin # TE-1356D	TSW-31	Bulletin # TE-1357B
2N1595 series	Bulletin # TE-1356C	SW-30	Bulletin # TE-1357E
2N1600 series	Bulletin # TE-1356B-1	3N56	Bulletin # TE-1360A
TCR-505 series	Bulletin # TE-1356B	3N57	Bulletin # TE-1360B
10 amp series	Bulletin # TE-1356A-1		
20 amp series	Bulletin # TE-1356A		
50 amp series	Bulletin # TE-1356AA		



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CHICAGO, Illinois
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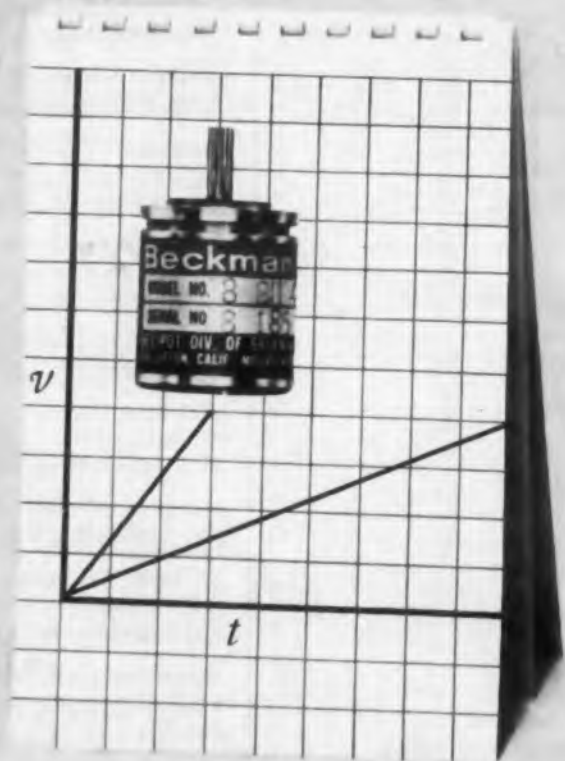
← CIRCLE 781 THRU 787

NEW SIZE 8 SERVOMOTOR RESPONDS 3-TIMES FASTER

These fast response Size 8's have a whopping acceleration of 86,500 rad/sec²...and feature torque at stall of 0.22 oz. in., rotor inertia, 0.18 gm. cm.². That's at least three times faster than any other Size 8's available.

The entire BECKMAN® Size 8 line is available in standard models for 26-volt or 115-volt sources—Servomotors, Inertia-Damps, Velocity Damps, or Servomotor Rate-Generators (special models available for other voltages). For the servosystems man working with 115-volt reference supplies, this can mean an end to accessory gear that so often compounds reliability and cost problems.

At the Breadboard stage? Several BECKMAN® Size 8 and Size 11 Servomotors are available from stock for immediate delivery in prototype quantities. Check with your Helipot rep, write us for the list of stock Servomotors and for the Size 8 and 11 Catalog.



Beckman / **Helipot**

POTS : MOTORS : METERS
Helipot Division of
Beckman Instruments, Inc.
Fullerton, California



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CIRCLE 96 ON READER-SERVICE CARD

NEW PRODUCTS

Variable Delay Line

656

Attenuation as low as 0.08 db



Model 801 variable delay line has a stability better than 5 ppm per C. The attenuation can be as low as 0.08 db per msec delay. Total delay can be as long as 200 msec, 0.2 sec.

Ad-Yu Electronics Lab., Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N.J.

Price: From \$140.

Availability: 2 weeks.

Printing Machines

516

For meter scales, panel boards, etc.

The Model RL printing machine prints circuit and panel boards using the dry offset method. It is available in either manual or motor-driven models. The machine will print three colors in one stroke.

International Eastern Co., Dept. ED, 801 Sixth Ave., New York 1, N.Y.

Rejection Filter

385

Frequency tolerance is $\pm 2\%$



Model CH Twin-T rejection filter is for use in original equipment for airborne, missile, ground support, and field applications. It has a minimum attenuation of 50 db at the null frequency and a frequency tolerance of $\pm 2\%$. Units with a frequency tolerance of $\pm 3\%$ are available on special order. They can be supplied in frequencies from 15 to 2,000 cps.

C. E. S. Electronic Products, Inc., Dept. ED, 7460 Girard Ave., La Jolla, Calif.

Price: \$26 through \$41.

LATEST DATA ON ULTRASONIC DELAY LINES!



THIS NEW CATALOG

gives you up-to-date specs on the industry's most complete line of ultrasonic delay lines for missiles, MTI, radar countermeasures and computer applications. Send for it today.



LABORATORY FOR ELECTRONICS, INC.

Computer Products Division
1079 Commonwealth Avenue
Boston 15, Mass., Dept.

CIRCLE 97 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

Pressure Controller 575

Measures 6 x 12 x 6 in.

Measuring 6 x 12 x 6 in., model 501F pressure controller weighs 12 lb and requires 50 w of 115 v at 60 cps, single-phase power. The ac amplifier has an input impedance of 1 meg and an open-loop gain of 10,000 \pm 10%. The suppressed-carrier demodulator has an output of \pm 8 ma into a 3 K load. A 3-kc oscillator and a power supply are also furnished.

Micro Gee Products, Inc., Dept. ED, P. O. Box 1005, 6319 W. Slauerson Ave., Culver City, Calif.

Price & Availability: Price is \$1000 when ordered in quantities of five units. Delivery time is 30 days.

Crossbar Switch 479

Has make-before-break contacts

This crossbar switch has a signal switching range from microvolts dc to megacycles. It is claimed to be the first available crossbar switch to use Form C, or make-before-break contacts. Up to 3 amp can be carried by the switch contacts. Break-down voltage between switching conductors and frame and across switch contacts is 1,000 v ac; with special construction this can be increased to 2,500 v ac.

James Cunningham, Sons & Co., Inc., Dept. ED, P. O. Box 516, Zone 2, Rochester 8, N.Y.

Price: \$400 to \$1200.

Availability: After November 1; 60 days.

Recorder-Reproducer 480

Response is 50 to 200,000 cps

This recorder-reproducer, designated the Pi recorder, provides a response of 50 to 200,000 cps at a tape speed of 60 in. per sec for direct recording. For fm recording, frequency response is 0 to 20,000 cps using standard 40% deviation for full-scale signal.

Precision Instrument Co., Dept. ED, 1011 Commercial St., San Carlos, Calif.

Price: Approx. \$7000 and up.

Availability: 60 days.



recti/riter[®] recorders prove what every engineer knows . . . SIMPLICITY MEANS RELIABILITY

What simpler and more reliable actuating device can you employ in an amperage-voltage-frequency recording instrument than a d'Arsonval galvanometer . . . a trouble-free horseshoe magnet and a coil of wire? The same is true of the exclusive "recti/rite"[®] system . . . a simple, shock resistant trigonometric linkage that straightens the arc described by the galvanometer metering arm, changing curvilinear motion to rectilinear motion.

All the other "recti/riter" recorder features which contribute to this instrument's multi-industry acceptance and hardworking reliability are equally simple: The optional a-c or d-c drives couple directly with chart speed change gears to allow ten chart speeds; all routine operations and adjustments are performed "up front"; the non-corrosive, honed metal alloy pens, closed ink system, and large capacity ink well give you long, consistent writing performance.

With all their simplicity and reliability, "recti/riter" recorders are offered in extremely wide and useful Basic Recorder Ranges (Dual channel recorders offer combination of any two ranges):

Two Cycle Pen Response

D-c Milliampere Ranges 1/4 ma to 100 ma
A-c Ampere Ranges 0.25 A to 25 A
D-c Ampere Range ..100 mv for use with standard shunts
Expanded Scale A-c Voltage Ranges 80-130 V,
160-260 V, 320-520 V

A-c and D-c Voltage Ranges 10 V to 1000 V
Frequency Ranges 50, 60, 400 cps

Five Cycle Pen Response

D-c Milliampere Range 5 ma

Ask the TI engineer about *customized* recorders for your OEM applications. Don't settle for any recorder until you know all the facts on the complete "recti/riter" recorder line.



TEXAS INSTRUMENTS INCORPORATED

GEOSCIENCES & INSTRUMENTATION DIVISION
3609 BUFFALO SPEEDWAY • HOUSTON 6, TEXAS • CABLE: TEXINS

The proved "recti/riter" recorder is a companion to the new "servo/riter"[™] recorder.

[™]"servo/riter" is a trademark of Texas Instruments



Westinghouse

SILICON POWER
RECTIFIERS
AND
TRANSISTORS

NOW IN STOCK

YOU CAN OBTAIN
UP TO 1000 PIECES
OF MOST TYPES
AT
FACTORY PRICES
FROM

Schweber

ELECTRONICS

60 HERRICKS ROAD,

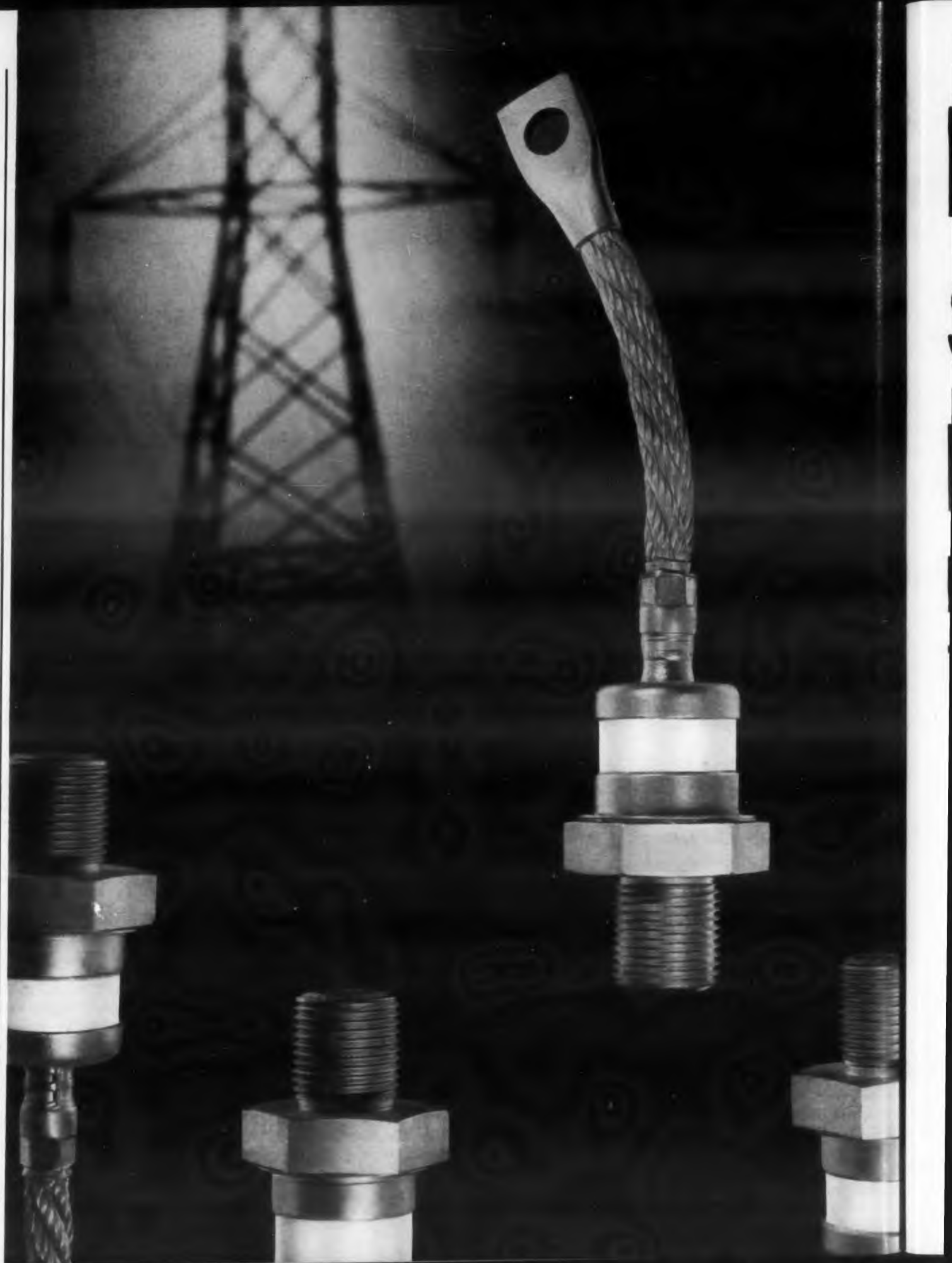
MINEOLA, L. I., N. Y.

PIONEER 6-6520.

TWX G-CY-NY-380U



CIRCLE 99 ON READER-SERVICE CARD



New high power silicon rectifier cells

Ratings to 600 volts... Currents to 240 amps!

Designed specifically for high-power applications, this new Type 439 Westinghouse rectifier cell features a peak reverse voltage rated at 600 volts. Another Westinghouse exclusive is the fused ceramic-to-metal construction that is hermetically sealed for extra reliability, extra ruggedness, extra-long life. Other features include:

- **Lightweight (8 oz.), small size**
- **Hard soldered connections**
- **Junction temperatures to 190°C.**
- **No thermal fatigue**

High current, high voltage applications include: Electro-chemical refining / Plating / Elevators / Cranes / D-C motors / Battery chargers / Railway traction / Welders.

For more information, call your nearest Westinghouse representative or semiconductor distributor. Or write: Westinghouse Electric Corp., Semiconductor Dept., Youngwood, Penna.

When it comes to semiconductors . . . **you can be sure . . . if it's Westinghouse.**

SC-1010

Westinghouse



Westinghouse

**SILICON POWER
RECTIFIERS
AND
TRANSISTORS**

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**YOU CAN OBTAIN
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OF MOST TYPES
AT
FACTORY PRICES
FROM**

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ELECTRONICS

60 HERRICKS ROAD.

MINEOLA, L. I., N. Y.

PIONEER 6-6520.

TWX G-CY-NY-580U



CIRCLE 100 ON READER-SERVICE CARD

← CIRCLE 101 ON READER-SERVICE CARD

For immediate "off-the-shelf" delivery, order from these Westinghouse Distributors:

EASTERN

CAMERADIO Pittsburgh, Pa./EX 1-4000
CRAMER ELECTRONICS, INC.

Boston, Mass./CO 7-4700

ELECTRONIC WHOLESALERS INC.

Melbourne, Florida/PA 3-1441

GENERAL RADIO SUPPLY CO., INC.

Camden, N. J./WO 4-8560

GENESSEE RADIO PARTS CO.

Buffalo, N. Y./DE 9661

KANN-ELLERT ELECTRONICS, INC.

Baltimore, Md./TU 9-4242

MILGRAY ELECTRONICS

New York, N. Y./RE 2-4400

RADIO & ELECTRONIC PARTS CORP.

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Long Island, N. Y./PI 6-6520

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ELECTRONIC COMPONENTS FOR

INDUSTRY CO. St. Louis, Mo./WO 2-9917

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LENERT CO. Houston, Texas/CA 4-2663

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Indianapolis, Ind./ME 7-5571

SEMICONDUCTOR SPECIALISTS, INC.

Chicago, Ill./NA 2-8860

S. STERLING CO. Detroit, Mich./BR 3-2900

UNITED RADIO, INC.

Cincinnati, Ohio/MA 1-6530

WHOLESALE ELECTRONICS SUPPLY

Dallas, Texas/TA 4-3001

WESTERN

ELMAR ELECTRONICS

Oakland, Calif./TE 4-3311

HAMILTON ELECTRO SALES

Los Angeles, Calif./BR 2-8453

NEWARK ELECTRONICS CO.

Inglewood, Calif./OR 4-8440

LAMBDA

COM-PAK Series

Regulated Power Supplies

- Immediate delivery from stock.
- Convection cooled, no troublesome blowers.
- Rated for 24 hour continuous operation at 50°C ambient.
- Swing open back for easy access.
- Transient free-output.
- Excellent regulation.



Guaranteed 5 Years

C-280 (without meters): 0-200 VDC, 0-200 MA. \$184.50	C-880 (without meters): 0-200 VDC, 0-800 MA. \$340.00
C-281 (without meters): 125-325 VDC, 0-200 MA. 159.50	C-881 (without meters): 125-325 VDC, 0-800 MA. 315.00
C-282 (without meters): 325-525 VDC, 0-200 MA. 169.50	C-882 (without meters): 325-525 VDC, 0-800 MA. 360.00
C-480 (without meters): 0-200 VDC, 0-400 MA. 259.50	C-1580 (without meters): 0-200 VDC, 0-1500 MA. 550.00
C-481 (without meters): 125-325 VDC, 0-400 MA. 244.50	C-1581 (without meters): 125-325 VDC, 0-1500 MA. 575.00
C-482 (without meters): 325-525 VDC, 0-400 MA. 259.50	C-1582 (without meters): 325-525 VDC, 0-1500 MA. 650.00

For Com-Pak Series models with meters, add the suffix "M" to the model number and add \$30 to the unmetred model price.

COM-PAK FEATURES

- Hermetically-sealed transformer—designed to MIL-T-27A
- 50 to 400 CPS input
- Semi-conductor rectifiers for higher efficiency in C-400, C-800 and C-1500 series.
- Overload protection with built-in blown-fuse indicators
- Stable, low noise wire wound reference networks and multipliers
- Oil-filled, hermetically-sealed capacitors
- Conservatively rated for continuous duty
- Easy service access without removal from rack; all tubes readily accessible for replacement
- Provision for remote DC vernier voltage adjustment
- Exclusive design, height only 5¼" (C-200 and C-400 series), 7" (C-800 series) and 8¾" (C-1500 series)

CONDENSED DATA

Regulation: Line Better than 0.15% or 0.3 Volt (whichever is greater). For input variations from 105-125 VAC.

Load: Better than 0.25% or 0.5 Volt (whichever is greater). For load variations from 0 to full load.

Transient Response: Line Output voltage is constant within regulation specifications for step-function line voltage change of plus (+) 10 volts or minus (-) 10 volts rms within the limits of 105-125 VAC.

Load: Output voltage is constant within regulation specifications for step-function load change from 0 to full load or full load to 0.

Ripple and Noise: Less than 3 millivolts rms.

AC Output: (unregulated) . . . 6.5 VAC (at 115 VAC Input). C-200 Series . . . 10 AMP; C-400 Series . . . 15 AMP; C-800 Series . . . 20 AMP; C-1500 Series . . . 30 AMP.

AC Input: 105-125 VAC, 50-400 CPS

Controls: DC Output Controls: Band-switches and screw-driver adjusting vernier-control, rear of chassis.

SEND TODAY FOR COMPLETE DATA

LAMBDA ELECTRONICS CORP.
 11-11 131 STREET • DEPT. 2 • COLLEGE POINT 56, N. Y. • INDEPENDENCE 1-8500
 CIRCLE 102 ON READER-SERVICE CARD

NEW PRODUCTS

Precision Air Capacitor

Is 1/2-in. long



For use in missiles, computers, and other electronic devices, type 2951 precision air capacitor measures 1/2-in. long and 1/4 in. in OD. It is adjustable from 0.8 to 10 pf. More than 10 turns to the adjustment screw are required to cover the capacitance range, which varies linearly with each turn. Breakdown voltage is 200 v dc min.

Johanson Manufacturing Corp., Dept. ED, 400 Rockaway Valley Road, Boonton, N. J.

Price & Availability: Units in production quantities will be priced at \$3 to \$4, approximately. Delivery time is 6 to 8 weeks.

Clutch-Brake

For electro-magnetic control

The Pancake clutch-brake with potentiometer is a single, permanently sealed unit with a common shaft and integral bearings. A special end cap becomes the potentiometer mounting plate and part of the housing.

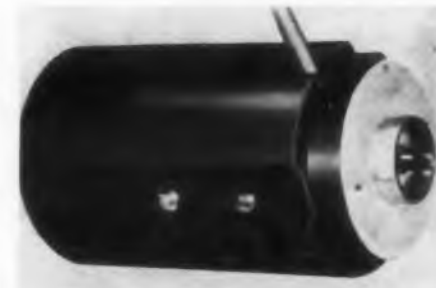
Autotronics Inc., Dept. ED, P.O. Box 208, Florissant, Mo.

Price: \$87.50 through \$185.

Availability: Two weeks.

Induction Motor

Is rated at 0.03 hp



Type BF-15-14 induction motor is designed for use as the driving unit for fuel, air and hydraulic pumps in aircraft. Speed is 10,000 rpm and full-load torque is 3 oz-in. The unit weighs 1 lb, 0.75 oz. It meets MIL-E-5272A and MIL-M-7969A.

Kearfott, Div. of General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

CIRCLE 103 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

count them . . .

Strain Gage

437

For military and space applications

Model MS 105-350 semiconductor device is for microstrain measurement in military and space applications. Gage factor is about 130; operating temperature range is -65 to $+180$ F. Resistance is 350 ohms; maximum operating strain is over 3,000 μ in. per in. The unit is bondable to most surfaces. It is 1 in. long and 1/2 in. wide.

Electro-Optical Systems, Inc., Dept. ED, 125 N. Vinedo Ave., Pasadena, Calif.

Price: \$98 for package of four.

Availability: From stock.

DC Power Supply

438

For missile applications

Designed for application in missiles, telemetering, radar, sonar and computers, these epoxy-encapsulated dc power supplies are rated up to 300 w output. High-temperature transistors and corrosion-resistant cadmium-plated base plates and connectors are employed. The units occupy about 15 cu in. and weigh 11 oz. Regulation is within 0.25%, and ripple is 0.2% rms. Devices operate from -55 to $+125$ C, withstand shock-loading in excess of 100 g, and meet military environmental specifications.

Rho Engineering Co., Dept. ED, 2242 Sepulveda Blvd., Los Angeles 64, Calif.

Price: \$300 to \$500.

Availability: 60 days.

Variable Delay Lines

445

For printed-circuit mounting

The series 700 variable delay lines are designed for printed-circuit mounting. Minimum delays range from 0.125 to 1.5 μ sec; impedance ranges from 93 to 1,800 ohms, and pulse rise time ranges from 0.03 to 0.3 μ sec max. Pulse attenuation is 1 db max. Working voltage is 500 v dc max.

ESC Electronics Corp., Dept. ED, 534 Bergen Blvd., Palisades Park, N.J.

Availability: 60 days.



. . . 13 basic types

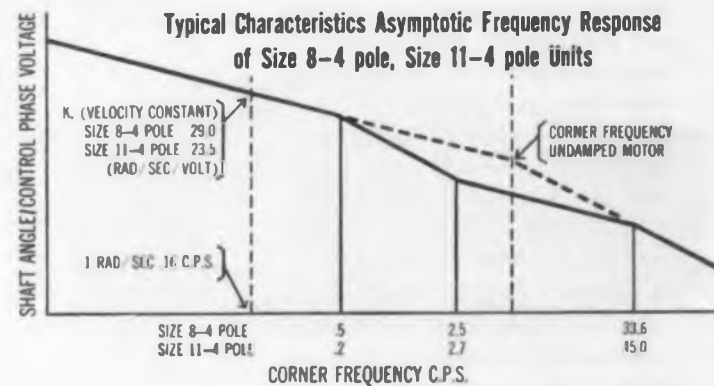
inertially damped servo motors

Thirteen lucky solutions to stability problems! Transicoil's complete new line of acceleration (inertially) damped servo motors matches every conceivable requirement with performance far in advance of previously available models. You can have size 8, 11, 15, or 18 . . . in 4, 6, or 8 poles . . . standard or high torque . . . corner frequencies cut to your special needs. And if necessary, an endless variety of special motor windings and shaft configurations. Highest 3rd corner frequency available in industry assures excellent system frequency response. Also, the large difference between the 2nd and 3rd corner frequencies simplifies amplifier stability requirements.

Using these new damped motors in a system you can operate at higher gain, with less position or velocity error, less backlash sensitivity, increased stability. They're far superior to damping generators in marginally unstable systems. And compared to viscous damping or rate feedback, permit high slewing speed, consume less

power, generate less heat, require less wiring, and need no warm-up period.

SPECIFICATION SHEETS on the complete line are available now on request. Or, just tell us your problems and we'll do our best to come up with a solution.



Foreign: Daystrom International Div., 100 Empire St., Newark 12, New Jersey. In Canada: Daystrom, Ltd., 840 Caledonia Rd., Toronto 19, Ontario.

DAYSTROM, INCORPORATED
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Acceleration and high shock

testing before trigger time, are critical to the quality control of bomb rack components at Singer-Bridgeport. Today high capability in engineering, precision machining and electro-mechanical assembly make Singer-Bridgeport a prime supplier to the military and sub-contractors.

Test facilities provide the range of equipment needed to check out components and systems to close specifications: acceleration, vibration and shock, temperature, altitude, humidity, salt spray conditions. Military and industrial procurement alike find both quality control and quality production at Singer-Bridgeport.

A comprehensive brochure describing these engineering and production capabilities is available to you on request.



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A DIVISION OF THE SINGER MANUFACTURING COMPANY
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CIRCLE 105 ON READER-SERVICE CARD

NEW PRODUCTS

Pressure Transducer

708

Rated to 5,000 psi



This sub-carrier oscillator pressure transducer, model TP 54, is available in both gage and absolute pressure ranges from 15 to 5,000 psi. A dc supply of 28 v is required. The units are designed for flight telemetering and meet Mil specs. Output voltage is 3 to 5 v across a 10-K load. Linearity is within $\pm 5\%$; temperature range is -65 to $+165$ F.

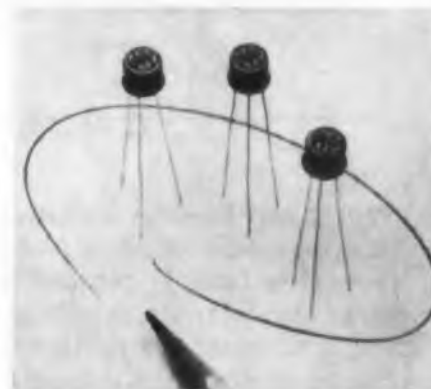
Pace Engineering Co., Dept. ED, 13035 Saticoy St., North Hollywood, Calif.

Price & Availability: Made to order in 30 days; \$485 each in single units.

Silicon Transistors

577

Unijunction type



These silicon unijunction transistors are for solid-state relay, triggering and switching circuits in industrial electronic equipment. Type 2N1671 is for general-purpose use. Type 2N1671A is for use in firing circuits for silicon-controlled rectifiers and other uses where a minimum pulse amplitude is required. Type 2N1671B is for use where a low emitter leakage current and a low trigger current are needed. The units have a maximum intrinsic stand-off ratio of 0.62. Inter-base resistance characteristics at 4.7 to 9.1 K at 25 C. Minimum valley point current is 8 ma.

General Electric Co., Semiconductor Products Div., Dept. ED, Charles Building, Liverpool, N.Y.

Price & Availability: Type 2N1671, \$3.05 (for OEM market); type 2N1671A, \$3.30; type 2N1671B, \$3.60. Delivery is from stock.

Announcing the

BE6

**BAND
ELIMINATION
FILTER**



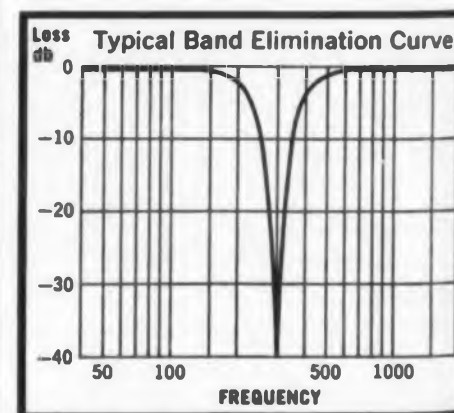
BE6 - \$385.00
Rack Mount Model Illus.

A New Allison Filter With Single Knob Control

The Allison Model BE6 Band Elimination Filter is a passive network filter with a direct reading dial, continuously tunable over full audio frequency range from 20 cps to 20,000 cps. It will transmit all frequencies from DC to more than 100 kcps, except for the reject band to which the filter is tuned.

SPECIFICATIONS

More than 40 db attenuation at one frequency.
Passive network—no power supply.
No vacuum tubes.
Impedance (in and out), 600 ohms.
Reject band less than 1 octave wide.
Loss in pass bands, $\frac{1}{2}$ db.
Single dial control.
Direct reading frequency dial.
Maximum input for minimum distortion, 5 V.
Size of portable units, excluding knobs and handle, 17" long, 5 $\frac{1}{4}$ " deep, 8" high.
Rack models are mounted on 7" rack panel.



Write today for complete literature and prices

**Allison
Laboratories, Inc.**

CIRCLE 106 ON READER-SERVICE CARD

Flexible Epoxy Resins

648

Increased flexibility and toughness of conventional epoxy systems is achieved by blending them with types X-2673.2, X-2673.6 and X-2674 epoxy flexible resins. Properties vary with the concentration of flexible resin and the hardener type. Flexure strength can be increased 25 to 40%; highly flexible systems may show elongation up to 300%.

Dow Chemical Co., Dept. ED, Midland, Mich.

Urethane Wire Enamel

649

Called Carthane 8063, this urethane wire enamel coating is designed to speed the soldering time of magnet wire. Soldering time for No. 29 AWG wire, single-coated with the enamel, is 2 sec at 685 F. Designed for dip application, the material's cut-through temperature is 480 F for No. 38 AWG single wire with a 1000-g load.

The Carwin Co., Dept. ED, North Haven, Conn.

Blower

650

The Powair Series of standard 2-in. diameter blowers have motor speeds up to 22,000 rpm and come in models with 400-cps, 3-phase; 400-cps, single-phase; and 28-v dc motors. Model HP has a no-stall characteristic performance curve with a shutoff pressure of 6 in. of water and a free air delivery of 32 cfm.

The Benson Manufacturing Co., Dean and Benson Research Div., Dept. ED, Kansas City 27, Mo.

Capacitor Standards

651

Type SS-32 kit consists of a set of 32 laboratory standard capacitors ranging from 0.0001 to 0.5 uf. A four-position adapter is available for a combination of standards to obtain exact values. Any capacitance value accurate to four significant figures with a $\pm 0.1\%$ tolerance can be constructed by using four units in conjunction with the adapter.

Arco Electronics, Inc., Dept. ED, 64 White St., New York 13, N. Y.

Printed Circuit Connectors

652

The APC 30-78 series of printed circuit connectors have spring type contacts with AMP 78 solderless taper tab termination. The connectors are molded of glass-filled Diayll Phthalate. They have a method of polarization which does not require the use of contact space. Dual readout termination on 0.156-in. board contact spacing with 1/16-in. boards are provided.

Acor Inc., Dept. ED, 2552 N. Rosemead Blvd., El Monte, Calif.

Not That Big . . .

The crystal discriminators described on page 85 of our August 31 issue and made by The Keystone Electronics Co. have a volume of 1 cu in.—not 1 cu ft, as reported.



*ESC's new miniature
Transponder Delay Line fits
into just 6 cubic inches!*

For modern airborne equipment, where space and weight are critical, ESC has created a new **Miniature Transponder Delay Line**—Model 52-44...which embodies the most advanced techniques of weight and space reduction. It measures just 6 cubic inches total!

Specifications—Model 52-44, Lumped Constant Delay Line:
Impedance—470 ohms
Delay Time—20.3 \pm .1
Rise Time—.6 (max.)
Temperature Coefficient—
65 ppm or better over a temperature range of -55°C to $+125^{\circ}\text{C}$
Attenuation—4 db
Size—1" x 2" x 3"
Weight—6 ounces
Tapped as required



Custom variations available to your exacting specifications.



ESC

WRITE TODAY FOR COMPLETE TECHNICAL DATA.

*exceptional employment opportunities for engineers experienced
in computer components... excellent profit-sharing plan.*

ELECTRONICS CORP. 534 Bergen Boulevard, Palisades Park, New Jersey

Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Step variable delay lines • Shift registers • Video transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

CIRCLE 107 ON READER-SERVICE CARD

NEW PRODUCTS

Rocker-Type Footswitch 446

Rated at 7 amp

Model T-51-D spdt footswitch is rated at 7 amp, 125 to 250 v ac, and has maintained contact action. The T-51-S is an spdt momentary model. The T-52-S has a partial downward stroke which opens or closes one circuit while added pressure actuates a second circuit.

Linemaster Switch Corp., Dept. ED, 432 Woodstock Terr., Woodstock, Conn.

Price: T-51-D, \$3.85; T-51-S, \$2.75; T-52-S, \$4.65.

Availability: From stock.

Radar Transponder 447

For airborne applications

The C/T Mod 2 radar transponder is a transistorized unit for airborne applications. It measures 92.6 cu in. and weighs 5.75 lb. A solid-state modulator is incorporated which has a recovery time of about 160 μ sec.

Aero Geo Astro Corp., Dept. ED, 1200 Duke St., Alexandria, Va.

Molding Powders 448

Glass content is 30% to 35%

Nylafil and Styrafil, fiberglass-reinforced nylon and styrene powders, are available in cylindrical pellets 1/8 in. in diameter and from 1/4 to 1/2 in. long. Nylafil is available in eight standard formulations; Styrafil is available in three standard formulations. Glass content of the powders is 30% to 35%. Special formulations and glass contents can be made to customer specifications.

R. S. Hughes Co., Inc., Dept. ED, 4515 Alger St., Los Angeles 39, Calif.

Price & Availability: Nylafil: In quantities of 20,000 lb and over, price is from \$1.46 to \$1.85 per lb. Styrafil: In quantities of 20,000 lb and over, price is from 49¢ to 72¢ per lb, fob.

No, it's not a transistor.



... it's the new Spectrol ultraminiature trimmer ... the smallest trimming potentiometer on the market! Measuring 1/3" in diameter, weighing only 1 gram, and designed specifically for transistor circuits, the Spectrol Model 80 is a remarkable breakthrough in component technology.

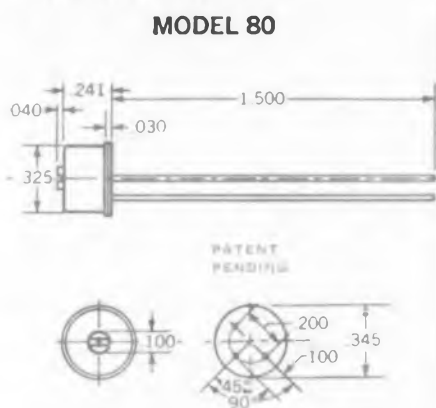
Design engineers can now shrink printed circuit packages in all three dimensions. The single turn adjustment is from the top, rather than the side. It is ideal for printed circuit applications. Sealed construction allows complete package encapsulation.

THE MODEL 80 is approximately one-quarter the size of ordinary trimmers, yet it offers greater resolution and resettability because the resistance element is nearly twice as long. These trimmers meet all applicable military and commercial specifications including the most severe humidity cycling and immersion tests.

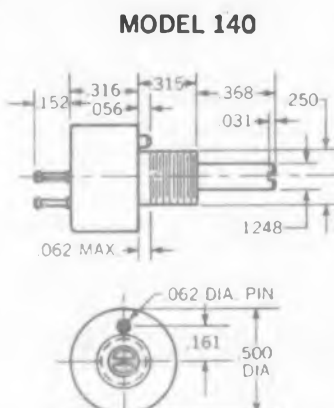
AND TWO NEW MINIATURE POTENTIOMETERS, TOO!

Sturdy construction provides reliable operation at a modest price. Only one-half inch in diameter, the new bantam weight Models 140 and 150 rotary potentiometers are well suited to trimming, control and servo applications where space and environmental conditions are critical. Standard linearity is $\pm 1.0\%$ with $\pm 0.5\%$ available on special order. Servo mount ball bearing type units have standard linearity of $\pm 0.5\%$. Slotted shafts are standard on all models.

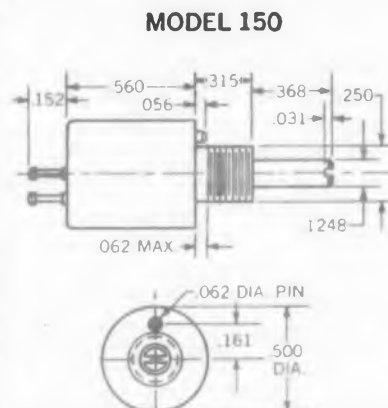
SPECIFICATIONS



DIAMETER: 0.345"
STANDARD RESISTANCES (ohms): 50, 100, 200, 500, 1K, 2K, 5K, 10K
RESISTANCE TOLERANCE: $\pm 5\%$
NO. TURNS: ONE
POWER RATING: 1 watt at 70°C
LINEARITY: $\pm 1.0\%$
NOISE: 100 Ω ENR per NAS-710
SHOCK: 50 G
VIBRATION: 30 G to 2,000 CPS
HUMIDITY: MIL-E-5272C, Proced. I (10 days, cycling) and MIL-STD-202A, Method 104, Condition A (immersion in hot water)
SALT SPRAY: MIL-STD-202A, Method 101A, Condition A (96 hours)
LOAD LIFE: 1000 hours
WEIGHT: 1 Gram
PRICE (1-9 units): \$6.00 each



DIAMETER: 0.500"
STANDARD RESISTANCES (ohms): 50, 100, 200, 500, 1K, 2K, 5K, 10K
RESISTANCE TOLERANCE: $\pm 5\%$
NO. TURNS: ONE
POWER RATING: 2 watts at 70°C
LINEARITY: $\pm 1.0\%$ standard, $\pm 0.5\%$ special ($\pm 0.5\%$ standard on servo mount)
NOISE: 100 Ω ENR per NAS-710
SHOCK: 50 G
VIBRATION: 30 G to 2,000 CPS
HUMIDITY: MIL-E-5272C, Proced. I (10 days, cycling)
SALT SPRAY: MIL-STD-202A, Method 101A, Condition A (96 hours)
LOAD LIFE: 1000 hours
WEIGHT: 0.1 oz.
PRICE (1-9 units): \$10.00 each



DIAMETER: 0.500"
STANDARD RESISTANCES (ohms): 20K, 50K, 70K (50 ohms to 20K also available)
RESISTANCE TOLERANCE: $\pm 5\%$
NO. TURNS: ONE
POWER RATING: 2 watts at 70°C
LINEARITY: $\pm 1.0\%$ standard, $\pm 0.5\%$ special ($\pm 0.5\%$ standard on servo mount)
NOISE: 100 Ω ENR per NAS-710
SHOCK: 50 G
VIBRATION: 30 G to 2,000 CPS
HUMIDITY: MIL-E-5272C, Proced. I (10 days, cycling)
SALT SPRAY: MIL-STD-202A, Method 101A, Condition A (96 hours)
LOAD LIFE: 1000 hours
WEIGHT: 0.15 oz.
PRICE (1-9 units): \$12.00 each

The Spectrol name, your assurance of quality. New Spectrol trimmers and miniature potentiometers are produced to the same exacting standards of quality and reliability engineered into the entire Spectrol potentiometer line...the largest selection in the industry.

Available now for immediate delivery. Standard models of Spectrol trimmers and miniature potentiometers, as well as other standard precision potentiometers, are available from your nearby Spectrol distributor. For complete technical information, contact your Spectrol engineering representative or write directly to the factory. Please address Dept. 36.



ELECTRONICS CORPORATION

1704 South Del Mar Avenue • San Gabriel, California
 Phone: ATLantic 7-9761

Manufacturers of precision and miniature wirewound potentiometers, trimmers, solid state power supplies, servo mechanisms and other precision electronic components.

CIRCLE 108 ON READER-SERVICE CARD

Servo Amplifier

449

Transfer gain is 1000

Model 735D transistorized servo-amplifier drives 400-cps servomotors requiring up to 18 w per phase. The unit is adapted to all data systems, including pot, synchro and summing networks. Transfer gain is 1,000 when the control phase of the mating motor is wound for 57-v, rms. Higher gains can be obtained with an input impedance of 0.5 meg and an external step-up transformer. The unit measures 2-3/4 x 2-1/4 x 5-1/4 in, and operates to 71 C, with an input of 117 v, 400 cps.

Industrial Control Co., Inc., Dept. ED, Central Ave. at Pinelawn, Farmingdale, N.Y.

Price & Availability: \$310; 45 days.

Inertia Switch

451

Has one moving part

Model 6UO-115 inertia switch is preset to respond to acceleration from 1 to 25 g within $\pm 5\%$ tolerance of setting. A steel ball, held against a solid base by a uniform magnetic field, is the only moving part. When the opposing force of acceleration exceeds the magnetic force, the ball moves to close a normally open electrical contact. The switch meets environmental requirements of MIL-E-5272 and has control and limiting applications.

Inertia Switch, Inc., Dept. ED, 311 W. 43rd St., New York 36, N.Y.
 Price & Availability: \$55; 3 to 5 weeks.

Rotary Selector Switch 453

Has 1 to 20 load circuits

From 1 to 20 load circuits are standard in this rotary selector switch. Each load circuit is adjustable through 1 to 12 on-off positions. Each circuit has a 10-amp contact rating. Screw terminals are supplied on all units.

Industrial Timer Corp., Dept. ED, 1407 McCarter Highway, Newark 4, N.J.

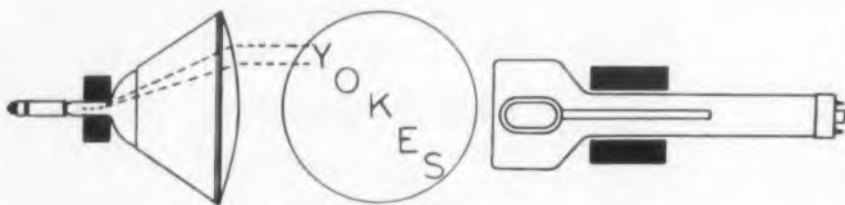
Availability: 6 to 8 weeks.

Specialists in precision displays

Celco

YOKES

Celco YOKES FOR CHARACTER DISPLAYS & HIGH RESOLUTION APPLICATIONS



Deflection yokes for difficult character displays and high resolution problems are another achievement in advanced design and engineering at Celco.

Celco Deflection Yokes permit rapid presentation of random character and alpha numeric displays. Low hysteresis, high accuracy and fast Recovery time with emphasis on spot approach to absolute zero, assures highest performance of magnetic deflection character displays.

Celco High Sensitivity Yokes minimize the deflecting currents required from the deflection drivers, resulting in high efficiency for your system.

For best utilization of the New High Resolution CRT's CELCO YOKES assure minimum defocusing at large deflections.

The construction of our yokes makes it possible to achieve sensitivities, linearities, responses and distortion-free deflecting fields not possible with the usual types of yoke.

Celco FOR STANDARD, COMMERCIAL & MILITARY APPLICATIONS

Single units or production quantities immediately available in wide range of inductance - resistance - Recovery time - pin cushion corrected or optimum focus as required. Also available 2-1/8" and 2-1/2" neck CRT yokes.



TYPE BY

Transistorized encapsulated yokes for 70° 7/8" neck CRT and 1" neck image storage tubes.



TYPE AY

Push-pull or single ended yokes for 52°, 70° and 90° deflections for 1-7/16" neck CRT.



TYPE RY

Rotating deflection yokes for PPI displays. Gears, bearings, slip rings and contact assembly included.



TYPE CF

Electromagnetic focusing coil for 7/8", 1" and 1-7/16" neck CRT.



TYPE MY

Miniature light weight deflection yoke coils or assemblies for incorporation into customer housings.

Celco ENGINEERED YOKES FOR PRECISION DISPLAYS



TYPE DP

Dual purpose yoke custom designed. Deflection system plus axial off-centering coils.



TYPE HS

Special high sensitivity deflection yoke with critical damping provisions.



TYPE PI

Plug in type encapsulated deflection yoke for rapid insertion.



TYPE ER

Encapsulated rotating, 4 axis slip ring precision deflection yoke.



TYPE MS

Miniature deflection yoke for rotating or fixed coil radar system.

Write for CELCO DEFLECTION YOKE Catalogue & Design Sheets or for assistance Call your nearest CELCO Plant listed below.

Celco

Constantine Engineering Laboratories Company

Main Plant: MAHWAH, N. J. DAVIS 7-1123

• Pacific Division - Cucamonga, Calif. - YUKON 2-2688

NEW PRODUCTS

High-Stability Oscillator

455

Meets Mil specs

This oscillator can be used in single side-band communications equipment, missile systems, navigation equipment, telemetering and instrumentations. It meets Mil specs for both airborne and ground equipment and operates at 3 mc. Stability is better than 1×10^{-6} . Other features include rapid warm-up time and low power consumption.

Motorola Inc., Communications and Industrial Electronics Div., Dept. ED, 4501 W. Augusta Blvd., Chicago 51, Ill.

Availability: 8 to 10 weeks.

Drum Commutators 454

Range from 3/4 to 12 in. in OD

These drum commutators range in size from 3/4 to 12 in. in OD. Lengths are 1/2 through 18 in. Line tolerances can be maintained to an accuracy of ± 0.0005 in. Mechanical tolerance of ± 0.001 in. can be achieved.

The Sibley Co., Dept. ED, Had-dam 3, Conn.

Availability: Made to customer specs.

RF Pentodes 457

Transconductances are 13,000 and 15,000 μ mhos

Type EF183/6EH7 rf pentode has a transconductance of 13,000 μ mhos and a plate current of 12 ma. Type EF184/6EJ7 cut-off pentode has a transconductance of 15,000 μ mhos and a plate current of 10 ma. Both units have a plate voltage of 200 v, a heater voltage of 6.3 v, and a heater current of 0.3 amp. The pentodes are for amplifier stages of TV receivers.

International Electronics Corp., Dept. ED, 81 Spring St., New York 12, N.Y.

Price: 65¢.

Availability: From stock.

CIC**PRECISION FILM POTS****AVAILABLE
FROM STOCK!**

You can have any of these precision film pots on their way to you within hours. No need to wait for "custom" pots.

LINEAR SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Linearity
1/2"	1K.....	± .5%
	10K.....	± .5%
	50K.....	± .5%
7/8"	1K.....	± .5%
	10K.....	± .5%
	50K.....	± .5%
	1K.....	± .25%
	50K.....	± .25%
1-3/32"	1K.....	± .5%
	10K.....	± .5%
	50K.....	± .5%
	1K.....	± .25%
	50K.....	± .25%
2"	5K.....	± .25%
	20K.....	± .25%
	50K.....	± .25%
	5K.....	± .1%
	20K.....	± .1%
3"	50K.....	± .1%
	5K.....	± .1%
	20K.....	± .1%
	5K.....	± .05%
	20K.....	± .05%

SINE-COSINE SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Conformity
1-3/32"	10K.....	± .75%
	20K.....	± .75%
2"	10K.....	± .25%
	20K.....	± .25%
3"	10K.....	± .15%
	20K.....	± .15%

LINEAR MOTION FILM POTENTIOMETERS

Size	Resistance	Stroke	Linearity
1" Sq.	10K...	1" Stroke	± .5%
	20K...	1" Stroke	± .5%
	10K...	2" Stroke	± .25%
	20K...	2" Stroke	± .25%
	10K...	3" Stroke	± .1%
	20K...	3" Stroke	± .1%

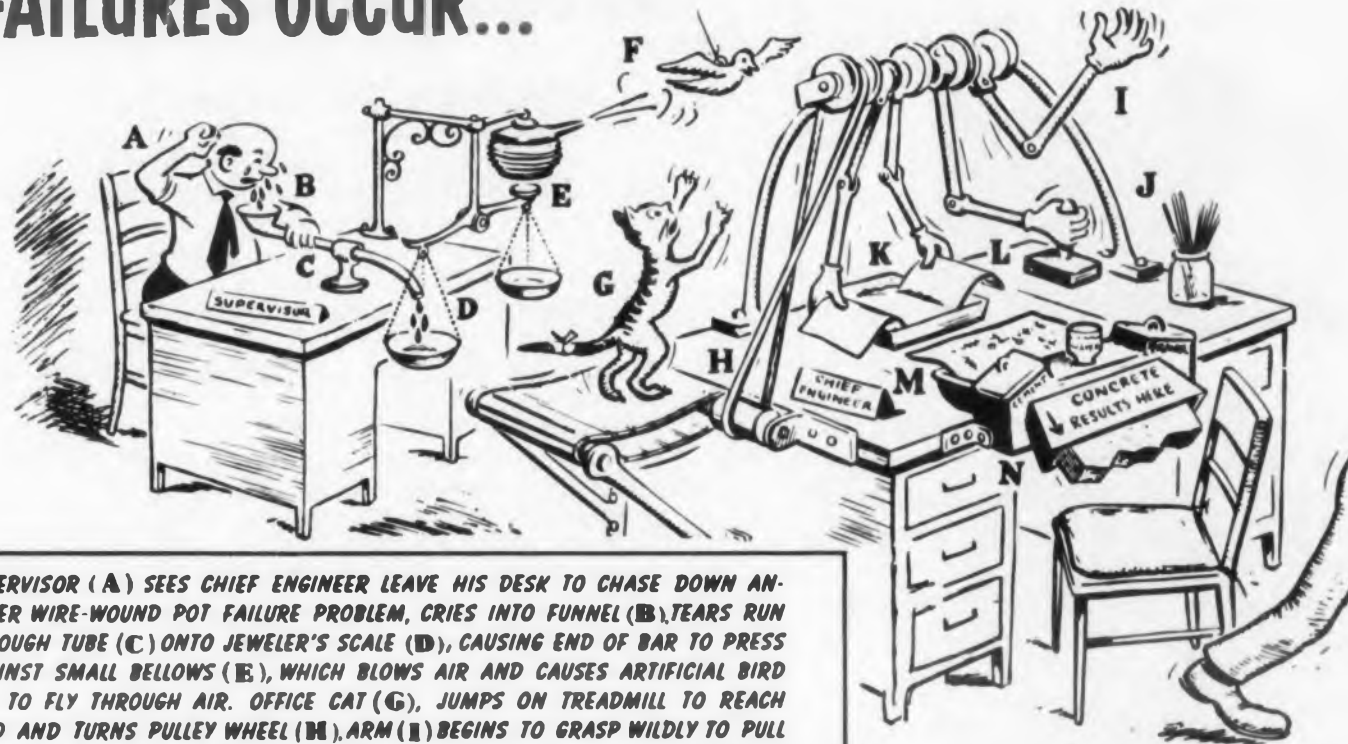
Write or call in your order! Potentiometers will be in your plant within 24 hours.

CIC
COMPUTER INSTRUMENTS CORPORATION

90 MADISON AVE., HEMPSTEAD, L. I., N. Y.

CIRCLE 110 ON READER-SERVICE CARD

HERE'S ONE WAY TO GET WORK DONE WHEN WIRE-WOUND POT FAILURES OCCUR...



SUPERVISOR (A) SEES CHIEF ENGINEER LEAVE HIS DESK TO CHASE DOWN ANOTHER WIRE-WOUND POT FAILURE PROBLEM, CRIES INTO FUNNEL (B), TEARS RUN THROUGH TUBE (C) ONTO JEWELER'S SCALE (D), CAUSING END OF BAR TO PRESS AGAINST SMALL BELLOWS (E), WHICH BLOWS AIR AND CAUSES ARTIFICIAL BIRD (F) TO FLY THROUGH AIR. OFFICE CAT (G), JUMPS ON TREADMILL TO REACH BIRD AND TURNS PULLEY WHEEL (H), ARM (I) BEGINS TO GRASP WILDLY TO PULL IDEAS OUT OF THIN AIR [IN EMERGENCIES, ARM GRASPS AT STRAWS PROVIDED (J)]. ORIGINAL IDEAS DEVELOP FURTHER IN TRAY (K), DESIGN RECEIVES SUPERVISOR'S APPROVAL STAMP (L), PASSES INTO HOPPER (M), MIXES WITH CEMENT, WATER AND GRAVEL, AND EMERGES IN CONCRETE FORM (N). NOTE: MACHINE REACHES EFFICIENCY OF 87.326% IF OFFICE CAT IS KEPT HUNGRY.

Send for full scale reproduction of this unique "circuit machine" drawing.



1/2" to 5" Diameters.

- INHERENT RELIABILITY
- INFINITE RESOLUTION
- PRECISION LINEARITY
- LOW OPERATIONAL NOISE
- MULTI-MILLION CYCLE LIFE
- VIDEO FREQUENCY OPERATION

BUT THE BEST WAY YET...

USE INHERENTLY RELIABLE* C.I.C. FILM POTS—THEY DON'T FAIL!

**GAIN THE TIME TO DEVELOP YOUR OWN CIRCUITS**

*The single, solid broad-band resistance element, along with the multiple finger wiper design, insure continuous high-reliability operation of this unique precision potentiometer, and guarantee that the element cannot "open" even under the worst environmental conditions. Send for our free package of "POT RELIABILITY FACTS."

COMPUTER INSTRUMENTS CORPORATION

92 MADISON AVENUE • HEMPSTEAD, L. I., NEW YORK

CIRCLE 111 ON READER-SERVICE CARD

FIRST IN FILM POTS

CIC

NEW PRODUCTS

Dielectric Tester

For testing insulating liquids

568



Model K35-20C test set is for on the spot testing of insulating oils. It has a continuously variable output of 0 to 35 kv rms at 2 kva and operates from 110 v, 60 cps. Requirements of ASTM and Mil specs are met. The kv meter has a linear scale and measures 4.5 sq in.

Peschel Electronics, Inc., Dept. ED, Towners, Patterson, N. Y.

Price: \$625.

Availability: On short delivery.

Flux Reset Tester

428

For testing magnetic-amplifier cores

This constant-current flux reset tester is designed for testing magnetic-amplifier cores. Principal features are: direct reading in oersteds and kilogauss over a wide range of core sizes, auxiliary scales for reading amperes dc, scale changes which can be automatically switched to preset values for each test, preset path length, compact test jig assembly and convenient operating controls.

Magnetic Metals, Dept. ED, Hayes Ave. at 21st St., Camden 1, N. J.

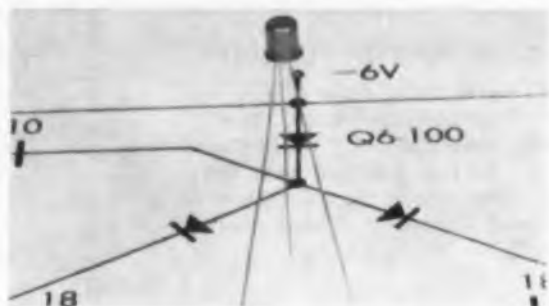
Price: \$10,556.

Availability: 90 days.

Germanium Transistor

432

Has 800 mc gain bandwidth product



Type 2N769 transistor, a micro-alloy diffused base unit, has an 800 mc gain bandwidth product and low emitter and collector diode capacities. The pnp unit is intended for usage in saturated switching circuits at switching rates up to 300

ECONOTAPE crossbar contacts are most efficient for electrical relays

You can now get ideally efficient crossbar contacts for your electrical relays—with as many contacts as you need, where you need them—with positive assurance of full, contact surface. This has been made possible through the development of Makepeace's new ECONOTAPE, a precision-drawn shaped or rectangular contact wire in either solid precious metal or in laminated metal—in your choice of gold, platinum, palladium, silver and their various alloys.

Econotape crossbar contacts are supplied complete, attached to Makepeace blades... attached to blades supplied by you... or Econotape for your own attaching.

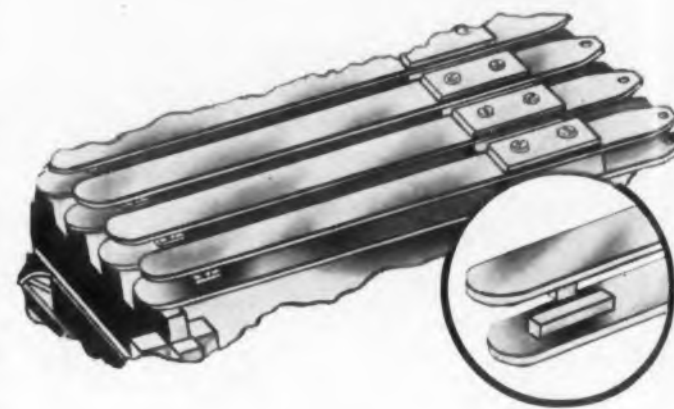
Econotape is cut off and welded to the blade in one operation. It is no longer necessary to handle and attach individual button type contacts. Positioning of Econotape on the blade is done automatically as the tape is cut off and welded. Permanent attachment is assured by a homogenous metallurgical bond that is undisturbed by expansion and contraction caused by temperature changes.

If you are designing a new relay or trying to cut the cost of your present mechanism, send for Econotape literature.

D. E. MAKEPEACE DIVISION • PINE & DUNHAM STREET
ATTLEBORO, MASS.

CIRCLE 246 ON READER-SERVICE CARD

D. E.
MAKEPEACE
DIVISION



fine wire, thin foils, ribbon and tubing in noble metals and their alloys, for all applications.

The unique combination of properties of the noble metals continually recommend them for industrial applications. Our modern melting, wire drawing, rolling and heat treating equipment coupled with long experience in the field is at your service for production of standard and special items. **WIRES:** Bare drawn wire of ductile materials down to .004" —High temperature thermocouple wires—High temperature furnace windings—Potentiometer and Resistance wires—Platinum clad tungsten wire.

FOILS: In platinum, palladium and gold down to .0001"—In iridium and rhodium as thin as .001".

TUBING: Seamless in platinum, palladium, gold and their alloys. Sizes from .018" with .004" wall up to 1½" with .042" wall.

For complete information write for our leaflets, "Fine Wire, Foils, Ribbons" and "Noble Metal Thermocouple Wire".

BAKER PLATINUM DIVISION • 113 ASTOR STREET
NEWARK, N. J.

CIRCLE 247 ON READER-SERVICE CARD

BAKER
PLATINUM
DIVISION



DOMESTIC DIVISIONS: AMERICAN PLATINUM & SILVER DIVISION • AMERSIL QUARTZ DIVISION • BAKER CONTACT DIVISION • BAKER DENTAL DIVISION • BAKER PLATINUM DIVISION • BAKER SETTING DIVISION • CHEMICAL DIVISION • HANOVIA LIQUID GOLD DIVISION • INSTRUMENTS & SYSTEMS DIVISION • IRVINGTON-BAKER REFINING DIVISION • D. E. MAKEPEACE DIVISION • RESEARCH & DEVELOPMENT DIVISION • H. A. WILSON DIVISION. COMPANIES ABROAD: ENGELHARD INDUSTRIES OF CANADA, LTD., TORONTO • ENGELHARD INDUSTRIES LTD., BAKER PLATINUM DIVISION, HANOVIA PRODUCTS DIVISION, LONDON • SOCIEDAD SURAMERICANA DE METALES PRECIOSOS S.A., BO-

PROMPT PRECIOUS METAL SCRAP RECOVERY SERVICE • ENGELHARD PROCEDURES RECOVER

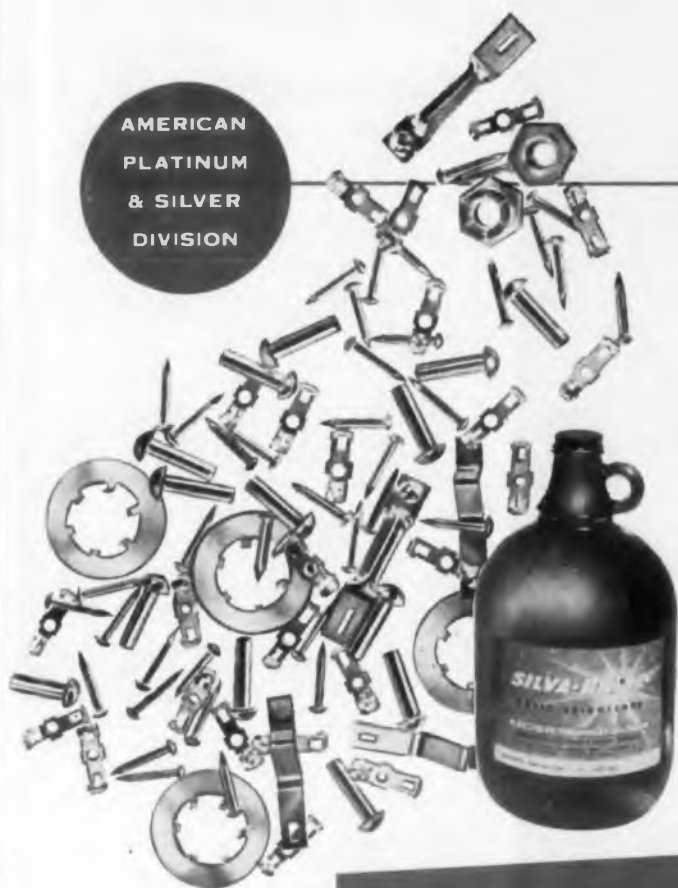
ELECTRONIC DESIGN • November 9, 1960

AMERICAN
PLATINUM
& SILVER
DIVISION

a simplified mirror-bright silver plating process for electrical and electronic components

Here is the most efficient, simple procedure to protect electrical electronic and lamp components with a mirror-bright silver finish—through a complete range from flash to heavy deposit. The procedure is easy, economical and non-critical—with little or no polishing required. Silva-Brite is a clear, water-white solution, enabling the operator to observe work as it is being plated. Uniformly good results are attained with current densities ranging from 10 to 40 amperes per square foot. Normal room temperature operation minimizes fumes and tendency toward bath decomposition. Send for descriptive data together with detailed plating procedures.

AMERICAN PLATINUM & SILVER DIVISION
231 N. J. RAILROAD AVENUE, NEWARK, N. J.
CIRCLE 248 ON READER-SERVICE CARD



ENGELHARD
INDUSTRIES, INC.

EXECUTIVE OFFICES:

113 ASTOR STREET • NEWARK 2, NEW JERSEY

CHEMICAL
DIVISION

for low cost purification and drying of hydrogen and other gases

The Deoxo Catalytic Purifier is combined with an extremely efficient automatically operated drying unit to provide oxygen-free hydrogen that is ideally pure and dry. The combined units are identified as the Deoxo Dual Puridryer. It supplies hydrogen with less than one part oxygen per million—dried to a dew point of -100°F . No inert gas purging is needed. The Deoxo Dual Puridryer can also be used with other gases such as: Nitrogen, Argon, Helium and saturated hydrocarbons, with equally fine performance. Write for descriptive literature.

CHEMICAL DIVISION • 113 ASTOR STREET
NEWARK, N. J.

CIRCLE 249 ON READER-SERVICE CARD



SCA • ENGELHARD INDUSTRIES S.A.R.L., PARIS • ENGELHARD INDUSTRIES A/S, COPENHAGEN • GLOVER & GOODE PTY., LTD., MELBOURNE • ENGELHARD INDUSTRIES, K.K., TOKYO • ENGELHARD INDUSTRIES, PTY., LTD., MELBOURNE • ENGELHARD INDUSTRIES, LTD., ZURICH • INDUSTRIE ENGELHARD S.P.A., ROME • GIULIANO STACCIOLI-METALLI PREZIOSI S.P.A., ROME • INVERSIONES EN INDUSTRIAS NACIONALES, S.A., BOGOTA. ASSOCIATED COMPANIES: KALIE-CHEMIE-ENGELHARD KATALYSATOREN G.M.B.H., HANOVER

1.0% OF ASSAYED PRECIOUS METAL CONTENT • IRVINGTON-BAKER REFINING DIVISION
CIRCLE 246, 247, 248, 249 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

mc. It is housed in a TO-18 case. Some absolute maximum ratings are: storage temperature, 100°C ; V_{cbo} , -2 v ; V_{ces} , -12 v ; V_{ceo} , -7 v ; V_{ebo} , -2 v ; I_c , -100 ma ; dissipation at 25°C , 35 mw .

Philco Corp., Lansdale Div., Dept. ED, Lansdale, Pa.

Price: \$7.45 ea in 1,000 and up production quantities.

Turn-Counting Dial

742

Counts to 999



Model 1330 turn-counting dial, designed for both military and commercial applications, counts from 000 to 999 in 10 turns. Rotation is continuous in standard models. Over-all size is $1\frac{3}{4}$ in. in diameter and $1\frac{3}{4}$ in. in height. Numerals are $\frac{3}{16}$ in. high and are displayed through a lens providing 1.5 magnification.

Amphenol-Borg Electronics Corp., Borg Equipment Div., Dept. ED, 120 S. Main St., Janesville, Wis.

Microwave Components

416

Typical unit weighs about 1 lb

A typical Epsi-line component measures $5\frac{1}{4} \times 3\frac{1}{2} \times \frac{9}{16}$ in. and weighs about 1 lb. Broad-band balanced mixers, from 0.8 to 12.5 kmc, are for applications ranging from microwave instruments to radar telescoping. Average specifications include: input impedance, 50 ohms; input vswr, greater than 2 to 1; isolation, 20 db min; and noise figure, 8 ± 0.5 db. Components include directional couplers and multi-terminal power dividers for uhf and shf applications. All units are hermetically sealed and parts are encapsulated.

Laboratory for Electronics, Inc., Instruments Div., Dept. ED, 1079 Commonwealth Ave., Boston 15, Mass.

Price: \$375 ea.

Availability: 2 to 4 weeks.

TIME AND EMOTION STUDY



A SOURCE OF PRIDE

SPERRY

SPERRY SEMICONDUCTOR
DIVISION

OF
SPERRY RAND CORPORATION
NORWALK, CONNECTICUT

Sure it's late and all you've had was coffee and cigarettes—but now the job is done. The design is a good one—the components reliable—the specs have been met—now it's time to go home and relax. You feel secure knowing the components are equal to your design.

We try our very best to build semiconductor devices that you can "design in" with confidence. Typical case in point: The Sperry IN690 and IN920 series silicon diodes enable a single diode to handle more current at a lower junction temperature than that possible with a combination of several low current diodes* - - - this reduces "multi-component unreliability". - - - 17 separate tests during mechanized manufacture ensure reliability of product performance. You experience a good feeling doing business with quality manufacturers.

*excerpt from Technical Application Bulletin #2105

SEMICONDUCTOR IS OUR MIDDLE NAME . . . SEMICONDUCTOR INTEGRATED NETWORKS (SEMINETS®), TUNNEL DIODES, MESA AND ALLOY SILICON TRANSISTORS AND DIODES. REGIONAL OFFICES: CHICAGO, ILLINOIS; EL SEGUNDO, CALIFORNIA; WESTWOOD, NEW JERSEY; TEWKSBURY, MASSACHUSETTS; STAMFORD, CONNECTICUT; TOWSON, MARYLAND; MASSAPEQUA PARK, NEW YORK.

*Trade Mark, Sperry Rand Corporation

NEW PRODUCTS

Panel-Mounting Blower 503

Provides 415 cfm

Model B-400 panel-mounting blower provides 415 cfm of filtered air. It needs 8-3/4 in. of vertical panel space and has a total depth of 9-1/2 in. Optional control ducts provide hot-spot cooling. Because the unit has dual outlets, it can be used for general and spot cooling simultaneously.

Amco Engineering Co., Dept. ED, 7333 W. Ainslie St., Chicago, Ill.

Price & Availability: \$90; immediate.

Rate of Change Computer 599

Features wide range of applications

Model 0557-1 rate-of-change computer measures temperature changes directly from thermocouples and pressure changes from strain gages or resistance bulbs. The unit accepts dc signals, functions in parallel with other instruments without loading them, and directly drives strip chart recorders. It has no drift.

Magnetic Instruments Company, Dept. ED, Thornwood, N.Y.

Price & Availability: \$950 ea; 4-wk delivery.

Delay Lines 456

Rise time less than 1.5% of time delay

This series of delay lines provides a ratio of rise time to total delay of less than 1.5%. Attenuation is less than 0.1 db per msec delay. Temperature coefficient is less than 0.01% per deg C; saturation level is above 150 v. The units can be used in computers, radar systems, and control devices.

AD-Yu Electronics Lab., Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N.J.

Price: Starts at \$185.

Availability: Two weeks.

◀ CIRCLE 112 ON READER-SERVICE CARD

Tunable X-Band Magnetrons

588

For 220-kw pulse operation

Two tunable X-band magnetrons, types 7008 and 7111, operate as 220-kw pulse oscillators from 8,500 to 9,600 mc. Type 7008 is designed for servo tuning, while type 7111 is hand tuned. Both units employ a coupled-cavity tuning system external to their vane-type resonator systems. They are designed to replace fixed-frequency type 4J50 magnetrons.

Westinghouse Electric Corp.,
Electronic Tube Div., Dept. ED,
P.O. Box 284, Elmira, N.Y.

Price & Availability: Type 7008,
\$1,675; type 7111, \$1,400. *Immediately available in sample quantities.*

Fluid Connectors

589

For cooling equipment

The series 20 miniature fluid connectors are designed for cooling equipment. They are available with 1/4-in. ends, and have an automatic push-pull device for quick connect-disconnect operation. The units withstand pressures up to 5,000 psi and temperatures from -20 to +400 F. Weight is 1 oz.

E. B. Wiggins Oil Tool Co., Inc.,
Dept. ED, 3424 E. Olympic Blvd.,
Los Angeles 23, Calif.

Price & Availability: Nipple, \$5.25;
socket, \$7.50; from stock.

Elapsed-Time Indicator

592

Weighs 1.6 oz

This elapsed-time indicator incorporates a 50-rpm tell-tale disk and integrates 1,000 hr in 0.1-hr increments or 10,000 hr in 1-hr increments. The device weighs 1.6 oz and measures 0.680 in. in diameter. It stands temperatures from -65 to +165 F, and 20-g vibration over a range of 10 to 2,000 cps. The unit is suitable for airborne and missile equipment applications.

Elgin National Watch Co., Elgin
Microelectronics Div., Dept. ED, 366
Huff City Blvd., Elgin, Ill.

201 ROTARY SWITCH TYPES FOR IMMEDIATE OFF-THE-SHELF DELIVERY... FROM DAVEN!

Standard switches, adjustable stop switches, ceramic switches, subminiature Series G switches . . . available for immediate delivery from Daven or your local Daven Distributor.

This solves your problem of obtaining Daven precision rotary tap switches overnight . . . in breadboard, prototype or production quantities.

Write today for complete listings and technical data.



THE **DAVEN** COMPANY, Livingston, New Jersey

General
Mills

SWITCHES

TODAY, MORE THAN EVER, THE DAVEN © STANDS FOR DEPENDABILITY

NEW PRODUCTS

Rotary Switches

468

Handle up to 400 positions

Type RSG-40 and RSG-30 removable-wafer rotary switches handle up to 400 positions, single pole; type RSG-21 up to 100 positions. Types RSG-40 and RSG-30 can be furnished with two poles for 200 positions. Switching is transferred from one wafer to the next by a Geneva gear control unit and a control wafer. Wafers lift out without unsoldering or disassembling.

Chicago Dynamic Industries, Inc., Precision Products Div., Dept. ED, 1725 Diversity Blvd., Chicago 14, Ill.

Availability: Delivery is in 30 to 60 days.

Rate Integrating Gyros

621

For missile applications

The Alpha series is a group of lightweight, floated, rate integrating gyros designed for missile applications. Adjustment features include a mechanical mass unbalance along the spin and input axes, a mechanical fixed torque adjustment and an adjustment for spin axes alignment. Typical characteristics for the M2514-01A model are: angular momentum, 100,000 gm per cm² per sec; operating temperature, 115 to 185 F; drift, vertical, 0.03 deg per hr; drift, azimuth, 0.05 deg per hr; operating life, 1,000 hr; weight, 0.9 lb.

General Precision Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

Oscilloscope

706

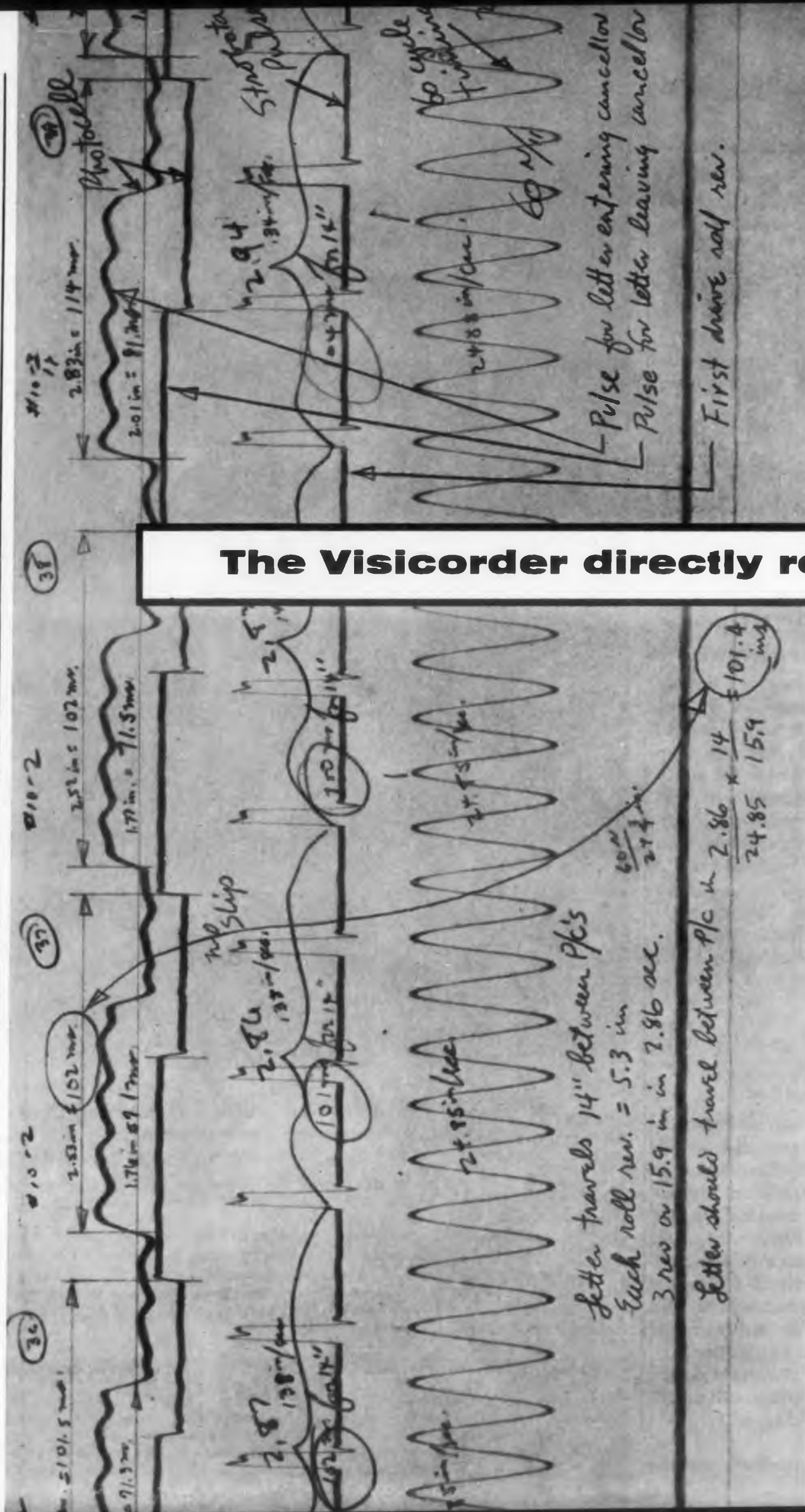
Double-beam type



Model 350C oscilloscope, usable to 10 mc, is flat to 6 mc. Both ac and dc voltages from 50 mv to 600 v can be measured. Rise time is 0.06 μ sec. Sensitivity is 100 mv per cm. Input impedance is 1 meg across 15 pf and sweep range is 1 to 500 msec per cm. The unit measures 9 x 6-3/4 x 13 in. and weighs 20 lb.

Interlab Inc., Dept. ED, 116 Kraft Ave., Bronxville, N.Y.

Price: \$345 fob New York.



The Emerson Research Laboratories at Washington, D.C., directly-recorded this chart on a Honeywell Model 906 Visicorder. The chart shows a canceller test of a number of letters through a new mail-handling machine developed by Emerson for the U.S. Post Office Department.

In this test, the Visicorder took only 3 hours to reveal information that would have taken 3 weeks to get by any other means: what factors were responsible for the changing speeds of letters as they traveled through the machine at the rate of 30,000 letters per hour. Constant letter-travel speeds were necessary in order to register the cancellation mark on the stamp every time.

This Visicorder record revealed that motor speed variations, belt slippage and slippage of the letter in the drive rollers were responsible. A synchronous drive motor, a timing belt drive and a better grade of rubber in the drive rollers were added to solve the problem—at a vast saving in engineering time.



Milton Stovall, Emerson Project Engineer, uses the Visicorder to measure roller bounce caused by various letter thicknesses, and the consistency of letter speed through the new Emerson Automatic Mail Cancelling and Facing Machine.

ds high-speed letter travel



Recent Models of the 906 Visicorder incorporate time lines and grid lines and record up to 14 simultaneous channels of data.



The NEW Model 1108 Visicorder, with many automatic features and the convenience of pushbutton controls, is ideal for intermediate uses requiring up to 24 channels of data.



The Model 1012 Visicorder is the most versatile and convenient oscillograph ever devised for recording as many as 36 channels of data.

The Honeywell Visicorder is the pioneer, completely proven, and unquestioned leader in the field of high-frequency, high-sensitivity, direct-recording ultra-violet oscillography. Here are some of the reasons why Visicorders provide the most accurate analog recordings available: constant flat response and sensitivity of galvanometers; grid-lines simultaneously recorded with traces to guarantee exact reference regardless of possible paper shift or shrinkage; flash-tube timing system for greater accuracy of time lines; superior optics for maximum linearity of traces.

No matter what field you are in . . . research, development, computing, rocketry, product design, control, nucleonics . . . the high-frequency (DC to 5000 cps) Visicorder Oscillograph will save you time and money in data acquisition.

Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: write for Bulletins 1108, 1012, and HC906B

Minneapolis-Honeywell Regulator Co.
Industrial Products Group, Heiland Division
5200 E. Evans Avenue, Denver 22, Colorado

75th
PIONEERING THE FUTURE
YEAR

Honeywell



Industrial Products Group

CIRCLE 114 ON READER-SERVICE CARD

Noise Figure Meter

567

Operates on 25 or 30 mc



Model 344 AR noise-figure meter is designed for direct application to pulse radars with repetition rates of 90 and 500 pps or up to 3,000 pps with special sampling circuitry. The noise source and modulator are separate units.

Hewlett-Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.

Price: About \$1,600.

IF Amplifier

578

Noise figure is 1.75 db



This general-purpose IF amplifier, for radar receivers or instrumentation, has a 60-mc center frequency. Bandwidth is 10 mc, -3 db or 20 mc, -40 db. Gain-control range is 70 db.

Tridea Electronics, Dept. ED, 1020 Mission St., S. Pasadena, Calif.

Price: \$350; job S. Pasadena.

Fixed Inductors

580

Outside diameter is 0.460 in.



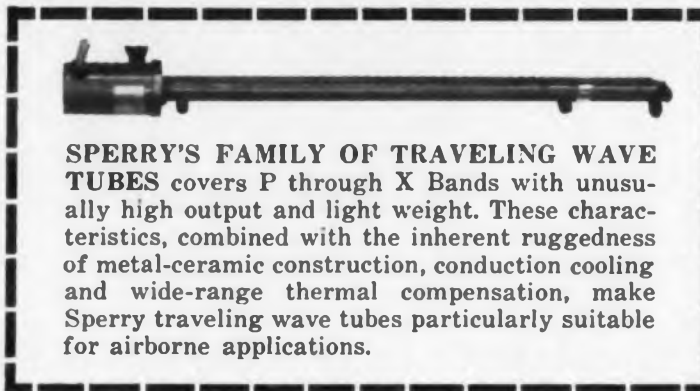
The 26 models of fixed inductors, for mounting on printed-circuit boards, have outside diameters of 0.460 in. Temperature coefficient is less than +20 ppm per deg C. Range of inductance is 0.05 to 2 μ h; Q values range from 120 to 250; temperature range is -55 to +125 C. The units are for applications at frequencies from 10 to 250 mc.

Corning Glass Works, Electronic Components Div., Dept. ED, Bradford, Pa.

TIME means both money and reputation to system builders. To help customers save both, over 10,200 klystron and traveling wave tubes have been shipped ON TIME from Sperry's Gainesville, Florida plant. If prompt tube delivery is vital to your system, call Gainesville, FRanklin 2-0411 collect, for full information about Sperry capabilities.



Gainesville, Florida • A Division of Sperry Rand Corporation



SPERRY'S FAMILY OF TRAVELING WAVE TUBES covers P through X Bands with unusually high output and light weight. These characteristics, combined with the inherent ruggedness of metal-ceramic construction, conduction cooling and wide-range thermal compensation, make Sperry traveling wave tubes particularly suitable for airborne applications.

SPECIFY RAPIDLY AND ACCURATELY WITH SPERRY'S SPECI-FILE



Now you can have Sperry's complete family of klystron and traveling wave tubes right at your fingertips for faster, more accurate tube selection. Attractively packaged and comprehensively indexed, the Sperry Spec-File gives you complete electronic and physical characteristics of every tube in the Sperry line.

TO GET YOUR FREE Spec-File, use this coupon:

Section D-104
SPERRY
ELECTRONIC TUBE DIVISION
 Gainesville, Fla.

Please send me a **FREE** Sperry Spec-File:

Name _____

Title _____

Company _____

Address _____

City _____

State _____

CIRCLE 115 ON READER-SERVICE CARD



GAINESVILLE, FLORIDA
 A Division of Sperry Rand Corporation

◀ CIRCLE 116 ON READER-SERVICE CARD



NEW PRODUCTS

Digital Computing Units

581

Have 100-kc serial operation



The 3-300 series computing units are used in data-processing, instrumentation, and control systems where computations are desired but complex general-purpose computers are not needed. Typical speed of 100-kc serial operation is 8,000 additions per sec and 750 multiplications per sec. The Uni-Bloc units perform on-line digital computations in addition, subtraction, multiplication or division. Power requirements are 115 v \pm 10%, 50 to 60 cps, 100 w. These transistorized units are adaptable to any type of digital system and handle various data codes.

Applied Development Corp., Dept. ED, 12838 Weber Way, Hawthorne, Calif.

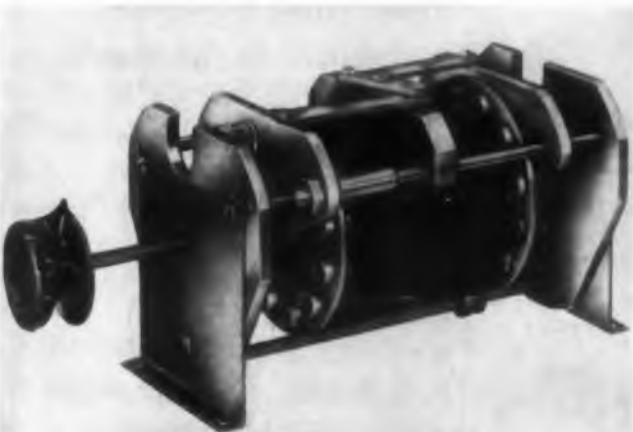
Price: From \$4,550 ea; fob Los Angeles.

Availability: From stock.

Coaxial Attenuators

683

Have dc to 10,000-mc range



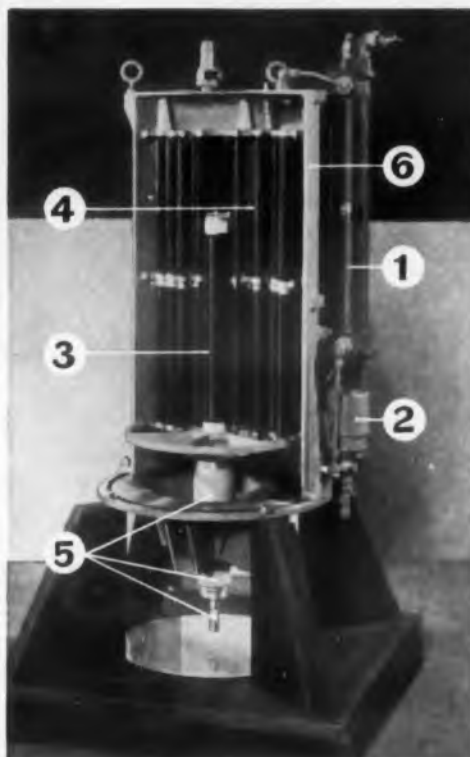
These coaxial attenuators cover the dc to 10,000-mc range and have attenuation values of from 1 to 60 db. Models AT-150 and AT-160 (fixed pad) are available in 56 standard variations; models AT-203 and AT-205 (six step) in 14 versions; and models AT-204 and AT-206 (12-step) in 12 versions. Applications include calibration and broadband attenuation; The units can also be used as isolating pads or laboratory standards. They dissipate continuous power of 1 or 2 w and peak power of 1 or 2 kw.

Empire Devices Products Corp., Dept. ED, Amsterdam, N. Y.

Electronic Products **NEWS**

by **CARBORUNDUM**[®]

Custom-built DUMMY MAGNETRON LOAD inserts in magnetron socket



(1) Heat exchanger (2) Pump — water and ethylene glycol (3) GLOBAR 500 watt resistor to simulate magnetron filament characteristics (4) Varistor load bank to simulate anode characteristics (5) Ceramic-to-metal assembly duplicating magnetron termination (6) "O" ring sealed aluminum cast housing.

CIRCLE 804 ON READER-SERVICE CARD

The dummy magnetron load at left, cut open to show construction, was designed by Hazeltine Corporation engineers and produced by Carborundum's Globar Plant. It is used as a stable termination of known characteristics for evaluating the pulse performance of the Hazeltine AN/APS-95 transmitter modulator, newest Air Force early warning radar development.

The dummy load dissipates 10 kw average power. Peak pulse amplitude is 50/70 kv. Unique features include provision for direct insertion of the load in magnetron socket, use of liquid heat exchanger and inclusion of a proportional viewing resistor.

This load is typical of custom-built devices by Carborundum, utilizing the non-linear characteristics of GLOBAR[®] resistors and varistors. Ceramic-to-metal assemblies and ceramic parts were produced at Carborundum's Latrobe Plant. For information on high power packaged loads to suit your requirements, write Globar Plant, Refractories Div., Dept. EDL-110, Carborundum Co., Niagara Falls, N. Y.

CIRCLE 805 ON READER-SERVICE CARD



Crushable Ceramic Preforms — Swaging tubes for thermocouples

These preforms are used for stringing on thermocouple leads, insertion in seamless stainless steel sheaths and subsequent crushing during swaging to produce densely packed ceramic powder insulation. They are now available in a choice of materials:

Low Boron Content Magnesium Oxide
High Purity Aluminum Oxide (Fused and Calcined)
Stabilized Zirconium Oxide
Low Hafnium Stabilized Zirconium Oxide

Preforms are offered for one, two and four hole applications, with other multiple four up to six hole tubing available on request. Sizes range from .022" O.D. with holes from .005" diam. as standard sizes. Special diameters made to specifications. For complete technical data, write Latrobe Plant, Refractories Div., Dept. EDP-110, Carborundum Company, Latrobe, Pa.

CIRCLE 806 ON READER-SERVICE CARD

CUSTOM-BUILT SEALS AND METAL-BONDED CERAMICS



CIRCLE 804, 805, 806, 807 ON READER-SERVICE CARD

offer advantages for your product

The samples shown at left are typical of the many types produced by Carborundum's Latrobe plant.

#1 is a metal-bonded ceramic-to-metal assembly with an operating range up to 500 C in air and 1080 C in controlled atmosphere. It's highly resistant to thermal and physical shock and can be readily brazed. Used for thermopile lead-throughs, pressure vessels, space capsules, canned nuclear pumps and reactors, heating elements, rectifier housings.

#2 is another example of metal-bonded ceramic with similar properties.

#3 is a silver metallized ceramic part for less severe requirements. Operating range up to 150 C.

#4 Vacuum-tight lightweight glass-to-metal assembly produced with KOVAR[®] matched expansion type glass seals. The glass and metal oxide interfuse to make a true chemical bond. For information, write Latrobe Plant, Refractories Div., Dept. EDS-110, Latrobe, Pa.

CIRCLE 807 ON READER-SERVICE CARD



Model 737A shown with Model 732A Converter Plug-In

- > Measure frequency dc to 220 mc
- > Measure period to 0.1 microsecond
- > Measure time interval 0.1 microsecond to 10^7 seconds
- > Count dc to 10 mc

CMC, first with solid state reliability, announces the transistorized Model 737A frequency-period meter.

Here, combined in one compact package weighing a scant 53 pounds, are the functions of a high speed counter, frequency meter, and period meter. Sensibly priced at \$2400, the Model 737A mates an all solid state counter with a plug-in vacuum tube heterodyne converter.

Only 14" high, 17" wide, and 13" deep, CMC's new Model 737A requires a mere 125 watts of power which in itself reduces operating temperatures and contributes to long trouble-free life. And except for the vacuum tubes, the new unit is unconditionally guaranteed for two years.

**NEW
TECHNICAL
BULLETIN
TELLS ALL**

Your nearby CMC engineering representative will be happy to provide you with full technical, sales, and delivery information and arrange a demonstration at your convenience. For a free copy of our new technical bulletin, please address Dept. 36.

THREE PLUG-INS AVAILABLE
1. 10 mc to 100 mc frequency converter; 2. 100 mc to 220 mc frequency converter; 3. Solid state 0.1 microsecond to 10^7 second time interval section.
Converter plug-ins \$250 each. Time interval plug-in \$300.

FEATURES AND ADVANTAGES * Decade count down time base, frequency divider circuits never need adjustment. * Automatic decimal point. * Nixie readout available as standard option. * Stability, 2 parts in 10^7 standard, 5 parts in 10^8 special. * Accuracy, ± 1 count \pm oscillator stability. * Sensitivity, 0.25 v rms. * Standardize against WWV. * Remote programming without special regard to cable length, type of cable, or impedance matching. * Printer output to drive digital recording equipment, punches, inline readout and other data handling gear, \$80 extra.

CMC **Computer Measurements Co.**
A Division of Pacific Industries
12970 Bradley Avenue, Sylmar, California
Phone: EMpire 7-2161

NEW PRODUCTS

Epoxy and Polyester Resin Stripper 587

Does not damage parts or materials

Tele-Solv is a resin stripper designed to remove epoxy and polyester resins from potted components quickly and without damage to parts or materials. The stripper does not corrode, discolor, or otherwise affect copper, aluminum, ferrous metals, or resin-based enamels. The process can be stopped at any point when complete depotting is not necessary. No special equipment or mixing is needed. The solvent is non-flammable and non-acidic. A related product, Tele-Solv Gel, can be spread on specific components without flowing to unwanted areas.

Telecomputing Corp., Electronic Components Div., Dept. ED, 14706 Arminta St., Van Nuys, Calif.

Price: From \$6.00 to \$7.95 per gallon depending on quantity.

Information Processing Computer 569

Translates English input into machine language

The model GE-225 information processing system uses a General Compiler programing technique which automatically translates English words and symbols into machine language, reducing the need for special training among programing personnel. The machine uses core memory, high-speed computation, low power requirements and the ability to handle a variety of accessories. The computer can add 25,000 five-digit numbers per second.

General Electric Co., Computer Dept., Dept. ED, Deer Valley Park, Phoenix, Ariz.

Price & Availability: The computer, priced in the \$125,000 to \$400,000 range, rents from \$4,000 to \$12,000 monthly. Current delivery is 18 months.

◀ CIRCLE 118 ON READER-SERVICE CARD

Rotary Switch 439

Has from 1 to 25 sections

The type 2300 rotary, multiple, non-shortening switch is designed for panel or base mounting and is furnished in from 1 to 25 sections. Contacts are rated for 15 amp at 125 v ac, and can withstand a 1,200 v surge. Minimum life is 40,000 cycles. Plastic parts are molded from mineral glass alkyd material per MIL-M-14 specifications. MIL-S-21604 specifications are also met.

Standard Electrical Products Co., Dept. ED, 2240 E. Third St., Dayton, Ohio.

Price: \$12.15 to \$66.

Availability: 30 days.

Silicon Rectifiers 443

Handle 750 ma at piv of 1,000 v

These miniature silicon rectifiers are rated at 750 ma at 25 C or 500 ma at 100 C and have piv ratings from 200 to 1,000 v. Designated types DI-52, DI-54, DI-56, DI-58 and DI-510, the units give full output beyond 100 kc, and have the 3-db point at 250 kc. Temperature range is -65 to +150 C. Bodies measure 0.11 in. diam and 0.25 in. long. Units are hermetically sealed.

Diodes, Inc., Dept. ED, 7303 Canoga Ave., Canoga Park, Calif. Price: DI-52, 55¢ to 75¢; DI-54, 65¢ to 90¢; DI-56, 80¢ to \$1; DI-58, \$1.75 to \$2; DI-510, \$2.50 to \$3.

Availability: From stock.

Gangable Wirewound 444 Potentiometers

Wipers can be positioned independently

Series 319 miniature wirewound potentiometers are gangable within a resistance range of 100 to 200,000 ohms. Each wiper can be positioned independently throughout 360 deg to adjust phasing. Units measure 7/8 in. diameter and 1/4 in. long per section. Both servo and panel versions are available.

Daystrom, Inc., Pacific Div., Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.

Availability: 30 days.

4 OUTSTANDING BRIDGES



Type 1650-A Impedance Bridge . . . \$450

For general purpose R/L/C measurements

Ranges: R: 1 mΩ to 10 MΩ
L: 1 μh to 1000 h
C: 1 pf to 1000 μf
D: 0.01 to 50 (at 1kc)
Q: 0.02 to 1000 (at 1kc)

Basic ±1% accuracy
Built-in null detector
Built-in 1-kc oscillator; bridge useful to 20kc with external sources



Type 1632-A Inductance Bridge . . . \$950

For precise measurement of inductance

Full-Scale Ranges: L: 111 μh to 1111 h
(minimum indication is 0.0001 μh)
G: 111 μmhos to 1111 mhos

Basic ±0.1% accuracy. Inductors having nearly equal values can be compared to an accuracy of 1 part in 10⁴.
Designed for 1-kc measurements. Can be used to at least 10kc with slight decrease in accuracy.



Type 1605-A Impedance Comparator . . . \$800

For rapid measurements of impedance and phase angle without manual balancing

Panel meters indicate percent difference in impedance magnitude and phase angle between unknown and external standard

Ranges: Z: 2Ω to 20MΩ
ΔZ: ±0.01% to ±10%
Δθ: ±0.0001 to ±0.1 radian

Accuracy: ±0.01%
Built-in 100c, 1kc, 10kc, and 100kc frequency sources.

Write For Complete Information



Type 1607-A Transfer-Function and Immittance Bridge . . . \$1775

For VHF-UHF measurements of transistors, tubes, networks and components

Frequency Range: 25 to 1500 Mc

Biasing Provisions: Built in for use with external d-c sources. Maximum current, 250 ma; maximum voltage, 400 volts.

Measurement	Range	Accuracy (from 150-1000 Mc)
Voltage and current ratios (R)	0-30	2.5 (1 + √R)% + 0.025
Transimpedance (Z ₂₁)	0-1500 ohms	2.5 (1 + √(Z ₂₁ /50))% + 1.25 ohms
Transadmittance (Y ₂₁)	0-600 mmhos	2.5 (1 + √(Y ₂₁ /20))% + 0.5 mmho
Impedance (Z ₁₁)	0-1000 ohms	2.0 (1 + √(Z ₁₁ /50))% + 1.0 ohm
Admittance (Y ₁₁)	0-400 mmhos	2.0 (1 + √(Y ₁₁ /50))% + 0.4 mmho

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

NEW YORK, WOrth 4-2722
NEW JERSEY, Ridgefield, WHimey 3-3140

CHICAGO
Oak Park
Village 8-9400

PHILADELPHIA
Abington
HAncock 4-7419

WASHINGTON, D.C.
Silver Spring
JUUniper 5-1088

SAN FRANCISCO
Los Altos
WHitecliff 8-8233

LOS ANGELES
Los Angeles
HOLlywood 9-6201

IN CANADA
Toronto
CHerry 6-2171



Tung-Sol transistors handle critical switching in high speed tape transport

Cook Electric's Model 59 Digital Tape Transport embodies the design know-how gathered by Cook during its 12 years of active participation in missile programs which include the Atlas, Polaris and Titan missiles. It was built to fulfill the demands of modern industry for reliable, high-speed data processing and storage equipment. This tape transport is a direct adaptation of the equipment originally developed to provide unattended, 45-day documentation of the Polaris Missile system.

Gratified with the superior performance demonstrated by Tung-Sol switching transistors in the Polaris version, Cook assigned Tung-Sol units to these critical tasks in the industrial model. Tung-Sol's 2N414 germanium high-speed switching transistors serve in the flip-flop and logic circuits. Here's how Cook engineers evaluated the Tung-Sol semiconductors: "Tung-Sol transistors meet our exacting demands for performance and reliability"

There are many reasons for the superlative performance of all Tung-Sol components. Consider just three: Tung-Sol's exclusive concentration on the technology of component manufacture . . . strict adherence to the highest manufacturing standards . . . a quality control network that's unsurpassed.

If your design requires tubes or semiconductors, or both, specify Tung-Sol. There are many Tung-Sol components for virtually every military and industrial requirement ready to perform with full-life reliability. Our applications engineers will be glad to help you select the components that'll do the best job for you. Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193.

Technical assistance is available through the following sales offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. Canada: Toronto, Ont.



 **TUNG-SOL**[®]

NEW PRODUCTS

Conductivity Monitor 527

Completely transistorized

Model 4957 conductivity monitor continuously indicates an electrolytic conductivity measurement. It also produces a dc signal for transmission to a recorder or other data logging equipment. Linear ranges are from 0 to 1 μ mhos per cm to 0 to 5,000 μ mhos per cm. Non-linear ranges are 0 to 10 μ mhos per cm and 0 to 5,000 μ mhos per cm. Additional ranges are available in percent concentration of H₂SO₄ and NaOH.

Leeds and Northrup Co., Dept. ED, 4934 Stenton Ave., Philadelphia, Pa.

Loop Tape Recorder 531

Is small enough to hold in one hand

This continuous loop tape recorder is designed as a high capacity memory system, small enough to hold in one hand and capable of recording 1,200,000 bits of information per minute. The unit can operate in any position and from 0 C to within the thermal limits of today's space vehicles. It can record continuously or intermittently for 1-1/2 hr and unload its data in 5 min via telemetry to ground stations.

Lockheed Missiles and Space Div., Dept. ED, Sunnyvale, Calif.

Disk-File Memory 590

Capacity is nearly 100 million characters

The firm's model II disk file memory system has a capacity of nearly 100 million characters and an access time of 150 msec. Read-record heads, designed on airfoil principles, maintain an air boundary between themselves and the disks. Two pairs of heads operate in conjunction with each 31-in. recording disk. The instrument measures 84 x 60 x 32 in., weighs about 3,000 lb, and consumes 7 kw.

Telex, Inc., Dept. ED, 1633 Eustis St., St. Paul 1, Minn.

◀ CIRCLE 120 ON READER-SERVICE CARD
CIRCLE 121 FOR ALLIED RADIO ▶
CIRCLE 122 FOR POTTER & BROMFIELD ▶



appearances are not deceiving

THIS P&B 10-AMP RELAY IS AS RELIABLE AS IT LOOKS

Our AB relay looks rugged... and it is. You can specify it for 10 amp switching and confidently expect 100,000 cycles. Yet it is compact, easily mounted, and does not require special handling. Installation is simple, using your preference of screw terminals (adapters), quick connects, or dip soldering.

Designers specify the AB for air conditioners and other products where dependable, continual service is paramount.

These standard AB and ABC relays are listed by Underwriters' Laboratories and Canadian Standards Association:

Type	Arrangements	Type	Arrangements
AB7AY	DPST-NO	ABC7AY	DPST-NO
ABBAY	DPST-NC	ABC8AY	DPST-NC
AB11AY	DPDT	ABC11AY	DPDT

Coil voltages: 6, 12, 24, 115 and 230 volts AC, 50/60 cycle.
Contact rating 10 amps, 115 volts AC or 5 amps, 230 volts AC noninductive.

U/L File E-29244

CSA No. 15734

Write for complete data or contact your nearest P&B sales engineer.

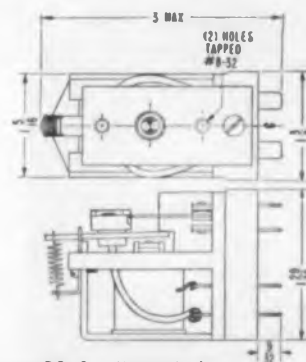
AB AND ABC RELAYS ENGINEERING DATA

GENERAL:
Insulation Resistance: 100 megohms minimum.
Life: 3 million cycles (mechanical).
Breakdown Voltage: 1500 volts rms between all elements and ground.
Temperature Range: DC: -55 to +45°C.
AC: -55 to +45°C.

Weight: AB—5 ozs. ABC—7 ozs.
Terminals: Fit 1/4" quick-connect terminals, or may be applied to printed circuits using dip soldering. Screw adapters furnished on request.
Enclosure: ABC: Heavy duty dust cover.
Dimensions: 1 3/16" x 2 3/32" x 2 3/32".

CONTACTS:
Arrangements: DPDT
Material: 1/4" dia. silver. Other materials available.
Load: 5 amps at 230 volts AC or 10 amps at 115 volts AC noninductive.
10 amps at 28 volts DC.

COIL:
Voltage: DC: 6 to 110 volts.
AC: 6 to 230 volts.



Power: DC: 2 watts nominal.
AC: 6.4 volt-amps.
Resistance: 35,000 ohms max.
Duty: Continuous: DC coils will withstand 6 watts at +25°C.

MOUNTINGS:
AB: Two 8-32 tapped holes on 1 1/4" centers.
ABC: One 8-32 stud 1/4" long and locating tab.

P & B STANDARD RELAYS

ARE AVAILABLE AT YOUR LOCAL
ELECTRONIC PARTS DISTRIBUTOR



POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA
IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

ONE ORDER TO
ALLIED
FILLS THE
WHOLE BILL

Make **ALLIED**
Your Headquarters For
P&B RELAYS

O.E.M.
PRICES
to **499**

We stock the complete POTTER & BRUMFIELD line—in depth.

Your orders are always filled accurately—and shipped immediately.

FREE 576-page Allied catalog—includes detailed listings of POTTER & BRUMFIELD relays.

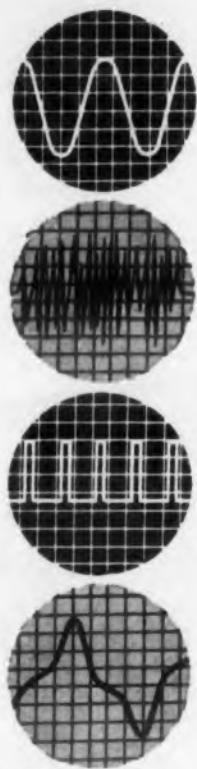


SAME-DAY SHIPMENT
... on ALL your
ELECTRONIC NEEDS
(next-day delivery by
air where required)

ALLIED RADIO CORP.

100 N. WESTERN AVE.
CHICAGO 80, ILLINOIS
HAYmarket 1-6800 TWX: CG-2898

POTTER & BRUMFIELD
Princeton, Indiana



TRUE RMS

frequency range 5 to 500,000 cps

FEATURES

Built-in calibrator . . . easy-to-read 5 inch log meter . . . immunity to severe overload . . . useful auxiliary functions

SPECIFICATIONS

VOLTAGE RANGE: 100 microvolts to 320 volts

DECIBEL RANGE: -80 dbv to +50 dbv

FREQUENCY RANGE: 5 to 500,000 cycles per second

ACCURACY: 3% from 15 cps to 150KC; 5% elsewhere. Figures apply to all meter readings

MAXIMUM CREST FACTORS: 5 at full scale; 15 at bottom scale

CALIBRATOR STABILITY: 0.5% for line variation 105-125 volts

INPUT IMPEDANCE: 10 MΩ and 25 μf, below 10 millivolts; 10 MΩ and 8 μf above 10 millivolts

POWER SUPPLY: 105-125 volts; 50-420 cps, 75 watt. Provision for 210-250 volt operation

measures
from

100 MICROVOLTS to 320 VOLTS

regardless
of
waveform

DIMENSIONS: (Portable Model) 14³/₈" wide, 10¹/₈" high, 12³/₈" deep—Relay Rack Model is available

WEIGHT: 21 lbs., approximately

Write for catalog for complete information

BALLANTINE VOLTMETER Model 320

Price:
\$445.



— Since 1932 —

B BALLANTINE LABORATORIES INC.
Boonton, New Jersey

CHECK WITH BALLANTINE FIRST FOR LABORATORY AC VACUUM TUBE VOLTMETERS. REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY, OR WAVEFORM. WE HAVE A LARGE LINE, WITH ADDITIONS EACH YEAR. ALSO AC/DC AND DC/AC INVERTERS, CALIBRATORS, CALIBRATED WIDE BAND AF AMPLIFIER, DIRECT-READING CAPACITANCE METER, OTHER ACCESSORIES.

CIRCLE 123 ON READER-SERVICE CARD

NEW PRODUCTS

Frequency Monitors

473

Accuracy is 0.01%

Series 4000 frequency monitors indicate the frequency of a 400-cps source with an accuracy of 0.01%. The units have 50-μa meter movements and anti-parallax mirror scales. The indicating meters have three calibrations: 375 to 425 cps, 395 to 405 cps, and 399 to 401 cps. Units will drive recorders having an impedance of about 500 K.

Airpax Electronics, Inc., Seminole Div., Dept. ED, Fort Lauderdale, Fla.

Price & Availability: \$895 ea in quantities of one to three; 4- to 6-week delivery.

Geared Servo Motor

628

For industrial or military use

The M336-002 geared servo motor is designed for both military and industrial use. Centered-shaft gear-heads can be provided in 28 ratios ranging from 7.62:1 to 1254:1 and eccentric-shaft gear-heads in 25 ratios ranging from 7.62:1 to 903:1. Shafts may be plain, pinion or of special design. Characteristics are: no load speed, from 4.7 to 773 rpm; minimum stall torque, from 1.8 to 20 in.-oz; backlash, from 30 to 45 min max; weight, 2 oz approximately.

General Precision Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

Low-Level Magnetic Amplifier

705

Power gain is 3,000,000



The model F1 low-level magnetic amplifier has a power gain of 3,000,000 and requires no preamplification. The unit has a control-winding sensitivity of 3 μa at 1 K, and a minimum control-winding power of 0.01 μw. Power output is 1 w. The devices occupy less than 1 cu in. when powered by 2-kc or higher sources.

Polyphase Instrument Co., Dept. ED, Bridgeport, Pa.

Price & Availability: \$150 each; delivery from stock.

FULL SCALE BALANCE IN

1/4 second!



WITH L&N's HIGH SPEED SPEEDOMAX® RECORDER

Need to follow extremely fast-changing d-c millivolt signals . . . get detailed records for test analysis? Then you'll want this Speedomax instrument, widely-used for rocket testing, radiation monitoring of nuclear reactors, and other data-gathering applications.

The pen speeds across the 9¹/₂" chart and balances in 0.25 second or less without overshoot. Even when loaded with an alarm contact, a retransmitting slidewire and a digital encoder, it balances in 0.4 sec. or less.

LIST NO.—69801-C4-E2-F7-N3-P28-742
SPEEDOMAX G RECORDER, normally available for delivery from stock.

Record—Single-point continuous line.

Measuring Circuit—D-c potentiometer.

Electrical Range—0 to 10 mv.

Accuracy Rating—±0.3% of range.

Dead Band—0.15% of range.

Span Step Response Time Rating—With unloaded slidewire shaft, 0.25 sec.; with loaded shaft, 0.4 sec. or less.

Chart Speed—¹/₂" per second, exact. Chart and balancing motor switching provided.

Chart Number—742, 100 uniform div. in 9¹/₂" with ³/₁₆" overtravel at each end.

Standardization—Semi-automatic.

Power Supply—Operates on 120v, 60-

Price—\$1186.00 f.o.b. Phila. or North Wales, Pa. (subject to change without notice). Use List No. 69801-E2-N3-P28-742 when ordering from L&N, 4908 Stenton Ave., Phila. 44, Pa.

LEEDS **NORTHROP**
Instruments Automatic Controls • Furnace

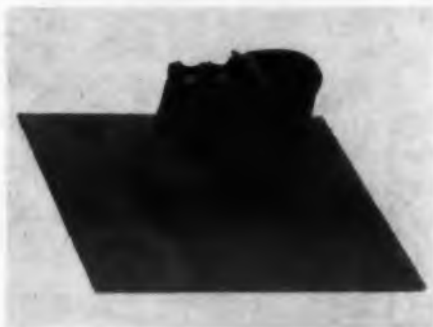
CIRCLE 124 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

Miniature Relay

571

For 100,000,000 operations



Series 550 relays are made in plug-in types with special rectangular sockets, printed-circuit types, and models for use with ac, using built-in full-wave rectifications. Coils are available for voltages from 1 to 125 v. Contact ratings are up to 5 amp for switching resistive loads of 150 w. max. With two form C contacts, dimensions are 3/4 x 1-7/32 x 1-9/64 in. and sensitivity is 85 mw.

Caine Electronic Sales Co., Dept. ED, 4120 W. Lawrence Ave., Chicago 30, Ill.

Price: \$1.45 or \$1.65 in lots of 5,000.

Availability: From stock to three or four weeks.

Octal Bases

582

Molded-wafer type



The type 10A8-0, 8-pin octal bases have a temperature range of -55 to $+85$ C. The molded-wafer type units are for relays, power supplies, radio tubes, crystal ovens, transistorized packages and molded components. The pin has an 0.053-in. diameter hole which permits insertion of a wire that handles up to 10 amp. The bases adapt themselves to automated staking or molding processes.

Clairtron, Dept. ED, Box 171, Orange, N. J.
Price: 4¢ to 9¢ ea.

Static DC Power Supply

627

For general instrumentation

Model 3078 static dc power supply converts 60-cps, 115-v ac to 28-v dc power. It is designed for use in missile checkout systems and for general instrumentation. Specifications are: input, 115 v ac single phase; output, 28 v dc $\pm 5\%$, current variable 0.6 to 2 amp, ripple 1% rms max; life, 2,000 hr min; duty cycle, continuous.

Varo Manufacturing Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

THOMAS A.

EDISON

**Servo Motor-Generators
are designed specifically
for your systems
applications**



Edison Servo Motor-Generators are available with any type or size gear head or gear train.

Unlike ordinary "off-the-shelf" components, Edison Servo Motor-Generators are designed specifically to operate as part of an electro-mechanical system.

For example, their motor sections are built to have minimum time constants and reversing times. To insure precise coupling with mating gear trains, output pinions are fabricated to *better than AGMA standards*. Damping constants, from unit to unit, are held to very close tolerances.

In addition to these special system features, Edison Servo Motor-Generators are made to the highest

quality standards. They outperform MIL-S-17087 (for motors) and MIL-S-17806 (for generators).

Edison engineers provide you with the exact servo motor-generator your system calls for—not a cataloged component that will only approximate your needs. For this reason, they will work closely with you in developing components that will assure you of the best system performance.

For additional information on Edison Servo Motors, Motor-Generators and other rotary components, write for Catalog 3044.

Thomas A. Edison Industries
INSTRUMENT DIVISION

55 LAKESIDE AVENUE, WEST ORANGE, N. J.

CIRCLE 125 ON READER-SERVICE CARD



do you tremble at the sign of a sine?

Does a sine-cosine pot in your pet project mean special prices and annoying delay? No need to pay more . . . no need to wait. Ace has a *full* line of sine-cosine function pots — in sizes, conformities and driving resistances to meet all your requirements — and delivery is prompt. Our *standard* line — which meets 95% of your needs — we can ship promptly . . . AND a special one goes off to you with minimum delay! Ace offers, as standards, conformities in a 7/8" or 1-1/16" size that you'd pay for as a *special* in a 2" size elsewhere! Consider the space, weight and money you save!

Ace's standard sine-cosine line includes sizes from 3/4" to 3", driving resistances from 1K to 1 megohm, in comparable conformities from 0.5% peak to peak. So if you think you have a special requirement — talk to us! Chances are it's an Ace *standard* sine-cosine pot!

This 3/4" sine-cosine ACEPOT® features conformity of 1.0%, peak to peak, in a resistance range of 1K to 30K. Other driving resistance ranges and conformities available.

ACE ELECTRONICS ASSOCIATES, INC.
99 Dover Street, Somerville 44, Mass.
SOMerset 6-5130 TAx SMVL 181 West. Union WUX

Acepot® Acetrim* Acesol® Aceohm® *Reg. Appl. for
CIRCLE 126 ON READER-SERVICE CARD

NEW PRODUCTS

Adhesive

487

Rubber-to-metal

Type 820 rubber-to-metal adhesive needs no heat or pressure for curing. It may be applied to bare metal or applied after the metal is coated with type 338 epoxy solution. Tensile strength is high.

Plastic Associates, Dept. ED, 2900 S. Coast Blvd., Laguna Beach, Calif.

Price & Availability: \$3.50 per lb; immediate.

Preamplifier

565

Has 3-db bandwidth from 10 cps to 80 kc



Type A102 miniature preamplifier can be plugged into a laboratory instrument or an electronic device. It increases the sensitivity of the instrument 100 times. For a gain of 10,000, two units can be connected in tandem. The noise level is less than 3 μ v with an input source impedance of 10,000 ohms. Specifications are: 3-db bandwidth from 10 cps to 80 kc; distortion of less than 0.5%, and maximum output of 2.5 v rms with a 100-K load or 1.25 v rms with a 5,000-ohm load. Application is 40 \pm 1 db at 1,000 cps.

AD-YU Electronics Lab., Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N.J.

Price & Availability: \$69; two weeks.

PNP Alloy Junction Transistor 626

For medium frequency applications

This series of germanium alloy junction transistors is designed for medium frequency applications in industrial and military computers. The units, types 2N395, 2N396, 2N396A, 2N397, have a maximum base to collector voltage of 30 v, a maximum current of 200 ma, and a maximum storage temperature of 100 C. Their 500-mw peak maximum dissipation is defined by a maximum of 50- μ sec pulse width at a 20% duty cycle.

Sylvania Electric Products Inc., Semiconductor Div., Dept. ED, 730 Third Ave., New York 17, N.Y.



64-IN-1 ELECTROMETER

You can measure dc voltage, current, and resistance over 64 ranges with the Keithley 610A Electrometer. Some examples of its extreme versatility are voltage measurements of piezo-electric crystals and charged capacitors; currents in ion chambers, photocells, and semi-conductors; and resistance measurements of insulation.

The input resistance of the 610A can be selected from one ohm to over 10¹⁴ ohms; it checks its own resistance standards and is a stable dc preamplifier. Brief specifications are:

- 9 voltage ranges from 0.01 to 100 v full scale, 2% accuracy all ranges.
- current ranges from 3 amperes to 1 x 10⁻¹² ampere full scale with 2 ranges per decade.
- resistance ranges from 10 ohms to 10¹⁴ ohms full scale on linear scales.
- gains to 1000 as a preamplifier, dc to 500 cps bandwidth, 10 volts and one milliamper outputs.
- accessory probes and test shield facilitate measurements and extend upper voltage range to 30 kv.
- price, \$480.00.

Write for complete details



**KEITHLEY
INSTRUMENTS**

12415 EUCLID AVENUE
CLEVELAND 6, OHIO
CIRCLE 127 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

Static Contactors 522

Available in four models

These static contactors are available in spst, dpst, 3pst and 4pst models with output of 10 amp at 115 v ac and input of 28 v, 125 ma. Input values can be as low as 40 mw. Temperature range is from -54 C to +100 C. Utilization of silicon controlled rectifier circuitry permits performance of high speed transfer functions while maintaining reliability in severe environments.

Electronic Specialty Co., Dept. ED, 5121 San Fernando Road, Los Angeles 39, Calif.

Ultra-High Resistance 528 Bridge

Measures from 1 K to 110 million megohms

Computer grade one-megohm resistors can be selected to a tolerance of 0.05% with this ultra-high resistance bridge. The bridge is capable of measurements from 1 K to 110 million meg. Inherent accuracy is 0.08% at 10^9 ohms and 0.2% at 10^{13} ohms. Unskilled personnel can sort resistors within blocks of 0.025% within seconds according to the manufacturer.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

High Speed Centrifuge Rotors 535

For electronic reliability tests

These centrifuge rotors have cavities cut in them to conform to the exact contours of the components to be tested. Designed for the reliability testing of electronic components such as diodes, transistors and capacitors, the cavities can be shaped to accommodate almost all semiconductor components. Relative centrifugal forces of 10,000 to 25,000 times gravity can be obtained.

Lourdes Instrument Corp., Dept. ED, 53rd St. and First Ave., Brooklyn 32, N.Y.



We Can Make Precision Ceramic-to-Metal Assemblies for Your Stock or Special Requirements

On your right is a specialized ceramic-to-metal assembly that we make in small quantity. This vacuum tight assembly includes several thicknesses of metal, two sizes of ceramic envelopes, brazed together with close dimensional tolerances.

On your left are some of our stock terminal insulators. They are made in large runs for economical, off-the-shelf delivery. We also have customers who require large runs of ceramic-to-metal assemblies to meet their own production demands.

Coors furnishes either metalized ceramic parts ready for brazing by the customer, or complete ceramic-to-metal assemblies in sizes up to 10" OD by 12" length. High temperature subsequent brazes can be made up to 1500° F. Braze bond strengths are from 9,000 to 12,000 PSI. Coors offers a variety of alumina or beryllia ceramic materials for use in your metalized assemblies.

If you need ceramic-to-metal assemblies, in quantity or prototype, get in touch with us here in

Golden, contact the Coors regional sales manager nearest you, or write for new bulletin.

REGIONAL SALES MANAGERS

West Coast.....	William S. Smith, Jr. EM 6-8129 - Redwood City, Calif.
Midwest.....	John E. Marozek FR 2-7100 - Chicago, Ill.
Central.....	Donald Dobbins GL 4-9638 - Canton, Ohio
East Coast.....	John J. McManus MA 7-3996 - Manhasset, N. Y.
New England.....	Warren G. McDonald FR 4-0663 - Schenectady, N. Y.
Southwest.....	Kenneth R. Lundy DA 7-5716 - Dallas, Texas
Southwest.....	William H. Ramsey UN 4-6369 - Houston, Texas

Coors

Alumina Ceramics

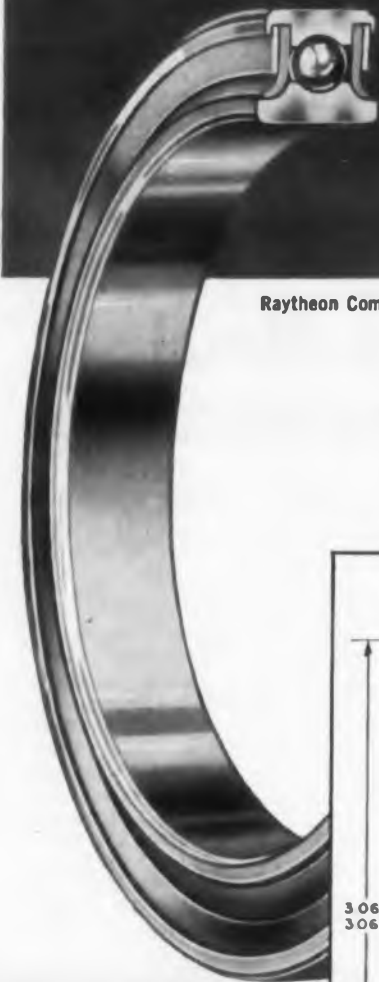
COORS PORCELAIN COMPANY - 900 NINTH STREET, GOLDEN, COLORADO

CIRCLE 128 ON READER-SERVICE CARD >

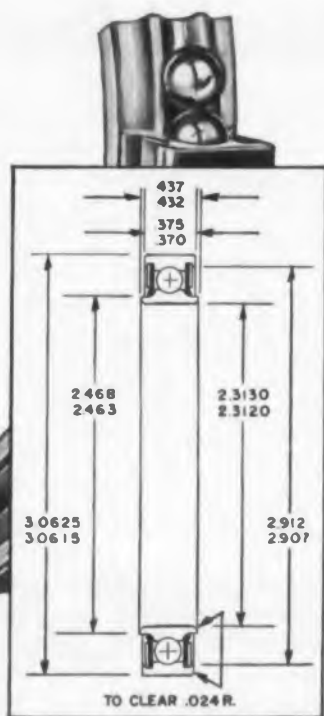
SPARROW III "flies home" on FAFNIR BALL BEARINGS!



Raytheon Company's Sparrow III air-to-air radar homing missile, fired from Navy Interceptor, can track and destroy target on its own.



FAFNIR KP-B TORQUE TUBE TYPE BALL BEARINGS
Used as pivot supports and seals for wings of Sparrow III missile.



Fafnir Torque Tube Type Ball Bearings less than 1/2" thick and weighing only 4 ounces each, support the wing pivots in Raytheon's Sparrow III missile.

To carry loads imposed by wing operation at Mach 2+, each of these Fafnir bearings is fitted with its maximum complement of 45 balls. The bearings also have tight, integral seals of extra-thick Buna N material to withstand the pressures of supersonic flight. These seals provide positive protection against atmospheric contaminants and loss of factory-packed bearing lubricant.

Fafnir's experience with bearings for missiles, jet engines, and aircraft controls and accessories is unmatched in the industry. Take advantage of it. Look to Fafnir for a *sure* approach to your bearing requirements. Write The Fafnir Bearing Company, New Britain, Conn.



FAFNIR
BALL BEARINGS

CIRCLE 129 ON READER-SERVICE CARD

NEW PRODUCTS

Microminiature Relay

423

For use on printed-circuit boards



Called the Pillbox, this relay is made for use where high-density packaging is required, particularly on printed-circuit boards. The header has been rotated 90 deg so that the relay terminals project from the side of the relay rather than from the end as in other crystal-case relays.

Filtors, Inc., Dept. ED, Port Washington, N.Y.
Availability: From stock.

Recording System

471

Helix-type

Model 305 helix-type recording system consists of a flying-spot helix recorder and four synchronous helix drive assemblies. These drive assemblies provide a dynamic recording speed range of 60 to 1,800 rpm, corresponding to a helix sweep range of 1 to 1/30 sec. Four paper feed drives provide a corresponding paper feed rate range of 0.6 to 18 in. per min for a resolution of 100 lines per in. The system provides graphic recordings in a variety of applications such as the recording of radar returns, spectrum analysis, and transducer monitoring.

Alden Electronic & Impulse Recording Equipment Co., Inc., Dept. ED, Westboro, Mass.
Price: \$3,968 fob Brockton, Mass.

Strain Gage

611

Rated at 120 ohm

The Series SS-E-6 strain gage is a weldable, folded-filament, 120-ohm unit 1-5/32 in. long. It can be used in temperatures up to 800 F for static strains and to 1,600 F for dynamic strains. The SS-E-6A unit is temperature-compensated for specific material; SS-E-6B, in a set, is matched to a temperature-compensating gage; SS-E-6C is uncompensated.

Micro-Test, Inc., Dept. ED, 1718 21st St., Santa Monica, Calif.

Availability: All immediately available.

CIRCLE 130 ON READER-SERVICE CARD

Coaxial Cable Connector 631

The series TPS coaxial cable connectors are designed to replace the series BNC connectors on type RG 58 C/U cable. The series TPS connectors are about 1/3 the size of the series BNC devices. The units have a three-pin lock.

Dage Electric Co., Inc., Dept. ED, 67 N. Second St., Beech Grove, Ind.

Chassis Slides 632

Dial-Lock chassis slides can be locked in horizontal position, or 45 or 90 deg below horizontal. They mount 17-in. chassis into a 17 3/4-in. cabinet opening. The slides are rated to carry over 200 lb in extended position.

Electro-Rack, Inc., Dept. ED, 11505 Jefferson Blvd., Culver City, Calif.

Stainless-Steel Wire Strands 633

Silver-plated stainless-steel strands are intended as reinforcing members in stranded conductors. The strands have high tensile strength, and are readily solderable.

Hudson Wire Co., Ossining Div., Dept. ED, Ossining, N. Y.

Sub-Miniature Lamps 634

These lamps, as small as 1/2 in. over-all, are rated from 1.4 to 28 v. They are designed for application in aircraft equipment.

Hudson Lamp Co., Dept. ED, 528 Elm St., Kearny, N. J.

Die-Cast Taper-Pin Receptacles 635

These die-cast taper pin receptacles are insert-molded into plastic terminal boards. Pins can be inserted from either side. Receptacles are cast in groups of four double receptacles; groups can be broken apart when other combinations are desired.

Gries Reproducer Corp., Dept. ED, 400 Beechwood Ave., New Rochelle, N. Y.

Exterior-Mount Lights 636

Designed for exterior mounting on instrument panels, control panels, and dash boards, these lights, called Tab Mount lights, provide non-glare illumination. Glare is controlled by adjustment of prisms. Units are about 3.4 in. long, and operate on 6, 14, or 28 v.

Clar-Ban Corp., Dept. ED, 3807 Harlem Road, Buffalo 15, N. Y.

Polishing Cloth 637

This polishing cloth will produce finishes required for fabricating mesa and planar semiconductor devices, moletronic circuits, epitaxial crystals, and precision infrared optics. Adhesives-backed polishing disks are available.

Geoscience Instruments Corp., Dept. ED, 425 Park Ave., New York 22, N. Y.

← CIRCLE 130 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

Riddle:

What has all
the gold or silver
it needs but
doesn't have a nickel
to its name?

GIVE UP? The answer is General Electric's gold or silver-plated tungsten or molybdenum wire.

There's no alloying action between the plated metal and a nickel undercoat because—quite simply—no nickel exists anywhere in General Electric's plated wire.

It's strictly gold or silver on tungsten. Or gold or silver on moly. Nothing in-between!

You get standard weight percentages of plate on moly—5-7% on smaller diameters, 3-5% on larger. Tungsten is generally all 5-7%. In both cases, we'll gladly review requests for special weight percentages.

General Electric puts only one piece of wire on a spool—a long, long, long piece. Elongation ratings are exceptionally good. There's no delayed yield point on the stress-strain curve. You can choose either a high luster or dull finish, get

Progress Is Our Most Important Product

GENERAL  ELECTRIC

experienced engineering help, and count on fast delivery.

Fill in, tear out and mail the coupon if you're interested in nickel-free high quality tungsten or moly wire with gold or silver plating.

General Electric Co.
Lamp Metals & Components Dept. ED-011
21800 Tungsten Road, Cleveland 17, Ohio
(In Canada, it's Canadian General Electric Co., Ltd.,
Component Sales, 221 Dufferin St., Toronto 3, Ontario.)

Check as many as you wish.

- Send me samples for testing.
 I'd like more specific information.
 I'd like engineering assistance.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

← CIRCLE 131 ON READER-SERVICE CARD

NEW PRODUCTS

Oscilloscope

576

Has an 8 x 10 cm viewing area



Model 560 oscilloscope contains a 5-in. crt with a 3.5-kv accelerating potential, an amplitude and sweeping calibrator, and a regulated dc supply providing 30 w. It can be used with signal-amplifier and time-base plug-in units. Dimensions are 13.5 x 9.75 x 21.5 in. Weight is less than 27 lb.

Tektronix, Inc., Dept. ED, P. O. Box 500, Beaverton, Ore.

Price: \$325.

Elapsed Time Indicator

523

Reads to 9999 hr

The Model 1440 elapsed time indicator is a miniature device presenting four digits 0.109 in. high on black counter drums. Readings from 0000 to 9999 hours are presented in 1-hr increments. The indicator has a diameter of 0.67 in., a length of 1.68 in., and weighs about 1 oz. Input is 115 v, 400 cps, single phase, at about 10 ma. Units are self-contained, including motor, and hermetically sealed. MIL-M-26650A requirements are met.

Bowmar Instrument Corp., Dept. ED, 8000 Bluffton Road, Fort Wayne, Ind.

Power Supply

469

Output is 0 to 50 v

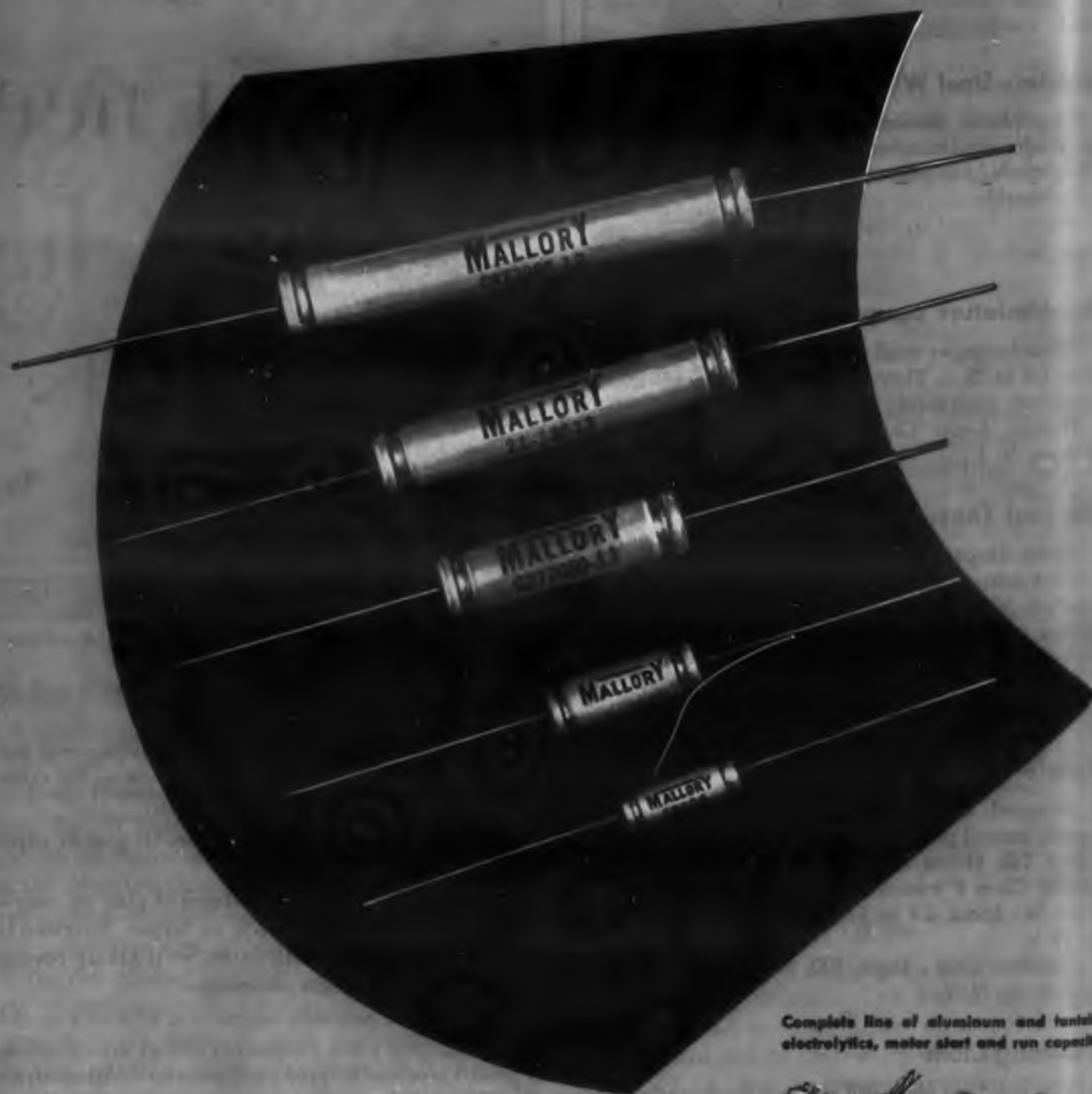
This bench-type power supply provides a continuously adjustable output of 0 to 50 v dc at 0 to 500 ma. The input is 95 to 125 v ac, rms, 60 cps, single phase. Ripple is 3.5 mv at maximum voltage and full load. Stability after warm-up is 0.01%; long term thermal drift from start to stable temperature is 50 mv. Output impedance is less than 0.1 ohm. Size of the unit is 5 1/4 x 4 1/4 x 5 in.

Autotronics Inc., Dept. ED, Box 208, Florissant, Mo.

TAF TANTALUM FOIL

... polarized and

... for high working voltages
in small case sizes



Complete line of aluminum and tantalum electrolytics, motor start and run capacitors



CAPACITORS

non-polarized

Here's a tantalum capacitor that's small in size but large in voltage handling capacity. Mallory TAF Tantalum Foil Capacitors are available in voltage ratings up to 150 WVDC in case sizes as small as $\frac{3}{16}$ " x $\frac{11}{16}$ ". Available in polarized and non-polarized designs, these capacitors are ideal for computers, airborne radar, control systems, and other applications requiring the reliability, stability, low leakage current, and long shelf-life of a quality tantalum foil capacitor.

TAF Plain (unetched) Foil Tantalum Capacitors operate over a temperature range of -55°C to $+85^{\circ}\text{C}$. Standard capacitance tolerance for all units is $\pm 20\%$. TAF capacitors are designed to meet the electrical and environmental characteristics of military specification MIL-C-3965B. Capacitors may be ordered with or without Mylar* insulating sleeves.

IT'S MALLORY FOR TANTALUM CAPACITORS!

... immediate delivery on 13 different types!

The TAF Capacitor Series is just one of the 13 tantalum types now available for immediate delivery—including microminiature to high capacitance, foil and sintered anode, solid and liquid electrolyte, encapsulated and metal case, medium and high temperature. Reliability of these capacitors is firmly established by thousands of test hours and more than a decade of in-service performance.

Write for complete technical data. For expert consultation on your circuit requirements, see a Mallory capacitor specialist.

*Registered trademark—E. I. du Pont de Nemours & Co., Inc.

TYPE TAF PLAIN TANTALUM FOIL CAPACITORS

POLARIZED (150-3 WVDC) CAP. MFD.	NON-POLARIZED (150-8 WVMP) CAP. MFD.	BODY LENGTH	BODY DIAMETER
.5-10	.25-5	$1\frac{1}{16}$	$\frac{7}{16}$
1-50	1-25	$\frac{7}{8}$	$\frac{7}{32}$
4-160	3.5-85	$1\frac{1}{16}$	$\frac{7}{8}$
8-350	7-170	$2\frac{1}{8}$	$\frac{7}{8}$
20-440	10-250	$2\frac{3}{4}$	$\frac{7}{8}$

Mallory Capacitor Co. • Indianapolis 6, Indiana
a division of

P. R. MALLORY & CO. Inc.
MALLORY

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Capacitors
Stocked
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distributors



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Binghamton, N.Y.
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Lenert Company

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Graham Electronics

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California Electronics
Kierulff Electronics, Inc.
Radio Product Sales

Minneapolis, Minn.
Northwest Radio

Montreal, Que.
Canadian Electrical Supply Co.

Mountainside, N.J.
Federated Purchaser, Inc.

Nashville, Tenn.
Electra Dist. Co.

Newark, N.J.
Lafayette Radio

New York, N.Y.
Harrison Radio Corp.
Harvey Radio Co., Inc.
Hudson Radio & TV Corp.
Lafayette Radio
Terminal Electronics

Oakland, Calif.
Elmar Electronics, Inc.
Zack Radio Supply Co.

Orlando, Fla.
East Coast Radio

Ottawa, Ont.
Wackid Radio-TV Lab.

Palo Alto, Calif.
Zack Radio Supply Co.

Pasadena, Calif.
Electronic Supply Corp.

Perth Amboy, N.J.
Atlas Electronics

Philadelphia, Pa.
Herbach & Rademan
Philadelphia Electronics

Pittsburgh, Pa.
Radio Parts Co.

St. Louis, Mo.
Olive Electronics

Seattle, Wash.
F. B. Connelly Co.

Tampa, Florida
Thurrow Distributors, Inc.

Toronto, Ont.
Alpha Aracon Radio Co.
Electro Sonic Supply
Wholesale Radio & Electronics

Tucson, Ariz.
Standard Radio Parts

Tulsa, Okla.
Engineering Supply Co.

Washington, D.C.
Electronic Industrial Sales

White Plains, N.Y.
Westchester Electric

Winston-Salem, N.C.
Dalton-Hege Radio

Panel Light

629

The Stetlight is a panel light that can serve either as an on-off indicator or as a source of lateral illumination for meters, controls, and dials. The lens is a plexiglass hexagonal prism.

Aerotronic Associates, Inc., Dept. ED, P. O. Box 367, Contoocock, N. H.

Tools for Snap-In Contacts

630

These tools for the insertion and removal of snap-in contacts have replaceable tips. The devices are designed to be used with the firm's type DS snap-in contact connectors.

The Deutsch Co., Electronic Components Div., Dept. ED, Municipal Airport, Banning, Calif.

Wire Harness and Cable Assembly

638

Vinyl tubing which, when cured, contracts tightly around encased wires, is suitable for wire harnessing and cable assembly. The tubing method is said to combine the advantages of electrical tape and insulated sleeving.

Foley Electronics Co., Dept. ED, 4810 Calvert Road, College Park, Md.

Capacitor Tester

639

This capacitor tester, designated Cappy, tests paper, ceramic, and electrolytic capacitors for open circuits, shorts, and leakage. The device can also be used to test continuity of motors and transformers, to trace wiring, and to check tube heaters. It will supply bias voltage or act as a low-current power supply up to 45 v dc.

Elgin International, Ltd., Dept. ED, 1410 Broadway, New York 18, N. Y.

Metal-Composite Laminated Plastics

640

These laminated plastics, suitable for applications requiring intermittent electrical contact without the close tolerance of printed-circuits, consist of metal embedded in insulation material.

Taylor Fibre Co., Dept. ED, Norristown, Pa.

Dry-Circuit Contact

482

The Metact, a resilient mesh contact, provides self-wiping action, multi-contact areas and anti-bounce characteristics. For use in relays, switches, and choppers, the contact is gold plated or is supplied in any specified metal.

General Cable Corp., Dept. ED, 730 Third Ave., New York 17, N. Y.

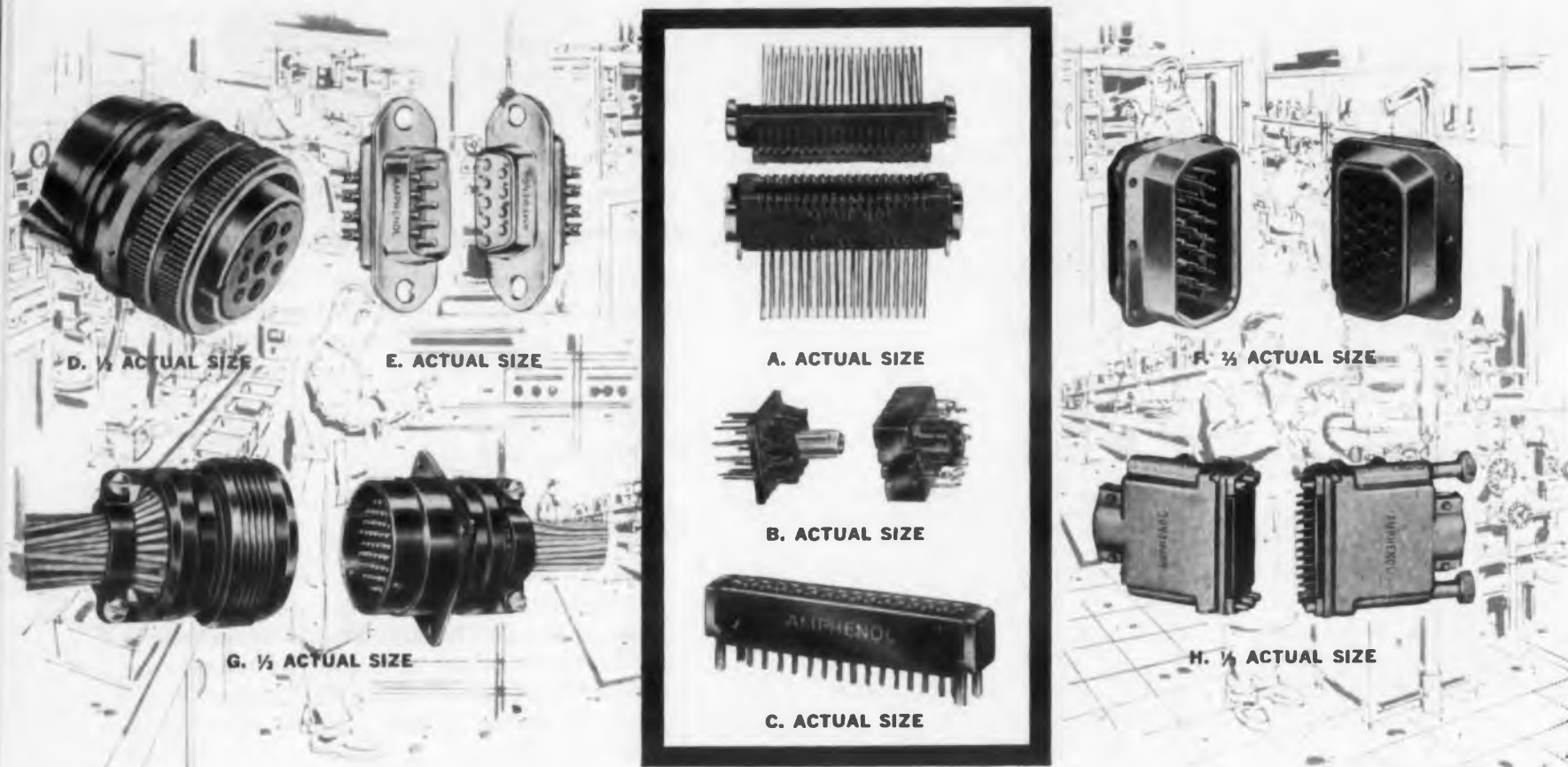
Not That Much . . .

The volume controls described on page 122 of the August 17 issue and made by Clarostat Manufacturing Co., Inc., are priced at \$1.55, separately—not \$57.10 as reported.

NEW CONTRIBUTIONS TO RELIABILITY

Continuing AMPHENOL R & D is markedly increasing the reliability of interconnecting devices. In two areas this activity has produced particularly valuable results. In micro-miniaturization, revolutionary Micro Min, Micro Mod and Micro Edge (pat. pend.) have been developed to accommodate flat form, modular and printed circuit

packaging. And in the AMPHENOL-developed concept of crimp Poke Home contacts (U.S. Patent 2,419,018), aircraft and other industries have an outstandingly reliable method of connector wiring. Contacts are uniformly crimped outside the connector body, then quickly inspected and inserted to complete the assembly.



MICRO MINIATURE

A Micro Min 19 contacts single side or 38 contacts double side, on .050" centers. Pair weigh .008 pound.

B Micro Mod WESCON design award winning module/stick connectors. 12 contacts on .075" centers. Pair weigh 0.73 grams.

C Micro Edge Newest edge-board or printed wiring receptacle. 15 contacts on .075" center. Connector is 1.292" long.

POKE HOME CONTACTS

D 69 Series "Poke R" Upgraded MIL-C-5015 "R" construction with the decided advantage of crimp Poke Home contacts. 3 shell styles, sizes 10SL through 36.

E Min Rac 17 Space- and weight-saving miniature rack & panels, 9 to 50 Poke Home contacts.

F 94 Series Up to 63 Poke Home contacts in these rectangular rack & panel connectors developed for airborne equipment.

G MII-C-26500 Sophisticated aircraft and missile connectors. Performance unaffected by 1000 hours at 200°C. 3 shell styles, 4 to 55 Poke Home contacts.

H 93 Series 34, 42 and 50 Poke Home contacts. Rack & panel connectors originally developed for missile applications.

AMPHENOL CONNECTOR DIVISION

Amphenol-Borg Electronics Corporation
1830 S. 54th Avenue, Chicago 50, Illinois

Check for full data: A B C
 D E F G H

Name _____

Title _____

Company _____

Company Address _____ Department _____

City _____ Zone _____ State _____



AMPHENOL CONNECTOR DIVISION

Amphenol-Borg Electronics Corporation
1830 S. 54th Avenue, Chicago 50, Illinois

NEW PRODUCTS

Silicon-Switching Transistor

530

Has low saturation resistance

An improved internal mesa structure in the 2N706B transistor assures a maximum collector saturation voltage of 0.4 v and a base resistance of 50 ohms. It has a typical storage time of 18 nsec. The device is intended for use from low-frequency switching circuits up through ultra-high speed computer applications. Maximum ratings are: collector-base voltage, 25 v; collector-emitter voltage, 20 v; emitter-base voltage, 5 v. It is housed in a TO-18 package and has 0.3 w dissipation in a 25 C ambient.

Motorola Semiconductor Products Inc., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.

Variable-Frequency Power Source

579

Amplitude stability is 0.01%



This 50-w, variable-frequency power source has an amplitude stability of 0.01% and harmonic distortion of 0.1%. Called model LSD-1500, the unit is for calibrating such devices as ac voltmeters, ac ammeters, and digital meters. It delivers continuously variable outputs of up to 1,500 v and up to 12 amp at frequencies between 20 and 20,000 cps. Its dimensions are 40 x 22 x 19 in.

Krohn-Hite Corp., Dept. ED, 580 Massachusetts Ave., Cambridge 39, Mass.

Price & Availability: \$2,950 fob Cambridge; four weeks delivery.

← CIRCLE 133 ON READER-SERVICE CARD

Semiconductor Relay 513

Operates at up to 2,500 bits per sec

Model SCR-60 semiconductor relay operates at up to 2,500 bits per second, as a spst unit with input coil and output circuit isolation. Output transistors are operated to key circuit loads of up to 300 v dc. Independent isolation of transistor inputs provides a variety of series or parallel connections. Input current is 20 to 60 ma nominal; input resistance is 135 ohms; closed circuit voltage drop per contact is less than one volt.

Rixon Electronics, Inc., Dept. ED, 2414 Reddie Drive, Silver Spring, Md.

Fast Release Relay 534

For direct-current operations

The Type 1 relay is applicable to direct-current operations requiring rapid opening and closing of circuits. Depending on the selection of coils and proper adjustment, it delivers high-speed operation of 0.0002 sec min or marginal operation of 0.025 sec max. Operating voltages are up to 230 v dc. Models can be custom-designed to suit the customers exact circuit requirements.

Lakewood Controls Corp., Dept. ED, Industrial Road, Crystal Lake, Ill.

Servo Control 607

Self-zeroing unitized module

This self-zeroing unitized servo control module, used in analog computers, eliminates manual erasing or clearing of data. The module is designed to return the shaft fully clockwise, fully counter-clockwise or to any intermediate position. This module is claimed to solve the space and reliability problems posed by complex control systems, to reduce parts purchased from 7 to 1 and cut assembly time from 11 hr to 0.8 hr.

Technology Instrument Corp., Dept. ED, 850 Lawrence Drive, Newbury Park, Calif.

CIRCLE 134 ON READER-SERVICE CARD



How to make a shrewd increase in recorder efficiency

With twice the performance, the Ampex FR-600 is still compatible with earlier equipment.

Doubles tape utilization and obviates standby equipment

Your FR-600 records 125 kc data at 30 ips instead of 60 — gives twice the recording time per reel. For example, you get 48 minutes recording time on 10½-inch reels, 96 minutes on 14-inch at 30 ips. Not only are tape expenditures cut in half, but standby recorders on long sessions may no longer be needed. And for a broader data spectrum in the future, your FR-600 can accommodate 250 kc at 60 ips or 500 kc at 120 ips.

Multiplies available recording time and eliminates error

Two-hour warmup and adjust sessions are reduced to ten minutes by the FR-600's transistorized circuitry. Final calibration is a one-time-per-use operation. Post-warmup stability — less than 1% drift per 24 hours — precludes time-wasting adjustments and minimizes creeping inaccuracies. Because your FR-600 is ready when needed, it works more hours per day, saving both your time and its own.

Updates performance of older equipment

The FR-600 plays back tapes from most existing data recorders. And because playback heads generally determine overall frequency response, use of an FR-600 for playback can permit earlier equipment (with simple adjustment) to record the same high information density as your FR-600.

The essential data

The Model: FR-600 Laboratory Recorder/Reproducer. Number of tracks: up to 14. Reel sizes and tape widths: 10½- or 14-inch NAB, with ½-inch or 1-inch tape, interchangeably. Frequency response: 300 to 250,000 cps ± 3 db at 60 ips with direct recordings; 0 to 20,000 cps ± 0.25 db at 60 ips in FM-carrier recording — proportionate response at other speeds. Tape speeds: 60, 30, 15, 7½ ips; 120, 3¾, 1½ ips optional. Types of recording: direct, PDM and FM-carrier, by plug-in modules. Compatibility: yes, with Ampex 300 and 800 series; FR-100 and FR-1100 series, and AR-200 and CP-100 series.

Write for full information

AMPEX DATA PRODUCTS COMPANY
Box 5000 • Redwood City, California • EMerson 9-7111



AMPEX

NEW PRODUCTS

Non-floated Free Gyros

Are torquable and cageable

405



This series of miniature, non-floated free gyros are torquable and cageable. The two models available offer miniature size and weight with high performance characteristics. The cageable FN30 series is a two-axis, free gyro with either ac or dc motor. It is available with outer gimbal synchro pick-off, potentiometer pick-offs on both axes or potentiometer pick-off on the inner gimbal and synchro pick-off of the outer gimbal. The FM30 series is also a two-axis free gyro but with synchro pick-offs and torquers on both gimbal axes. Both series provide low drift rate and 10-g vibration resistance.

Daystrom, Inc., Pacific Div., Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.

Spectrum Analyzers

466

For Fourier spectrum analyses

Spectrum analyzer model 5-10A computes the Fourier spectrum of an input signal in real time and displays it on an oscilloscope. It determines the spectral composition of an input within any specified 10-kc wide-band in 1/5 sec, with a resolution of 7.5 cps. Model 5C-100 provides 100-kc wide Fourier spectrum analyses of 2-msec long if pulses at rates up to 100 per second with 700 cps resolution. Model 53 operates in real time, and simultaneously covers any specified 3-kc wide band without the use of contiguous filters. It has a 3-db resolution of 7 cps and a 40-db bandwidth of 70 cps.

Federal Scientific Corp., Dept. ED, 615 W. 131 St., New York 27, N.Y.

Two-Pen Chart Recorder

464

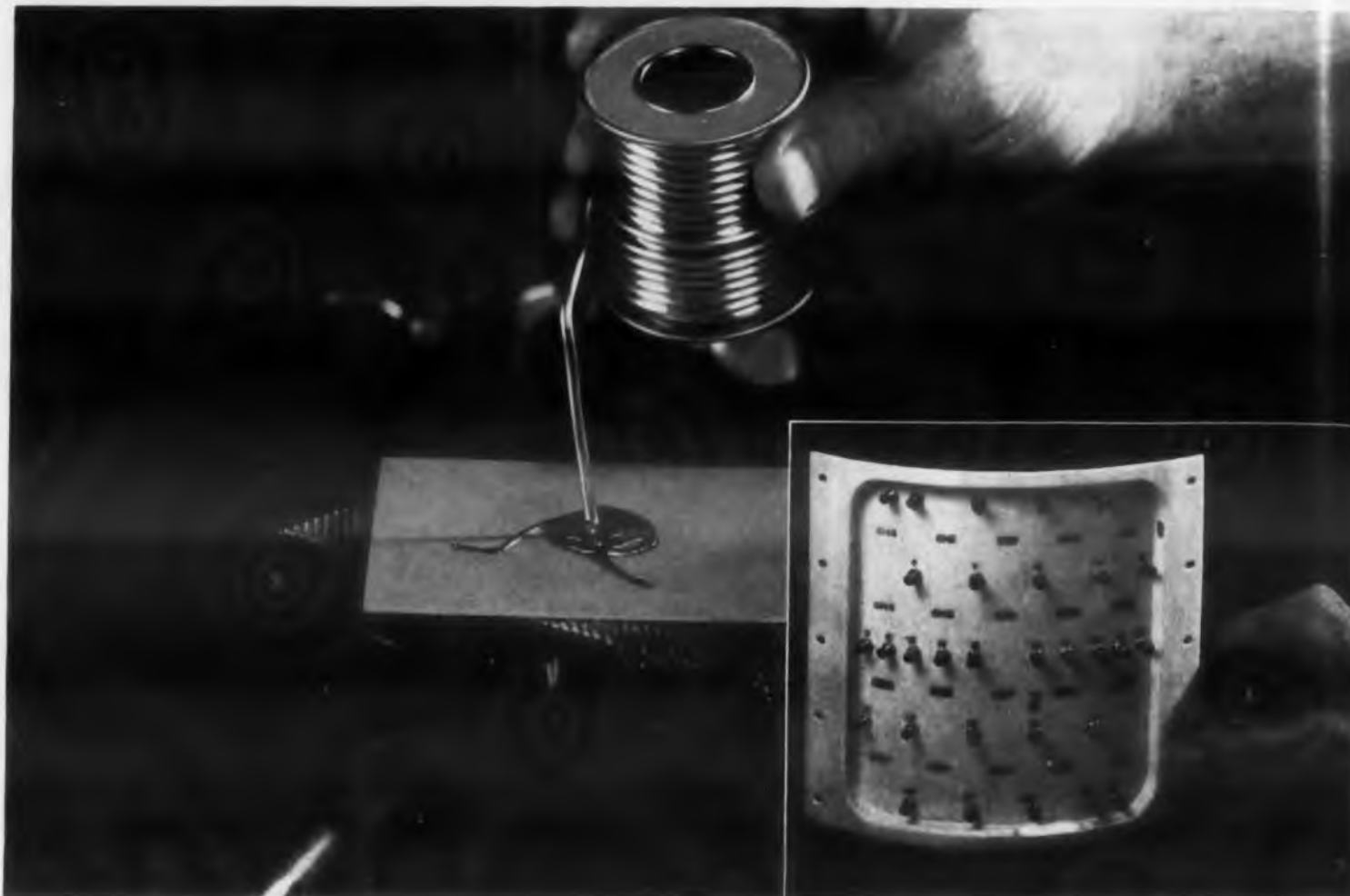
Is accurate to within $\pm 1/4\%$

This two-pen potentiometer chart recorder-controller is accurate to within $\pm 1/4\%$. It is designed for application where two variables must be recorded on a single chart. Chart speeds are one, eight, 12 or 24 hr; or seven days. All recorder components are easily accessible for maintenance.

General Electric Co., Dept. ED, Schenectady 5, N.Y.

SILICONE NEWS from Dow Corning

When Going Is Rough . . .



For Environmental Engineering... Select Silicone-Glass Laminates

LOX cold . . . high Mach heat . . . corona . . . ozone . . . launching and sonic shock — more and more environmental challenges are being met by Dow Corning Silicones.

Take glass laminates bonded with Dow Corning silicone resins, as examples. Silicone glass laminates have good mechanical strength, low loss factor, low moisture absorption, excellent resistance to arcing, corona, corrosive atmospheres, fungus and contaminants. What's even more important, they retain these properties despite elevated temperatures, storage, environmental aging, rapidly changing ambients, vibration and shock. Heat resistance of silicone-glass laminates is exceptional . . . up to 250 C continuous for years . . . much higher for short time periods. Lastly, silicone-glass laminates, even in thin sections, have fine machinability and resist creep under pressure of terminal fasteners.

Lear, Inc., Grand Rapids, Michigan mounts the mica capacitors of their Model 2013J Stable Platform on this formed silicone-glass laminate terminal board. Lear engineers chose glass laminates after an intermediate material had been tried. Tolerance requirements, plus assembler variations, dictated a material that could be formed . . . would withstand soldering temperatures . . . would hold its form despite environmental extremes. Environmental conditions are: —40 to 160 F; shocks of 30 G's for about 11 milliseconds each; complex wave vibration for 20 minutes in each plane as follows — 30-100 cps: 0.46 g²/cps and 100-2000 cps: 0.015 g²/cps. Silicone-glass laminates made with Dow Corning resins are available from leading laminators. Write for a list.

For 12-page manual
"Silicones for the Electronic Engineer"
Write Dept. 3311



Dow Corning co

CIRCLE 800 ON READER SERVICE CARD

...Specify Silicones

Flexible from -100 to 300F

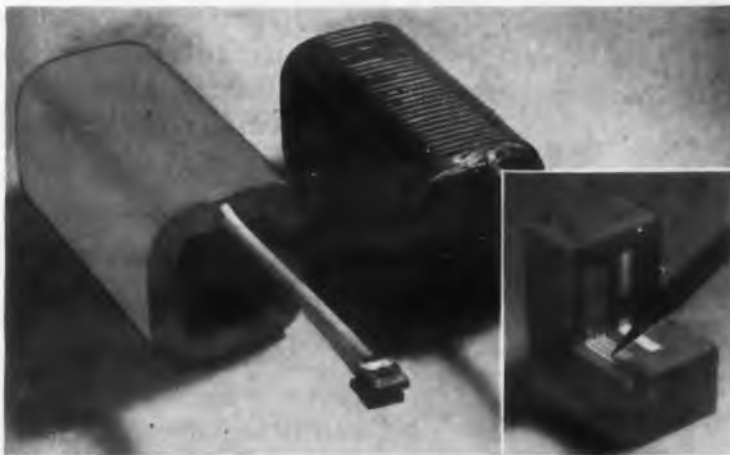
Silastic®, the Dow Corning silicone rubber, is specified by Airtron, a division of Litton Industries, for the jacket of their silver-plated brass, and all-aluminum flexible waveguide designed to resist operating temperatures from -100 to 300 F. With its Silastic jacket, Airtron's Flexaguide is particularly suited for applications in the missile field where environmental operating conditions are severe. In addition, the jacket supports the waveguide during flexure, insures airtightness for pressurized applications. Silastic resists a long list of environments including: cold, heat, ozone, oxygen, voltage stress, thermal cycling, corona, corrosive atmospheres, and weathering.



CIRCLE 801 ON READER SERVICE CARD

Rigid, Void-Free Protection

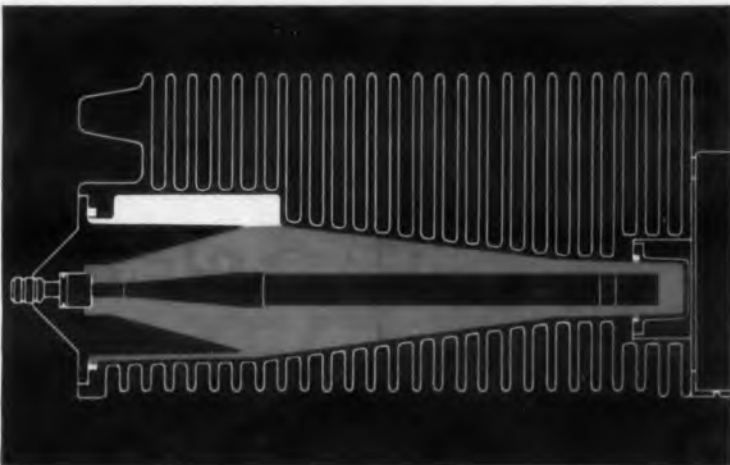
This induction heating coil is used to keep metal molten. Metal splatter caused frequent insulation and coil failure until the decision was made to encapsulate the unit in Dow Corning solventless silicone resin. The resin — with zirconium orthosilicate filler — forms a tough, rigid armor that withstands temperatures as high as 300 C indefinitely ... much higher for short time periods. With no solvents to evaporate, the resin cures without voids. Note the excellent fill between plates of an encapsulated test capacitor.



CIRCLE 802 ON READER SERVICE CARD

For Rapid Heat Dissipation

Dow Corning silicone fluids are used as dielectric coolants for rapid heat dissipation because of their thermal stability and relatively flat viscosity-temperature curves. They can be pumped at high speeds without breakdown due to shear; maintain consistency from -65 to 250 C; and they will not oxidize or act as corrosives to metals even at high temperature. For these reasons and because of low vapor pressure, Sierra Electronics, Menlo Park, California specifies Dow Corning 200 Fluid as the heat transfer medium in their 100 and 500 watt, 60 ohm coaxial RF loads.



CIRCLE 803 ON READER SERVICE CARD

Reversible Stepping Motor

410

Capable of speeds up to 400 steps per sec



The series 9AD00 is a bi-directional stepping motor in which each input impulse or current reversal causes 18 deg of shaft rotation within $\pm 1/4$ deg. Operation is magnetic and speeds of up to 400 steps per sec can be achieved. Major characteristics include: 20 positions, 10 for each alternate positive and negative input; magnetic detent; maximum torque, 80 per cm; driving power, 1/3 to 40 w depending on speed and load. Typical applications are as a positioning servomotor, digital to analog converter or high torque, instant-start synchronous motor.

Sigma Instruments, Inc., Dept. ED, 195 Pearl St., South Braintree 85, Mass.

Computer Language Translator 461

Has all solid-state circuits

The ZA-100T all solid-state computer language translator was developed for off-line, multi-mode data communication between computers. It converts data from magnetic tape in one computer format to that of another format, or in any of several combinations. The system can be supplied to accept or generate magnetic tapes of any of the commonly used computers.

Electronic Engineering Co. of California, Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

Price: Approximately \$100,000.

Laboratory Standard Voltmeter 515

For 10 to 1,000 mc range

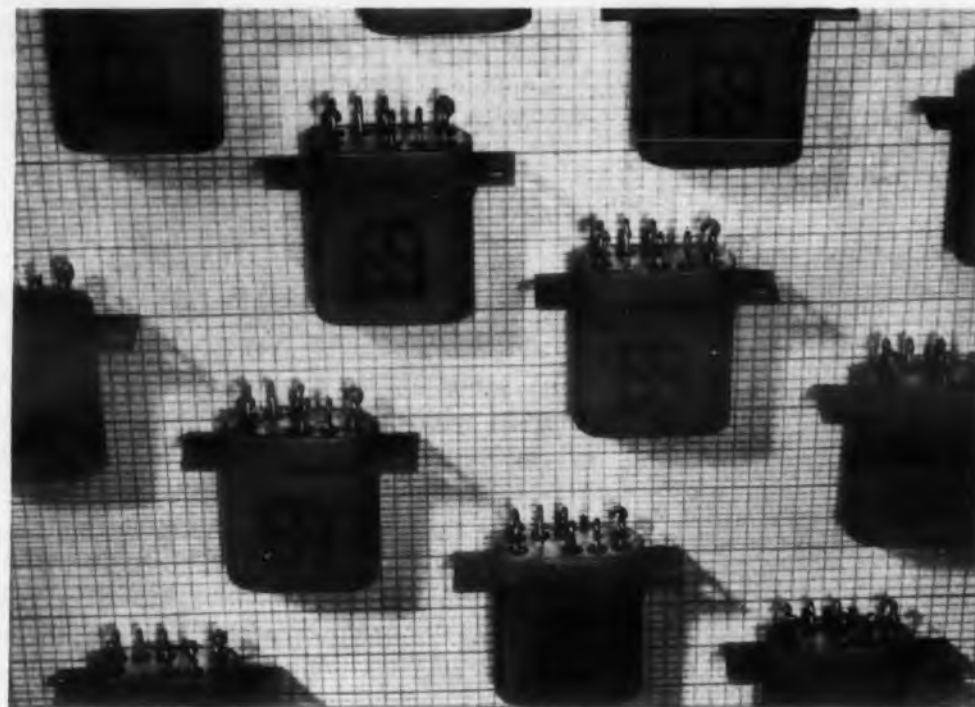
This laboratory standard voltmeter, model 390, is designed for the measurement of voltages or the calibration of ac voltmeters operating in the range of 10 to 1,000 mc at voltages of 0.5 to 300 v. The movable electrode and thermocouple are mounted on a machined carriage that slides inside the attenuator barrel on six nylon-pins and two sets of plated finger-stock. The thermocouple is an insulated, ultra-high-frequency type. After manufacture each model 390 must be calibrated by the National Bureau of Standards.

Ballantine Laboratories, Inc., Dept. ED, Boonton, N.J.

ng CORPORATION MIDLAND, MICHIGAN

branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

CIRCLE 800, 801, 802, 803 ON READER-SERVICE CARD



This is the new Union Crystal Case Relay

The UNION 2-PDT General Purpose Crystal Case Relay is designed to consistently meet the requirements of MS 24250, Mil-R-25018, Mil-R-5757C. Use it where minimum size and *optimum reliability* are essential—in control systems, computers, airborne and guided missile electronic equipment.

To provide vibration immunity, we have incorporated a unique feature in this relay's armature suspension system. A torsion wire is anchored to the armature and backstrap. It acts as a biasing spring; supports the armature and eliminates end play. The relay uses the rotary principle of operation, found in the entire line of extremely reliable Union Switch & Signal miniature relays.

The 2-pole, double throw, bifurcated contact structure increases reliability and efficiency in dry circuit applications. UNION Crystal Case Relays are designed for continuous operations in the -65°C to $+125^{\circ}\text{C}$ range.

Union Switch & Signal's manufacturing capabilities and experience make it possible to provide these quality relays in quantity. Manufacturing techniques make it possible to provide the ultimate in reliability.

The new UNION Crystal Case Relay is available with the 0.2" grid-spaced header or "S" type header, with solder lugs, plug-in terminals, or 3-inch leads, and for various operating voltages.

Contact Union Switch & Signal for additional information about this new Crystal Case Relay. Write for bulletin 1064.

Vibration: 20 G—2,000 cps

Shock: 50 G

Temperature Rating: -65°C to $+125^{\circ}\text{C}$

Contact Rating: Dry circuit to 2 amp., 28-volt DC resistive load.

"Pioneers in Push-Button Science"



UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA

NEW PRODUCTS

Microwave Transitions

552

For 5.2 to 9.5 kmc



These coaxial line-to-waveguide transitions are available in six models with frequencies ranging from 5.2 to 9.5 kmc. Useful in the testing of magnetrons, the units present a maximum vswr of 1.1 over the specified band.

Bomac Laboratories, Inc., Dept. ED, Salem Road, Beverly, Mass.

Availability: Units are made on order and can be delivered in 45 to 60 days.

Silicon Zener-Voltage Regulators 511

Ranges from 5.6 to 100 v

This series of silicon zener-voltage regulators comes in three power classifications: 1/4 w, 1 w, and 10 w. Voltage ranges in each rating are from 5.6 to 100 v. They are constant voltage devices used to control output voltages of power sources and as voltage reference elements capable of operating over a wide temperature range. They are hermetically sealed.

Sarkes-Tarzian, Inc., Dept. ED, Bloomington, Ind.

Price: From \$3.60 to \$8.15 in sample quantities.

Voltage-Tunable Magnetron 465

For operation in the S-Band

This high-power, voltage-tunable magnetron is designed to operate in the S-band. Designated type Z-5424, it has a minimum cw power output of 50 w over the entire 2,900- to 3,200-mc frequency range. Filament voltage is 2.5 v; filament current is 3 amp. Maximum-anode voltage is 2400 v and maximum-anode current is 70 ma. The tube can be installed in any position.

General Electric Co., Dept. ED, Schenectady 5, N.Y.

Price: In sample quantities, \$1,900.

Get the Facts About These Cost-Saving Terminals and Components

STANDOFF AND FEED THROUGH TERMINALS

Low cost and high electrical specs. have made these the most popular in the industry. Choice of fork, single and double turret, post... standard, miniature, sub-miniature... molded or metal base... wide variety of body materials, including diallyl phthalate and melamine, and plating combinations.



Request Catalog SFT-1

PUSHLOCK NYLON TIP JACKS

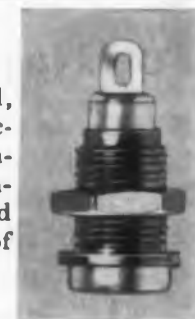


Save time and money regardless of installation method. Just push into cabinet or chassis hole and the one-piece Pushlocks align and self-anchor. Eliminate threads, nuts, lockwashers and vibration problems.

Request literature

MELAMINE JACKS

Very economical, yet designed electrically and mechanically for long, reliable service. Supplied in a wide range of code colors.



Request details

POINTER KNOBS

A military and industrial favorite by reason of price and practicability. Supplied in attractive black, satin-finished phenolic.



Request details

WHITSO, INC.

9326 Byron Street, Schiller Park, Illinois
(Chicago Suburb)

CIRCLE 136 ON READER-SERVICE CARD

You can look at Philbrick's USA-3 Amplifier at least 3 ways

1. Undressed — Here's the basic unit itself — more performance per dollar than any other operational amplifier. Highly reliable — no electrolytic capacitors or glow tubes. Designed to prevent self-destruction, even when output is grounded. Drift, noise, offset under 100 microvolts. Output, \approx 115 vdc. Wide frequency range — dc to 100 kc (attenuation less than 3 db) when connected as gain-of-ten amplifier. Printed circuit board, 7" x 2½". Price, 1 to 9 units: **\$95**

2. Dressed — In a neat 3" x 7½" ventilated aluminum package, it becomes the USA-3-M3. It has sufficient room for the user to implement its operational destiny by installing additional circuit components. For example, you make it into a complete diode function generator, or integrator, or whatever you wish. The important feature of plug-in interchangeability is enhanced by the 4 to 7 spare terminals on the Blue Ribbon Connector. Price, 1 to 9 units: **\$125**

3. Dressed-up — Now it's a full fledged utility packaged amplifier, known as the UPA-2. Combining a new level of convenience and flexibility, it is immediately operational when plugged into any Philbrick power supply. It can be made to drive a 12,000 ohm load to 100 volts in either direction. Designed for bench top use, it comes installed in a 3½" rack adapter, from which it is easily removed. The UPA-2 is ideal for analog computing, measurement and control, continuous data reduction, and many other feedback operations. Price, 1 to 9 units: **\$149**

- OEM's: write, wire, or phone for quantity prices
- Military equivalents available
- 8 page technical manual available on request

GEORGE A.
PHILBRICK
RESEARCHES, INC.

285 Columbus Avenue, Boston 16, Mass.
Commonwealth 6-5375, TWX: BS1032, FAX: BSN
Representatives in principal cities

Export Office: 135 Liberty Street, New York 6, N. Y.
Tel. WOrth 4-3311, CABLE: TERMRADIO

CIRCLE 137 ON READER-SERVICE CARD

ELCTRONIC DESIGN • November 9, 1960

Heat Sinks

642

These heat sinks, type 6030, for transistors, diodes and rectifiers, are anodized to withstand over 1,000 v rms. A variety of hole patterns are available.

Vemaline Products Co., Dept. ED, Franklin Lakes, N. J.

Availability: Delivery from stock.

Circuit and Relay Test Unit

643

The Posicheck units may be used for continuity testing of 6, 12, and 110-v ac circuits and contacts. They can be plugged into any ac outlet. A buzzer or a light indicates circuit continuity.

Jody Sales Co., Dept. ED, 19611 John R. St., Detroit 3, Mich.

Price: \$42.50, including clips, cords, and probes.

Subminiature Potentiometer

644

Model 55M 10-turn precision subminiature potentiometer, has resistance values from 25 to 200 K and a tolerance of $\pm 0.15\%$. Construction is all-metal; the device has sleeve or instrument ball bearings.

New England Instrument Co., Inc., Dept. ED, 3334 Main St., Waltham, Mass.

Ferrite Materials

645

Types M-092 and M-112 microwave ferrites have been added to a series of magnesium-manganese-aluminum ferrites suitable for the development of isolators, circulators, duplexers, and other microwave devices.

Motorola, Inc., Military Electronics Div., Dept. ED, 8201 E. McDowell Road, Phoenix, Ariz.

Insulated Plugs

495

Types 2660 and 2661 are solder type with 0.62- and 0.045-in. diameters. Types 2662 and 2663 are solderless types with 0.62- and 0.045-in. diameters. Pins are 3/16 in. long. They are for quick, tight patch work on panel boards.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

Electronic Military Cabinets

655

These electronic military cabinets have box-frame, welded construction. Frames are made of 12 gage or 3/16-in. steel or 1/8-in. aluminum, standard cabinets are 24 in. wide for 19 in. panels and 28 in. wide for 24 in. panels.

Electro-Rack, Inc., Dept. ED, 11505 Jefferson Blvd., Culver City, Calif.

Price & Availability: Prices start at \$98.80; from stock.

One "Zero" Missing . . .

The Micromodule Laboratory Kit described on page 112 of our July 6 issue and made by the Radio Corporation of America is priced at \$8,000—not \$800, as reported.



Look at the specs on this brand new UNION 4-PDT-10 amp. relay

- 4-pole 10 amp. rating
- Rotary-type armature
- Shock: 50 G
- Vibration: 30 G—2000 cps
- Temperature: -65°C to $+125^{\circ}\text{C}$
- Contact Rating: 10 amp. 28-Volt DC resistive load

The new 4-pole, 10 amp. UNION miniature relay is designed to meet the requirements of Mil-R-6106. It has exceptionally sturdy terminals and a very rugged, welded metal armature with glass-coated metal actuators. It has been designed to withstand the toughest environment.

For example:

- ... The balanced, rotary-type armature gives maximum resistance to severe shock and vibration.
- ... The glass-coated cylindrical actuators provide full width contact drive to assure square mating of contact surfaces.
- ... It has an all-glass header.

The unique combination of design features in this new UNION 4-pole, 10 amp. relay makes it possible to have a power relay that is extremely rugged, yet takes no more space than the UNION 6-PDT, 2-amp. relay. It is the smallest 4-pole, 10 amp. rotary-type relay now available.

Union Switch & Signal has the manufacturing facilities to immediately handle large quantity orders for this addition to the fine family of UNION Reliable Relays. Call or write today.

"Pioneers in Push-Button Science"



UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY —

PITTSBURGH 18, PENNSYLVANIA

CIRCLE 138 ON READER-SERVICE CARD

NEW PRODUCTS

Potentiometer

413

For demonstration of principles



Model 7645 students potentiometer is designed for use by educators to demonstrate the potentiometer principle in measurements of voltage, current, temperature and electrolytic conductivity. Limits of error are ± 0.0005 v on the high range, ± 0.0001 v on the medium range and ± 0.00001 v on the low range. Ranges are: 0 to 1.6 v; 0 to 0.16 v; 0 to 0.016 v.

Leeds and Northrup Co., Dept. ED, 4934 Stenton Ave., Philadelphia 44, Pa.

Laboratory DC Power Supply

475

Output is 0 to 15 v, 1.75 amp



Model PS-1236 laboratory dc power supply provides 0 to 15 v. Maximum output current is adjustable between 0.6 and 1.75 amp. Regulation is better than ± 7.5 mv for full load change or rated line change. Ripple is less than 1 mv. The device has low internal impedance and fast recovery time. Input is 105 to 125 v, 60 cps. The unit measures 7.5 x 7.5 x 4.7 in. and weighs 9 lb.

Power Instruments Corp., Dept. ED, 235 Oregon St., El Segundo, Calif.

Price: \$170.

Availability: 3 to 4 weeks.

Oscillographic Recording System 510

Provides up to 16 identical channels

This oscillographic recording system provides up to 16-identical channels, or two different sets of eight-identical channels, with all 16 inputs recorded on a single chart. Permanent, inkless traces are produced on rectangular-coordinate

Fastest,
easiest
way
yet devised to



Model 434A Calorimetric Power Meter

MEASURE POWER 10 MW TO without external terminations of ec

Now you can quickly and confidently measure power to 10 watts average, 1 Kw peak! With the Model 434A, simply connect power to be measured to the 50-ohm type N front-panel coaxial connector . . . and read power directly in watts and DBW.

This precision instrument fills the important range between bolometer type microwave power meters (such as the popular Model 430C) and conventional calorimeters whose lower range is approximately 10 watts. The 434A is useful for measuring AM power, pulsed power, cw power and dc power.

Just two operating controls, range switch and zero set. No other adjustments are necessary to make power measurements at any frequency, dc to 12.4 KMC. The 434A requires no barretter, thermistor or external power termination. Directional couplers or similar external equipment can be used to extend the 434A power range above 10 watts. An internal calibrator assures

that the 434A is always operating at peak performance.

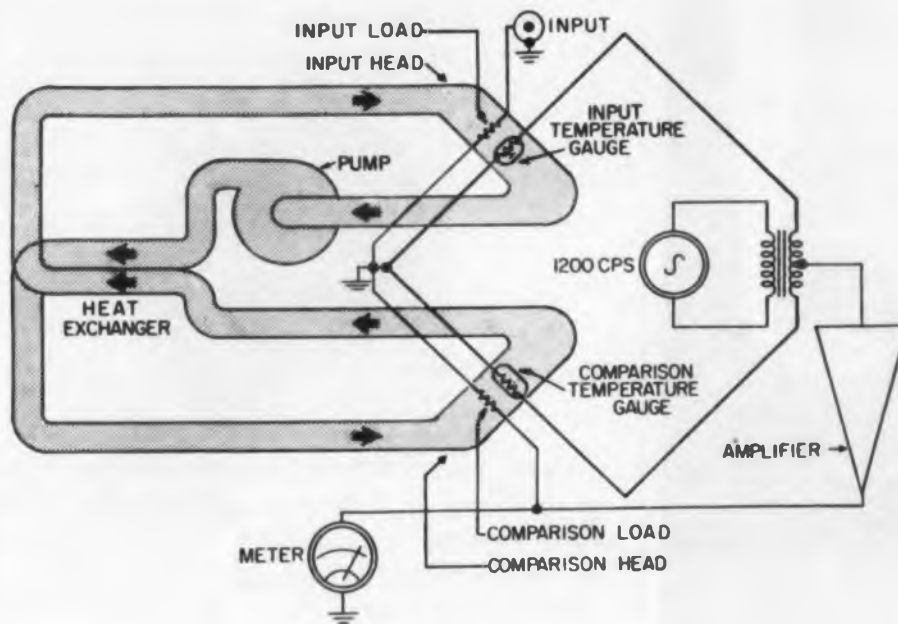
Rapid response time—high stability

The 434A contains a self-balancing bridge and high-efficiency heat transfer system using an oil stream to provide a full scale response time of 5 seconds or less. This fast response, a fraction of the response time of ordinary calorimeters, means the 434A quickly follows small adjustments in input tuning circuits. A new high in stability is achieved through the use of twin power-sensitive elements immersed in a single oil stream, making the 434A independent of variations in oil flow rate and temperature.

Operating in 7 meter ranges, the Model 434A has a specified accuracy of $\pm 5\%$ of full scale. Even greater accuracy is achievable through appropriate techniques. Typical techniques are briefly described in the *Journal*, Volume 9 Number 12, August 1958.

World leader in precision test instrumentation

Just connect, then read power
 Direct reading in watts, DBW
 Only two operating controls
 Measure cw or pulsed power
 Compact, self-contained
 Fast reading — 5 sec. response
 maximum
 Internal 1% calibrator



TO 10 WATTS, DC TO 12.4 KMC

Equipment

SPECIFICATIONS

Input power range: Seven meter ranges. Full-scale readings of 0.01, 0.03, 0.1, 0.3, 1.0, 3.0 and 10 watts. Meter scale also calibrated from -10 to 0 DBW, providing continuous readings from -30 to +10 DBW. Power range can be extended upward with attenuators or directional couplers.

Peak input power: 1 kilowatt, maximum

Frequency range: Dc to 12.4 KMC

Dc input impedance: 50 ohms \pm 5 ohms at type N input jack

Input VSWR: Dc to 5 KMC, less than 1.3. 5 to 10 KMC, less than 1.5. 10 to 12.4 KMC, less than 1.7.

Meter response time: Less than 5 seconds for full scale deflection.

Accuracy: Within \pm 5% of full scale. Includes dc calibration and termination efficiency, but not mismatch loss. Greater accuracy can be achieved through appropriate techniques.

Power supply: 115/230 volts \pm 10%, 50/60 cycles, approximately 155 watts with no input. 175 watts with 10 watts input.

Price: Model 434A (cabinet), \$1,400.00; Model 434AR (rack mount), \$1,385.00.

Data subject to change without notice.

Prices f.o.b. factory.



Circuitry Basically, the Model 434A consists of a self-balancing bridge which has identical temperature-sensitive resistors (gauges) in two legs, an indicating meter and two load resistors, one for the unknown input power and one for the comparison power. The input load resistor and one gauge are in close thermal proximity so that heat generated in the input load resistor heats the gauge and unbalances the bridge. The unbalance signal is amplified and applied to the comparison load resistor which is in close thermal proximity to the other gauge, so that the heat generated in the comparison load resistor is transferred to its gauge and rebalances the bridge.

The meter measures the power supplied to the comparison load to rebalance the bridge. Characteristics of the gauges are the same and heat transfer characteristics from each load are the same, so the power dissipated in each load is the same, and the meter may be calibrated directly in input power.

The power measurement is accurate, because the flow rate through the input head and comparison head (see diagram) is the same and the oil enters the heads at nearly the same temperature. To insure constant temperature and to bring the streams to nearly the same temperature, they are passed through a parallel-flow heat exchanger just prior to entering the heads. Identical flow rates are obtained by placing all elements of the oil system in series.

HEWLETT-PACKARD COMPANY

1047K Page Mill Road Palo Alto, California, U.S.A.
 Cable "HEWPACK" Davenport 6-7000

Field representatives in all principal areas

HEWLETT-PACKARD S. A.

Rue du Vieux Billard No. 1 Geneva, Switzerland
 Cable "HEWPACKSA" Tel. No. (022) 26. 43. 86

20 mm channels for comparison of the inputs on a single-time base. Nine chart speeds are selected remotely or by push-button. Electronics for the system consists of two transistorized amplifier sections which are available in high, medium- and low-gain types. Amplifiers have a maximum sensitivity of 20 μ v per mm and a frequency response to 125 cps within 3 db at 10 mm peak-to-peak.

Sanborn Co., Industrial Div., Dept. ED, 175 Wyman St., Waltham 54, Mass.

Multi-Section Capacitor Blocks 583

Voltage ratings are from 100 v dc



These blocks are for use in frequency determining and timing circuits; as circuit elements in capacitance, comparison, impedance and incremental bridges; and as standards of capacitance. Capacitance per section ranges from 0.001 to 10 μ f. These blocks, in hermetically-sealed cases, are available in polystyrene, Teflon and Mylar dielectrics.

Film Capacitors, Inc., Dept. ED, 3400 Park Ave., New York 56, N. Y.

Price: \$2 to \$10 ea.

Availability: 3 weeks.

Inertially-Damped Motors 356

Come in sizes 8, 11, 15 and 18



Offered in frame sizes 8, 11, 15 and 18, these inertially-damped motors can be supplied with 4, 6 or 8 poles and with either standard or high-torque rating. Corner frequencies can be adjusted to obtain required performance characteristics.

Daystrom, Inc., Transicoil Div., Dept. ED, Worcester, Pa.

Availability: Pilot production quantities can be furnished.

3 WAYS TO PERMANENT THREADS — IN ANY MATERIAL!

For original design — production salvage and "on-the-job" thread repairs — use *Heli-Coil*® Stainless Steel Wire Screw Thread Inserts.



HELI-COIL Standard Insert for stronger, smoother, lifetime threads

Permanently protects threads against wear, stripping, corrosion, galling, seizing, vibration, and shock. Made of 18-8 stainless steel wire, this precision-formed *Heli-Coil* Insert has a tensile strength of approximately 200,000 psi. Conforms to military standards and all commercial and industrial thread forms.



HELI-COIL Screw-Lock Insert eliminates lock wiring and lock nuts

This one-piece wire Screw-Lock Insert provides all the thread protection of the Screw-Thread Insert, PLUS an exclusive resilient *internal* locking feature that eliminates clumsy protruding lock nuts, lock wiring and other supplementary locking devices. It saves cost, space and weight — permits simple streamlined design in standard bosses. Meets military and N.A.S. specifications for locking torque and vibration.



HELI-COIL Shop-pack for all "on-the-job" thread repairs

Contains everything needed for fast, easy thread repair — *on the spot!* Salvage expensive parts — for pennies! Shop Pack restores threads to original size. Available in U.N.F. and U.N.C. sizes 6-32 to 1½-6. There's a kit for spark plug and pipe thread sizes, too. Each Shop Pack contains a supply of *Heli-Coil* Screw-Thread Inserts with special tap plus inserting tool.



There is a complete line of *Heli-Coil* products for every thread need: inserts, taps, tools and gages. Let us help with your design and application problems. Write today for complete information.



HELI-COIL CORPORATION

411 Shelter Rock Lane, Danbury, Connecticut

CIRCLE 140 ON READER-SERVICE CARD

Ⓢ 3103

NEW PRODUCTS

Silicon Rectifiers

Deliver 6 amp in half wave



These double-diffused silicon rectifiers deliver up to 6 amp in half-wave and 30 amp in full-wave circuits. Suitable for magnetic-amplifier and power-supply applications, they can be used at ambient temperatures of up to 250 C. Units are available in bridge-and center-tap assemblies.

Trans-Sil Corp., Dept. ED, 55 Honeck St., Englewood, N. J.

Availability: 10 days.

Data Transceiver

431

Generates a voice-frequency subcarrier



The model Sebit-24 data transceiver, designed for operation on 3-kc voice communications circuits, generates a voice-frequency sub-carrier modulated by a high-speed binary data stream. It provides for simultaneous transmission and reception over four-wire systems, or for alternate transmission and reception over two-wire systems. A self-contained clock generates time information for synchronous timing of input-output data at 2,400, 1,200 or 600 bits per second. Outputs are 5-v, peak-to-peak square waves.

Rixon Electronics, Inc., Dept. ED, 2414 Reddie Drive, Silver Spring, Md.

Price: \$9950, 1 to 3 units; \$9500, 4 to 10 units.

Availability: 90 days.

Frequency-Telemetry System 463

Has a rated accuracy of $\pm 1\%$

This transistorized, frequency-telemetry system is designed for use by electric utilities to telemeter such quantities as watts, volts, amperes

573

for **CONTINUOUS
RELIABILITY....**

**INSTALL Hoyt
PANEL METERS**



NEW!
Model 1060
Transparent
Polystyrene

Quality meters on the panel indicate quality throughout—and HOYT Panel Meters are quality in appearance and function... the complete Line of matching AC and DC Meters for original equipment and replacement applications. Get accuracy, readability, and reliability; plus economy. Specify HOYT Electrical Instruments—compatible components for production, research, and test requirements.



Model 647
Black Bakelite

Moving coil, rectifier, and repulsion types available promptly in a wide assortment of sizes, ranges, cases, shapes, and colors; some with parallax-free mirror scales—all with standard mounting dimensions. Or custom designed to the most exacting specifications.



Model 17/3
Black Bakelite



Send for latest fully illustrated brochure with descriptions, engineering data, and moderate prices.

Hoyt
SINCE 1904

**ELECTRICAL
INSTRUMENTS**

BURTON-ROGERS COMPANY

Sales Division—Dept. ED

42 Carleton Street, Cambridge 42, Mass.

CIRCLE 141 ON READER-SERVICE CARD



Capacitors for NO COMPROMISE Circuit Design

Unusual requirements in capacitance, tolerance, case size or configuration no longer need compromise your circuit designs. SOUTHERN ELECTRONICS' engineers are experienced in solving these problems to the extent that non-standard capacitors have become routine at SEC.

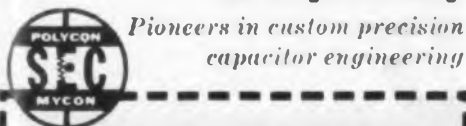
SEC has developed multiple block capacitors that are now saving space and weight in a production missile. Two 12mfd capacitors were designed to take less space than one, with improved electrical characteristics. In another application, SEC eliminated 6 tubular capacitors, utilizing a single can, 6 terminals and a common ground. Result: Room for additional components, easier wiring, and a less expensive component.

SEC, in addition to designing special capacitors to save weight and space, has developed dual-dielectrics to solve unusual temperature coefficient problems, and has introduced special dielectrics and oils for extreme high temperature and high voltage applications.

This engineering know-how has resulted in the use of SEC capacitors in twelve U.S. missiles, analog computers, and many radar and communications services.

SEC capacitors are manufactured in a wide range of capacitance to meet your needs from 100mmf to any higher value, with tolerances as low as 0.1%. They are made under unusually critical quality control standards, and meet or exceed the most rigid MIL-SPECS.

Write today for detailed technical data and general catalog.



Pioneers in custom precision capacitor engineering

SOUTHERN ELECTRONICS Corporation

150 WEST CYPRESS AVENUE
BURBANK, CALIFORNIA

CIRCLE 142 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

and vars to a central location from remote sensors. The system has an accuracy rating of $\pm 1\%$. It has a frequency rating of either 5 to 15 or 6 to 27 cps, converting to audio-tone frequencies is done by inserting transistorized-circuit boards into the transmitter and receiver.

General Electric Co., Dept. ED, Schenectady 5, N.Y.

Silicon Tunnel Diodes 414



Offer wide peak-current range

This line of silicon tunnel diodes offers a wide range of peak-current levels. Peak currents of the 14 types in the line range from 470 μ a to 100 ma. The units are encased in the JEDEC TO-18 package and operate over a temperature range of -85 to $+200$ C. Units are designated types 1N2928 through 1N2934. Standard units are available with $\pm 10\%$ peak-current tolerance and "A" versions have $\pm 2\%$ peak-current tolerance.

Hoffman Electronics Corp., Dept. ED, 3761 S. Hill St., Los Angeles, Calif.

Price: Standard units from \$12.50 to \$19 in quantities of from 1 to 99; "A" types from \$17.50 to \$26.60.

Three-Mode Controller 564

Is completely transistorized



Model SCD-2001-P controller has a full-scale input signal of 50 mv dc. The input of the amplifier is floating. Optional types of output include -15 v dc at 10 ma, $+7.5$ v dc at 15 ma. Either voltage- or current-output signals are available. Gain, rate and reset control modes can be provided.

Plug-in Instruments, Inc., 1416 Lebanon Road, Nashville, Tenn.

Availability: Immediate.

THE NEW ITT VIBRATION EXCITER



VIBRATION AND SHOCK TESTING

WITH ONE
COMPACT
INSTRUMENT

First of its type, the 50 force-pound vibration exciter Model ST-100, is unmatched for components testing. Designed specifically for vibration and shock measurement to military specification, the unique features of this instrument also provide:

- no measurable distortion to 10 KC
- first major resonance above 12 KC
- useful frequency range exceeds 50 KC
- shock testing to 3,000 g
- simple operation and portability

The performance-proven Model ST-100 is an entirely new type of vibration exciter. It virtually does away with "cross talk" ... completely eliminates unwanted output harmonics, structural and flexure resonances ... provides an exceptionally linear frequency response that makes possible true conformance to the test specifications.

For complete information and applications data, contact ITT Instruments representative or write for Data File ED-1301-1

The ITT Model ST-100 can be easily integrated into your own system design ... or it can be ordered as part of these complete, self-contained ITT testing systems:



MODEL 1201 VIBRATION TEST SYSTEM



MODEL 1205 VIBRATION AND SHOCK TEST SYSTEM

ITT

Industrial Products Division

International Telephone and Telegraph Corporation
35191 Biedue Street • San Fernando, Calif. • (818) 741-1111

static power conversion • instruments • closed circuit television

CIRCLE 143 ON READER-SERVICE CARD

NEW PRODUCTS

Variable Resistors

404

Stand 20 to 2000 cps vibration



Model 7 Radiohms, miniature linear-motion variable resistors have no contact bounce when subjected to vibration tests of 20 to 2000 cps at 30 g for 10 min in each of three planes. They can be furnished with wirewound or composition elements. The resistance range is 100 ohms to 20 K for the wirewound units and 10 K to 2.5 meg for the composition units. End resistance is 1% of total.

Centralab, Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

Crystal Resistors

436

Resistance is from 25 to 400 ohms



These crystal type resistors on 1N21 or 1N23 bodies plug into any component using the equivalent crystal type. They are supplied in any resistance value from 25 to 400 ohms with 2% or 5% tolerance. Crystal mounts and mixers can be checked and standardized independently of crystal impedance. Power rating is 1 w avg at 100 C. Filmohm Corp., Dept. ED, 48 W. 25th St., New York 10, N.Y.

Price & Availability: \$4 to \$7. Small quantities can be delivered one to two weeks after order received.

Power Access Plug-In

467

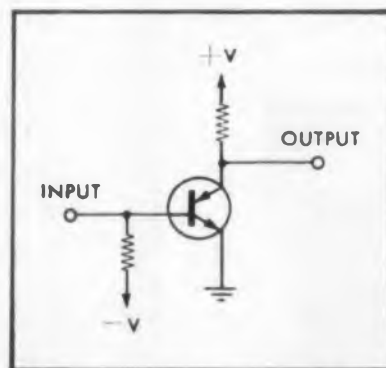
Supplies regulated voltages

Power access plug-in type 4208 is designed for the manufacturers 425 high-frequency digital-

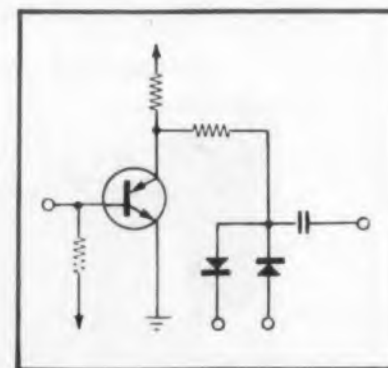
with advanced PNP semiconductor
available NOW — from **SSPI**

... already finding wide use in

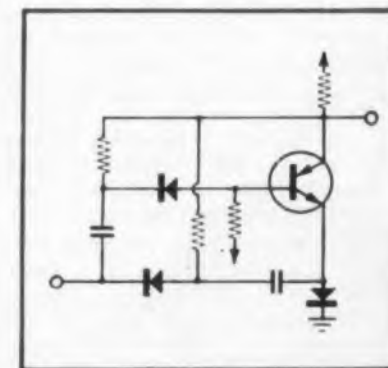
- Shift registers
- Ring counters
- Binary counters
- Gating
- Nixie drivers
- Programming
- Squib firing
- Relay drivers
- Replacing relays
- Replacing mag-amps
- Indicator lamp drivers
- Electronic circuit breakers
- Voltage sensing
- Current sensing
- Static switching
- Pulse generator
- Time delay



Trigistor Flip-Flop



Shift Register Stage

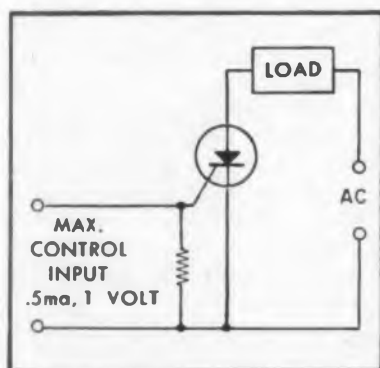


Binary Counter

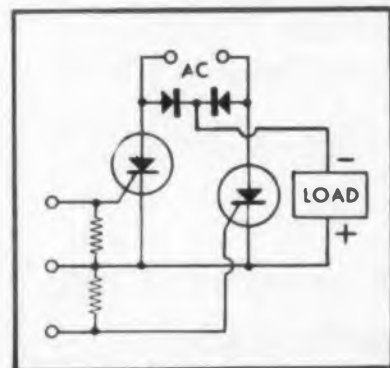
Write for Applications Bulletin D410-02

SSPI

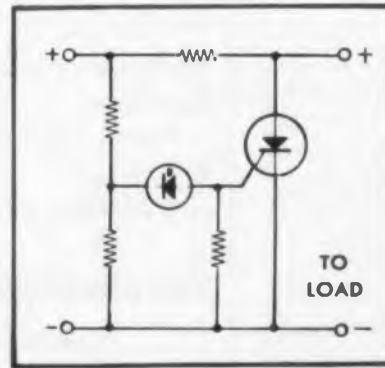
- . . . Major advances in circuit simplicity, component reduction, and reliability are possible through the use of proven PNP Semiconductors --- from SSPI.
- . . . New PNP logic possibilities with SSPI Trigtors --- full on-off control with pulsed input at a single terminal --- operation down to 1 ma allows significant current conservation.
- . . . SSPI Miniature SCR's and Controlled Switches allow precise firing control ($1.52 \pm .08$ volt) with high gain --- $20 \mu\text{a}$ will control 10-1250 ma D.C. and peak pulses up to 30 amperes with efficiencies to 99%.
- . . . Miniature packaging --- all leads isolated from case --- MIL-S-19500 environmental capabilities --- Operation — 65°C to $+150^\circ\text{C}$.
- . . . Investigate these devices in terms of your design.



Relay or Lamp Driver



Power Control



Overvoltage Protection

Write for Applications Bulletin D420-02

readout oscilloscope. It supplies various regulated voltages for powering breadboard experiments, testing power-supply performance, or any work requiring several different power sources. Meter scale is color-coded in relation to the output terminals.

Fairchild Camera and Instrument Corp., Allen B. DuMont Laboratories Div., Dept. ED, Clifton, N.J.

Price: \$75.

Strip Chart Recorders

424

Both single-pen and two-pen units

Models MR1SL and MR2SL, for use in indicating, recording or controlling dimensional variables, employ the continuous null-balance principle. In Model MR2SL, two null-balance systems are used to record the two variables simultaneously, thus correlating events to a common-time base. The chart is 12 in. wide and 122 in. long. The variables that can be handled include displacement, force, pressure, liquid level, weight and stress as well as changes in dimensions.

Schaevitz Engineering, Dept. ED, Rt. 130 at Schaevitz Blvd., Pennsauken, N. J.

Price: \$1,200 to \$2,200.

Availability: 12 to 14 weeks.

Strip Chart Recorders

425

Are flush-mounting

These flush-mounting models of the "servo/riter" have swing-out chart carriages and a slide-out chassis. Power sensitivity is better than 10^{-17} w and off-balance input resistance is 4 meg. Units are available in 1 to 100 mv dc ranges. Span-step response rating is 0.5 sec.

Texas Instruments Inc., Dept. ED, 3609 Buffalo Speedway, Houston 6, Tex.

Price: \$695 to \$1,495.

Availability: 60 days.

Electric Counters

426

Speed is up to 1,500 counts per min

The YE series electric counters have speeds of up to 1,500 counts per min. They can be instantly reset to zero, either manually or electrically. Uses are in computers and in photoelectric and remote-control counting instruments. Base-mounting and panel-mounting types are offered. Figures are 3/16 in. high.

Durant Manufacturing Co., Dept. ED, 1993-IS. Buffum St., Milwaukee 1, Wis.

Price: Standard models, \$33 to \$47.50.

Availability: From stock or made to order.

Why struggle with up to 19 bits straight binary readout



when you can have the convenience
of display directly in the units



of your own data system with

HERMES TRANSLATORS



Typical Problem: Readout of angular position of a radar encoder is in the form of 16 bits straight binary. You want to convert the 16 bits readout into decimal display expressed in degrees.

Solution: Since the radar can track in a complete circle, each bit represents $360^\circ \div 65,535$ (16 bits binary = $2^{16} - 1 = 65,535$ parts). There are, therefore, 0.00549° per binary count. The Hermes Translator transforms straight binary to decimal, manipulates the data arithmetically to multiply by 0.00549 , and displays the required readout in degrees.



HERMES TRANSLATOR, MODEL 2060

This same method may be applied to any data system where the original output is any number of straight binary bits and digital readout in the units of the measuring system is required.

Three basic types of conversion can be accommodated by Hermes Translators for a wide variety of applications:

Code-Format Conversion in which the actual physical characteristics of input data are transformed into the required output data form.

Code-to-Code Conversion in which only the language or code in which the information is represented is transformed.

Scale Conversion in which data is manipulated arithmetically (as in the Typical Problem above) to display readout in decimal form and in the units of the measuring system being employed.

Write for Technical Bulletin Translators

Hermes



ELECTRONICS CO.

75 CAMBRIDGE PARKWAY, CAMBRIDGE 42, MASS.

A DIVISION OF

Itek

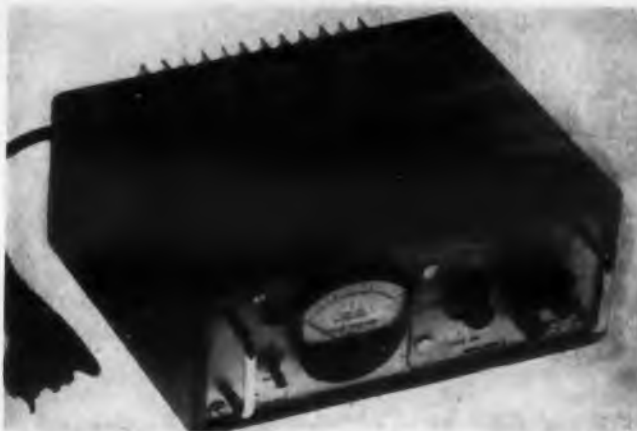
CIRCLE 145 ON READER-SERVICE CARD

NEW PRODUCTS

Power Supply

593

Delivers 10 and 20 v



Model 500 power supply provides separate, regulated outputs of 10 and 20 v at 200 ma. Other specifications include: 0.2% regulation, current and voltage monitoring, electronic overload protection and a thermal cutout for high ambient temperatures. The unit is packaged in a module measuring 3-1/2 x 9-1/2 x 11 in.

Burr-Brown Research Corp., Dept. ED, Box 6444, Tucson, Ariz.

Price: \$365.

Availability: Delivery from stock to 60 days.

Waveguide

422

For testing applications

The Half-X waveguide, designed to mate commercially available carriages, permits measurement of impedance and vswr. Tests which ordinarily require the use of transformer sections can be performed with minimum incidental error. Flanging consists of a modified UG-39/U configuration.

Turbo Machine Co., Dept. ED, Lansdale, Pa.

Price: \$250.

Availability: From stock.

Oscilloscope

433

Accommodates 7-in. plug-ins

Type 1100-R scope is a basic cathode-ray indicator designed for incorporation into rack-mounted systems. There are 64 contacts for the transfer of signals and voltages between the main frame and the plug-ins. The scope is for conventional power-line operation as well as airborne equipment systems. It is rated for use on 50 to 2,500-cps power at 115 or 230 v. Frequency response is flat to 500 kc within ± 3 db.

Analab Instrument Corp., Dept. ED, 30 Canfield Road, Cedar Grove, N. J.

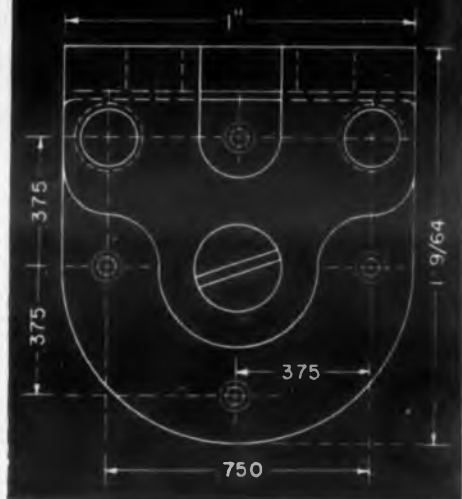
Price: \$385.

Availability: 30 days.



Telephone Relay

interchangeable with
many other makes



Stromberg-Carlson's type "E" relay combines the time-proven characteristics of the type "A" relay with a mounting arrangement common to many other makes.

As the drawing above shows, universal frame mounting holes and coil terminal spacing allow you to specify these relays—of "telephone quality"—interchangeable with the brands you have been using. Costs are competitive and expanded production means prompt delivery.

Welcome engineering features of the telephone type "E" relay are—**Contact spring assembly:** maximum of 20 Form A, 18 B, 10 C per relay.

Coil: single or double wound, with taper tab or solder type terminals at back of relay.

Operating voltage: 200 volts DC maximum.

You may order individual coil covers in a choice of 3 sizes for the new relay, as well as for our type "A" and "C" relays.

For complete details and specifications on the "E" relay and other Stromberg-Carlson relays, send for your free copy of Catalog T-5000R2. Write to Telecommunication Industrial Sales, 116 Carlson Road, Rochester 3, New York.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

CIRCLE 146 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

Heat Resistant DROTHERM HT

Patent Pending

● Adherent coatings direct on stainless steels. No preplates necessary.

● 10 millionths shows no discoloration after 24 hours at 360°F. in an air atmosphere. Faster production at lower cost.

● Meets all Mil specifications for 24 karat gold.



Technicinc ST1-6100

P.O. BOX 965 PROVIDENCE, 1 R.I.
7001 NO. CLARK ST. CHICAGO 26 ILL.

X-Band Circulator

570

Isolation is 20 db min



This 3-oz unit measures 3/4-in. high and 1-1/2-in. in diameter, not including TNC coaxial connectors. It has an insertion loss of 0.4 db over a 6% band, a vswr of less than 1.4 and an input impedance of 50 ohms. It handles 10 w avg and 10 kw peak.

Hycon Manufacturing Co., Dept. ED, 1030 S. Arroyo Parkway, Pasadena, Calif.
Availability: 30 days (for limited quantities).

Rack and Panel Plugs

429

Have coaxial inserts

The inserts for types DPNB, DPG and DPJ plugs and receptacles, containing 1, 2 and 3 coaxial inserts, are now suitable for use in the 5-kmc area. The inserts are 50-ohm coaxial plugs and jacks; they can be used with RG-58C/U and RG-142/U cable and 1/4-in. spirafil HT. The mated assemblies have a vswr of 1.25 max to 10 kmc.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.
Availability: Six weeks.

Modular-Silicon Rectifiers

512

For individual or combined use

These three series of modular-silicon rectifiers are designed for use individually or in a variety of circuit combinations. The S-5536 to S-5541 series is primarily for use as a voltage doubler or center tap; the S-5544 to S-5549 series is for connections into three-phase, half-wave connections; the S-5462 to S-5467 series is for use as open bridge for magnetic amplifiers or connected into bridge, and also as half-wave sections, individual, series or parallel.

Sarkes-Tarzian, Inc., Dept. ED, Bloomington, Ind.
Price: From \$2.05 to \$6.50 ea in sample quantities.



Here's what they've done with this remarkable READALL® instrument

Several weeks ago, we used the ad you see in the picture to ask a question and give some facts. We said that the READALL readout instrument was about the size of a candy bar, and that it could display, store or transfer up to 64 different numbers, letters or symbols *without* using complicated conversion equipment and "black boxes."

We explained that the READALL instrument was originally developed for data display in flight control equipment. We described the READALL instrument as an electro-mechanical, D.C. operated, readout device for displaying characters in accordance with a pre-determined binary code . . . a compact self-contained device . . . which can be applied to the output of digital computers, teletype receiving equipment, telemetering systems, or wherever data must be displayed. And we wound up by asking about new applications for our READALL instrument. Here are some of the answers to our question:

1. A leading aircraft corporation is using READALL instruments in a visual intercom system in patrol aircraft that's connected with anti-submarine warfare.
2. Another company uses READALL instruments in ground checkout equipment for a new Air Force bomber.

3. An oil company uses these readout instruments in a data reduction system that converts magnetic tape seismographic data to printed digital data and graphic chart strips.

4. A missile manufacturer uses READALL instruments in an automated "Missile Skin" milling machine.

5. These readout devices are being applied in nuclear reactor work for remote control and indication of rod position.

6. READALL instruments are now used in an electric power station monitoring system in Philadelphia.

7. READALL instruments are being used in display boards for the Air Defense Headquarters.

8. Another aircraft manufacturer uses READALL instruments in a flight simulator.

9. A branch of the military designed the READALL instruments into an airborne bomb-direction computer.

10. An aircraft systems manufacturer uses READALL instruments for display and print-out of data with a computer in a high altitude weather reconnaissance project.

We would be happy to tell you more about the READALL and its applications.

We would be happy to hear from you about possible applications. Please write to us at the address below.

"Pioneers in Push-Button Science"



UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA
CIRCLE 148 ON READER-SERVICE CARD

FROM RIVERSIDE-ALLOY



"Put ups" by the ALLOYIST* pay off in Production

There's a right *kind* of wire or strip "put up" for your production equipment . . . there's a right *size* for long runs and short runs. But, are you getting the kind and size of "put up" you need, *when* you need it?

The ALLOYIST has them all . . . spools, reels and Pay-Off-Paks for wire in overlapping weights 25 to 1000 pounds . . . strip by coil weight to 2000 pounds or exact lengths . . . rod in exact lengths or randoms. Start the job right. Order your alloys from the ALLOYIST for a pay-off in smoother production.

*Riverside-Alloy is the ALLOYIST to the electrical/electronic industry . . . a single, reliable source of strip, rod and wire in Nickel, Nickel silver, Cupro nickel, Stainless steels (ISOLOY), Phosphor bronze, Monel and Inconel . . . a supplier whose manufacturing processes insure your product superiority.

Riverside-Alloy Metal Division, H. K. Porter Company, Inc., Riverside, New Jersey.

RIVERSIDE-ALLOY

PORTER

METAL DIVISION

H.K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

CIRCLE 238 ON READER-SERVICE CARD

NEW PRODUCTS

Variable Delay Line

709

Delay range is 20 to 2,200 μ sec



A magnetostrictive variable delay line, model 192-1, provides delay lengths from 20 to 2,200 μ sec, adjustable to within 4 μ sec. Pulse repetition rate is 1 mc max. Signal-to-noise ratio is on the order of 10:1; insertion loss is about 60 db. Input and output impedances are 50 to 1,500 ohms. Temperature range is -55 to $+80$ C. The device, hermetically sealed, measures 4-1/2 x 5-9/16 x 23/32 in. MIL-STD-202A specifications are met.

Delttime, Inc., Dept. ED, 608 Fayette Ave., Mamaroneck, N.Y.

Availability: Delivery is 45 to 60 days.

Bi-Stable Magnetic Amplifier 406

Has multiple inputs for bias and logic functions

This transistorized, potted bistable magnetic amplifier is hermetically sealed. It has multiple inputs for bias and logic functions. Input signal power is 0.016 μ w, min; output is 28 v at 200 ma into a resistive load. Power requirement is 115 v, 400 cps. Temperature range is 0 to 65 C. The unit measures 2 x 2 x 3 in.

Microdot, Inc., Transformer Div., Dept. ED, 220 Pasadena Ave., South Pasadena, Calif.

Price: On request.

Availability: 2 to 4 weeks.

Trimmer Capacitor 409

Temperature coefficients are ± 50 , ± 75 and ± 100

The five models of the PDT series capacitors have linear tuning with a capacitance change of 0.5 pf per turn. Temperature coefficients are $+50$, $+75$ and $+100$. Capacitance ranges are 0.8 to 4.5, 0.8 to 8.5, 0.8 to 12, 1 to 18 and 1 to 30 pf. The Q factor at 50 mc is 500, dc voltage is 1,000, dielectric strength is 1,500 and insulation resistance is 10^6 meg.

Corning Glass Works, Electronic Components Div., Dept. ED, Bradford, Pa.

Price: At request.

Availability: From stock in prototype quantities.

Time-Sharing Problem?



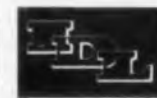
IDL MAY HAVE A SOLUTION -

Your data handling system, whether RF carrier or wire transmission line, may require time-sharing to increase its capacity and efficiency.

In the past, the advantages of motor driven switches used for multiplexing were outweighed by their disadvantages. They were smaller, lighter and simpler but, because of high contact resistance, bounce and short life, they contaminated data.

Then IDL introduced multi-fingered brushes traveling on the inner periphery of cylindrical sections to minimize resistance and bounce and extend trouble-free life to hundreds of hours. These concepts have been successfully applied to missiles in sampling 900 data points per second for more than 500 hours without signal contamination even in the milli-volt signal level ranges.

For example, Switch No. 500660 is a complete unit within a compact case, available at reasonable cost and capable of sampling up to 180 transducers. It combines 2 poles of 30 data channels with 2 poles of 60 data channels, each operating at 5 rps.



For further information, write for Technical Bulletin No. 500660; or let us propose a solution to your Time-Sharing Problem.

INSTRUMENT DEVELOPMENT LABORATORIES

INCORPORATED

Subsidiary of Royal McBee Corporation

55 MECHANIC STREET, ATTLEBORO, MASS.

CIRCLE 239 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

Voltage Dividers

584

Weigh approximately 5 lb.



The VDR series voltage dividers weigh approximately 5 lb and measure 9 x 6 x 4 in. Available in three grades of accuracy, these units have from five to seven switch-controlled decades of ± 2 ppm max absolute linearity and 0.1 ppm max resolution in resistance values from 100 ohm to 10 meg. They are suitable for table, panel or rack mounting.

Consolidated Resistance Co. of America, Inc., Dept. ED, 44 Prospect St., Yonkers, N. Y.
Price: \$200 to \$700 ea.
Availability: 6 weeks.

Power Supplies

427

Output is 117 v

These transistor-regulated sine-wave inverters provide an output of 117 v, nominal. Line regulation is better than 6% for input variations. Model PS3200 operates from inputs of 23.5 to 28.5 v dc and provides 250 va; model PS3201 operates from 23.5 to 28.5 and provides 500 va; and model PS3202 operates from 47 to 57 v dc and provides 1,000 va. Load regulation is better than 5% from no-load to full-load. Frequency is 60 cps $\pm 1\%$. The units can be rack mounted.

Power Sources, Inc., Dept. ED, Burlington, Mass.
Availability: 30 to 60 days.

Coaxial Crimp-Type Connectors 407

Mated length is 1-13/16 in.

These solderless connectors are available in a variety of mounting configurations. Male and female connectors can be mounted interchangeably. Mated length is 1-13/16 in. Working voltages are: 1,000 v max at sea level; 500 v max at 60,000 ft; vswr, less than 1.2 up to 2,000 mc. Life is 5,000 matings, minimum, without electrical deterioration.

Microdot, Inc., Dept. ED, 220 Pasadena Ave., South Pasadena, Calif.
Price: Varies with configurations.
Availability: 30 days.

For fast, high-resolution servo positioning

Inland d-c torque motors

From 0.1 to 3000 pound-feet

High torque-to-inertia at the output shaft

A typical stabilization application requiring a peak torque of 60 ounce-inches now uses an Inland torquer with a torque-to-inertia ratio of 5350 radians/sec.². This torquer replaces a gear train servo motor that had a ratio at the output shaft less than *one-tenth* that of the Inland torquer.

Direct drive promotes system accuracy

Direct drive without servo motor gear trains reduces friction and eliminates backlash and elasticity, leading to better over-all system accuracy.



COMPACT PANCAKE SHAPE now available in d-c torquers through exclusive Inland design



Exclusive commutator and brush rigging design

Patented features enable Inland to combine the compact pancake configuration with low-power input —high-torque output characteristics of a d-c torquer.

TYPICAL RATINGS FOR 20 OZ.-IN. TORQUERS

	T-1321-D	T-1321-B	T-1321-C
PEAK TORQUE, OZ.-IN.	20	20	20
VOLTS AT PEAK TORQUE, STALLED AT 25°C	31.4	24.8	39.6
AMPS AT PEAK TORQUE	1.82	2.25	1.46
TOTAL FRICTION, OZ.-IN.	0.5	0.5	0.5
ROTOR INERTIA, OZ.-IN. SEC. ²	.001	.001	.001
WEIGHT, OUNCES	5	5	5

Inland Power Amplifiers

Inland makes a complete line of power amplifiers for systems duty with Inland torquers whether in airborne, shipboard, or ground service. Specification sheets available on request.

For complete data on these or other d-c pancake torquers up to 3000 pound-foot output, address Dept. ED, Inland Motor Corporation of Virginia, Northampton, Massachusetts.



INLAND MOTOR CORPORATION
OF VIRGINIA
A SUBSIDIARY OF KOLLMORGEN CORPORATION
NORTHAMPTON, MASS.

Factory: Radford, Virginia

CIRCLE 150 ON READER-SERVICE CARD

NEW PRODUCTS

Transistorized Decade Counter 421

In-line, in-plane display is 1 in. high

Model 1401 decade counter has an in-line, in-plane numerical display 1 in. high. Some specifications are: paired-pulse resolution, less than 5 μ sec; counting rate, 200 kc with input of -10 kv at 1.5 μ sec; 55 C max temp; operating voltage, +30 v at 50 ma and +50 v at 4 ma pulsating dc; total power, 1.6 w. The unit measures 1-7/16 x 2-1/8 x 4-1/4 in. and weighs 7 oz.

Robotomics, Inc., Dept. ED, 4624 E. Garfield, Phoenix, Ariz.

Price: \$147 ea for 10 to 99 units.

Availability: 4 to 6 weeks.

Differential Preamplifier 585

Input impedance is 10 meg



Type LRA-042 preamplifier has an input impedance of 10 meg. Fixed gains of the ac unit are 10 x, 100 x, and 1,000 x. Noise level is less than 10 mv peak-to-peak over a maximum bandwidth in excess of 60 K. The high-frequency filter has nominal steps of 60, 10 and 1 kc, and 250 and 50 cycles. Low frequency is variable in increments of 0.01, 0.1, 1, 10 and 100 cycles.

Argonaut Associates Inc., Dept. ED, P.O. Box 273, Beaverton, Ore.

Price: \$160 F.O.B. Beaverton, Ore.

Availability: 2 weeks.

Oscillographic Recording System 474

Has eight channels

This direct-writing rectilinear recording system, less pre-amplifiers, comprises one eight-channel recorder and eight driver amplifiers. The recording elements provide a total deflection of ± 20 mm with a frequency response to 120 cps. Standard features include: choice of dc, ac, carrier and servo pre-amplifiers; 18 push-button chart speeds from 0.5 cm per hr to 200 mm per sec. Paper capacity is 400 ft for ink; 250 ft for electric.

Cohu Electronics, Inc., Massa Div., Dept. ED, 5 Fottler Road, Hingham, Mass.

NEW SYLVANIA FLEXI-CORE TRANSFORMER

creates new freedom for designers!

Radically new in concept! Radically different in construction! Radically smaller and lighter! That's the dramatic news in the Sylvania Flexi-core transformer. And for the design engineer, Flexi-core opens up whole new design possibilities.

Thanks to this new core construction, Sylvania can now make transformers up to 30% smaller and lighter than types now in use! Odd size and special shape transformers can be made without the usual penalties in cost and delivery. **RESULT:** the design engineer can make the sweeping changes he desires and still stay within budget restrictions.

The heart of the new transformer is a formed core consisting of nests of laminations of fabricated steel strips.

These transformers have identical electrical characteristics.



STANDARD
E-I CONFIGURATION



NEW FLEXI-CORE
PRODUCED BY SYLVANIA

The nests are fitted together providing 100% interleaving, thus minimizing magnetizing current. And since virtually any size core can be produced from the steel strips—no tools or dies are needed. **RESULT:** the design engineer now for the first time can dictate the physical configuration of a transformer, depending upon the electrical characteristics required.

Consult your Sylvania Special Products representative. Or write: Sylvania Electric Products Inc., Ipswich, Mass.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**



Miniature Circuit Breaker

408

For commercial applications

This commercial version of a previously developed military-type circuit breaker weighs 1-1/2 oz and is slightly larger than a match-box. Designated series VP, the device is suitable for airborne, portable and mobile applications. Ratings from 0.05 through 15 amp are available for 110-v ac or 50-v dc operation. The devices also operate as on-off power switches. Series-trip, shunt-trip, relay-trip and calibrating-tap models are available.

Heinemann Electric Co., Dept. ED, 248 Magnetic Drive, Trenton 2, N. J.

Price: On request.

Availability: 4 to 5 weeks.

Spectrum Analyzer

745

High-resolution type



Model MD-500 high-resolution spectrum analyzer is for monitoring single-sideband modulation, fm modulation, parasitic oscillation and 60- or 120-cps hum. Two inputs allow for conversion of any signal from 450 kc to 100 mc with the use of an external oscillator. Specs include: variable sweep width, 0 to 100 kc with fixed sweeps of 150 cps, 500 cps, 2 kc and 10 kc; 50-ohm input impedance, 60-db dynamic range; 20- μ v sensitivity; and scan rates of 0.1 to 30 cps.

Proboscope Co., Inc., Dept. ED, 8 Sagamore Hill Drive, Port Washington, N.Y.

Low-Level Magnetic Preamplifier

420

Detects 10- μ v dc signals

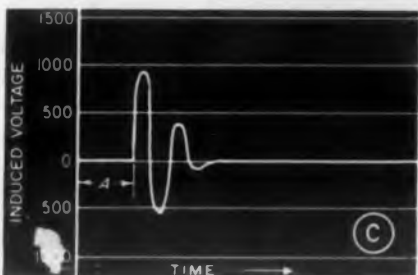
Model 164 amplifier detects 10- μ v dc signals from thermocouples, strain gages, hall generators, and other low-level dc signal sensors. The self-contained unit requires less than 3 w of 115 v \pm 10% power for operation.

Acromag, Inc., Dept. ED, 22515 Telegraph Road, Southfield, Mich.

Price: \$65 to \$147.

Availability: From stock.

HOW DO YOU RATE AS AN ELECTRONICS DESIGN ENGINEER?



RELAY APPLICATION QUIZ

CHANCES are that a circuit with more than one relay will use the contacts of one relay to energize the coil of a second relay. Which curve best represents the emf induced by interrupting the power to a standard subminiature 28-volt, d-c relay coil: A, B, or C?

When the current through a relay coil is interrupted, the emf induced opposes the change of current which caused it. The magnitude of the emf equals $-L di/dt$, and, since the time increment is practically instantaneous, the induced emf assumes very large proportions, often reaching values of 1200 to 1500 volts. The answer is A.

What does this mean in terms of relay circuit design?

It means that there isn't a subminiature or microminiature relay that can handle 1200 volts between open contacts without arcing. Arcing erodes contact surfaces and creates radio-interference problems.

Most contact erosion occurs during contact break. The rate of erosion correlates closely with the amount of energy in the load which is approximated by the relation $W = \frac{1}{2}LI^2$ where W is energy in joules, L is the load inductance in henries, and I is the steady-state current. The L/R ratio has little effect on the erosion rate.

A life of 100,000 operations is a limit for contacts handling a 1.5 to 2.0-joule load; reducing the load by a third will extend the probable life by a factor of 10.

Filtors' has developed an efficient arc-inhibiting circuit that is sealed within the relay. The increase in relay reliability and life more than offsets the small additional cost.

FILTORS, INC., SPECIALISTS IN THE DESIGN AND MANUFACTURE OF SUBMINIATURE AND MICROMINIATURE RELAYS.



Makers of the most efficient microminiature relay motor in the industry—the powerful new Sensi-Tork rotary relay motor; used in the J-series relays, the "Pillbox" printed circuit relay, and in the first premium quality microminiature relay, the Golden G.

FILTORS, INC. RELAYS

PORT WASHINGTON/NEW YORK/PORT Washington 7-8220

CIRCLE 240 ON READER-SERVICE CARD

NEW PRODUCTS

Silicon Power Transistors 419

For high-power switching applications

These silicon transistors are for use in high-current power supplies, regulators, amplifiers and high-power switching applications. Maximum ratings are: collector-current and emitter-current, 30 amp; power dissipation, 250 w, V_{ce} , up to 100, 150, or 200 v. The three series have I_c ratings of 10, 15 and 20 amp at a current gain of 10. Some of the maximum ratings are: Base current, 10 amp; base-to-emitter voltage, 15 v; thermal impedance, 0.45 deg C per w.

Westinghouse Electric Corp., Dept. ED, P.O. Box 2099, Pittsburgh 30, Pa.

Price: Over 25 units: 10-amp, \$74 to \$137 ea; 15-amp, \$98 to \$163 ea; 20-amp, \$123 to \$173 ea.

Rotary Switch 746

For aircraft and missile uses



This size 8 rotary switch is designed for aircraft and missile applications. It can be used to sequence or switch circuitry as a function of time or of shaft position. Typical specifications are: two switching tracks; mechanical accuracy of segmentation, ± 3 deg; maximum speed 700 rpm; torque from -65 to $+260$ F, 0.1 oz-in.; and weight, 1 oz.

Kearfott Div., General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

Transistorized Crystal Oscillator 417

Frequency range is 1 to 5 mc

This oscillator is for application in communications systems, airborne electronic equipment, and guided missiles. It contains a silicon transistor oscillator circuit. Frequency range is 1 to 5 mc; 24-hr frequency stability is $\pm 2 \times 10^{-7}$.

Hughes Aircraft Co., Industrial Systems Div., Dept. ED, International Airport Station, Los Angeles 45, Calif.

Price: \$350 ea in lots of 10; \$240 ea in lots of 100.

ALL THE TUBES YOU NEED... SONOTONE HAS!

Now you can simplify your inventory, boost discounts, add higher quality to your tube line...with Sonotone's expanded new line of more than 150 top-quality tube types. All Sonotone tubes undergo rigid performance and production tests...many reliable tubes are being used right now for rigorous space and military projects. Available for industrial and entertainment uses, as well. For high quality and top profits, you can rely on Sonotone tubes.

Sonotone. P. PROD

Electronic Applications Division, Dept. T23-110

ELMSFORD, NEW YORK

Leading makers of rechargeable batteries, phone cartridges, speakers, microphones, tape heads and electronic tubes.

In Canada, contact Atlas Radio Corp., Ltd., Toronto

CIRCLE 241 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

Speed Reductor 658

The Inco step-function speed reductor provides a variety of positive and exactly repeatable speed ratios. Used with crystal growing furnaces, the Inco step-function speed reductor controls furnace elements to provide precise temperature and rate-of-temperature changes. The reductor mounts in a standard 19 x 7-3/4 in. relay rack panel.

Barry Controls, Inc., Inco Co. Div., Dept. ED, Hollis St., Groton, Mass.

Photoelectric Scanner Relay 659

Type PE5 photoelectric scanner relay has an adjustable delay that can be varied from 50 msec to 1.5 sec. Combinations of light source and photocell permit a choice of scanning distance and the use of direct light or a proximity sensor. The dpdt plug-in relay handles an 8 amp, non-inductible load at 115 v ac. Power required is 100 to 130 v ac.

Farmer Electric Products Co., Inc., Dept. ED, 2300 Washington St., Newton Lower Falls, Mass.

High-Temperature Insulation 660

Type XR-65 silicone, a solventless silicone resin for high-temperature insulation, is suitable for form-wound coil impregnation, lamination using wet lay-up techniques and for potting and encapsulation.

Union Carbide Corp., Silicones Div., Dept. ED, 270 Park Ave., New York 17, N. Y.

Price & Availability: is immediately available from stock at \$7.50 per lb.

Corona Pick-Up Network 653

This corona pick-up network is composed of a corona-free high-voltage capacitor and a suitable rf choke with input and output connections. It is an l-c voltage divider that resonates at about the correct frequency and matches the usual pulse amplifier-scope detector combination used in corona test sets. Unit is corona-free to 25 kv rms for use with corona-free high voltage transformers of 25 kv rms or lower output.

Peschel Electronics, Inc., Dept. ED, Towners, Patterson, N. Y.

Price & Availability: \$200 ea; delivery 14 days after order received.

Precision Work Lamp 541

This work lamp has been designed for use in close, critical assembly, inspection and quality control. It supplies glare-free, concentrated lighting in five stages up to 1,000 ft-c. The light shaft proper has three joints and the entire shaft rotates 360 deg on the base. A five stage switch is located on the power supply base and a 7-1/2-ft extension cord hooks in between the base and the lamp, permitting inspection of areas within large consoles.

Tensor Electric Development Co., Inc., Dept. ED, 1873 Eastern Parkway, Brooklyn, N.Y.

Price: Under \$50.

Availability: Two to three weeks.

If you have this problem, investigate

GRIP-EZE®

—an example of Phelps Dodge's
realistic approach
to Magnet Wire research



THE PROBLEM: To develop a solderable film-coated wire without fabric for winding universal lattice-wound coils without adhesive application.

THE SOLUTION: Phelps Dodge Grip-eze*—a solderable film wire with controlled surface friction for lattice-wound coils that provides mechanical gripping between turns and keeps wire in place.

EXAMPLE: Coils wound with (a) conventional film wire; (b) Grip-eze. Note clean pattern of Grip-eze as compared to fall-down of conventional film wire.

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

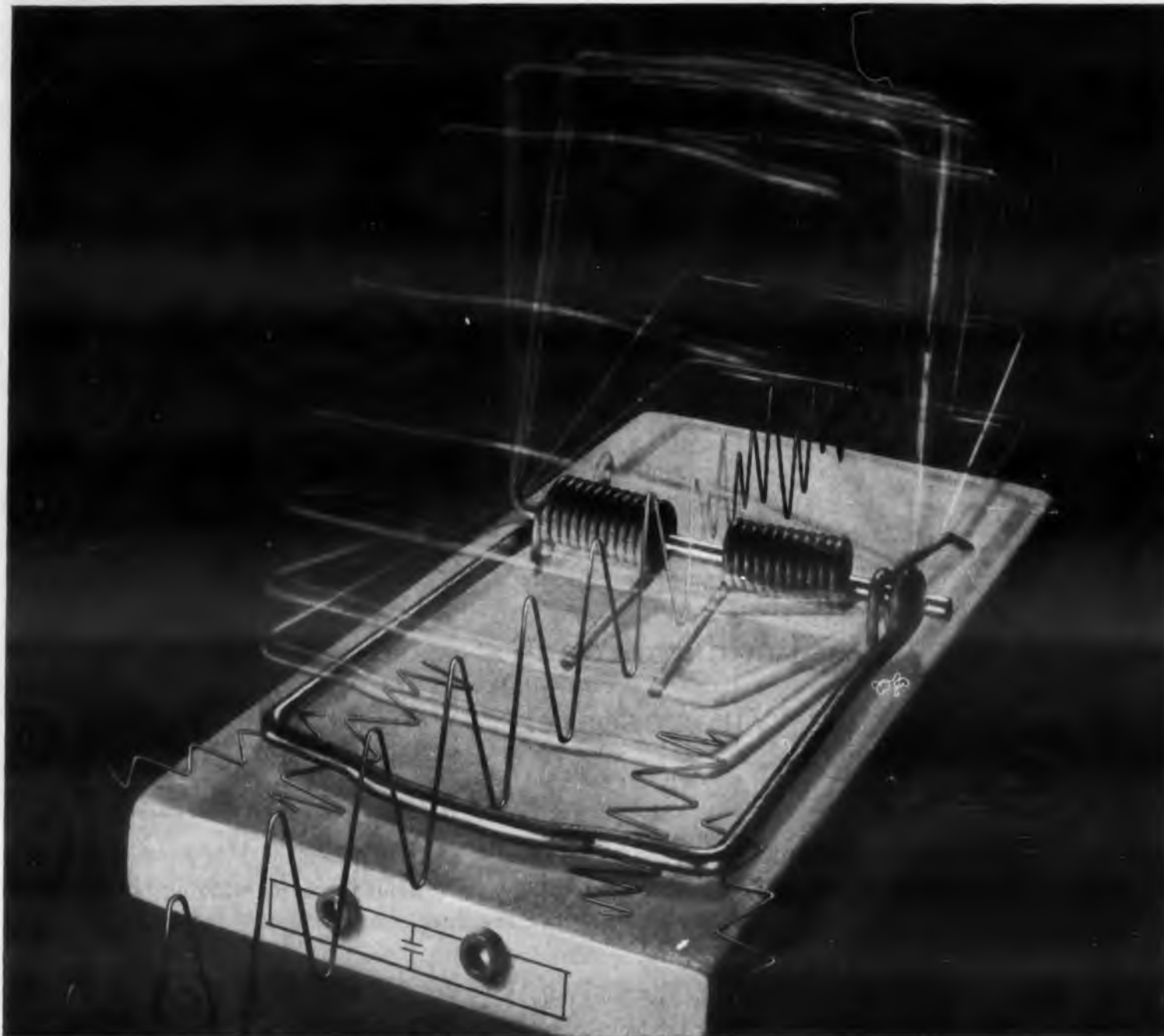
FIRST FOR
LASTING QUALITY
— FROM MINE
TO MARKET !



**PHELPS DODGE COPPER PRODUCTS
CORPORATION**

**INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA**

CIRCLE 154 ON READER-SERVICE CARD



How to build a better (audio signal) trap!

Magnetics Inc. permalloy powder cores give filter designers new attenuation and stability standards—and miniaturization to boot!

The art of trapping unwanted frequencies has been advanced during the past year with a succession of improvements in molybdenum permalloy powder cores by Magnetics Inc. Most audio filter designers now work with smaller cores, more stable cores and cores whose attenuation characteristics are ultra-sharp. Do you?

Do you, for example, specify our 160-mu cores when space is a problem? With this higher inductance, you need at least 10 percent fewer turns for a given inductance than with the 125-mu core. What's more, you can use heavier wire, and thus cut down d-c resistance.

What about temperature stability? Our linear cores are used with polystyrene capacitors, cutting costs in half compared to temperature stabilized moly-permalloy cores with silvered mica capacitors. Yet frequency stability over a wide swing in ambient temperatures is increased!

And what do you specify when you must rigidly define channel cut-offs, with sharp, permanent attenuation at channel crossovers? Our moly-permalloy cores have virtually no resistive component, so there is almost no core loss. The resultant high Q means sharp attenuation of blocked frequencies in high and low band pass ranges.

Why not write for complete information? Like all of our components, molybdenum permalloy powder cores are *performance-guaranteed* to standards unsurpassed in the industry. *Magnetics Inc., Dept. ED-82, Butler, Pa.*



CIRCLE 155 ON READER-SERVICE CARD

NEW PRODUCTS

Beacon Code Simulator

430

Covers 2.7 to 2.9 and 5.1 to 5.9 kmc bands



This model PSG-10A beacon code simulator is a double-pulsed microwave signal source covering 2.7 to 2.9 kmc and 5.1 to 5.9 kmc. Pulse width can be adjusted from 0.3 to 10 μ sec, pulse spacing from 0 to 100 μ sec, and prf from 10 to 2,000 pps. Pulse controls can be preset in the C and S bands. Pulse or cw power of 100 mw is available through 40 db variable attenuators for sensitivity measurements. The instrument is housed in a 19 x 10-1/2 x 15 in. cabinet and operates from a 60 to 400 cps power source. The instrument is designed to check sensitivity and pulse decoding circuitry of radar beacons.

Micro-Tel Corp., Dept. ED, 2127 Maryland Ave., Baltimore 18, Md.

Price & Availability: \$3150; 30 days.

Image-Intensifier Tube

418

Intensifies light radiation by electronic means

Type WX-4047 image-intensifier tube intensifies light radiation by electronic means. It produces an image of reduced size whose brightness is increased by a factor of 2,500, minimum, for actinic blue input radiation, by 1,000 for input radiation at a color temperature of 2,870 deg K. The brightness decays to 10% in 2 μ sec. Input resolution is 75 line pairs per in. For imaging, it is approximately 10^{-7} ft-c. Maximum ratings are 30 kv, anode screen to photocathode and 1 ma peak-pulse anode screen current. The 15-3/4 in. long tube weighs 6-1/8 lb and has a diameter of 8-11/16 in. max.

Westinghouse Electric Corp., Electronic Tube Div., Dept. ED, P.O. Box 284, Elmira, N.Y.

Price: \$3,000.

Availability: 30 days.

Subminiature Microwave Antennas

411

Operate at 2,000 F

These coaxial-microwave antennas are capable of constant radiation in 2,000 F, 60 g shock environments. Designated the Di-optic series, the devices are subminiature, have end-fire radiation characteristics, and are suitable for aircraft and

CIRCLE 157 ON READER-SERVICE CARD

missile applications. Units with linear or elliptical polarization from 1,300 to 14,000 mc are available.

Don-Lan Electronics, Inc., Dept. ED, 1131 Olympic Blvd., Santa Monica, Calif.
 Price: \$175 through \$7,000.
 Availability: 30 to 45 days.

Weldable Strain Gages 415

Have 60-ohm resistance

These strain gages are available in three types: Model SS-E-5, uncompensated; model SS-E-5A, temperature-compensated for a specific material; and model SS-E-5B, in a set, matched for temperature to a compensating gage. The units, measuring 9/16-in. long, have a 60-ohm resistance. They are for static-strain measurements to 800 deg F and dynamic-strain measurements to 1,600 deg F.

Micro-Test, Inc., Dept. ED, 1718 21st St., Santa Monica, Calif.
 Price: \$16.50 to \$19.
 Availability: From stock.

Stereo Controls for Audio Tracking 412

Have matched elements

These matched-element controls provide tracking characteristics suitable for gain control of dual-channel sound systems. These dual assemblies have tolerances within 2, 4 or 6 db over ranges of 40, 60 and 80 db. These units are said to simplify operation of stereo equipment by allowing one-knob control of both channels.

Clarostat Manufacturing Co., Dept. ED, Dover, N. H.
 Availability: 4 to 8 weeks.

Video Correlator 472

To increase radar effectiveness

The "Video Correlator" is adaptable to most radar systems. It performs post-detector correlation of the video signal. Its basic function is the sorting of target pulses out of noise and interference, based on a uniform time-spacing or delay between successive video-pulses or the pulse-repetition period of the radar. Key elements of the device are two matched magnetostrictive delay lines and their associated coincidence gates. All characteristics of the raw-video signal are retained without distortion.

Chance Vought, Electronics Div., Dept. ED, Dallas, Texas.

finding the golden needle in the haystack



(Top right) sketch illustrates mid-air catch of returning Discoverer XIV nose cone snagged by an airplane-towed "skyhook." (left) A captured practice capsule is slowly reeled towards the rear opening of airborne C-119 Recovery Plane.

NOSE CONES PLATED WITH SEL-REX BRIGHT GOLD* RECOVERED FROM SPACE ORBITS!

Orbiting the globe, then returning earthward upon signal, Discoverer XIV's space capsule plummeted home to be snatched from the heavens in an historic mid-air catch!

U.S. teamwork had plucked the nose cone from a million miles of firmament—marking a significant stride forward in the Free World's space program.

The returning space capsule was plated with Sel-Rex Bright Gold. So was its predecessor, Discoverer XIII, which had been rescued earlier from the Pacific Ocean.

This patented plating process was applied by Philadelphia Rust-Proof Co., Inc. to provide maximum heat reflectivity and emissivity, under sub-contract from General Electric Company, Missile and Space Vehicle Department. Sel-Rex precious metal plating processes, in fact, are included in the original specifications of many advanced Space Age projects.

As producer of the world's largest selection of precious metal processes, Sel-Rex offers unique dependability to users of its plating systems. For, Sel-Rex engineers have removed the guess work, instead assure you of consistent plating quality, the quality that counts in critical areas.

Sel-Rex sales and service technicians throughout the Free World are ready to serve you with unmatched professional precious metal plating services.

Technical literature free on request. Specify precious metal(s) and your application.

Patented processes for plating with Gold, Rhodium, Platinum, Palladium, Silver, and to produce "custom alloys" for your particular requirements.



SEL-REX CORPORATION

MUTLEY 10, NEW JERSEY

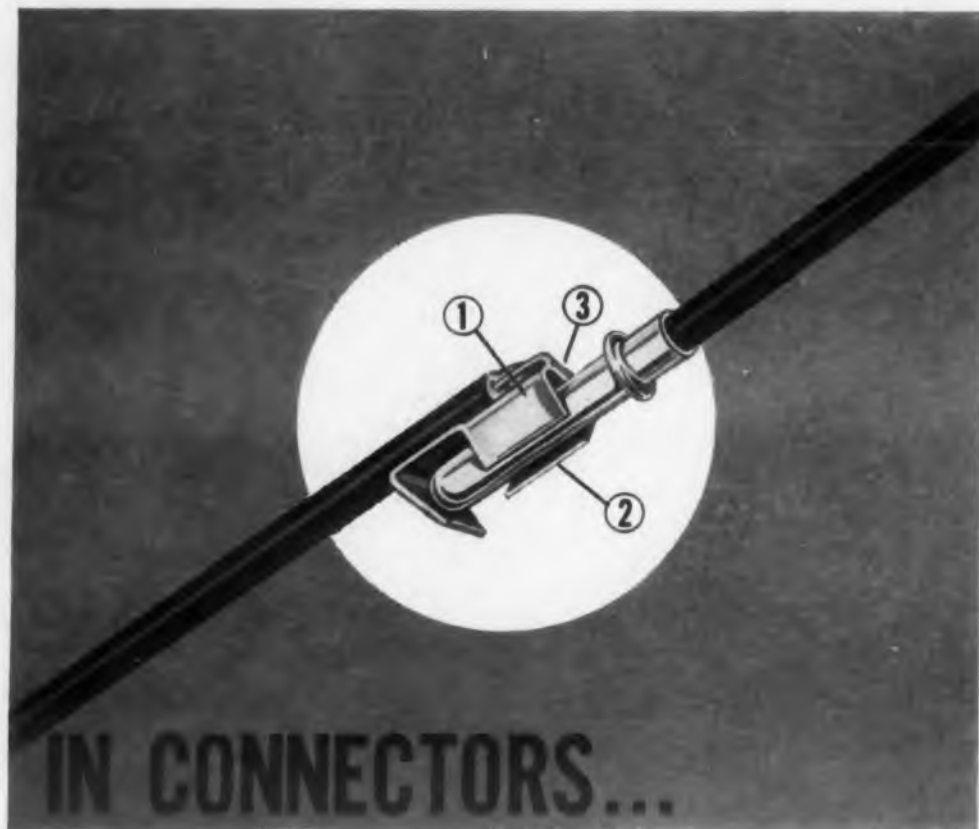
World's largest selling precious metal plating processes

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(Above) President Eisenhower holds American flag which was in recovered capsule during its flight through space. Capsule shown was electroplated with patented Sel-Rex Bright Gold Process. With the President are General Thomas D. White, Air Force chief (center) and Col. Charles G. Mathison, who directed the "capsule chase."

*Patented



IN CONNECTORS...

it's the
CONTACT
that counts!

3 positive contact surfaces on each Alden top-connected contact give you:

- More reliable electrical contact
- More secure mechanical grip
- Minimum electrical resistance

Each lead has individual strain relief because wire is doubled back through contact tab. Punch press contact design permits rapid heat transfer — eliminates unreliable cold solder joints as in screw machine contacts. Danger of insulation pull back is eliminated by bringing wire insulation right into molded clip pocket.

These unique Alden molding techniques in connector design drastically reduce the number of parts required and make possible multi-contact connectors of amazing basic simplicity and reliability.

Resilient Alden contacts can be included in any type of molded insulation for any combination of contacts. Hundreds of standard off-the-shelf designs are quickly available — with or without leads — or as part of unit-molded cables.

Our Customer Department will work closely with you on any connecting or cabling problems. A letter with description or sketch will enable us to provide recommendations or samples at once.



New, flameproof, high voltage connectors now available in high-density, flame-retardant polyethylene. Light, compact connectors for applications up to 30 KVDC and up to 250° F without distortion.

First major advance in connector reliability since potting offers fool-proof, tamper-proof connections for trouble-free operation. Alden "IMI" connectors and cables (wires, contacts, or other inserts) are integrally molded in a single hot shot of insulation so that material forming the connectors and covering the wires forms a single continuous, bonded insulation.

Standard assembled connectors in non-interchangeable layouts with from 2 to 11 contacts; miniature connectors, plain or shielded, for carrying power or signal; miniature plugs and sockets; signal connectors; and CRT connectors are all available for fast delivery.

ALDEN
PRODUCTS COMPANY
11139 North Main St., Brockton, Mass.
CIRCLE 158 ON READER-SERVICE CARD

NEW PRODUCTS

Special-Purpose Receiver

440

For am and cw reception



Having a tuning range of 55 to 260 mc, model 2501-A receiver is designed for measuring the Doppler shifts of incoming signals. It has a low-noise figure with uniform performance throughout the entire range. The input signal is compared with a standard reference signal of known characteristics. Power requirement is 70 w.

Vitro Corp. of America, Nems-Clark Co., Dept. ED, 919 Jesup-Blair Drive, Silver Spring, Md.

Price: \$1,980.

Milli-Microvoltmeter

441

Ranges from 0.1 μ v to 100 μ v



Milli-microvoltmeter model 149 will measure potentials of a few milli-microvolts. Ranges cover from 0.1 μ v to 100 μ v full scale in steps of one and three times. Stability after a 1-hr warm-up is within 0.03 μ v per 8 hr. Speed of response to 90% of full scale is less than 0.5 sec on most ranges. Output is 10 v, 5 ma for a full scale deflection on any range.

Keithley Instruments, Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

Price: \$850 fob Cleveland.

Peak Reading Voltmeter

442

Displays positive transient voltage peaks



The PRV-2 Single Transient Peak Reading Voltmeter is designed to accept and display the

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DEVICE DEVELOPMENT ENGINEERS

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S-C DIVISION

offers you

1. A key position with the leader in the field.
2. Real opportunity for personal, professional advancement.
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At Texas Instruments, solid state device development engineers will find the opportunity to pioneer in the application of unique phenomena in semiconductor materials to create specialized components. Studies involve high-speed, high-frequency germanium mesa transistors; tunnel diodes; computer devices; silicon transistors.

Requirements: degree in Electrical Engineering, Physical Chemistry of Physics and experience in semiconductor or related development areas.

TEXAS INSTRUMENTS INCORPORATED
Semiconductor-Components Division
Box 312, Dept. 147, Dallas, Texas



For more information on opportunities for Device Development Engineers with TI in Texas, please return coupon together with brief statement of your qualifications.

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STATE _____

CIRCLE 908 ON PAGE 209

ELECTRONIC DESIGN • November 9, 1960

peak values of any transient, positive-voltage pulse of arbitrary shape. An input-sensing circuit detects a peak voltage and initiates readout while blocking further input signals until the instrument is reset. Readout is provided as a four-digit, decimal value, directly in volts with an accuracy of one per cent.

Curtiss-Wright Corp., Electronics Div., Dept. ED, P.O. Box 8324, Albuquerque, N.M.
Price: \$2,750; fob Albuquerque.

Voltage Regulator

435

Occupies 2.1 cu in.



Designed for missile applications, this solid-state voltage regulator accepts 24 to 32 v dc and provides a regulated output of 16 to 18 v. For load currents up to 100 ma, the output voltage is constant to within 300 mv. As the input varies from 24 to 32 v, the output voltage does not vary more than 100 mv. Nominal efficiency is 90% of rated load.

Acton Laboratories, Inc., Space Instrumentation Div., Dept. ED, 533 Main St., Acton, Mass.

FM-FM Telemetry System

452

For high acceleration data



Model 5000 silicon-transistorized fm-fm telemetry system has been designed to obtain data from systems in a high state of acceleration. Transmission of data is by means of a radio-frequency link between the system and a remote receiving station. Specifications include: radio-frequency carrier, to 100 mc; subcarrier frequencies, 400 cps to 70 kc; typical range, up to 250 ft; power supply, 9 v dc; weight, 10-oz nominal. Typical applications include engine piston and turbine temperature and pressure measurements.

Solid State Electronics Co., Dept. ED, 15321 Raven St., Sepulveda, Calif.

An Invitation to Come Alive

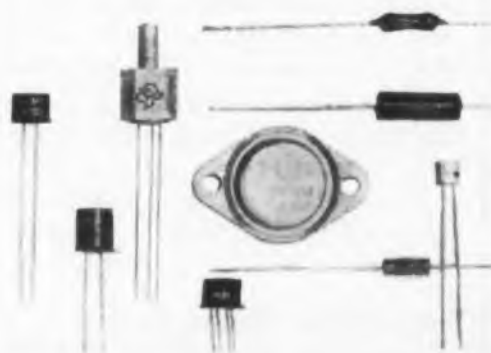
Not to suggest that you're dead if you aren't on the TI team!

➔ We are suggesting, though, that you consider some of the factors that make Semiconductor-Components division of TI an unusually lively atmosphere for achieving a keen sense of personal, professional accomplishment. Consider, for example . . .

TI PRODUCTS

. . . they pace the industry

TI manufactured the first commercially-available silicon transistors . . . developed the first semiconductor network . . . originated high voltage silicon rectifiers . . . produced the first VHF transistors . . . made the first high-gain low-cost radio frequency transistor (making possible the first "pocket" radio) . . . developed the first 400 milliampere 200-600 volt diffused silicon glass diodes.



TI LOCATION-IT ENCOURAGES RELAXED LIVING

Dallas provides many advantages for wholesome family living. It's an outdoor, informal way of life . . . combined with the convenience and stimulation of one of America's most modern cities.



TI PEOPLE-- they pioneer, invent, succeed

"It's a fact that an individual's opportunities at TI S-C are limited only by his own ability. That — and the highly interesting work and good people — makes this company unique in my opinion." — Harry Goff (BS/EE, Texas '51), Manager of Silicon Power Transistor Department (upper right).

"I've enjoyed my 10 years with TI because of the constant challenge, growth opportunities, association with creative people who don't depend on handbooks for answers." — Art Evans (BS/EE, SMU '49) Section Head, Semiconductor Networks Department, holder of patent for Temperature Control System for S/C Crystal Puller (upper left).

"The most appealing thing about working at TI S-C is the freedom I have on technical programs. To an engineer this is all-important." — Elmer Wolff (BS/EE, SMU '52) Project Manager, Silicon Design Engineering, participant in development of the first silicon mesa transistor (lower photo).

TI MANAGEMENT -- It Stresses Research, Creates Markets

"Texas Instruments leads the industry in sales, and in technology it's considered second only to Bell. In 1959, it scored net sales of \$193-million, about half attributable to its broad line of semiconductors which includes silicon and germanium transistors of all types, silicon diodes and rectifiers, and silicon controlled rectifiers . . . Most of this growing has been

done on self-generated capital, thanks to the Semiconductor-Components division, undoubtedly TI's most profitable operation. The company has won its eminence by astute assessment of new products and canny timing. Its broad technological skills have made it first with many semiconductor devices." — *Business Week*, March 26, 1960.

TEXAS  INSTRUMENTS
SEMICONDUCTOR - COMPONENTS DIVISION INCORPORATED



Scientists and engineers in semiconductor and related fields are invited to investigate TI's opportunities for professional advancement and personal accomplishment. The coupon below will bring you our booklet detailing the TI and Dallas stories.

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My specialty is _____

CIRCLE 875 ON READER-SERVICE CARD

READ .0002 $\mu\mu\text{f}$



PRECISION 3-TERMINAL (INSENSITIVE TO GROUNDED CAPACITANCE) CAPACITANCE BRIDGES

MODEL 74C

- 100 KC Test Frequency
- 0.0002-11,000 $\mu\mu\text{f}$
Generally 0.25%
- 1000 ohms to 1000 megohms
Shunt Resistance
- 0.001 to 1000 μmhos
Conductance

Price \$935

MODEL 75A

- 1 Mc Test Frequency
MIL SPEC. TESTING
- 0.0002 to 1000 $\mu\mu\text{f}$
Generally 0.25%
- 1000 ohms to 100 megohms
Shunt Resistance
- 0.01 to 1000 μmhos
Conductance

Price \$990

MODEL 74C-88 (Shown)

- With -5 to +100V DC Bias
for Diode Testing

Price \$995

MODEL 75A-88

- With -5 to +100 VDC Bias
for Diode Testing

Price \$1050



Boonton ELECTRONICS Corp.

MORRIS PLAINS, N. J. • Phone JEFFERSON 9-4210

CIRCLE 161 ON READER-SERVICE CARD

NEW PRODUCTS

Explosive Switch 492

This miniature switch has a reliability factor of 99.997%. The action of an explosive charge established a large-area permanent contact, providing virtually failure-proof completion of the circuit. The unit withstands normal missile environments. Contact capacity is 20 amp.

Mimx Corp., Dept. ED, 1505 Gardena Ave., Glendale, Calif.

Cable Tubing With Zipper Closure 543

This jacketing of vinyl-impregnated nylon cloth has a vinyl zipper closure and can be applied after the individual conductors of the cables have been tested and the system proved reliable. The vinyl zipper closure of the jacketing permits easy re-inspection of the system at any time. High tensile strength and abrasion resistance are claimed by the manufacturer.

Zippertubing Co., Dept. ED, 13000 Broadway, Los Angeles 61, Calif.

Electronic Drawer Package 547

The electronic drawer package, series ED1, is designed for use in standard 19-in. EIA relay rack cabinets. Drawer material is all aluminum alloy. Front panel is standard 19-in. wide by 5-1/4 in., 7-in., 8-3/4 in. or 10-1/2 in. high. Chassis depths are 15, 17 or 19-in. Side frames are drilled for Chassis-Trak (R) mounting and notched for panel locks if desired.

Western Devices, Inc., Dept. ED, 600 W. Florence Ave., Inglewood 1, Calif.

Thick Panel Phone Jack 542

The thick panel phone jack can be mounted in any panel up to 1-1/4 in. thick. It mates with the firm's "Littel Plugs." There are no exposed contact springs, body is nickel-plated and insulation is of nylon and XXP paper phenolic. Available in two and three conductor types.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

Price: Two conductor, \$1.35; three conductor, \$1.50.

High Temperature Control Knobs 545

This line of control knobs is molded of high-temperature nylon and was designed to meet the specifications of MIL-K-3926. The skirted, pointer-type knobs will withstand temperatures to well over +300° F and have excellent resistance to impact, torque, humidity and salt spray, according to the manufacturer. For use on standard 1/4-in. shafts, each knob has two recessed-hex-head set screws located 90 deg apart to ensure secure fastening.

Milton Ross Co., Dept. ED, 237 Jacksonville Road, Hatboro 48, Pa.

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FOR USE IN PRODUCTION OF SEMI-CONDUCTOR METALS...

VITREOSIL is ideal for producing such metals as germanium and silicon. Write us your requirements or special problems. See our ad in Chemical Engineering Catalog.

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- PURITY**—purest form of fused silica
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- HOMOGENEITY**—completely homogeneous and free from granularity
- AVAILABILITY**—block material for lenses, prisms, etc.; rod, fiber, wool; hollow ware as tubing, crucibles, and special apparatus.

Write for complete, illustrated catalog.



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CIRCLE 162 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

reliable
long life
up to 125°C



TANTALUM FOIL ELECTROLYTIC CAPACITORS



iei Tantalum foil electrolytic capacitors (Series HT) operate between -55° and $+125^{\circ}$ C without voltage derating, have long life packed into their small cases, and hence are eminently suited for the extreme environments of aircraft and missile flights. Also used extensively for radar, communications, computers and control systems, because of their reliability.

iei Series HT features.

Superior etching gives better finish in foil edges • Hermetic seal guards against electrolyte leakage • Long shelf life without deterioration • Non-corrosive electrolyte • Partial polar units available for space and weight economy • Dissipation factor appreciably lower than MIL-C-3965 • D.C. leakage only half the maximum allowed • Polar and non-polar construction, etched or plain foil, 0.15 to 580 μ F, 10 to 150 WVDC in five case sizes • Equal ratings in smaller cases for subminiaturization • Higher capacities on special order.

Write for further information.

International Electronics Industries, Inc.
Box 9036-Z, Nashville, Tennessee

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where reliability replaces probability

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Test Jacks For Electronic Circuits 544

No external hardware is required to mount this test jack into a panel board or chassis, it is simply pressed into a pre-drilled or punched hole. Contacts are beryllium copper, electro-tin plated. Insulators are molded nylon and available in colors of blue, red and black.

Augat Bros., Inc., Dept. ED, 33 Perry Ave., Attleboro, Mass.

Price: \$0.045 and up.

Availability: From stock.

Cable Retractor 548

These cable retractors utilize elastic cord which meets or exceeds MIL specifications for tear and tensile strength, tension set, ozone resistance, fungus resistance and temperature range. They maintain a constant tension and correct suspension of cable at all times permitting adequate cable length for full extension and tilting of chassis without hazard of snagging.

Western Devices, Inc., Dept. ED, 600 W. Florence Ave., Inglewood 1, Calif.

Portable Tape Winder 549

This tape winder is designed for use in storing transmitted tape wherever teletypewriter equipment is used. Equipped with a 12 in. metallic reel, it holds up to 1,300 ft of chadless and up to 2,000 ft of fully perforated tape. Winding tension is adjustable. Dimensions are: height, 16-3/8 in.; width 12-1/2 in.; depth, 6 in. The unit weighs 13-1/2 lb.

Western Apparatus Co., Div. of Comptometer Corp., Dept. ED, 5600 Jarvis Ave., Chicago 48, Ill.

AF Meter 394

Model 300 operates on any waveform with peak ratios of less than 8:1. It makes direct measurements from 0 to 30,000 cps in six ranges. Integral power supply and input-level control are included. Minimum input is 0.25 v. Dimensions are 13-3/4 x 7-1/4 x 9-1/2 in.

Barker & Williamson, Inc., Dept. ED, Bristol, Pa.

Pencil-Probe Thermocouple 399

Model G has a response time of less than 10 μ sec, a continuous service temperature of over 2,000 F, and an operating pressure range to 3,000 psi.

Nanmac Corp., Dept. ED, P.O. Box 8, Indian Head, Md.

Silicone Rubber Coating 397

Melcoat S-100, having good resilience and dielectric strength, is suitable for cushioning fragile components against shrinkage during encapsulation. It also minimizes arc-over on open leads.

Melpar, Inc., Dept. ED, 3000 Arlington Blvd., Falls Church, Va.

WOULD 30 DAY DELIVERY HELP?

Then call Helipot. We'll deliver BECKMAN® Panel Meters... in a variety of styles, shapes and models... within 30 days after receipt of your order. Specials may take 45 days.

Fact is, quick delivery and customer service go along with every BECKMAN meter... voltmeters, ammeters, milliammeters, and microammeters... in sizes ranging from 2 1/2" to 4 1/2".

Best of all, they are excellent meters... and we can prove it! A Certified Test Report (which you may have for the asking) gives details of rigidly controlled tests conducted to find out just how good our meters are. In all cases, units tested met or exceeded MIL-M-10304A. Like we said: they are excellent meters.

Clearly, if you need panel meters, call Helipot. Delivery is dependable, quality is excellent, and the price is right. The other things we could say in favor of these meters are contained in the latest meter Data File. Send for it: your meter problems will be solved.



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Helipot Division of
Beckman Instruments, Inc.
Fullerton, California



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Missile Guidance—Instrumentation—Telemetry
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Advanced positions are open in our "Eagle" Missile Program in Electrical Engineering for the design of transistor circuits, servo-mechanisms, microwave electronics and data links.

Please send resume to W. C. WALKER
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NORTH HOLLYWOOD, CALIF.



CIRCLE 901 ON CAREER INQUIRY FORM, PAGE 209

mobility for MICROWAVE INSTRUMENTS... in trailers housed in LINDSAY STRUCTURE!

The degree of flexibility in design offered by Lindsay Structure components is ably demonstrated by these mobile microwave units—built by Motorola, and in use at Edwards Air Force Base. And they provide a weather-tight exterior, easily insulated for operation under any climatic conditions.

Sensitive electronic instruments have the added protection of R.F.I. shielding, and leakproof doors or openings can be designed wherever desired in the housing or enclosure.

LINDSAY STRUCTURE DIVISION
INTERNATIONAL STEEL COMPANY

1629 Edgar Street
Evansville 7, Indiana

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"THE MODERN METHOD OF 'PRE-
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CIRCLE 165 ON READER-SERVICE CARD



Complete Pressure-to-Voltage System WITH ONLY ONE MOVING PART

The only moving part in the new Ultradyne DCS-4 pressure transducer package is the stiff metal diaphragm. It moves only .003". Simplified design withstands most severe vibration and shock. Weighs only 9 ounces. Measures 2" x 2 1/2" x 1 1/8". Send for complete specifications.

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INCORPORATED

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CIRCLE 166 ON READER-SERVICE CARD

NEW PRODUCTS

Ceramic Insulated Diode Base 395

Series 696 is for use in a variety of insulated diode-base assemblies. Minimum alumina content is 97%. Other characteristics include good thermal conductivity.

Ceramics For Industry Corp., Dept. ED, Cottage Place, Mineola, N. Y.

Availability: Samples or production quantities can now be furnished.

Test Jack 654

This test jack has threaded, all-nylon bodies in 11 standard code colors and heat-treated, silver plated beryllium-copper contacts. Peak voltage before flash-over is 10,000 v at 5 amp. Insulation resistance is 5,000 meg. It takes an 0.08-in. test probe.

United-Carr Fastener Corp., Ucinite Co. Div., Dept. ED, 459 Watertown St., Newtonville 60, Mass.

Price & Availability: From stock; \$0.05 to \$0.10 ea, depending on quantity.

Polyolefin Tubing 393

This tubing and sleeving material heat shrinks to form a tight bond. Called Hyshrink, it can be used on terminals, connectors, wire and cable, and devices of irregular shapes. It is flame retardant and thermally stable. It needs the application of 275 F.

Anaconda Wire & Cable Co., Dept. ED, 25 Broadway, New York 4, N. Y.

Toggle Switches 398

Switches in the 400 series require about 1-in. of behind-the-panel space and weigh 1/14 oz. Each switch has two isolated spdt circuits, rated at 5 amp at 125 or 250 v. They can be used in aircraft, data processing, and industrial consoles.

Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Dept. ED, Freeport, Ill.

Ferrite Filters 392

These ferrite mechanical filters have flat pass band response and low transmission losses. They withstand shock and vibration levels found in missile launching.

Collins Radio Co., Dept. ED, P. O. Box 1891, Dallas 21, Tex.

Chassis Slides 389

The SI series meets Mil specs and the SC series is for commercial applications. All accommodate 17-in. chassis. Construction is of aluminum and stainless steel.

Bud Radio, Inc., Dept. ED, 2118 E. 55th St., Cleveland 3, Ohio.

Liquid Cooling System 391

Type E/HT-250, 200 A, is for airborne ECM systems. Weighing 17 lb, the unit consists of a hydraulic coolant pack and a constant-mass blower radiator assembly. It operates on 115 to 208 v of 400 cps. three-phase power; 28 v dc is needed for control.

Eastern Industries, Inc., Dept. ED, 100 Skiff St., Hamden, Conn.

Voltmeters and Ammeters 396

Type KA-241 250-deg, circular-scale, switchboard ac ammeters and voltmeters employ the taut-band suspension system. Using no pivots or bearings, this system eliminates rolling and sliding friction. The units stand severe shock and vibration.

Westinghouse Electric Corp., Dept. ED, P. O. Box 2099, Pittsburgh 30, Pa.

Panel Fastener 388

For mounting flush with the panel surface, this fastener offers positive locking, instant release and good strength characteristics. It is available in normal-duty 1/4-in. diameter or heavy-duty 5/16-in. diameter.

AVDEL, Inc., Dept. ED, 210 S. Victory Blvd., Burbank, Calif.

Ceramic-Metal Seal 390

These seals are suited for insertion into envelope structures by means of high-temperature braze materials. They have copper studs of 1/8- and 1/4-in. diameters and over-all composite diameters of 5/16 and 1/12 in. The seal is isolated from terminal and envelope stresses. Uses include coaxial, high-voltage leadthroughs.

Ceramics for Industry Corp., Dept. ED, Cottage Place, Mineola, N. Y.

Trimmer Potentiometer 359

This single-turn, wirewound trimmer measures 3/4 in. in diameter and dissipates 2 w at 80 C. Housing is electro-tinned brass. Built to Mil specs, the unit can be used in environments having extreme humidity.

Maurey Instrument Corp., Dept. ED, 7917 S. Exchange Ave., Chicago 17, Ill.

Magnetically Actuated Sampling Switch 353

This sampling switch is suited for sampling of multiple low-level transducers such as strain gages and thermocouples. In many applications the switching unit introduces less than 10 μ v of extraneous signal into the circuit being commutated. Dwell periods can be as short as 300 μ sec; dynamic resistances can be less than 1 ohm.

Magnavox Research Laboratories, Dept. ED, 2128 Maricopa Ave., Torrance, Calif.

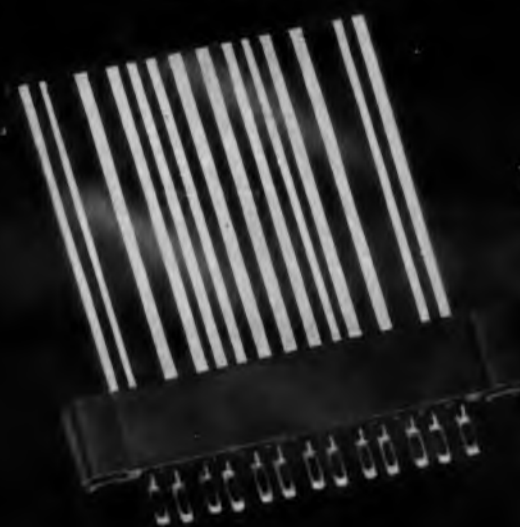
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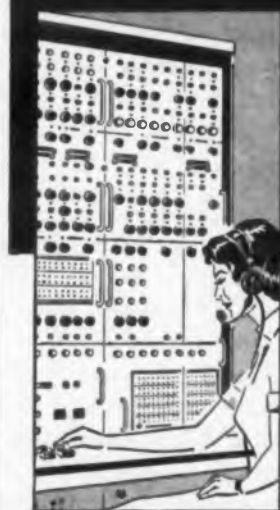
Series 600 7-1 18 contacts for 3/64" PC board or cable



Series 600 4PC10-10 dual contacts for 1/32" PC board or cable



Series 600 4PCSC13 13 contacts for 1/32" PC board or cable



Continental Connector MINIATURE PRINTED CIRCUIT CONNECTORS

Continental printed circuit connectors and "Bellowform" contacts are covered by patent number 2,875,425

WHERE RELIABILITY IS A MUST

and space limitations are critical . . .
specify Continental Miniature PC Connectors

Series 600 precision miniature printed circuit connectors provide a positive, space-saving connection between printed circuitry and conventional wiring, through printed circuit boards, tape cables or plug-mounted sub-assemblies.

SERIES 600-7-1. For 3/64" printed circuit board or tape cable. 18 contacts for #24 AWG wire. Solder lug terminations are staggered to simplify soldering operations.

SERIES 600-4PCSC13. For 1/32" printed circuit board or tape cable. 13 staggered contacts accommodate #22 AWG wire. Module design permits stacking of any reasonable number of single units. Contacts have minimum spacing with maximum contact wiping surface.

SERIES 600-4PC10. Accepts 1/32" printed circuit board or tape cable. Double row of 10 contacts with solder lug terminations provides a total of 20 connections. For #22 AWG wire. Overall length only 1 1/8".

Continental Connector's "Bellowform" contacts are used in this series and provide coil spring action grip that clasps the printed circuit board firmly over the entire contact area regardless of board tolerance variations.

Contact material is spring temper phosphor bronze with gold plate over silver plate. Body molding compound is glass reinforced Diallyl Phthalate (MIL-M-19833, Type GDI-30, green color).

Technical literature on Continental Connector Series 600 Miniature PC Connectors is available on request. Write to Electronics Division, DeJUR-AMSCO CORPORATION, 45-01 Northern Boulevard, Long Island City 1, N. Y. (Exclusive Sales Agent)



MANUFACTURED BY
CONTINENTAL CONNECTOR CORPORATION,
AMERICA'S FASTEST GROWING LINE OF
PRECISION CONNECTORS

CIRCLE 167 ON READER-SERVICE CARD



WHAT
THIS UNUSUAL
AC-DC "PLUG-IN"
TRANSISTORIZED
POWER SUPPLY
DESIGN
GIVES YOU...



One piece finned aluminum extrusion, achieving high heat dissipation. Most units need no external heat sink to 55° C ambient. All units have adjustable output. Platform mounted standardized subassemblies and components enable quick delivery of a wide range of voltages and currents.



Specifications:
Input: 105 to 125V AC, 45 to 420 cps, single phase
Regulation: 0.1% (line or load)
Stability: Better than 0.25% for 8 hours
Ripple: 0.02% rms
Response time: less than 100 microseconds
Low dynamic impedance



Designed primarily as a component power supply, units are widely used in computers, electronic instrumentation, production test equipment, and quality control check out systems. Best of all, the unique design makes these units available at the lowest possible cost to you.

(Unit pictured above: Model #1R 90-1; 85-95 V; 0-100 ma; Price \$145.00) Prices on other units range from \$100 to \$200.

All solid state — zener diode reference; transistor amplifiers and regulator
Output Voltages: from 2.0 to 300V DC
Output Power to 30 Watts
Reliable short circuit protection
All components readily accessible

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CIRCLE 168 ON READER-SERVICE CARD

NEW PRODUCTS

Thyratron

383

Type 2050-A is for relay and grid-controlled rectifier applications. Using a T-9 envelope, the unit is 1 in. shorter than type 2050. Other characteristics are similar.

General Electric Co., Dept. ED, Schenectady 5, N. Y.

Pure Gold Laminate

546

A laminate of 24 carat gold to a rubber-coated nylon material provides a material that is both steril and radiation repellent. This gold laminate may be had in continuous rolls 36-in. wide and 100-yd long. The rubber sheeting used meets applicable MIL specifications.

Lamart Corp., Dept. ED, 16 Richmond St., Clifton, N. J.

Automatic Spectrum Equalizer

361

Model AE 80/25, for random-motion vibration test systems, uses the multi-band compensation approach, dividing the spectrum into 25-cps increments. Solid-state, magnetostrictive filters with correct phase properties plus servo regulators are used on each of the 80 channels from 15 to 2,000 cps.

MB Electronics, Dept. ED, 781 Whalley Ave., New Haven 8, Conn.

Sine Wave Inverter

374

Model 603 is a dc-to-ac, single phase, 400 cycle, sine-wave inverter. Input is 24 to 30 vdc; output is a 115 v sine wave. Power output is 50 va, continuous duty cycle; 90 va, 25% duty cycle. Distortion is 6% max. Output voltage is adjustable $\pm 50\%$ from nominal; output frequency is adjustable $\pm 10\%$ from nominal. No heat sink is required under normal operating conditions.

Universal Transistor Products Corp., Dept. ED, 36 Sylvester St., Westbury, L.I., N.Y.

Double Scaler

355

Model 49-51 provides two scales of 10^4 , each followed by a four-digit electrically reset Sodeco register. The two sections may be operated individually or simultaneously. Resolving time is 0.8 μ sec; counting rates are in excess of 1,000,000 counts per min.

Radiation Instrument Development Laboratory, Inc., Dept. ED, 61 E. North Ave., Northlake, Ill.

Epoxy-Resin Casting System

357

META-CAST 405AP general-purpose casting system may be used over a wide temperature range. It contains no solvents, reactive diluents or other degrading adulterants.

Metachem Resins Corp., Dept. ED, 530 Wellington Ave., Cranston, R.I.

ACCURATE
ANGULAR INDEXING to
1/4 SECOND OF ARC with
MILICHEX

ROTARY INDEXING TABLES

Designed to provide indexing accuracies of $1/4$ second of arc, Milichex tables are available in many models and combinations to fit almost any need, including angular indexing to minutes and seconds. (1,296,000 positive settings within a full circle.) "Laboratory" accuracy to within 12-millionths of an inch at a 20 inch diameter is possible.



This Model M2X-900 Milichex allows quick setting to any full or fractional angle in $1/4$ degree increments on a production basis. Operator merely sets tables to two marks. They automatically lock into correct setting.

All Milichex models are flat and parallel within 0.000050 inches and provided with numerous threaded holes for easy mounting of workpiece or fixtures. Milichex tables can be used also for checking roundness or concentricity within 10-millionths.

For details write for Bulletin X-60



MICHIGAN TOOL CO.

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new...

Malco

TABON TERMINALS and Insulating Sleeves

For Quick
Connect/Disconnect
Applications



Exclusive MALCO
Design eliminates faulty
connections... assures
uniform crimping.

Specially contoured insulating
sleeve accurately guides termi-
nal into position on male tab.
Entry of male tab (outside of
terminal) within the insulating
sleeve is positively prevented.

Malco Terminals are avail-
able in chain form for rapid
machine crimping to wire. In-
sulating sleeves are
also machine applied

REQUEST
BULLETIN
NO. 603



Malco MANUFACTURING CO.
4027 W. Lake St., Chicago 24, Ill.

CIRCLE 170 ON READER-SERVICE CARD

Phase-Shifting Transducers 400

The Variogon transducers are for use at specific frequencies to produce continuous time delays or phase variations directly proportional to a shaft rotation. Capacitor, bridge network and balanced-line components are contained in one compact housing. Operating speed is 5,000 rpm max.

Nilsen Manufacturing Co., Dept. ED, 23 N. Church St., Addison, Ill.

Plastic Laminates 351

These laminates, having embedded electric heater elements, can be designed for various watt densities with maximum surface temperatures from 400 to 500 F. Sheets come in sizes up to 36 x 48 in. and in thicknesses of 0.02 in.

Bischoff Chemical Corp., Riverside Plastics Div., Dept. ED, Hicksville, N.Y.

Coincidence-Anticoincidence Analyzer 401

Model 32-2 four-channel analyzer may be used with almost any commercial scaler or ratemeter. Channel dead time is less than 10 μ sec. Input pulses range from -50 to +100 v; output voltage is -15 v.

Radiation Instrument Development Laboratory, Inc., Dept. ED, 61 E. North Ave., Northlake, Ill.

Cable Tester 402

This cable tester pinpoints underground insulation failures before they occur. The unit supplies up to 350,000 v dc; the tracer section supplies peak pulses up to 80,000 w at 16,000 or 8,000 v. The unit is portable.

Sorensen & Co., Raytheon Co., Dept. ED, South Norwalk, Conn.

Microfilm Attenuator Materials 375

These microfilm attenuator materials may be applied on microwave pistons and plungers in films as thin as 0.004 in. Application on the inner walls of cavities prevents leakage of energy. Film composition permits use from -60 to +300 F, special formulations can be made to go to 500 C.

United Products Co., Dept. ED, 165 Franklin Ave., Nutley, N.J.

Voltage Regulators 352

This line of instruments ranges from 10 to 10,000 va. Four types are offered: apparatus style with built-in capacitor; component style with vertical-core/end-bell construction; open style, similar to component style without end-bell; and encapsulated style, having coils epoxy-encapsulated to meet Mil specs.

Raytheon Co., Power Supply and Voltage Regulator Operations, Dept. ED, Keeler Ave., South Norwalk, Conn.



New Chassis-Trak Utility Slides Support 15 Times Their Own Weight

Three Models—TILT, TILT-DETENT, and NON-TILT

With the introduction of the C-230 Utility Slide, Chassis-Trak can now offer a complete line of electronic cabinet slides in a capacity range from 50 to 275 lbs. The new Utility Slide can be used in any standard rack and in any type of mobile or stationary installation where the chassis load does not exceed 100 lbs.

Chassis-Trak's famous "pencil thin" design is an outstanding advantage of the new C-230. A pair of these fully-extendable slides take up only .620" of usable chassis space—far less than any other slides of equal capacity.

Made of hard, cold-rolled steel, each slide is cadmium plated and then coated with Poxylube 75. This is a bonded film of molybdenum disulfide which provides permanent dry lubrication and protects the metal against solvents, acids and corrosion.

Chassis-Trak C-230 slides are available in seven lengths—12" to 24"—and in a choice of tilt, tilt-detent or non-tilt models. The detent model locks in three positions—90° up, horizontal, and 90° down—for convenience in servicing tube and circuitry sections.

For complete details and specifications on the new C-230 Utility Slide, request Engineering Data Sheet 1600.



chassis
Trak
inc.

for further information, contact

525 South Webster Avenue, Indianapolis, Indiana

CIRCLE 171 ON READER-SERVICE CARD

**For
greater
versatility...
longer life...
increased
reliability...**

Specify NARDA Microwave Modulators

Here's a line of new Microwave Modulators, designed to operate a maximum number of existing magnetrons, without any alterations to the modulator. In addition, provision has also been made for quickly converting the unit to handle any new or uncommon pulse microwave tubes.

Models 10001 and 10002 are designed to handle high-power magnetrons with provision for internal mounting of the tube. Model 10003 is designed for pulsing low-power magnetrons of the type now used in beacon transmitters and for low-power commercial pulse applications.

Since all units utilize silicon rectifiers and diodes, you can expect



MODEL 10002
35 KV

increased life and more reliable operation. At the same time, over-all size has been considerably reduced. Every Narda Microwave Modulator is complete with built-in safety provisions, built-in meters and viewing connectors for all principal parameters, a continuously variable repetition rate, and a standard pulse width of 1 microsecond (other widths available on special order) on Models 10001 and 10002; continuously variable on Model 10003.

The specifications below indicate those characteristics of the three new models which vary from each other. The listing of features indicates those features common to all models. For additional information, and a copy of our free catalog, write to us at Dept. ED-9.

SPECIFICATIONS

Narda Model #	Maximum Peak Pulse Power	Pulse Width (Microseconds)	Maximum Duty Cycle # at Maximum Power	Size H x W x D
10001	18KV@20A	1*	0.001	38x22x18
10002	35KV@40A	1*	0.001	67x24x24
10003	4.5KV@2A	0.5-2.2†	0.002	8½x18x12

* Other values of pulse width can be readily substituted.
† Pulse width is continuously adjustable over given range.
‡ Internal continuously variable trigger generator for adjusting repetition rate and duty cycle.

FEATURES

Built-in Meters:

High voltage power supply voltage
High voltage power supply current
Magnetron filament supply voltage
Magnetron filament supply current
Clipper average supply current*
*Models 10001 and 10002

Viewing Connectors (BNC):

Magnetron pulse voltage
Magnetron pulse current
Primary pulse voltage*
Thyratron pulse current*
PFN charging voltage*
*Models 10001 and 10002

Output sync pulses (BNC Connectors):

Positive
+ 50 v min. at 2 sec.
Negative
- 25 v min. at 2 sec.

Input sync (BNC Connectors):

Sine wave:
20 v RMS min.
Pulse:
20 v at .25 sec min.

SERVICES FOR DESIGNERS

Communications For Lease 260

A communications system said to transmit a 3,000-word message over a telephone line in three minutes is now available for lease.

The system, called Comex, consists of a two-speed magnetic tape recorder capable of recording the output of a standard teletypewriter on magnetic tape at low speed. The magnetic tape is then run at ten times the slow speed as it is transmitted over a standard telephone circuit. This high-speed message is then recorded at the receiving end by another unit of the Comex system. This recording can be fed into a teletypewriter at slow speed and the message printed out.

Comex is said to be adaptable for use by military and government agencies, suppliers and any organization desiring to tighten its communication network with outlying plants or offices. The system is available under a leasing arrangement for \$130 per month.

Avco Corp., Crosley Div., Dept. ED, 1329 Arlington St., Cincinnati 25, Ohio.

Reference Service 261 Provides Component Data

Issued semi-annually, the Characteristics Tabulations provide information on all available transistors, semiconductor diodes, rectifiers or microwave tubes to help select the right unit for a particular application. Listing is first by major characteristics; similar types are grouped together. A directory of manufacturers and their sales outlets is currently offered without charge with each new subscription to the tabulations.

Derivation and Tabulation Associates, Dept. ED, 95 Harrison Ave., West Orange, N.J.

Direct-Printed Circuits 262 Possible on Non-Dielectric Materials

Direct printing can now be used on cast or formed metal parts as well as on a wide range of dielectric-base materials. A virtually unlimited variety of shapes and sizes and exceptional accuracy and bond strength can be provided. Direct-printed circuits can be supplied for use in rotors, stators, waveguides, capacitors commutators, computers, telemetering equipment and missile equipment.

Direct-printed circuits differ from ordinary printed circuits in that the conductive material forming the circuit is applied directly to the base material only where required.

J. Frank Motson Co., Dept. ED, 1717 Bethlehem Pike, Flourtown, Pa.



the **narda** microwave
corporation
HIGH POWER ELECTRONICS DIVISION

118-160 HERRICKS ROAD, MINEOLA, L. I., N. Y. • PIONEER 6-4650

CIRCLE 172 ON READER-SERVICE CARD

Component Testing Facilities 263

The Reliability Assurance Equipment Division of The Daven Co. has developed a completely integrated line of equipment for testing electronic components. Equipment that can be tested includes: environmental chambers and component parts, load-life power supplies of all types, component-part scanning-switching systems for parameter measurement, automatic test equipment with visual or digitized data readout, and automatic-data recorders and data-analysis equipment.

Technical proposals and cost estimates on facilities of any size will be submitted to any firm providing the following data: number of parts to be tested, test specifications and test program rate.

The Daven Co., Reliability Assurance Equipment Div., Livingston, N. J.

New Company Is To Produce Selective Plating Equipment 264

Selectrons, Ltd., has been organized to build and market selective plating equipment for controlled deposits of many metals and alloys on almost any conductive basis material. The plating process allows for plating of selected areas without extensive masking or stopping off and without large tanks of expensive electrolytes. On-site plating, such as repairing corroded contacts on computer equipment, is possible with this equipment.

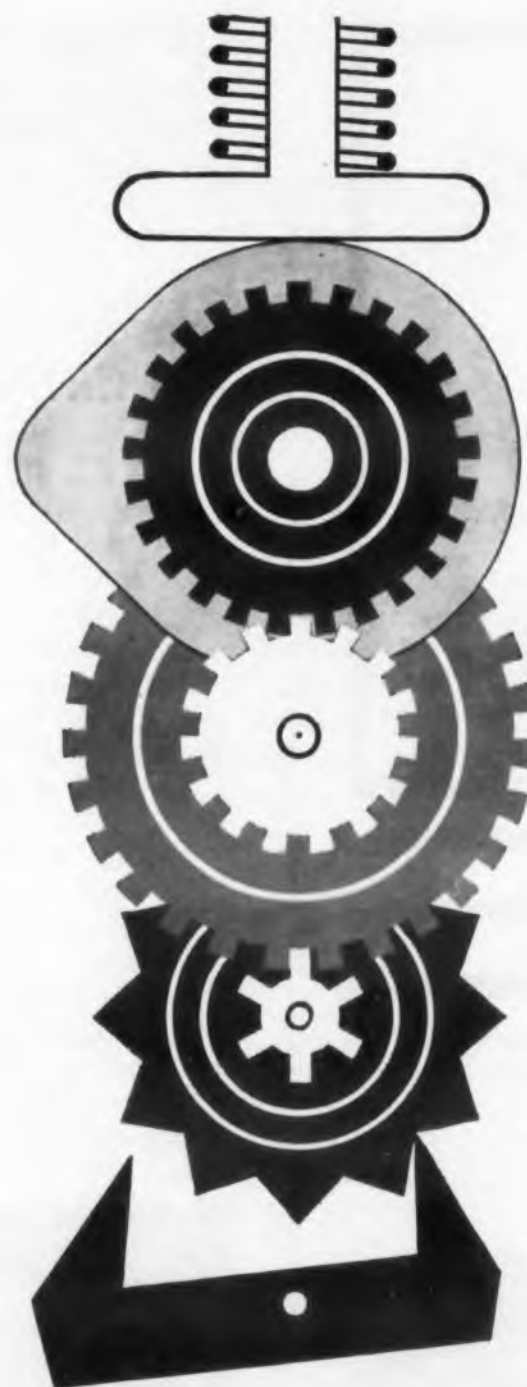
Selectrons, Ltd., Dept. ED, 520 Fifth Ave., New York 36, N.Y.

Shielded-Work Chambers Can Be Built In Any Size 265

The Eccoshield rf shielded chambers are double-shielded, solid-metal, cell-type enclosures that can be built to meet a wide variety of performance and size requirements. They have been built in sizes up to 35,000 sq ft. The enclosures afford a work space which is free of radiated or conducted interference from outside. Electrical wiring and equipment may be included.

Equipped to furnish the chambers as a complete job from design through construction and testing, the firm prefers to be consulted in the preliminary phase. The firm can provide construction crews as well as supervision; at the purchaser's option, supervision only can be furnished. These chambers have been constructed throughout the country.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.



Bulova run-away escapements

Bulova's mastery of the measurement of time holds practical solutions to some of the growing challenges in defense and industry. One case in point is the Bulova run-away escapement: a simple, rugged and relatively inexpensive device for metering short periods of time. Currently used in accelerometers and velocity indicators, these mechanisms have wide areas of application yet to be explored.

The artist's conception above depicts a run-away escapement designed for governing the speed of a cam system driven by a mainspring. The torque transmitted through the gear train rotates the scape wheel which, in turn, oscillates the pallet. The starting and stopping of the pallet as it oscillates acts as an inertia brake

or governor on the whole system.

The idealized equation defining the motion of the pallet is simply

$$T_p = I_p \frac{d^2\theta}{dt^2}$$

The initial conditions at $t=0$ are $\theta=0$ and $d\theta/dt=0$. Integrating Eq (1) twice and applying the initial conditions results in

$$t_1 = \sqrt{\frac{2I_p\theta_1}{T_{p1}}}$$

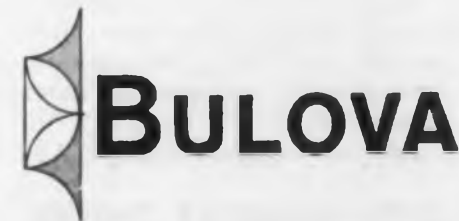
where θ_1 and t_1 denote the half-cycle amplitude and half-cycle period respectively, and the total pallet amplitude is $\theta_1 + \theta_2 = 2\pi/n$.

In this example, the escapement controls the action of a cam-follower mechanism. The same principle can be adapted to many other applications

CIRCLE 173 ON READER-SERVICE CARD

such as: a timer for closing an electric circuit; a velocity indicating device used in computers for integrating acceleration-time functions.

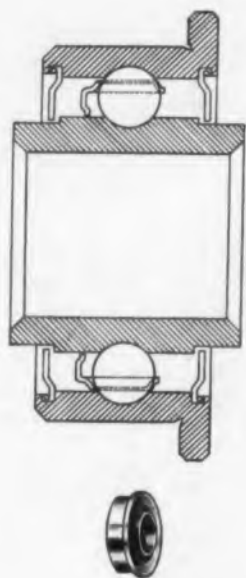
Bulova skills come from close association with the involved problems in developing, designing and producing timing mechanisms which fully meet the stringent specifications of the military and industry.



Bulova Research & Development Laboratories, Inc.
62-10 Woodside Avenue, Woodside 77, New York

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time/delay/relays

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ELASTIC STOP NUT CORPORATION OF AMERICA
1027 NEWARK AVENUE, ELIZABETH 3, NEW JERSEY
CIRCLE 175 ON READER-SERVICE CARD

DESIGN DECISIONS

Featuring the clever and unusual in packaging, appearance design, and circuitry in electronic equipment.

Conventional Resistance Networks And CRT Generate Characters as a SERIES OF DOTS

A NOVEL and very flexible approach to generating characters uses simple, resistive voltage dividers and equally simple resistive summers with a conventional crt.

With this technique, characters are generated as a series of overlapping dots on the crt face. Characters can be changed by changing resistors in a summing network.

Changing characters in other character-generation systems requires complex analysis of wave-shapes, complex waveform generators, special (and costly) display tubes, or other measures.



Fig. 1. Crt electron beam is positioned at sub-origin, from which dot pattern is generated, by voltages from two divider networks—one for X-axis coordinate and other for Y-axis coordinate.

With the new technique, for a given character, switches choose a voltage from each of two divider networks, shown in Fig 1. One voltage is applied to the X, and the other to the Y deflection plates of a crt.

Beam Positioned at Sub-Origin

This brings the beam to a sub-origin from which the character will be traced. There are as many sub-origins on the tube face as there are characters.

Incremental voltages, added sequentially to the X and Y voltages that brought the beam to the sub-origin, cause the beam to trace out the character in the area near the sub-origin.

While the beam is moving, it is blanked. As each incremental voltage is added, the beam is unblanked, producing a series of overlapping dots on the tube face.

The system was developed by the Link division of General Precision, Inc., Binghamton, N.Y.

Dot Positions Generated in Sequence

Because the dot positions are assumed by the beam in step sequence, new characters may be displayed by merely adding a network to put the proper deflection voltages on the crt in sequence. To obtain proper sequence the networks are driven by transistor switches. The network used to generate the character "T" is shown in Fig. 2.

A maximum of 19 dots is required to generate any of the forty characters thus far programed for the display device (called the Dotitron). However, most characters required fewer than 19 dots; the "T" requires only nine.

The "extra" dots were eliminated by driving the transistor switches from a unit that had the capacity to handle 19 switches sequentially, but handled only the number dictated by a "character selection matrix." ■ ■

A	B	C	D	E	F	G	H
I	J	K	L	M	N	O	P
Q	R	S	T	U	V	W	X
Y	Z	0	1	2	3	4	5
6	7	8	9	/	+	-	

Magnetic tapes of "Mylar"[®] insure reliability of recording and playback

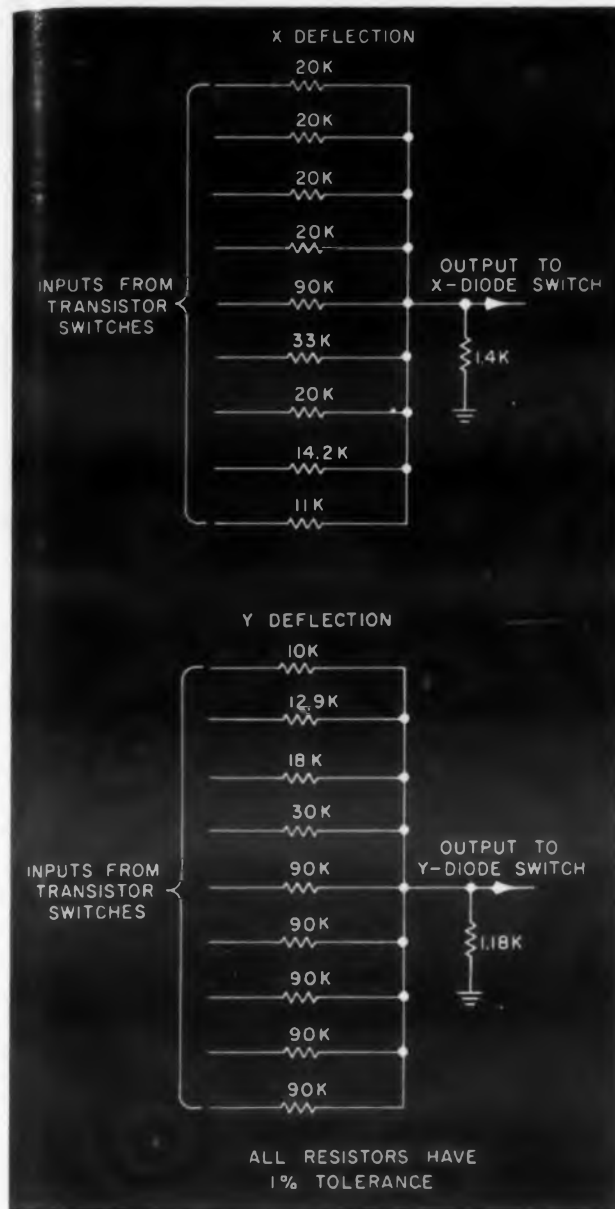
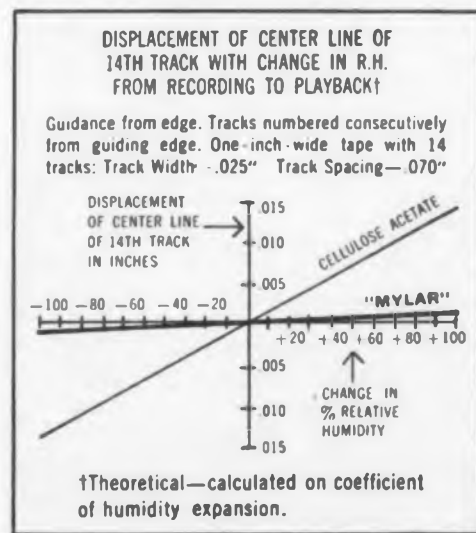


Fig. 2. Summing networks give X and Y deflection voltages for generating, in sequence, dots that form the letter "T". These deflection voltages are applied after electron beam is positioned at sub-origin. There is an X and Y summing network for each character. Characters are changed by adding new summing networks to the system.

The difficulty of duplicating test conditions means that much of the information on your magnetic tapes could not be replaced at any price. Tapes of "Mylar"^{*} polyester film protect your investment in valuable recorded data. Their small additional cost is negligible compared with the cost of the data they contain. Here's why they provide higher reliability than any other tapes.

CHART NO. 1

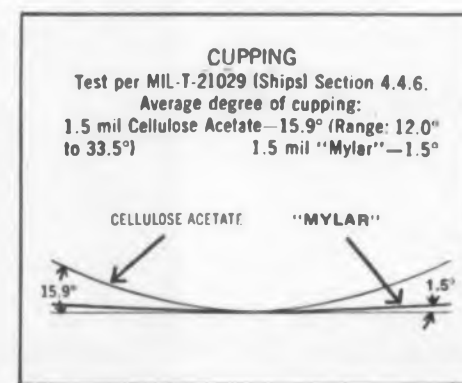


Less track displacement.

Because "Mylar" is virtually unaffected by changes in temperature or humidity, tapes do not shrink or

swell to cause shifting of tracks. Chart 1 compares lateral shifting of track due to dimensional change of "Mylar" and cellulose acetate. Tapes of "Mylar" minimize possibility of garbled or weak signals caused by track displacement.

CHART NO. 2



Fewer signal dropouts.

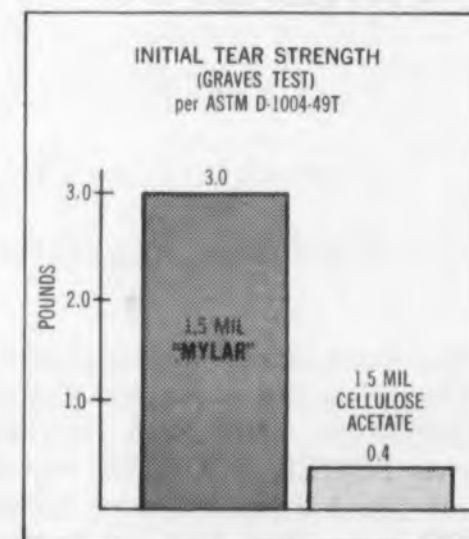
Chart 2 compares "Mylar" with cellulose acetate in cupping due to temperature and humidity change. Insignificant change in "Mylar" minimizes possibility of signal dropout caused by loss of total contact with the recording or playback head.

Less tape breakage.

Since most breaks start as edge nicks, the high initial tear strength of "Mylar" reduces chance of breakage

and subsequent failure to record critical information. Chart 3 compares initial tear strength of "Mylar" and acetate. In addition, "Mylar" polyester film has the highest tensile strength of any instrumentation-tape base. And "Mylar" does not lose its toughness with age, repeated playbacks or storage because it has no plasticizer to dry out.

CHART NO. 3



The superiority of "Mylar" can make an important contribution to the reliability of your magnetic-tape system. Ask your magnetic-tape supplier to recommend the specific tape of "Mylar" for your needs.

Compartment Separators in Wall Slot Improve Isolation in RF Equipment

Better isolation between compartments in rf equipment was achieved by milling slots in the walls to hold rectangular, aluminum-alloy or brass separators.

This method of isolation obviates additional, special shielding techniques necessary with sheet metal cases.

The technique, illustrated in the pictures, was developed by Telonic Industries, Inc., Beech Grove, Ind. The company said packages made this way are easier to design, manufacture and assemble than sheet metal cases.

Rf leakage, with this construction, is less than



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Film Department, Room #ED-11, Wilmington 98, Delaware

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- *Exclusive Regulator Circuit*

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For prices and complete specifications on POWER SOURCES high and low voltage solid state power supplies, write, wire or phone today.

High Voltage Supply Specifications

	PS4222	PS4230	PS4232
DC Output Range	35-215 volts 0-1.5 amps	90-300 volts 0-1.5 amps	115-325 volts 0-1.5 amps
AC Input	105-125 volts, 50-60 cps*, all models		
Regulation (line)	Better than 0.1% or 0.2 volts over entire input range (whichever is greater)		
Regulation (load)	Better than 0.1% or 0.2 volts for no-load to full load (whichever is greater)		
Transient Response	Output remains within regulation limits for step-function change of ± 10 volts in 105-125 volt input range		
	Output remains within regulation limits for changes from no-load to full-load or full-load to no-load		

Low Voltage Supply Specifications

	PS4305	PS4315	PS4330
DC Output Range	0-36 volts 0-5 amps	0-36 volts 0-15 amps	0-36 volts 0-30 amps
AC Input	105-125 volts, 50-60 cps*, all models		
Regulation (line)	Better than 0.025% or 3 mv over input range (whichever is greater)		
Regulation (load)	Better than 0.05% or 5 mv, no-load to full-load variation (whichever is greater)		
Transient Response	Output remains within regulation limits for line voltage steps of ± 10 volts within input range		
	Output recovers in 100 usec for no-load to full-load or full-load to 50% load step changes.		

*400 cps available on order

DESIGN DECISIONS

120 db, according to the company.

For most applications, the thickness of the slabs used for walls and separators is 1/8 in. Flathead machine screws hold the case together.

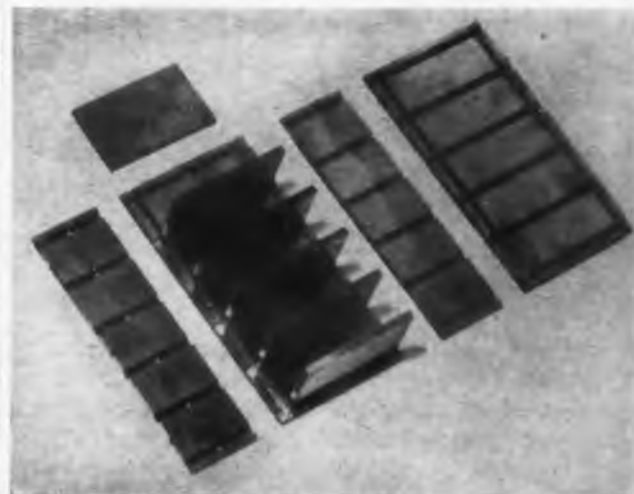
The cost of this method is said to be lower than that of sheet metal construction for production runs of 100 units or fewer.

Design and drafting time are cut considerably because all parts are rectangular and symmetrical.

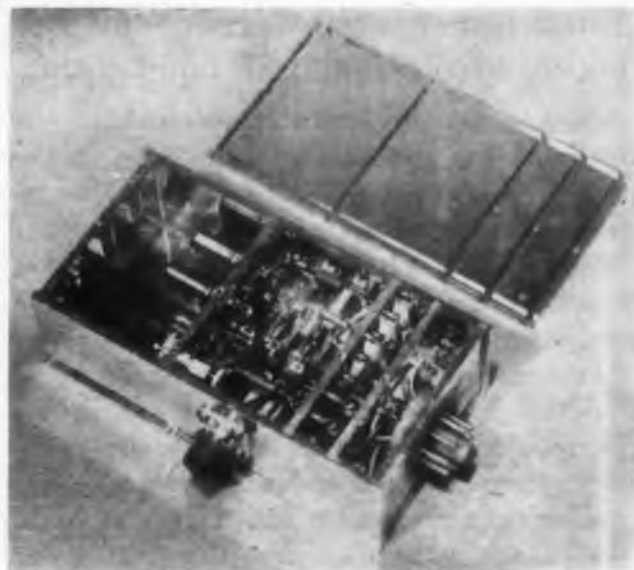
Bending problems are eliminated, and fastening is much simpler than with other techniques.

Machine layout-time is held to a minimum because the package is symmetrical. The top, bottom and side dimensioning are coordinated so all parts are milled alike.

For making connections from one isolated compartment to the next, feed-through capacitors or feed-through terminals can be used. The side walls also offer a surface for mounting components. The walls can be tapped, so bolts with nuts and washers can be eliminated in favor of machine screws.



Grooved walls of rf equipment case hold separators that give rf isolation. Screws are used in assembly of the case.



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POWER SOURCES, INC. Burlington, Massachusetts

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CIRCLE 179 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 9, 1960

DESIGN

Graphs Plot Coil Resistance As a Function of Temperature

Samuel G. Hanna
Electrical Engineer
Airborne Accessories Corp.
Hillside, N.J.

THE CHANGE in the electrical resistance of a wire coil because of a change in its temperature can be easily found from the curves shown.

Coil resistance is affected by the temperature of the coil according to the formula

$$R_{T_1} = R_{T_2} [1 + \alpha_{T_2} (T_1 - T_2)]$$

where R_{T_1} = resistance at temperature T_1
 R_{T_2} = resistance at temperature T_2
 α_{T_2} = temperature coefficient of resistance at temperature T_2 .

The solution of the formula is plotted for copper in Fig. 1, and for hard-drawn aluminum in Fig. 2. The ordinates are final temperature vs ratio of resistances and curves are drawn for a selection of ambient temperatures.

Example: (Fig. 1)

Assume that a copper wire coil has a resistance of 10 ohms at 70 F, and we want

Continued on p 184

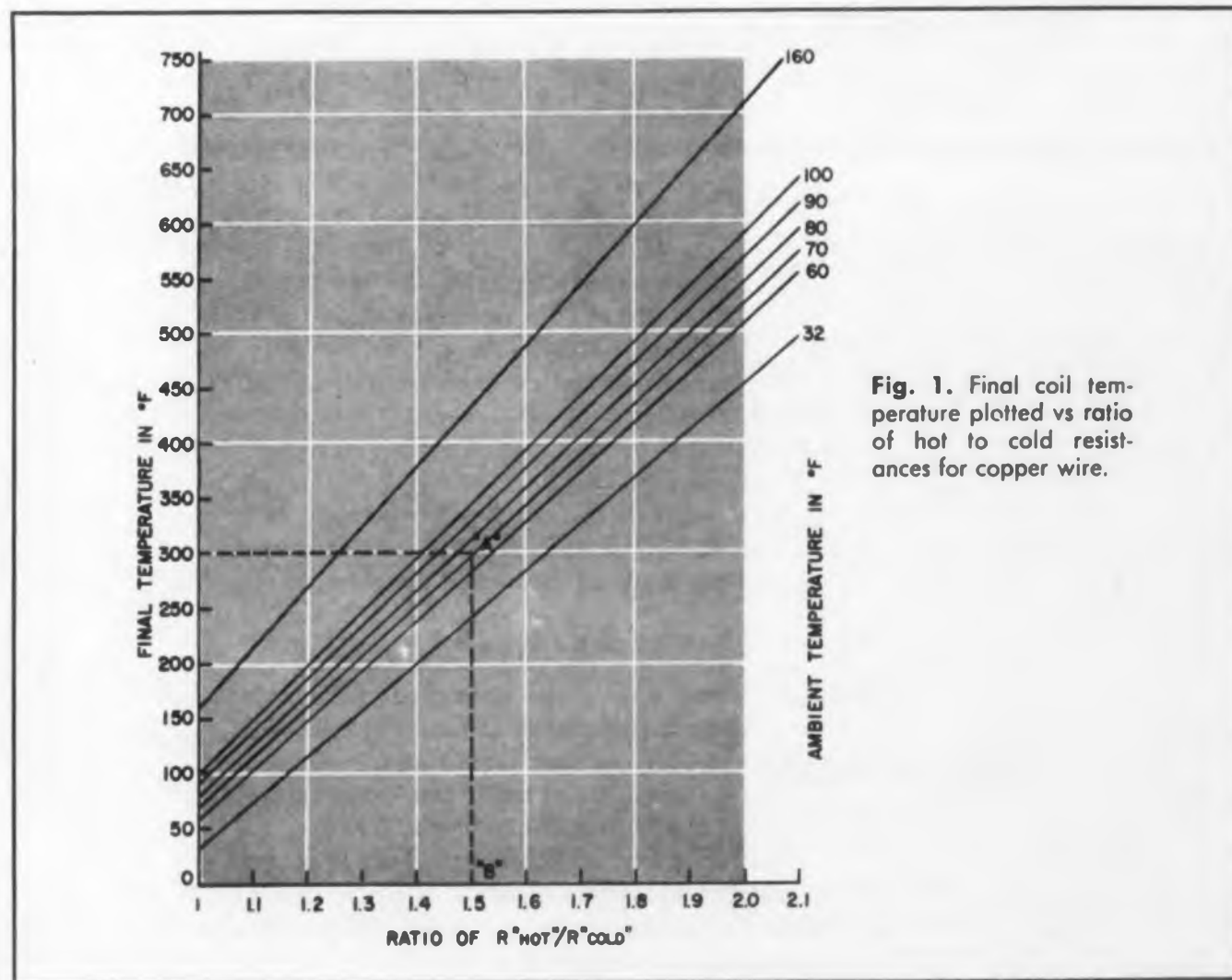


Fig. 1. Final coil temperature plotted vs ratio of hot to cold resistances for copper wire.

Graphs Plot Resistance (continued)

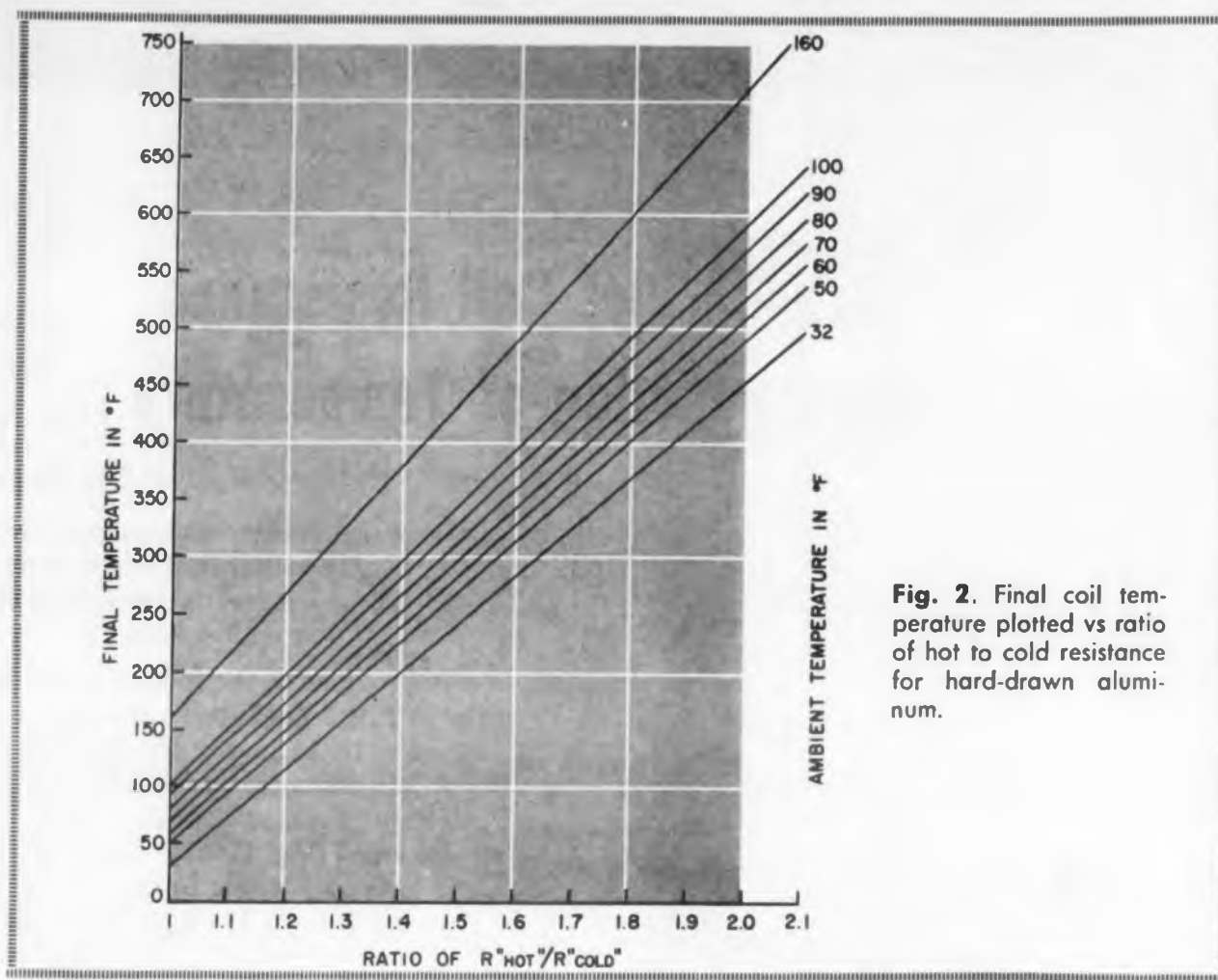


Fig. 2. Final coil temperature plotted vs ratio of hot to cold resistance for hard-drawn aluminum.

to know what the resistance would be at 300 F.

Procedure:

At 300 F on the "Final Temperature" scale, draw a horizontal line until it hits the 70 F ambient temperature line at A. From A, drop a perpendicular on the resistance ratio scale at B, the ratio reads 1.5, therefore, the resistance at 300 F is 10 ohms x 1.5 = 15 ohms.

The graphs can also be used for determining temperature by taking resistance readings at two temperatures.

Example: (Fig. 1)

Assume that a coil has a resistance of 1 ohm at 70 F and 1.5 ohms at an unknown temperature. What is that temperature?

The ratio of $\frac{R^{\text{Hot}}}{R^{\text{Cold}}}$ is $\frac{1.5}{1}$

From 1.5 on the resistance ratio scale, draw a perpendicular until it meets with the 70 F ambient time α at "A." Draw a horizontal line to the "Final Temperature" scale and read the answer = 300 F.

This latter method is often used for heat runs in rotating equipment where it is impractical to insert a thermocouple or other temperature measuring transducers. ■ ■

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ELECTRONIC DESIGN • November 9, 1960

NEW LITERATURE

Power Supplies

266

Application note DC400 describes power supplies connected in parallel to provide low-cost, regulated dc power supply systems of greater power output and higher current ratings. It illustrates the method of paralleling two standard-catalog MD supplies across a 115-v ac line to double the current rating of the units. Also described is a three-unit connection operating from a 208/120-v three-phase source. Sorensen & Co., Richards Ave., South Norwalk, Conn.

Electric Motors

This 14-page catalog, No. 150, describes electric motors. It gives construction, dimension and price data on the firm's line of fractional and integral horsepower motors. Also included are many motor modifications and special designs of varied types. Write on company letterhead to: Doerr Electric Corp., Cedarburg, Wis.

Bonding Silicone Rubber

267

This four-page illustrated bulletin, No. CDS-245, on bonding silicone rubber reviews the existing bonding technology and presents techniques that help eliminate the more difficult bonding problems. Tabulated data on typical bond strengths of silicone rubber under a variety of conditions is included. General Electric Co., Waterford, N.Y.

Connector Dust Covers

268

This bulletin, No. C8-60, describes a line of dust covers for the connector field. Dust and environmental covers are provided for the MS and QWL round types, and the DPD2, RTC and GMAB rectangular types. Both metal and neoprene covers are included. Glenair, Inc., 1211 Air Way, Glendale 1, Calif.

Fuses

269

This 12-page catalog, No. 59, describes small dimension non-indicating and indicating fuses for aircraft, electronics, instruments, appliances, and industrial use. It includes the firm's line of regular and time-lag fuses. Sightmaster Corp., 50 Aleppo St., Providence 9, R.I.

Coils

270

This four-page brochure describes and illustrates the development of coils and the steps involved in solving problems encountered by manufacturers of relays, solenoids and contactors. Tur-Bo Jet Products Co., Inc., 424 S. San Gabriel Blvd, San Gabriel, Calif.

2 NEW Tektronix OSCILLOSCOPES

HIGH ADAPTABILITY TO
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LOW COST

TYPE 560 INDICATOR . . . \$325

5-inch monoaccelerator cathode-ray tube.
3.5-kilovolts accelerating potential.
8 by 10 centimeter viewing area.
Z-axis input.

2 calibrator square-wave voltages, at line frequency (for time-base calibration).
12-volt dc regulated heater supply (for gain stability, low hum, and low drift).

Regulated dc supply operates between 105 to 125 volts or 210 to 250 volts, 50 to 800 cycles . . . provides 30 watts for powering the following signal-amplifier and time-base plug-in units:

TYPE 50 \$115

Passband—15 cps to 200 kc.
Sensitivity—1 mv/cm.

TYPE 51 TIME-BASE UNIT \$135

Sweep rate—5 ms/cm, calibrated.
Magnifier—Variable, uncalibrated, from 1X to 20X.
Triggering—Automatic or free-run.

TYPE 59 UNIT \$50

Passband—dc to 400 kc, at maximum sensitivity.
Sensitivity—approximately 1 v/cm, attenuation provided by variable potentiometer at the input.
Maximum Input Voltage—600 volts.

TYPE 60 UNIT \$100

Passband—dc to 1 mc.
Sensitivity—50 mv/cm to 50 v/cm, calibrated, decade-step attenuator (4 steps), with variable control.

TYPE 63 DIFFERENTIAL UNIT \$125

Differential input, 100-to-1 rejection ratio at maximum sensitivity.
Passband—dc to 300 kc.
Sensitivity—1 mv/cm to 20 v/cm in 14 calibrated steps, with variable control.

TYPE 67 TIME-BASE UNIT \$150

Sweep rates—21 calibrated steps from 1 μ sec/cm to 5 sec/cm, accurate within 3%.
Magnifier—5X.
Triggering—Amplitude-level selection, automatic, or free-run, ac-coupled or dc-coupled, rising or falling slope, internal source, external source, or line frequency.
External Input to Sweep Amplifier—1 v/cm sensitivity.

Basically indicators, the Type 560 and Type 561 Oscilloscopes accept a wide range of plug-in units in both channels and permit almost any type and degree of performance demanded for a particular application. They feature plug-in units which drive the crt deflection plates directly—therefore, they are not limited by the additional circuitry that other oscilloscopes impose (between the plug-ins and deflection plates). Fewer components and controls simplify operation. And, with approximately two-thirds of the circuitry housed within the plug-ins, servicing is easier and indicator unit "down time" is less.

You can even design your own circuitry into skeleton units available. Or, if you are faced with a measurement problem in the dc to 4 mc region, one not solved adequately by existing Tektronix plug-in combinations, your Field Engineer would like to hear from you.



TYPE 561 INDICATOR . . . \$425

5-inch monoaccelerator cathode-ray tube.
3.5 kilovolts accelerating potential.
8 by 10 centimeter viewing area.
Z-axis input.

18 calibrated square-wave voltages, approximately 2 μ sec risetime, at line frequency (for time-base calibration).

Regulated dc heater voltage thru separate regulator circuitry.

Regulated dc supply operates between 105 to 125 volts or 210 to 250 volts, 50 to 800 cycles . . . provides 90 watts for powering all future and present plug-in units in this series—including those six already mentioned: Types 50, 51, 59, 60, 63, 67, plus the following two:

TYPE 72 DUAL-TRACE UNIT \$250

Identical Channels—5 operating modes: alternate sweeps, chopped, Channel A only (may be inverted), Channel B only, both channels combined at output ($\pm A$).
Passband—dc to 650 kc.
Sensitivity—10 mv/cm to 20 v/cm in 11 calibrated steps, with variable control.

TYPE 75 WIDE-BAND UNIT \$175

Passband—dc to 4 mc.
Sensitivity—50 mv/cm to 20 v/cm in 8 calibrated steps, with variable control.
Risetime—approximately 85 nanoseconds.

SKELTON PLUG-IN UNITS FOR BOTH TYPE 560 AND TYPE 561 \$15

Contains 24-pin connector, latch, front-panel overlay . . . for constructing your own circuits.
Price F.O.B. Factory



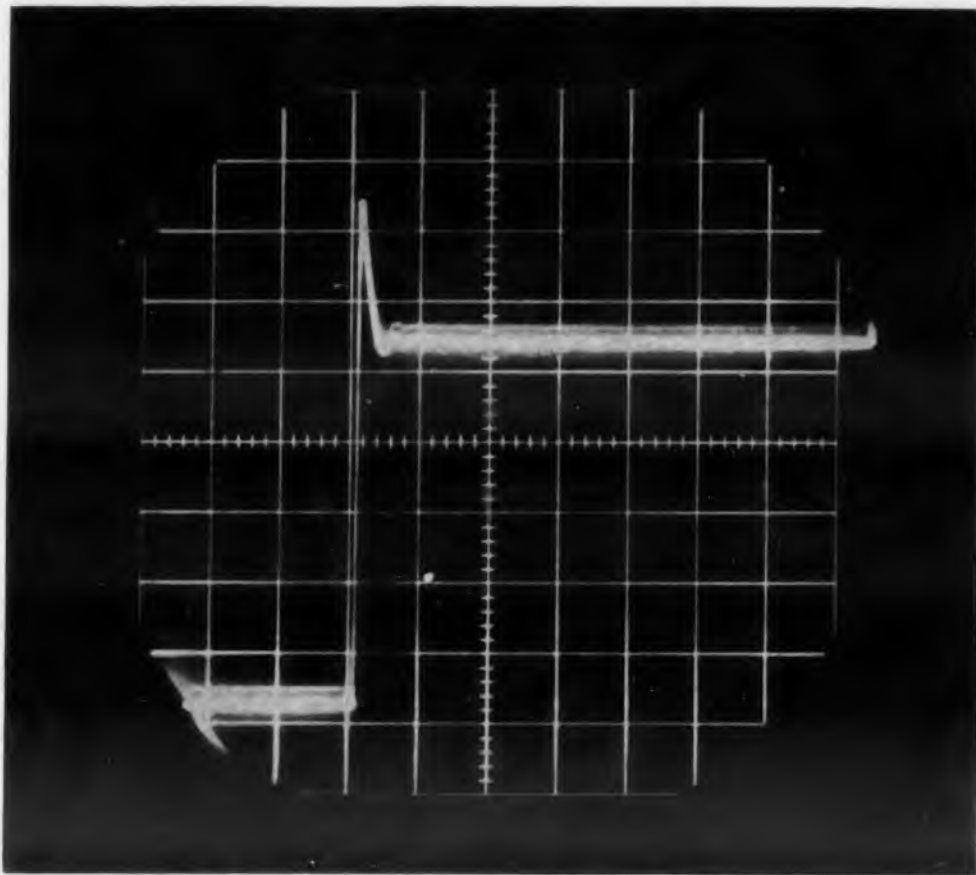
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TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon • Seattle, Washington. Tektronix is represented in twenty overseas countries by qualified engineering organizations. In Europe please write Tektronix Inc., Victoria Ave., St. Sampsons, Guernsey C.I., for the address of the Tektronix Representative in your country.

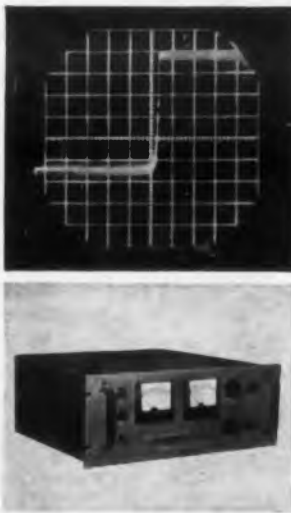
CIRCLE 182 ON READER-SERVICE CARD



TRANSISTOR-KILLER: THE VOLTAGE SPIKE TAMED BY PERKIN MTR DC POWER SUPPLIES

The "turn-on" transient above could destroy the transistors in your circuit in microseconds. Protect transistorized equipment against treacherous line and load transients with Perkin MTR tubeless power supplies. Combining the best of two solid-state regulation principles, they use magnetic amplifiers for high efficiency and transistors for instantaneous suppression of transients and ripple. No tubes, no moving parts, no trouble! Units sustain shorts and overloads indefinitely, resuming normal operation automatically. Ideal for continuous-duty and unattended operation. Prompt delivery anywhere.

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MTR036-15	0-36	15	±10MV	±10MV	±10MV	±.2V	105-125V	1MV
MTR636-15	6-36	15	±25MV	±50MV	±25MV	±.75V	105-125V	5MV
MTR636-30	6-36	30	±25MV	±75MV	±25MV	±.85V	105-125V	5MV
MTR28-5	24-32	5	±0.1%	±0.1%	±0.1%	±.3V	105-125V	5MV
MTR28-10	24-32	10	±0.1%	±0.1%	±0.1%	±.4V	105-125V	2MV
MTR28-30	24-32	30	±0.1%	±0.1%	±0.1%	±.5V	105-125V	5MV

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CIRCLE 183 ON READER-SERVICE CARD

NEW LITERATURE

Inductors

271

This two-page, two-color bulletin describes the Therm-L, high-Q, fixed inductors, which provide stability under temperatures of -55 to $+375$ C. Electrical and dimensional data are given on the units, which range in value from 0.068 to 3.9 μ h. The units, completely inorganic, employ one-piece construction for compliance to Class C operation under MIL-C-15305-A. Nytronics, Inc., Essex Electronics Div., 550 Springfield Ave., Berkeley Heights, N.J.

Solenoids, Coils, Transformers

Containing 20-pages, this catalog includes illustrations, technical information, and performance charts on the firm's solenoids, coils, transformers and electrical components. In addition to the series D solenoids, the ME series miniature solenoids are included. Write on company letterhead to: Anderson Controls, Inc., 9959 Pacific Ave., Franklin Park, Ill.

Plastic Parts

272

This 12-page catalog, No. 8, describes the line of Daka-Ware standard plastic parts including knobs, handles, balls and pulls for industrial and consumer use. It shows ball knobs, fluted knobs for mechanical and electronic use, and control and pointer knobs for electrical equipment and electronic instruments. Harry Davies Molding Co., 1428 N. Wells St., Chicago 10, Ill.

Transducer Systems

273

This two-page leaflet describes the series DCS-4 packaged pressure-to-voltage transducer systems. The systems incorporate a variable reluctance pressure transducer and stable electronic circuitry in a single package. A photograph, dimensions and electrical specifications are given on the units, which have aircraft and missile applications. Ultradyne, Inc., 2630 San Mateo Blvd., N. E., P. O. Box 3308, Albuquerque, N.M.

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Temperature Test Chambers 274

Having four-pages, this bulletin describes seven Hi-Lo temperature test chambers. It includes photographs of all the units, technical data, prices and complete specifications. The instructions and operation of the test chambers are covered along with optional features offered for each unit. The Electric Hotpack Co., Inc., 5065 Cottman Ave., Philadelphia 35, Pa.

Cathode Follower 275

This two-page bulletin describes the firm's model 4003 cathode follower. It includes data on characteristics of the instrument including frequency response, gain, input and output impedance, input capacitance, noise level, and peak overload voltage. Four graphs are included. Columbia Research Laboratories, MacDade Blvd. & Bullens Lane, Woodlyne, Pa.

Epoxy Resins 276

This data sheet contains information

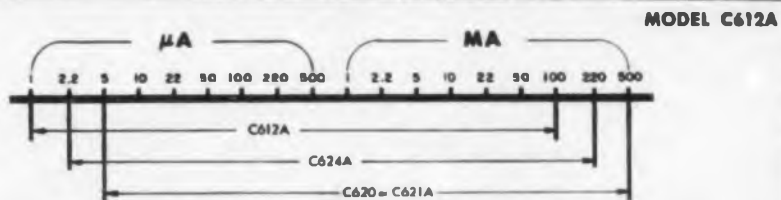
on basic epoxy resins. Modifications of the resins are demonstrated. Isochem Resins Co., 221 Oak St., Providence 9, R.I.

Silicone Rubber Insulation 277

In six-pages this brochure describes Silastic brand silicone rubber, used to insulate wire and cable. With data charts and graphs, the brochure explains why Silastic insulated wire and cable has a high load carrying capacity. A variety of existing applications for Silastic protected wire and cable are given. Dow Corning Corp., Midland, Mich.

Plastics Property Chart 278

This property chart, 11 x 13 in., lists electrical, structural, thermal, and other data of both regular- and flame-retardant diallyl phthalate and diallyl iso-phthalate plastics. The flame-retardant plastics have computer and missile applications. All applicable military specifications are given. Mesa Plastics Co, 12270 Nebraska Ave., Los Angeles 25, Calif.



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CIRCLE 187 ON READER-SERVICE CARD

NEW LITERATURE

Transformers 279

The firm's 1961 catalog includes miniature transformer information, diagrams and detailed specifications. The catalog is designed for simple direct ordering of all miniature transformers. Typical special transformers, designed and manufactured to customer specifications, are listed. Microtran Co., Inc., 145 E. Mincola Ave., Valley Stream, L.I., N.Y.

Transistor Test Instruments 280

This four-page, two-color brochure describes two transistor test instruments. Complete specifications are given for model 870 dynamic-beta transistor tester along with schematic diagrams showing the methods used to measure ac and dc beta with the instrument. Also described is the model 850P portable-transistor analyzer; suggestions concerning its use as a breadboard in transistor research are included. The Hickok Electrical Instrument Co., 10525 Dupont Ave., Cleveland 8, Ohio.

Thermostats 281

This four-page bulletin, No. 8-100, pictures each of the firm's major thermostat groups and gives specification and performance data for both semi-enclosed and hermetically sealed styles. Applications for the various types of thermostats include electronic and avionic devices, and apparatus. A chart for converting centigrade and fahrenheit temperature scales is included. Stevens Manufacturing Co., Inc., P. O. Box 1007, Mansfield, Ohio.

Radio Interference Control 282




A technical paper entitled "Radio Interference Control Of Semi-Conductor Circuitry" is included in this 32-page booklet. The paper discusses the radio interference spectrum and associated problems encountered with the use of diodes. Included are copies of actual test results and other test data gathered over an extended period. Genistron, Inc., 6320 Arizona Circle, Los Angeles, Calif.

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ELECTRONIC DESIGN • November 9, 1960

Photoelectric Scanner Relay 283

This two-page bulletin, PE-5, describes the type PE-5 photoelectric scanner relay, which provides an adjustable time delay between the changing of light and is suitable for light or dark operation. Included are photographs, dimensions, typical applications, timing-range and actions, installation, and adjustment. Farmer Electric Products Co., Inc., 2300 Washington St., Newton Lower Falls, Mass.

Sealed Switches 284

Catalog No. 130, 18 pages, describes hermetically-sealed and environment-free switches. Contact styles, terminations, housings and actuators are described. Illustrations, dimensional drawings and operating characteristics are given. Control Switch Div., Controls Co. of America, 1420 Delmar Drive, Folcroft, Pa.

Precision Switches 285

Miniature precision switches are de-

scribed in this 12-page bulletin, No. 110. Illustrations, outline drawings, operating characteristics are included. Control Switch Div., Controls Co. of America, 1420 Delmar Drive, Folcroft, Pa.

Machine Screws 286

This eight-page bulletin, No. DM773, gives specifications for the series 1960 socket screws. It includes tables giving dimensional standards, concentricity limits, and threading dimensions. Tables comparing dimensions of series 1960 and series 1936 screws and giving dimensions of series 1936 screws are included. The Bristol Co., Waterbury, 20, Conn.

Filters and High-Q Coils 287

This 16-page supplement catalog gives specifications on a line of filters and high-Q coils. A reactance-frequency chart is included. Information is given on transformers, reactors, magnetic amplifiers and pulse transformers. United Transformer Corp., 150 Varick St., New York 13, N. Y.

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Q & A

ABOUT DVST's

Q: Do you know the important differences between DVSTs (Direct View Storage Tubes) and conventional CRTs (Cathode Ray Tubes)?

A: The obvious answer concerns construction differences in the DVST (flood gun, various front-end meshes, etc.). But, more important is the new range of applications available to DVST users. These new applications result from DVST's high brightness, controllable persistence, storage capability, integrating properties—and the human factors compatibility which accompanies all of these advantages.

Q: Are all DVSTs alike?

A: Where storage time and brightness characteristics are concerned, most DVSTs are fundamentally similar. Significant differences exist, however, in other important criteria.

Q: What criteria should you look for in a DVST?

A: It depends, of course, on your particular application—but there are at least three important qualities you should check:

1. **Half-tone rendition:** When operating in the storage mode, DVSTs differ greatly in their ability to produce enough half-tones for photographic-quality detail.

2. **Resolution:** This important factor (together with half-tone rendition) is a measure of a DVST's ability to display a detailed, accurate picture. As a function of writing gun spot size, proper resolution depends on advanced developments in the field of high-performance electron guns.

3. **Uniformity of writing, storage and erasure:** DVSTs must present displays free from unwanted highlights—displays which will erase evenly and completely. Most important in influencing this capability is collimation (ability to arrange flood electrons in parallel array and then to strike the target assembly at a 90° angle).

Q: What does Hughes offer in the DVST line?

A: Everything you could ask for. (Warning! This is the commercial):

1. **Outstanding half-tone rendition** with DVSTs which store up to 7 shades of gray. (More than any competitive DVST!) They produce detail unmatched by any other storage tube.

2. **Higher resolution** resulting from advancements in electron gun design perfected by the famed Hughes Research Laboratories.

3. **Exact collimation** for uniformity of writing and erasure through the use of an advanced, Hughes-developed electronic lens system. This system features a precision machined metal lens integrated with the target assembly.

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CIRCLE 191 ON READER-SERVICE CARD

NEW LITERATURE

Transistorized Frequency Converter 288

This two-page data sheet offers technical data on a transistorized frequency converter. Unit is designed for use with the Gertsch models FM-6, or FM-7 VHF frequency meters, or other meters, to extend the frequency range downward to 10 kc. Specifications, a block diagram and a circuitry description are included. Gertsch Products, Inc., 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

Automatic Memory Core Handler 289

This two-page bulletin, No. 60-A, describes model CH-58 automatic memory core handler, a memory core feeder that grades and sorts standard 80 mil or 50 mil miniature ferrite cores at continuous operating speeds of over 10,000 cores per hour. Optional accessories and specifications are given. Also included is a brief description of models 4021 and 4022 manual core test jigs, instruments for pilot production and laboratory testing of metallic tape wound and miniature ferrite cores. Rese Engineering, Inc., 731 Arch St., Philadelphia 6, Pa.

Plastic Parts 290

This illustrated folder, No. CDC-375, describes Lexan polycarbonate resin. Typical applications of the resin are coil forms, connectors, battery and barrier parts, terminals, housings, windows and covers, and current-carrying support parts. General Electric Co., Chemical Materials Dept., One Plastics Ave., Pittsfield, Mass.

Thermosetting Laminating Plastics

The "Designer's Fact Book" is a reference brochure on a line of laminated plastics. In 115 pages, property and application data cover 70 standard, special and molding grades of high-pressure thermosetting laminating plastics. Military specs, a grade comparator chart, tolerance and weight specifications and illustrations are included. Send name and title on company letterhead to Formica Corp., 4550 Spring Grove Ave., Cincinnati, Ohio.

Cleaning Ultrasonically 291

This bulletin, No. 60-1, describes ultrasonic cleaning. It explains how ultrasonics works and contains a guide to selecting the correct tank and generator sizes or console model for the user's needs. Also included is a discussion of the Autosonic cleaner, which tunes itself without the need for operator attention. A chart-guide

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to the correct cleaning solutions and temperatures for more than 20 different common contaminants completes the bulletin. Powertron Ultrasonics Corp., Patterson Place, Roosevelt Field, Garden City, N.Y.

Casting, Impregnating Resins 292

This colored wall chart, 2 x 3 ft, tabulates electrical, physical, and application information about epoxy and ceramic casting and impregnating resins and adhesives. Over 40 different compounds are analyzed. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Magnetic Memories 293

This four-page bulletin, No. 59-J, describes series 3100 magnetic memories for data processing applications, with capacities ranging from 128 to 4096 words and from 4 to 64 bits per word. A block diagram and timing chart are included. Four typical applications, with description and block diagrams for each, are given. Rese Engineering, Inc., 731 Arch St., Philadelphia 6, Pa.

Machining of Teflon 294

This two-color, 12-page booklet on Teflon contains suggestions for stress relieving and machining. Variation in machining techniques to relieve stress, distribute heat resultant from tooling, and eliminate chips, are given. Plastic Products Div., Raybestos-Manhattan, Inc., Manheim, Pa.

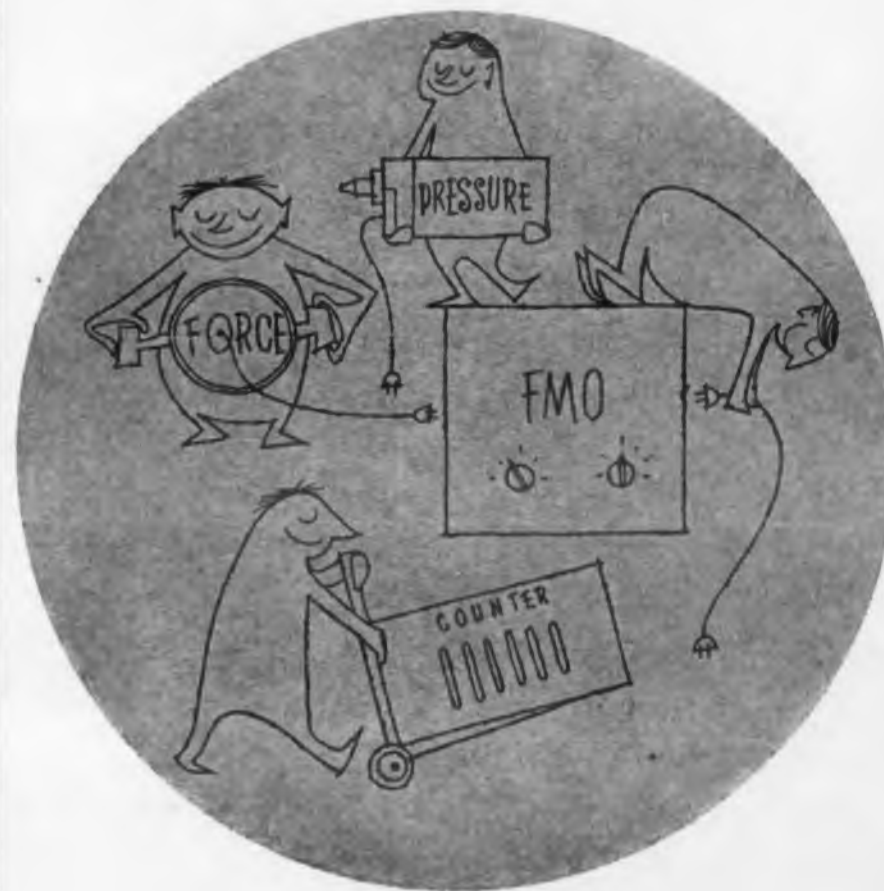
Transistor Heat Exchangers 295

Two lines of power-transistor heat exchangers, the firm's forced-air series LF-100 and unducted series LF-200, are described and illustrated in this four-page bulletin. Dimensional drawings are given. Cutaway drawings describe operation of the units. Gasket Manufacturing Co., Inc., 319 W. 17th St., Los Angeles 15, Calif.

Precision Stock Gears 296

This 128-page catalog, No. F-128, lists the firm's line of miniature precision gears, including anti-backlash gears (spring loaded solid and split hub), spur gears (hub, hubless, clamp type), bevel gears (mitre and ratio), worms and mating helical gears. Also included are differentials, speed reducers and gearheads, and transmissions with up to 15 available range of speeds from 3.3 rpm to 7812 rpm. Types of design kits available for experimental needs are illustrated. Prices of all items are listed. Dynamic Gear Co., Inc., Dixon Ave., Amityville, N.Y.

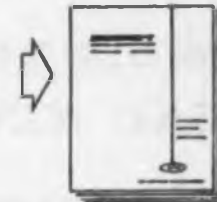
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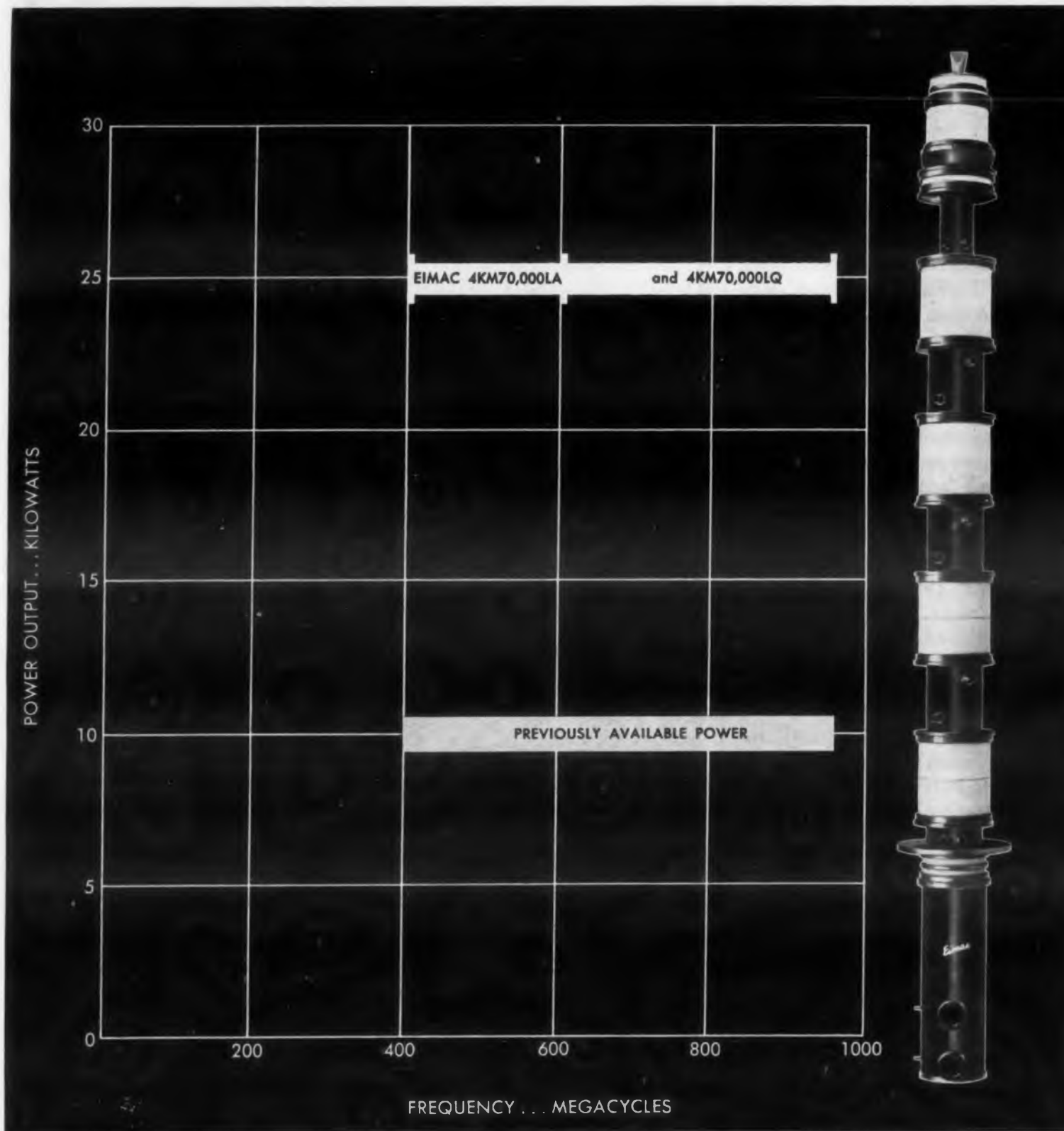
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Eimac fills an important gap in the power vs. frequency chart with the introduction of the 4KM70,000LA and the 4KM70,000LQ. These new power-amplifier klystrons deliver minimum CW output of 25 kilowatts with a narrow band gain of 50db at frequencies from 400 to 985 megacycles. That's improved performance and higher power in this range than previously available.

The reason: these new ceramic and metal tubes are manufactured with windows of beryllium oxide—the amazing insulating material recently introduced by Eimac for vacuum tube use. It breaks through the problem of

providing greater power-output capabilities in high power microwave tubes such as these by dissipating ever larger amounts of heat in dielectrics used as rf windows.

The 4KM70,000LA is designed for use at frequencies between 400 and 610 megacycles and the 4KM70,000LQ at frequencies between 610 and 985 megacycles. You'll find these tubes ideal for troposcatter communications and UHF television applications with an Eimac Klystron Amplifier Circuit Assembly to cover the specified frequency range. Eitel-McCullough, Inc., San Carlos, California.



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IDEAS FOR DESIGN

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Complementary Transistors Form Two-Stage, High-Gain Amplifier

BOTH high current and high voltage gain can be easily obtained from a two-stage transistor amplifier by using complementary transistors connected so that the second stage is prevented from loading down the first.

Ordinarily, when high power gain is sought, a two-stage amplifier with common emitter and/or emitter follower stages may fail to provide the necessary gain under load because of this loading effect. As the power output requirement is increased, the problem becomes more critical.

The difficulty becomes apparent when an amplifier with a common emitter first stage and an emitter follower second stage, Fig. 1, is considered. (The biasing network of Q_1 is not shown.) Total power gain will be reduced if R_1 is excessively loaded by $\beta_2 R_3$, where β_2 is the current gain of Q_2 . As the requirement for output current increases, R_3 must be decreased. If $\beta_2 R_3$ becomes

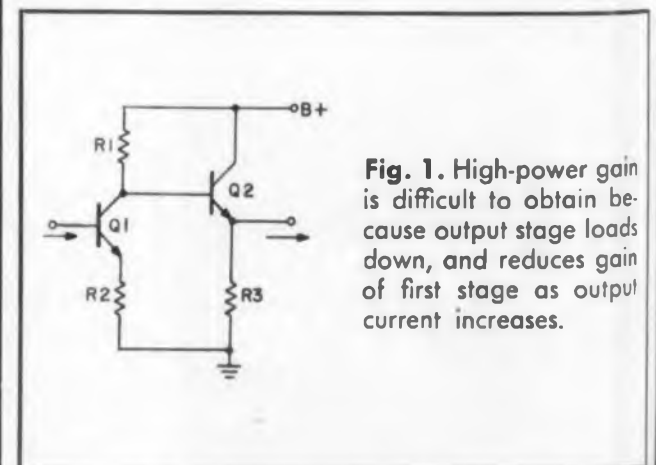


Fig. 1. High-power gain is difficult to obtain because output stage loads down, and reduces gain of first stage as output current increases.

CIRCLE 196 ON READER SERVICE CARD

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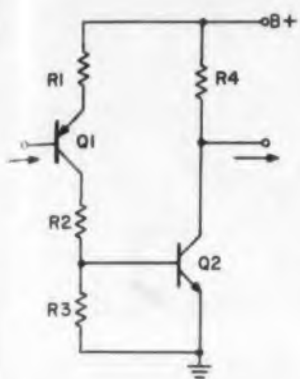


Fig. 2. Loading effect is eliminated when complementary transistors are connected with the collector resistor of first stage in series with the base-to-emitter junction of the second stage.

so small as to be comparable to, or even less than, R_1 , the necessary gain may not be obtainable.

This loading effect is eliminated by using a pair of complementary transistors, with the collector resistor of the first stage in series with the base-to-emitter junction of the second stage. The basic circuit is shown in Fig. 2, with the biasing network of Q_1 , again not shown. The emitter-degenerating resistor, R_1 , may be bypassed or shorted entirely if desired. Resistor R_2 is approximately equal to the load resistor of the first stage, and R_4 , is equal to the load resistor of the second stage. R_3 is chosen so that the total collector resistance associated with the first stage does not substantially exceed R_2 . Thus, in practice, $R_3 < 0.2 R_2$.

It is also desired that a major portion of the collector current of the first stage flow through the base-to-emitter junction of Q_2 . Hence R_3 must be less than R_{be2} , where R_{be2} is the equivalent base-to-emitter resistance of Q_2 in its saturated state. Therefore, as approximate design criteria, we have

$$R_3 < R_{be2}$$

$$R_2 < 5 R_3$$

The circuit is equally applicable as a linear amplifier and as a switching amplifier, provided that the values of the resistors are chosen according to the function. Feedback stabilization may be added as desired. Also, the complementary symmetry can be arranged either with

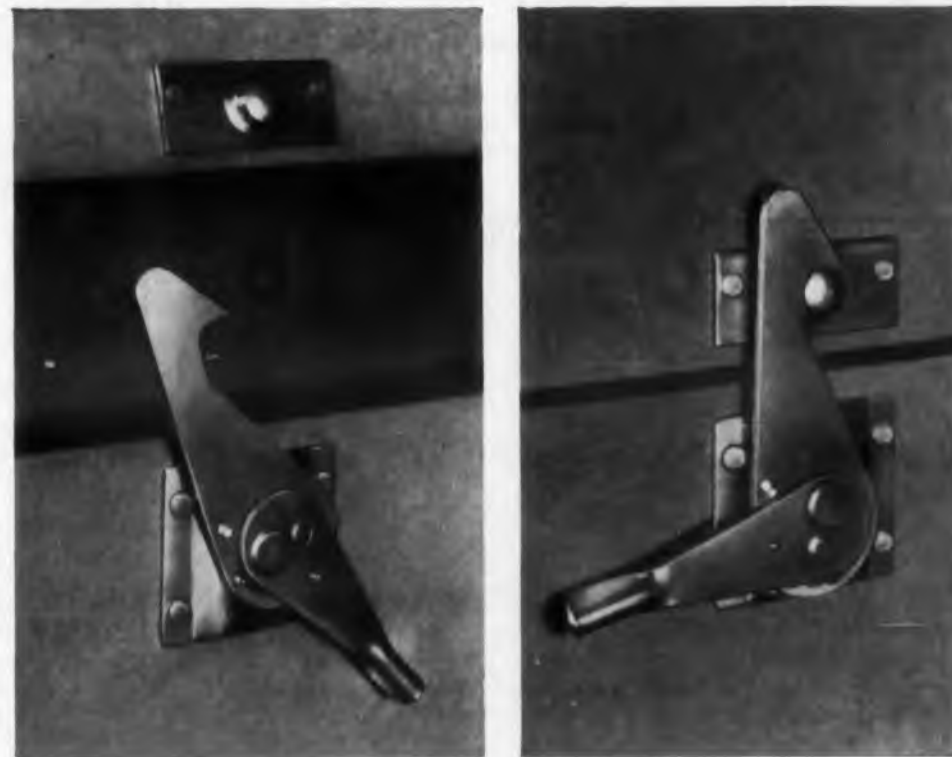
1. Q_1 , a pnp, Q_2 an npn, and a positive supply voltage, or
2. Q_1 , an npn, Q_2 a pnp, and a negative supply voltage.

Finally, the output resistor R_4 may be as small as power supply and dissipation considerations permit, without noticeably affecting the signal at the collector of Q_1 .

Lawrence Odess, Senior Engineer, ITT Laboratories, Nutley, N.J.

WHAT HOOK-LOCK IS

HOOK-LOCK is a springless, positive-locking latching device which is ideally suited for use on rigidly specified military transit cases as well as less expensive commercial containers. It provides high closing pressure and tremendous load-carrying capacity...is impact and shock-proof. HOOK-LOCK is so designed that it lies flat against the mounting surface whether in open or closed position. Since operation is parallel to mounting surface, no space for operating clearance is required.

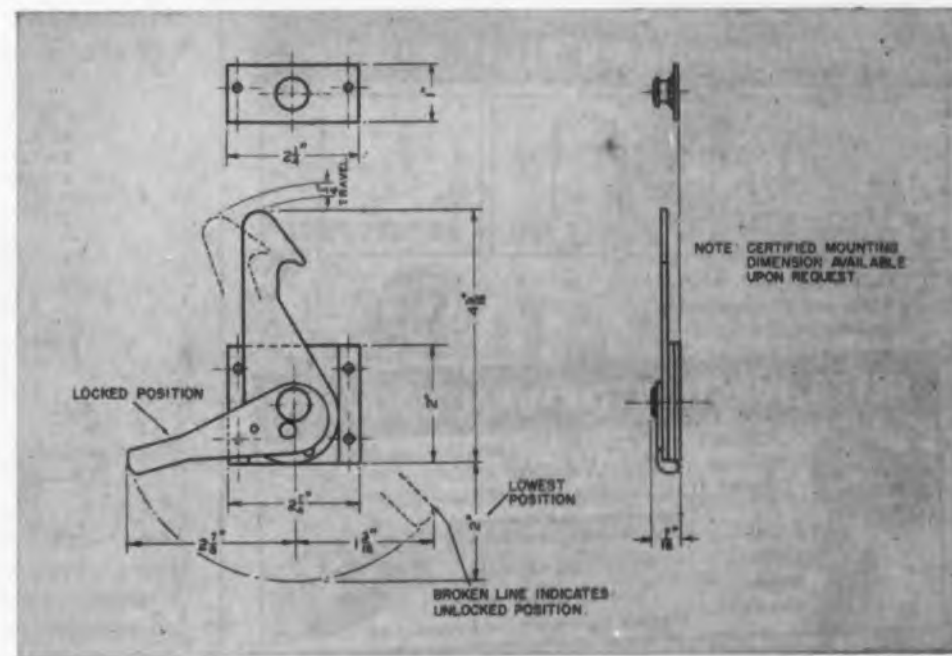


HOOK-LOCK lies flat against mounting surface, open or closed.

New—HOOK-LOCK container latch...It's flat!

FEATURES

- Shock-proof—solid construction...withstands high impact blows directly on the fastener.
- Closing pressure of 200 lb. Where needed, pull-down pressure can be substantially increased by modification of operating lever.
- Tensile load capacity: 750 lb.
- Compact—lies flat open or closed. Extends just 7/16" from container surface at thickest point.
- Positive-locking and springless. Unaffected by arctic temperatures.
- No operating clearance required, because hook and lever move parallel to mounting surface.



IF YOU have questions regarding the possible application of HOOK-LOCK or other Simmons industrial fasteners to your particular needs, your inquiry will receive our immediate attention. Contact your nearest Simmons office or write direct.

SIMMONS FASTENER CORPORATION

1763 North Broadway, Albany 1, New York

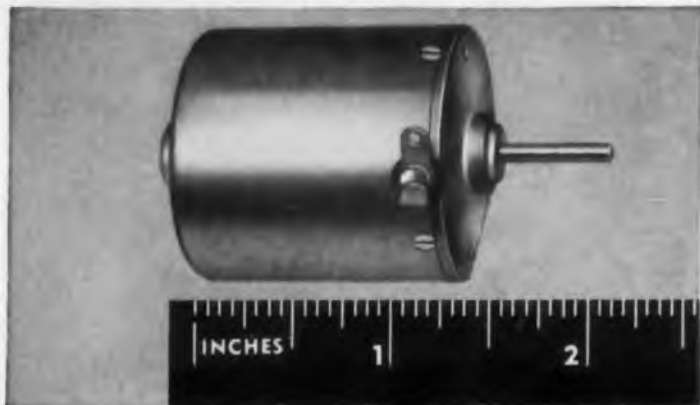
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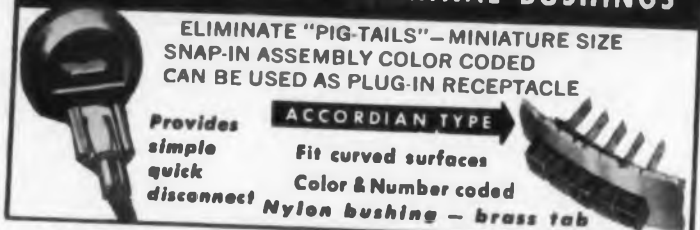
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IDEAS FOR DESIGN

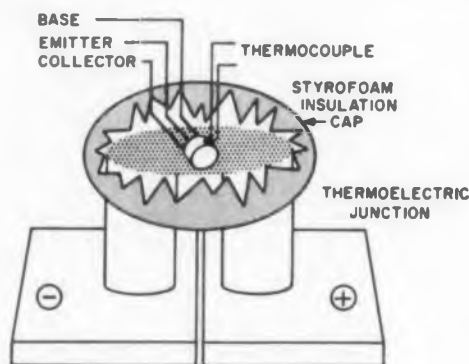
Thermoelectric Junction Cools Transistors For Temperature-Testing

In many applications it is required that transistors and diodes be tested for operating characteristics over a wide range of temperatures. Temperatures above ambient are easily obtained, but those lower than ambient are obtained with some difficulty.

The usual method of obtaining low temperatures is to dip one end of a copper bar in an ice or dry-ice bath. The device to be cooled and a temperature-measuring thermocouple are taped to the other end. The temperature at the cool end of the rod is maintained at the desired steady-state value by using a heater coil around the rod. Unfortunately, ice baths are sloppy and must be periodically renewed. And, often, they must be kept at some distance from the test equipment.

A cleaner and more convenient way to cool low-power devices during test is to use thermoelectric cooling. A compact device can be made from the Ohio Semiconductors TA-11 thermoelectric junction.

The TA-11 pn thermojunction is connected to a low-voltage, high-current power supply, p-type side negative for cooling. (Reversal of polarity would cause heating.) The unit to be tested and



Lower-than-ambient temperatures for transistor or diode testing can be obtained by fastening the units to a thermoelectric junction. A thermocouple for measuring temperature is also included under the insulating cap.

a temperature-measuring thermocouple are taped to the end of the thermojunction. If many units with the same size case are to be tested, a spring clip with thermocouple attached can be carefully soldered to the end of the thermojunction. A block of styrofoam or other thermal insulator, with a hole big enough to clear the transistor, may be placed on the end of the thermojunction. This reduces the thermal load from the room



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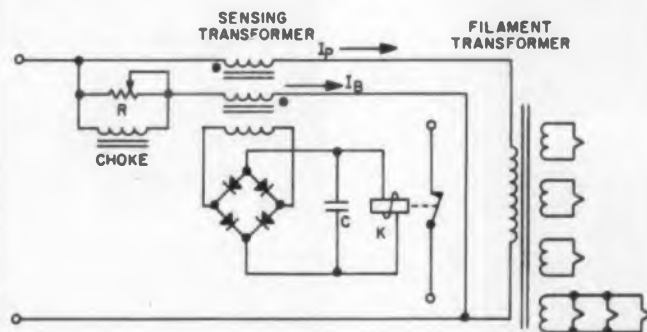
The temperature of the end of the thermojunction depends upon the current through the junction. For small changes in temperature a steady state is reached in less than a minute. Even large temperature changes stabilize in a few minutes, depending upon the amount and quality of the thermal insulation.

Louis E. Fay III, Engineer, Computer Products Div., Excello Corp., Walled Lake, Mich.

Transformer Senses Filament Fault Current

The use of six or more rectifier tubes in high-voltage rectifier circuits often requires detection of rectifier filament failure at the low-level primary winding of the rectifier filament transformer. This detection involves the sensing of a current change less than one-sixth of normal. This change in secondary load current also causes a phase-angle shift at the transformer primary.

Both the current change and the phase-angle shift are detected in a sensing transformer which



Voltage E_s is produced in the sensing transformer when fault occurs in any of the filaments. Relay K operates, opening the high-voltage circuit.

bucks the filament-transformer primary current with a current from the power source. For normal operation, the flux in the core of the sensing transformer bucks itself and can be adjusted to a value near zero with resistor R. The choke in parallel with resistor R provides approximately the same phase angle for the bucking windings. If an open or a short circuit occurs in any of the rectifier tubes, the current I_F and the phase angle change. The output voltage E_s produced in the sensing winding energizes relay K, whose contact interrupts the high voltage circuit.

Fred Bluemel, Project Engineer, FXR, Inc., Woodside, N.Y.

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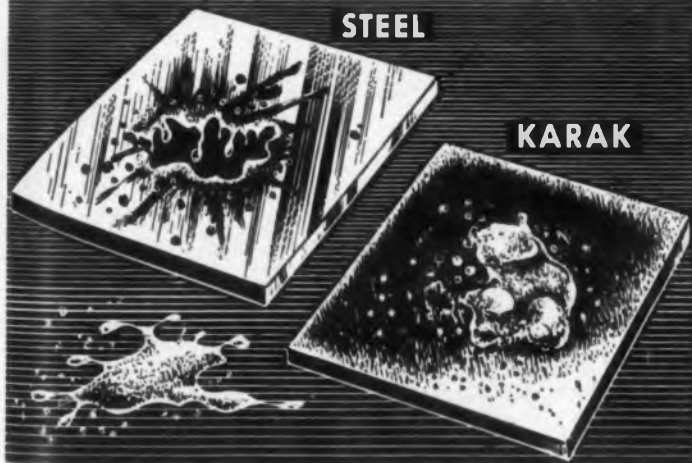
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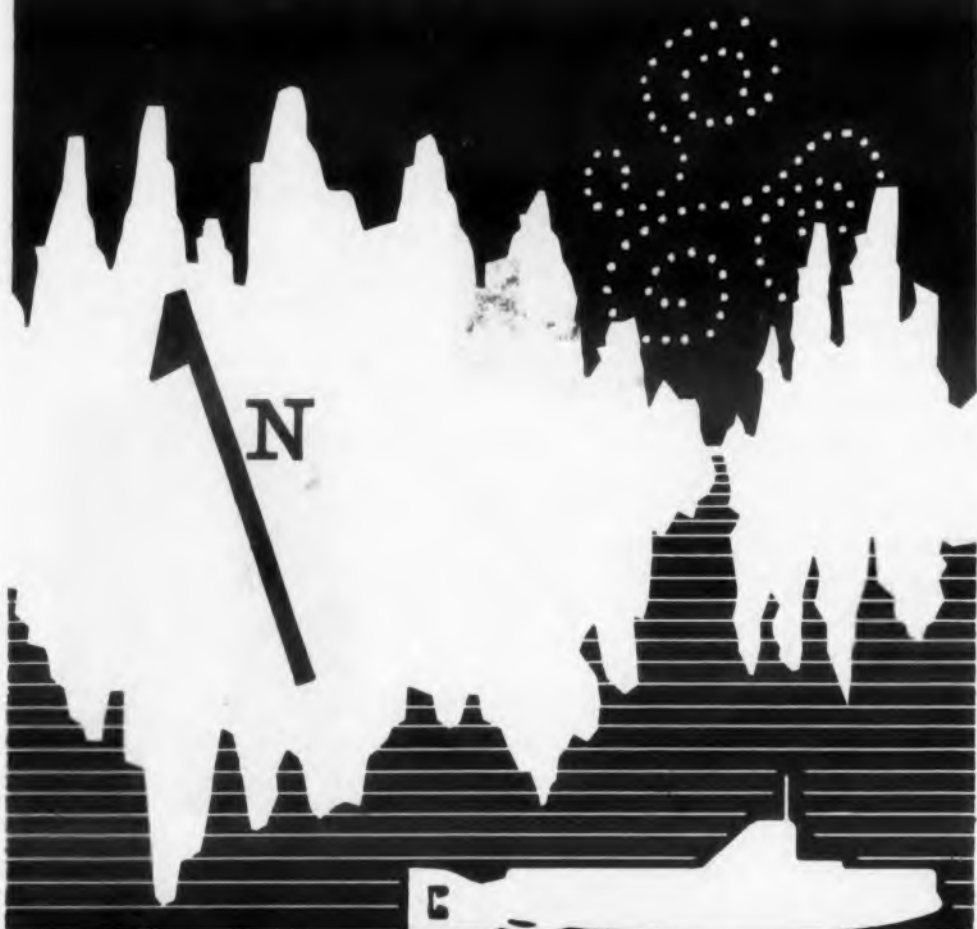
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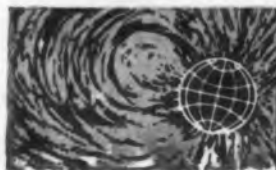
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PATENTS

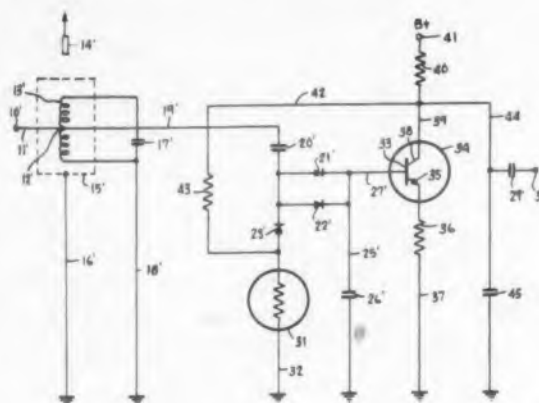
Benjamin Bernstein

Compound Demodulator

Patent No. 2,941,076. K. P. Congdon and E. J. H. Bussard. (Assigned to Avco Corp.)

The dynamic range of a demodulator is increased by using a diode-transistor combination. For low-level signals, the transistor acts as an efficient detector; for high-level signals, the diode detects and sets the bias on the transistor now being used as a linear amplifier.

Diode 23' and the parallel array of diodes 21' and 22' couple the weak sig-



nal to transistor 34 which is biased to operate as a diode. As signal level increases, diodes 23', 21' and 22' act as a voltage-doubling detector and the transistor amplifies the detected output. Diodes 21' and 22' are different enough to increase the over-all dynamic range. Thermistor 31 compensates for the temperature sensitivity of the transistor.

Electromagnetic Wave Phase Shifter

Patent No. 2,930,932. R. H. Geiger. (Assigned to Roger White Electron Devices, Inc.)

The phase of a microwave signal is shifted by changing the density of electrons in the medium surrounding the conductor along which the wave propagates. With an interaction region about one inch long, a 3000-mc signal can be shifted 360 deg by a change of a few hundredths of a volt.

A typical structure contains a propagating helix 12 which is at least partially contained in a vacuum envelope. Elec-

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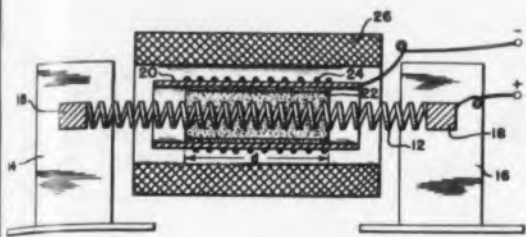
Electronic Engineering Company of California

1601 East Chestnut Avenue • Santa Ana, Calif. • Kimberly 7-5501 • TWX: S Ana 5263

EE 0-13

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electron emitting cathode 20 produces electrons which are accelerated radially because of the voltage between the cathode and the helix. The magnetic field produced by current through solenoid 26 causes the electrons to concentrate in the space between the cathode and the helix. This effectively changes the dielectric strength in the vicinity of the helix.

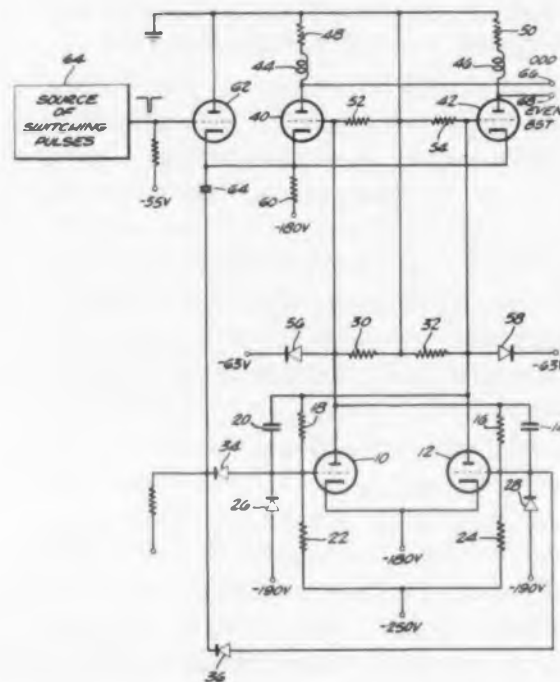
High-Speed Flip-Flop Circuit Arrangement

Patent No. 2,941,073. T. J. Scuitto. (Assigned to General Dynamics Corp.)

The response of a switching circuit is coincident with a control pulse when conventional amplifiers are gated by an ordinary flip-flop.

The flip-flop comprises tubes 10 and 12, shown coupled to the grids of ampli-

fier tubes 40 and 42. A negative going pulse is coupled by the common cathode resistor 60. The amplifier tied to the non-conducting stage of the flip-flop produces a fast, negative output. Subsequently, the flip-flop switches so as to condition the second amplifier for fast response to the next pulse.



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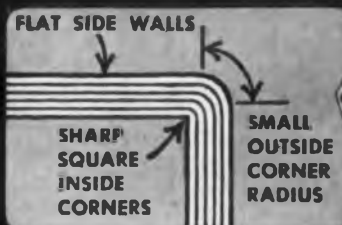
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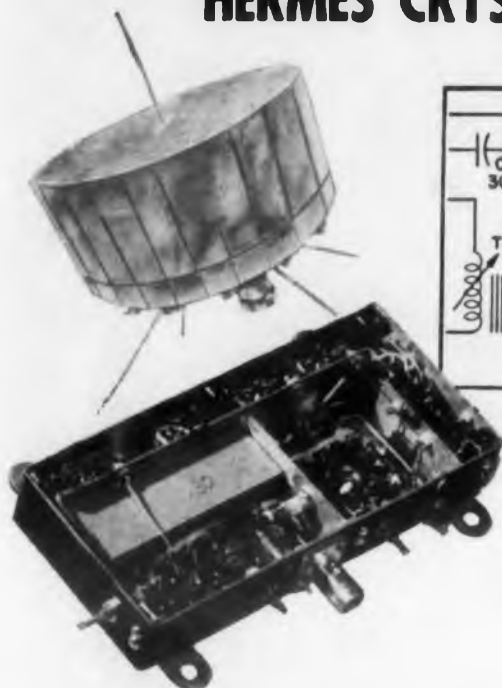
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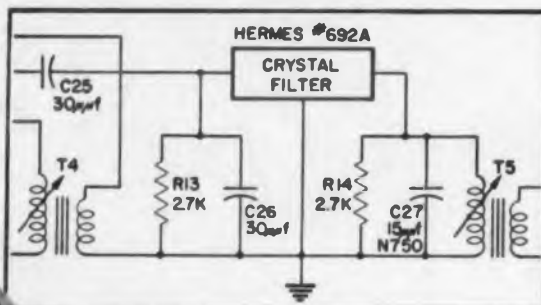
FIRST Tiros Weather Satellite

Uses

HERMES CRYSTAL FILTERS



One of the two Command Receivers in TIROS



A portion of the schematic diagram for the Command Receiver in TIROS showing Hermes 20 Mc Crystal Filter at first mixer.



Hermes Crystal Filter, Model 692A, shown half size, occupies only 1.5 cu. ins.

The TIROS satellite, carrying the nation's most advanced space-borne television "eye" to study the world's weather, comprises perhaps the most elaborate electronics package yet sent into orbit.

The information-gathering element in a complex satellite-and-ground system developed for the National Aeronautics and Space Administration by RCA, TIROS contains miniature TV cameras, video tape recorders, transmitters, solar cell and re-chargeable battery power supplies, and an array of control and communications equipment. One Hermes Crystal Filter, Model 692A, is used in each of two Command Receivers which pick up coded signals transmitted from the ground to establish the time during orbit when cameras, tape recorders, and playback equipment will operate. Launched April 1, 1960, TIROS relayed meteorological data for 78 days.

Hermes Crystal Filters were selected because of their unusual ability to meet the severe environmental conditions encountered in space, while providing extremely high selectivity to receive command signals reliably. Characteristics of Hermes Crystal Filter, Model 692A, include: *Center Frequency*: 20 mc \pm 1 kc; *6db Bandwidth*: 40 kc min; *Passband Response Variation*: $\pm 1/2$ db; *60 db Bandwidth*: 100 kc max; *Impedance*: 1K nominal; *Midband Insertion Loss*: 3 db max; *Size*: 1.5 cu. ins; *Environment*: *Shock*: 100 G's; *Vibration*: 20 G's - 2000 cps; *Center Frequency Variation*: ± 2 kc over the *Temperature Range*: -55° C. to + 85° C.

If you have a filtering problem, call on Hermes engineering specialists to assist you in the design of your circuitry and in the selection of filter characteristics best suited to your needs. Write for *Crystal Filter Bulletin* to Hermes Electronics Co., Dept F, 75 Cambridge Parkway, Cambridge 42, Mass.

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BOOKS

Proceedings of the Fifth Conference on Magnetism and Magnetic Materials

McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N.Y., 419 pp, \$10.

The papers presented at the Conference on Magnetism and Magnetic Materials in November, 1959, are compiled in this volume for reference use by the specialist who must have up-to-date information in this field. The articles are cataloged under the following headings; Magnetism, General and Theory; Garnets, Permanent Magnets, Spin Waves and Magneto-static Modes, Computers and Switching, Anisotropy, Techniques and Devices, Resonance, Soft Magnetic Materials, Ferrites and Oxides, Magnetic Films, Metals and Alloys, Magnetic Salts, Magnetic Compounds and Neu-

tron Diffractions, and Ferrimagnetic Resonance Effects. About 150 articles are included.

Research on Barium Titanate and Other Ferroelectric Materials For Use As Information Storage Media

Charles F. Pulvari, Armed Services Technical Information Agency, Arlington Hall Sta., Arlington 12, Va., or Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D.C., 224 pp, \$3.50.

Compiled for the specialist working with ferroelectric materials, this book covers ferroelectric research, storage cell stability, and the uses of ferroelectric storage condensers in digital calculators. The work leading to this report was done

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under the direction of the Aeronautical Research Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio. Graphs, charts, photographs and illustrations supplement the text.

Neutron Detection

W. D. Allen, *Philosophical Library Inc.*, 15 E. 40th St., New York 16, N. Y., 260 pp, \$10.

A study of the main methods of neutron detection, this book is addressed to the reader who has a background in nuclear physics and particle detectors and who needs more detailed information in this field. Included are chapters on these topics: reactions used in neutron detection, the chief instruments of neutron detection, applications of neutron detectors, and neutron standards.

The Electric Arc

J. M. Somerville, *John Wiley & Sons, Inc.*, 440 Fourth Ave., New York 16, N. Y. 150 pp, \$2.50.

Written for the non-specialist, this concise study of the electric arc provides

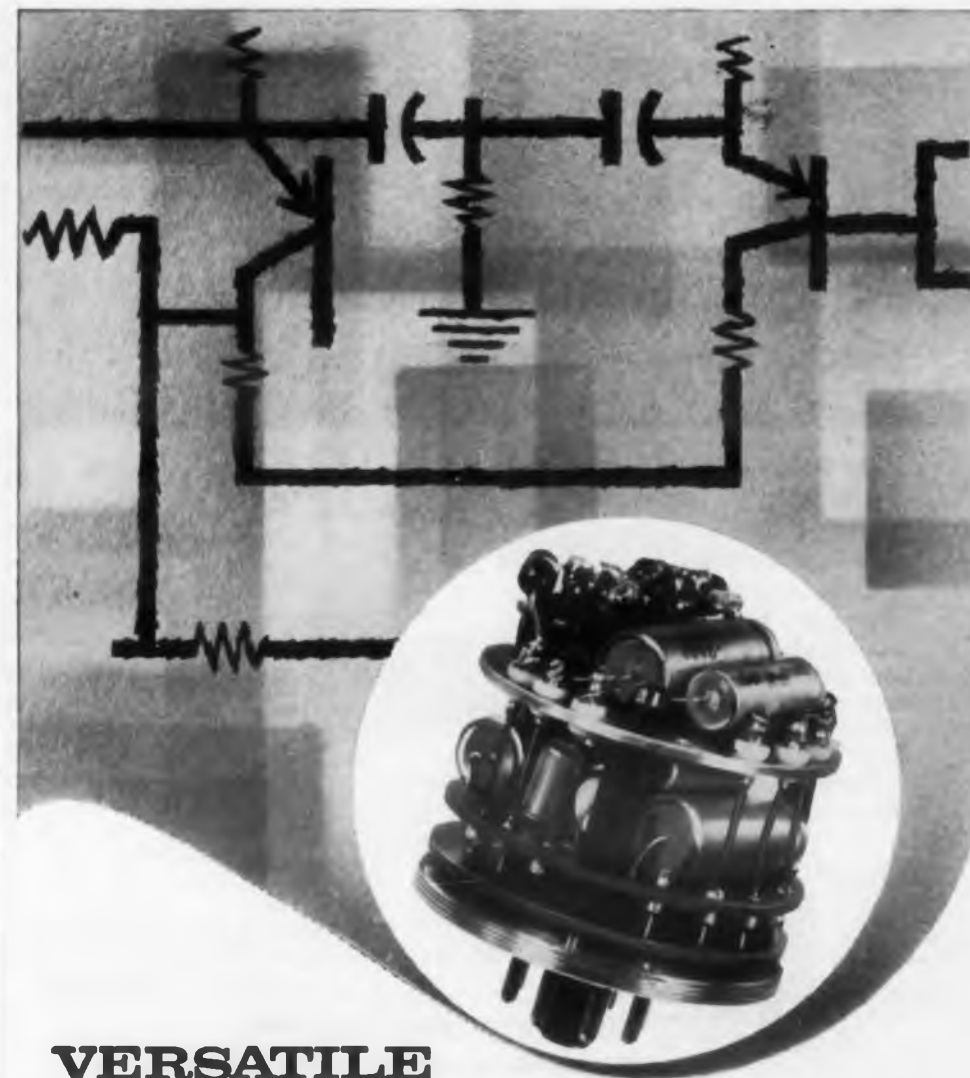
an explanation of the basic physical phenomena that operate when a high current passes through a gas.

Following an introductory chapter, Part I treats stable-arc discharge. It gives the properties of the arc column and the ways of measuring them. It discusses energy transfer to and from the column, the use of the column as a source of light, and thermonuclear reactions in high-temperature arc columns. Electrode-column junctions are described; competing theories are outlined. Part II provides various approaches to the stable arc.

Alternating-Current Circuits

Russel M. Kershner and George F. Corcoran, *John Wiley & Sons, Inc.*, 440 Park Ave. S., New York 16, N. Y., 602 pp.

Intended as a textbook for courses in alternating-current circuits, this book may also be used by practicing engineers in need of an up-to-date reference. Now in its fourth edition, the book has been revised to include new material on topology, duality and the pole-zero method of circuit analysis.



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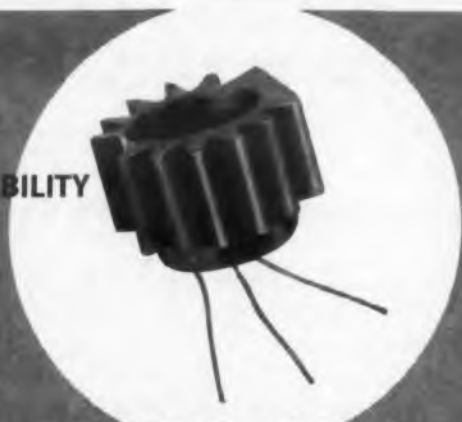


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RUSSIAN TRANSLATIONS

J. George Adashko

Combined Double Tee

THE COMBINED double tee, (CDT), shown in Fig. 1, consists of a turnstile, (whose arms are in the H plane), and two sections of rectangular wave guide, (forming the E arms), perpendicular to the turnstile plane. The planes of polarization of the electric field are mutually perpendicular in the E arms.

Some of the properties of the CDT are listed below:

1. If arms 2 and 4 are identically loaded and power is fed into arm 1 (or 3), equal power flows into 2 and 4, and no power flows into 5.
2. If arms 2 and 4 are identically loaded and power is fed into 5, the power is equally divided into 2 and 4, and does not flow into 1, 3, or 6.
3. If arms 1, 2, 3, and 4 are not matched to the CDT but are identically loaded, arms 5 and 6 are decoupled.
4. If arms 5 and 1 or 3 are not matched to the CDT, there will be no mutual coupling between arms 5 and 1 or 3.
5. If arms 5 and 1 or 3 are matched to the

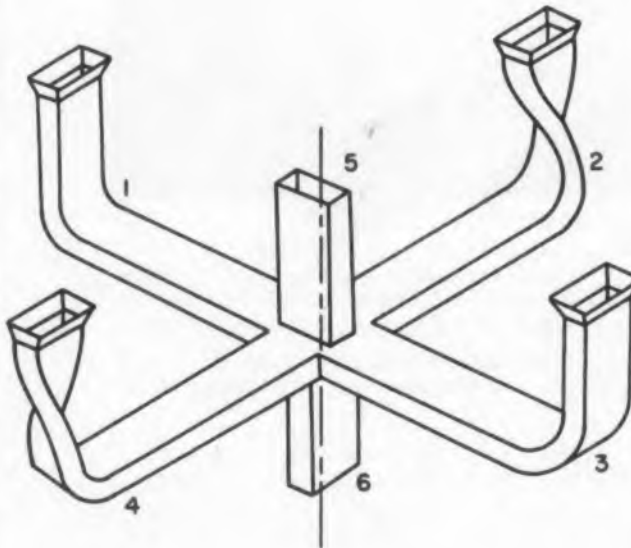


Fig. 1. Combined double-tee microwave junction.

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- Noise Fig. (1 Kc). .less than 2 db
- Total Noise (100K Source) 40 μ V
- Output Level. 3V p-p
- Z_{OUT} less than 600 ohms
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- Weight 1½ lbs.
- Size. 2½" x 6" x 5"

PRICE..... \$150⁰⁰

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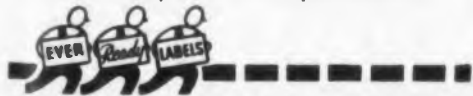
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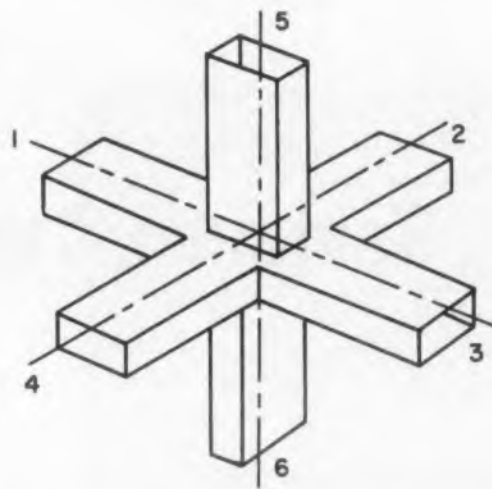


Fig. 2. Combined double-tee modified for the determination of the equal-signal zone of a radiation source in two mutually perpendicular planes.

CDT, then there is no mutual coupling between matched arms 2 and 4.

6. If arms 1, 3, and 5 are matched and power is fed into arm 2, the power flowing into 5 is twice the power entering 1 and 3.

It is easily seen that the ordinary double tee is a particular case of the combined double tee. That is, if arms 3 and 6 are short-circuited, the usual double tee junction results.

The combined double-tee differs from a turnstile because power can be conveniently drawn from the E arms. Also, it is not subject to errors due to unstable polarization of the field in the E arm of the turnstile.

The CDT can be used for electronic measurements, and in bridge circuits.

Fig. 2 shows how the CDT is modified for simultaneous determination of the equal-signal zone of a radiation source in two mutually-perpendicular planes. In accordance with properties 1 and 2 of the CDT, signal will enter into arms 5 and 6 if the radiation source is on the line joining the E arms. Indicators connected to arms 5 and 6 will read zero.

Translated from Combined Double Tee by G. V. Grisha, News of the Colleges, Radio Engineering, No. 2, Mar-Apr, 1960, pp 290



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C	.001—20MF	100—30KV	-55°C +200°C	.02% 1KC	-50 PPM/C	10' MEG	0.1—	0.01%
D	.0001—20MF	100—60KV	-55°C +125°C	.5% 1KC	+500 PPM	10' MEG	1.0%	0.10%

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GERMAN ABSTRACTS

E. Brenner

Tantalum Capacitors

SOLID semiconductor materials, when used as capacitor dielectrics, yield new components that are suited for applications where older types of electrolytics cannot be used.

The detailed operating and construction principles of tantalum capacitors date back only to 1956.¹ A typical tantalum unit consists of five layers. The anode is made either of tantalum wire or is formed by a powder-metallurgical process into a porous "composite." Next are layers of a tantalum oxide, Ta₂O₅, and of manganese dioxide. A graphite layer is then followed by the metallic alloy, conductively connected to the housing to form the negative terminal of the capacitor.

The temperature characteristics of tantalum

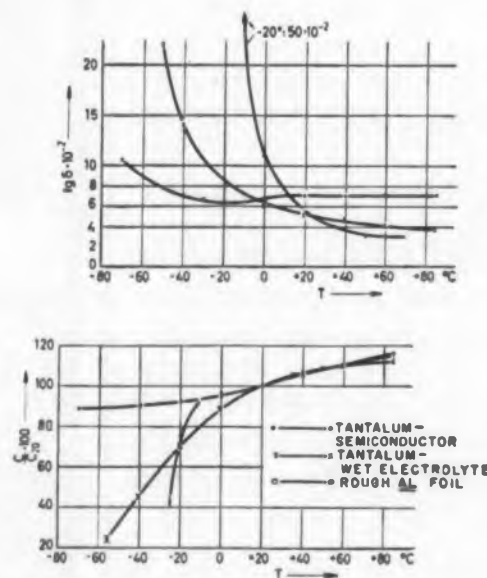


Fig. 1. Temperature dependence of capacitance and loss tangent at a frequency of 100 cps.

capacitors are stable between ± 85 C with respect to loss factor and capacitance values. In Fig. 1, comparative capacitance and loss tangent characteristics are shown. For wire anodes there is an average capacitance change which corresponds to 0.06 per cent per deg C, while for "composite" anodes the value is 0.2 per cent per deg C. The residual current however is more markedly temperature-dependent; it varies in the ratio 1:10 between 20 and 80 C. Similarly, residual current is a function of operating voltage, Fig. 2.

Comparative frequency characteristics are shown in Fig. 3 for "composite" anodes and in Fig. 4 for a wire anode. Typical impedance-frequency variations are given in Fig. 5.

Pulse and repeated switching tests show that the capacitor parameters do not change materially as long as no polarity reversals occur. To

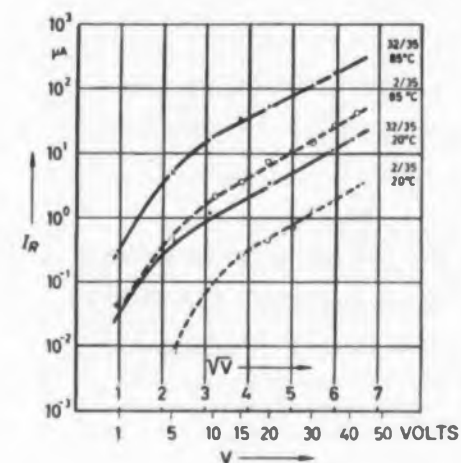


Fig. 2. Residual current as a function of applied voltage at 20 C and 85 C for two 35-v capacitors.

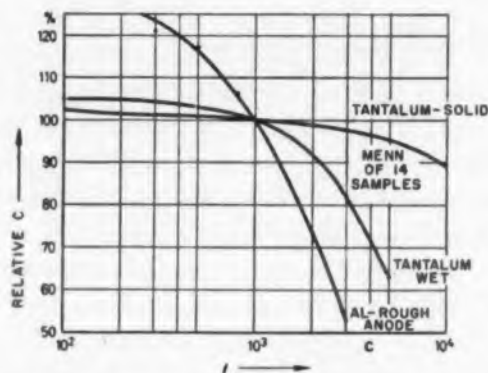


Fig. 3. Frequency dependence of tantalum capacitor with "composite" anode.

test the effect of polarity inversion capacitors, in series with 1-K resistors, were subjected to 10^6 cycles of 3-sec direct and 1.5-sec reverse polarity. While the resulting changes in capacitance were only 10 per cent, with no change in value of loss tangent, the residual currents were increased by a factor of 100. With reforming, these currents could be reduced, but in no case could the original values be recovered. Although life tests are not yet complete, it is expected that solid dielectric capacitors will be superior to liquid types in this respect, as well.

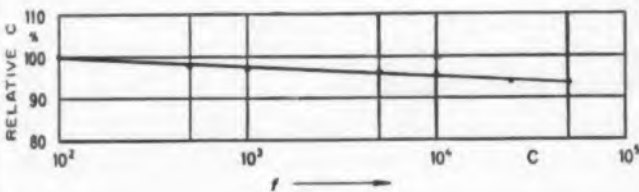


Fig. 4. Frequency dependence of tantalum capacitor with wire anode.

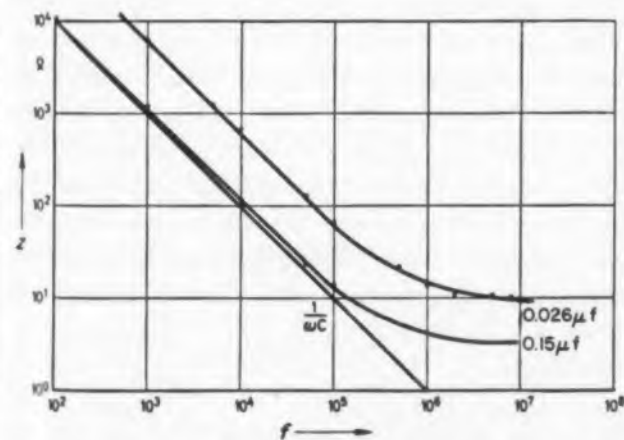


Fig. 5. Impedance as a function of frequency for tantalum capacitors with wire anodes.

Abstracted from an article by W. Ackmann *Nachrichtentechnische Zeitschrift*, Vol. 13, No. 6, June 1960, pp 261-265.

1. McLean and Power, *Proc. IRE* 44 (1956), No. 7, pp 872-878, P. Power, *Bell Laboratory Record*, Oct. 1957, pp 4-9.

2 NEW Electrostatic Deflection Tubes Highlight G-E Advances in Display Systems



The aim of General Electric research and development in cathode ray tubes is twofold: solve specific customer problems; advance the technology of the industry. Important progress in both areas is demonstrated by two G-E tube advances.

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All engineers interested in improving their writing are invited to attend the Early Bird seminar to be held from 9 to 10 A.M. Wednesday, November 16 in the Oval Room of the Sheraton-Plaza Hotel, Boston.

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REPORT BRIEFS

Microwave Electron Beams

A review of wave propagation along electron beams and of the interaction of these waves with the fields of microwave structures is presented. Also discussed is the basis for a unified theory of microwave amplifiers with distributed interaction. The small-signal power theorem for beams with zero curl of the generalized momentum is derived. The waves along longitudinal beams, cylindrical Brillouin beams, and Brillouin strip-beams in crossed fields are reviewed and their small-signal power flows are studied. A variational principle is derived for longitudinal beams and beams with zero curl of the generalized momentum. For reasonable trial fields, the principle leads to Pierce's coupling-of-modes formalism, and can also be applied to study cases of stronger coupling than those analyzable by the coupling-of-modes theory. Equations of the magnetron amplifier are derived from the variational principle. *Electron Beam Waves in Microwave Tubes*, H. A. Haus, Massachusetts Institute of Technology, Cambridge, Mass., April, 1958, 45 pp, Microfilm \$3.30, Photocopy \$7.80. Order PB 145783 from Library of Congress, Washington 25, D.C.

Pulse Transmission

The use of higher order alphabets for digital transmission was investigated. It was found that, for a practical system, higher order alphabets permit a more efficient approach than binary alphabets towards the maximum transmission rate. Electrical waveforms suitable for higher order alphabets were investigated. A set of four harmonic orthogonal waveforms is given. These waveforms are composed of sine and cosine components. The signal space occupancy for these waveforms was investigated in the low pass band and the carrier band. A most general waveform is one which is modulated in amplitude and frequency, here called FAM-waveform. *Pulse Transmission Study*, G. K. McAuliffe, R. Filipowsky, and E. I. Muehldorf, Westinghouse Electric Corp., Baltimore, Md., June 1959, 123 pp, Microfilm \$6.30, Photocopy \$19.80. Order PB 145569 from Library of Congress, Washington 25, D.C.

Magnetic Amplifiers

Multiple-hole magnetic cores, also called transfluxors, which have been developed recently, promise to be very useful in computer, control, and other logic circuitry. They are ferrite cores, with square hysteresis loops, of various complicated geometries. In this report, a workable

analysis procedure for circuits that contain transfluxors is developed; it is based on the square-wave shape approximation. This analysis forms a basis for a design procedure. Sample circuits were designed and tested, and the results were found to be within 10 per cent of the predicted values.

In the field of logical design, a symbolic notation was developed, and an approach to design was made using "gate boxes." A description of the physical properties of transfluxors is given. It includes some new, unpublished, special effects encountered with multiple-hole cores. *Analysis of Circuits with Multiple-Hole Magnetic Cores*, Lubomyr S. Onyshkevych, Massachusetts Institute of Technology, Cambridge, Mass., July, 1957, 67 pp, Microfilm \$3.90, Photocopy \$10.80. Order PB 145779 from Library of Congress, Washington 25, D.C.

Noisy Two-Port Networks

A new geometric-analytic theory of noisy two-port networks is presented. It is based, geometrically, on the isometric sphere method, a generalization of the isometric circle method to three dimensions, and, analytically, on a three-dimensional conformal transformation which was originally derived by Poincare and Picard. The transformation is used in a study of transformations of noise ensemble average ratios through bilateral two-port networks. The new theory has been used for studying several problems pertaining to noisy two-port networks: the Rothe and Dahlke method of splitting a noisy two-port network into noisy and noisy-free parts, cascading of noisy two-port networks, noise tuning and noise matching, the wave representation of noisy two-port networks, and the optimum noise factor. *Theory of Noisy Two-Port Networks*, E. Folke Bolinder, Massachusetts Institute of Technology, Cambridge, Mass., June, 1958, 30 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 145782 from Library of Congress, Washington 25, D.C.

P-N-P-N Negative Resistance Diode

The operation of the three-junction diode is analyzed and interpreted in terms of two contiguous transistors. It is seen that avalanche breakdown and the sum of the forward alphas determine the switching characteristics. The properties of four varieties of the diode are presented and comparisons made. A linear-equivalent circuit is developed. Some simple circuit applications are analyzed. *An Evaluation Of The P-N-P-N Negative Resistance Diode*, H. I. Honor, Air Force Cambridge Research Center, Bedford, Mass., Mar. 1959, 39 pp, Microfilm \$3.00, Photocopy \$6.30. Order PB 146446 from Library of Congress, Washington 25, D.C.



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LETTERS

Core Loss Important Sometimes

Dear Sir:

In your April 27 issue, the article entitled "Thermal Factors in Transformer Design" by W. W. Wahlgren stated that:

"Temperature rise is caused by core loss, and coil or copper loss. Core loss seldom presents a problem because the heat is generally conducted through the mounting device. Since the core does not ordinarily deteriorate as a result of high temperature operation, core loss does not have a significant effect on transformer life expectancy."

The author suggests here that core loss has essentially no effect on temperature rise of a transformer coil and consequently does not contribute to insulation deterioration and to a shorter life expectancy. This observation should be applied with caution and be qualified by saying that it depends on the magnitude of the core losses relative to the transformer size.

Some transformer and inductor applications involve very small core losses that can be ignored as far as coil temperature rise is concerned. For a large percentage of electronic power transformer applications, however, core loss must be taken into account. Consider a transformer that occupies approximately 8 cu in.; the temperature rise obtained with a non-core loss condition is increased by 50 per cent when the core loss is made equal to the coil loss. Translated into temperature for a rise due to coil loss alone of 40 C, this 50 per cent represents 20 C of additional coil rise. Even a 5-C added rise, obtained with a core-loss-to-coil-loss ratio of only 0.25 for this example, must be viewed as highly significant.

Sincerely,

Harold B. Harms

GE Advanced Development Engineering
Fort Wayne, Ind.

Mesa Mixup

In our article entitled, "Selecting Transistors and Diodes for Logic Applications," in the July 6 issue an error appeared on p 49. A sentence which read, "In the mesa transistor, GBW is usually considerably larger than f_{ab} " should have read, "In the mesa transistor f_{ab} is considerably larger than the GBW."

The factor relating common emitter cut-off frequency and common base cut-off frequency is defined as follows:

$$K = \frac{f_{ace}}{(1 - \alpha_0) f_{ab}}$$

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where α_0 is the low frequency common base current gain, f_{ab} is the frequency at which the magnitude α_0 is reduced 3 db.*

K will be unity having a retarding field in the base layer of the right magnitude to give an RC time constant common base cut-off defined by:

$$a = \frac{\alpha_0}{1 + j(f/f_a)}$$

For built-in fields corresponding to a decrease in impurity concentration from emitter-to-collector (as in the diffused base mesa and drift types), K decreases as the built-in field increases, thus demonstrating f_{ab} must be larger than GBW. This has been verified experimentally.

Carl Uretsky
Charles Askanas
General Transistor Corp.
Jamaica, N.Y.

Will Micromin Stimulate Computer Use?

Dear Sir:

Your feature article on design with digital computers in the August 31 issue of "ELECTRONIC DESIGN" was so informative and stimulating that I wish to make it more readily available to my design engineers in Advanced Development. Can you furnish 10 reprints of the article?

The limited use which has been made of digital computers in circuit and equipment design is a reflection of an empirical rather than analytical approach to design.

Although I do believe that much more extensive advantage could be taken of computers in this area, I feel that it must be pointed out, in defense of circuit designers, that the empirical approach is frequently dictated by lack of relevant data on new active components for the conditions under which the components will have the general characteristics needed for the circuits.

I foresee a partial change in this area, however, as microminiaturization in its various forms becomes more common. In this stage of the art I expect that circuits rather than component parts will be used as building blocks and that they may be more practical in that circumstance to have more detailed analytical information available on these building blocks.

Homer C. Knauss, Manager
Advanced Development
Raytheon Co.
Airborne Equipment Operations
Sudbury, Mass.

*Short Circuit Current Gain and Phase Determination
D. E. Thomas and J. L. Moll, IRE Proceedings, 1958.

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The new Alphlex Closing Tool (above) designed to save you time, labor and money in your cable production requirements is free with each order of 1,000 feet of Zipper Tubing.

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ZIP-31M	heavy duty construction. Similar to ZIP-31 type except nominal wall thickness of .040". Standard colors: Clear, Black.	Track Thickness (when closed) _____ .095"
ZIP-44	polyvinyl sheet made from MIL-I-7444B materials. Extremely flexible; for aircraft and low-temperature uses to -67°C. Standard colors: Clear (amber), Black.	Dielectric Strength, V/mil _____ 759
ZIP-44M	heavy duty construction. Similar to ZIP-44 type except nominal wall thickness of .040". Standard colors: Clear (amber), Black.	Tensile Strength P.S.I. _____ 3810
ZIP-50	"sandwich" of aluminum foil laminated between two sheets of polyvinyl. For 100% RF shielding applications to 105°C. Standard color: Silver Grey.	Ultimate Elongation _____ 255%
ZIP-90	polyvinyl bonded to woven fibreglass sheet per MIL-I-3190A. For rough usage, abrasion resistance, and high temperature uses to 130°C. Standard color: Black.	Operating Temperature, Upper Limit _____ 106°C
All types available in inside diameters from 1/4" to 2" in increments of 1/8"; and from 2" to 4" in increments of 1/4". Alphlex Zipper Tubing covered by Patents #RE24,613 and #2,558,367 and other patents.		Cold Brittleness _____ -86°C
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CIRCLE 231 ON READER-SERVICE CARD

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If you are working with infrared-actuated devices, you need this new Kodak folder, *Kodak Ektron Detectors*. It tells what you need to know about types and availabilities of these photosensitive resistors.

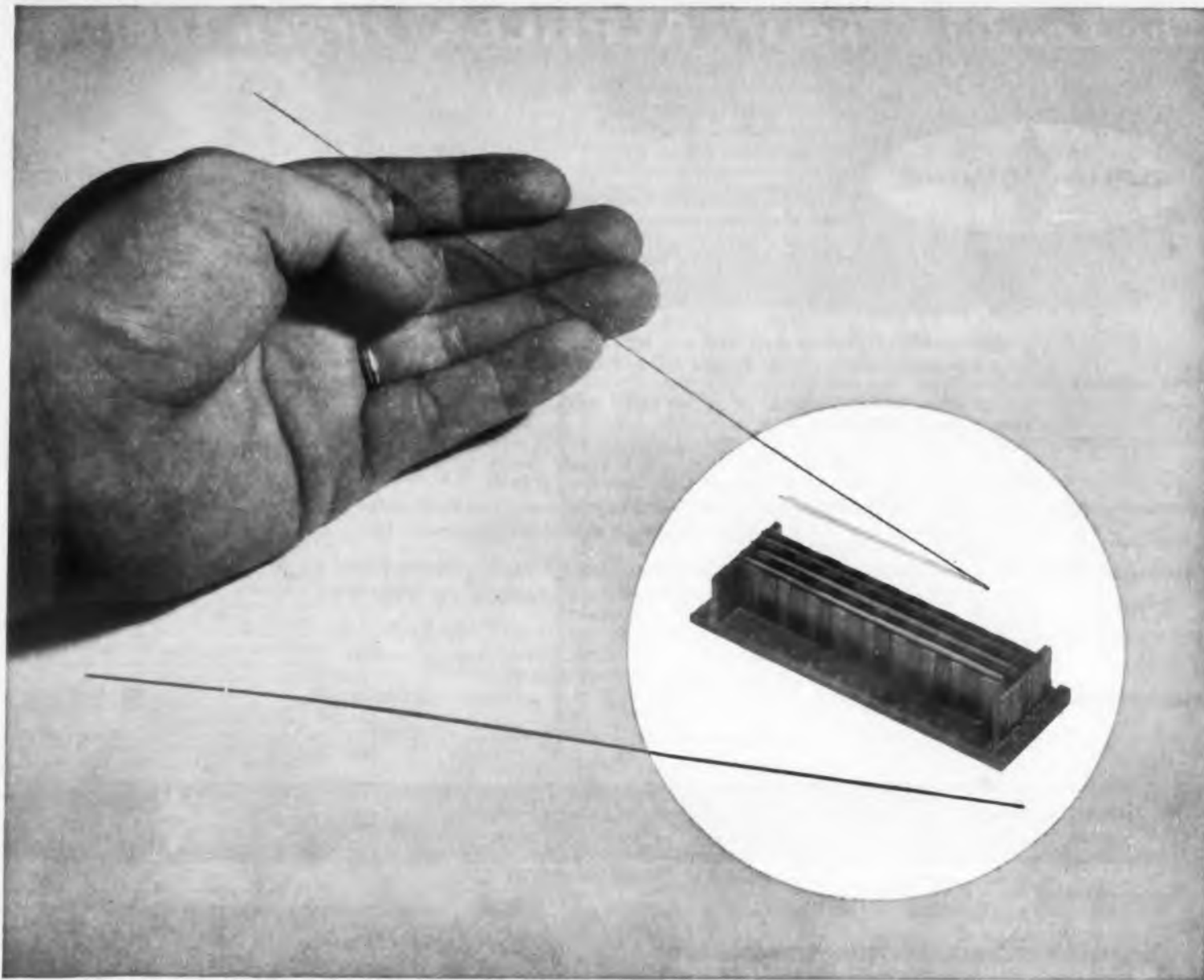
There are curves for the six different depositions available in Ektron Detectors that give specific responsivity and detectivity (signal-to-noise ratio) against wave length. Also description of physical forms available and a quick summary of basic effects.

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CHEMISTRY: Plastics and polymers, micro-encapsulation (of liquids or reactive solids),

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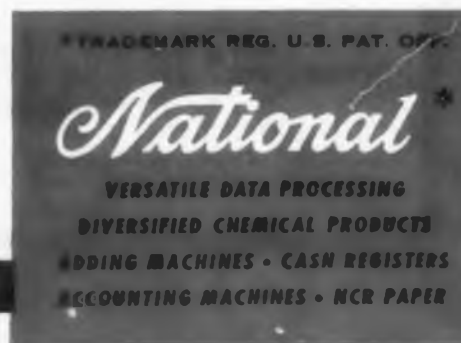
DATA PROCESSING: Computer theory and component development, programming studies, high-speed non-mechanical printing and multi-copy methods, direct character recognition, systems design.

SOLID STATE PHYSICS: Electro, chemical, and vacuum deposited magnetic films ferrites and ferro-magnetics, advanced magnetic tape studies, electroluminescence-photo-conductor investigations.

ADVANCED ENGINEERING DEVELOPMENT: High-speed switching circuits, random access memory systems, circuit design (conventional, printed, etched), advanced electron

beam type storage. The location of the new NCR Research and Development Center is progressive, energetic Dayton, Ohio. Facilities are extensive—a veritable "city within a city."

COMPLETE INFORMATION is yours by sending your résumé to Mr. T. F. Wade, Technical Placement Section F3-3, The National Cash Register Company, Dayton 9, Ohio. All correspondence will be kept strictly confidential.



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CIRCLE 902 ON CAREER INQUIRY FORM

YOUR CAREER NEWS AND NOTES

For a whole winter, a newspaper editor in a Long Island community assiduously attended adult-education classes in space navigation. But when spring came, and with it the day for the final examination, he failed to get credit for the course because he got lost trying to find the high school in a neighboring town where the exam was being given. Moral: He who would conquer space must first conquer the turnpike exits.

...

The U.S. Air Force Air Materiel Command is seeking electronics engineers at various grades and options. The salaries range from \$4,940 to \$12,770. Application (Standard Form 57) should be sent to any of the following Air Materiel areas:

Olmsted AFB, Pa.; Brookley AFB, Ala.; Hill AFB, Utah; Tinker AFB, Okla.; Griffiss AFB, N.Y.; Kelley AFB, Tex.; Norton AFB, Calif.; McClellan AFB, Calif.; and Robbins AFB, Ga.

The forms, which may be obtained at any post office, may also be sent to the New York Procurement District, N.Y., or the Detroit Air Procurement District, Mich.

...

An engineer's average term of employment with a leading electronics company is about six years, according to the company's bulletin.

Employee terms with the company varied from about nine months to 20 years. However, the length of service was only vaguely related to the employee's age.

In one department, for instance, a 29-year-old engineer had been with the company for seven years, while a 32-year-old engineer had just under three years of service.

The salary of an engineer who was with the company for one year averaged just above \$8,000 per year. A 15-year man earned about \$12,500 a year.

...

The median annual salary of scientists in the United States for 1956-58 was \$7,900, according to the National Science Foundation.

Of the 137,000 scientists who completed questionnaires for the foundation, about half were in private industry or self-employed. About 28 per cent were employed by educational institutions, and 14 per cent by the Federal government.

The scientists with the highest and lowest median salaries were those who had left scientific work. Persons in management had the highest median salary, \$11,000 per year. Those in teaching reported the lowest median annual salary, \$6,500.

ELECTRONIC DESIGN **CAREER INQUIRY SERVICE**

USE BEFORE DEC. 21, 1960

23

After completing, mail career form to *ELECTRONIC DESIGN*, 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below.

(Please print with a soft pencil or type.)

Name _____ Telephone _____

Home Address _____ City _____ Zone _____ State _____

Date of Birth _____ Place of Birth _____ Citizenship _____

Position Desired _____

Educational History

College	Dates	Degree	Major	Honors

Recent Special Training _____

Employment History

Company	City and State	Dates	Title	Engineering Specialty

Outstanding Engineering and Administrative Experience _____

Professional Societies _____

Published Articles _____

Minimum Salary Requirements (Optional) _____

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

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Your Goal?
Use
CONFIDENTIAL
Action Form**

ELECTRONIC DESIGN's Confidential Career Inquiry Service helps engineers "sell" themselves to employers—as confidentially and discreetly as they would do in person. The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—the same day the resume is received.

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

• All forms are delivered unopened to one reliable specialist at *ELECTRONIC DESIGN*.

• Your form is kept confidential and is processed only by this specialist.

• The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.

• All original applications are placed in confidential files at *ELECTRONIC DESIGN*, and after a reasonable lapse of time, they are destroyed.

If you are seeking a new job, act now!

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Engineers at The Garrett Corporation's AiResearch Manufacturing Divisions are dealing with challenging problems in fast-moving fields.

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- **Environmental Control Systems**—Pioneer, leading developer and supplier of air conditioning and pressurization systems for commercial and military aircraft, and life support systems for satellites and space vehicles.
- **Aircraft Flight and Electronic Systems**—Largest supplier of airborne centralized flight data systems; also working with other electronic controls and instruments including missile and submarine applications.
- **Missile Systems**—Largest supplier of accessory power units, AiResearch is also working with hydraulic, hot gas and hydrogen systems for missiles, liquid and gas cryogenic valves and controls for ground support.
- **Gas Turbine Engines**—World's largest producer of small gas turbine engines, with more than 9000 delivered in the 30–850 hp class. Studies include industrial and nuclear applications.

Excellent positions are available for qualified men with M.S., Ph. D. and Sc. D. degrees for work in these areas.



Send resume to: Mr. R. K. Richardson

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

CAREER NEWS

An engineer can find a new job if he has poor notices by not more than one previous employer, according to Industrial Relations News, a newsletter for the personnel field.

"Employees can get by with a single-negative reference . . . but a series of unfavorable reports might result in discharge," the newsletter concluded after a survey of 25 companies.

Although the majority of companies said they wanted honest reports from an applicant's previous employers, they admitted they themselves didn't "tattle" on ex-employees. The minority said they disclosed information, even though it was uncomplimentary to the ex-employee.

Only 15 of the 25 companies polled said they checked details on job applications, according to the newsletter. Although most companies warn applicants to the effect that "falsification of personnel information is just grounds for dismissal," minor falsehoods are overlooked, the survey disclosed. The most common area of error is in reporting the dates of previous employment. Other data often reported dishonestly are education, previous salary, age, and reasons for leaving previous jobs.

• • •

Employment opportunities for electronics specialists in Miami will increase in the future, a Miami county official has predicted. Richard J. Welsh, director of the Dade County development department, said the county's major program—called "Emphasis Electronics"—is aimed at attracting electronics manufacturers to Miami.

In a recent speech to a gathering of electronics technicians, Mr. Welsh said the 38 electronics plants now in Miami's metropolitan area employ 2,207 persons and do an annual business of \$20 million.

• • •

The amount of available technical information has surpassed the capacity of communications media to circulate it among engineers and scientists, according to a panel of journalists and industry representatives.

The panel, which met recently at New York University, said the inadequate communications methods between scientists and engineers is slowing technical progress in this country.

Company representatives said that their respective companies also were striving to improve communications between management and the technical community.

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CAREER OPPORTUNITIES BROCHURES



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"Solutions Unlimited," a 20-page illustrated brochure, describes the growth of the Radio Engineering Laboratories, Inc. located in Long Island City, N.Y. The corporation is in the business of solving problems, particularly the specialized problems of the design and manufacture of equipment for radio communications.

Meeting the radio equipment needs of major troposphere systems has made REL the world's leading manufacturer of tropo scatter equipment. The invention of REL's exclusive patented Serrasoid® modulator for fm transmission opened vast new vistas in radio.

Radio Engineering Laboratories, Inc., 29-01 Borden Ave., Long Island City 1, N.Y.

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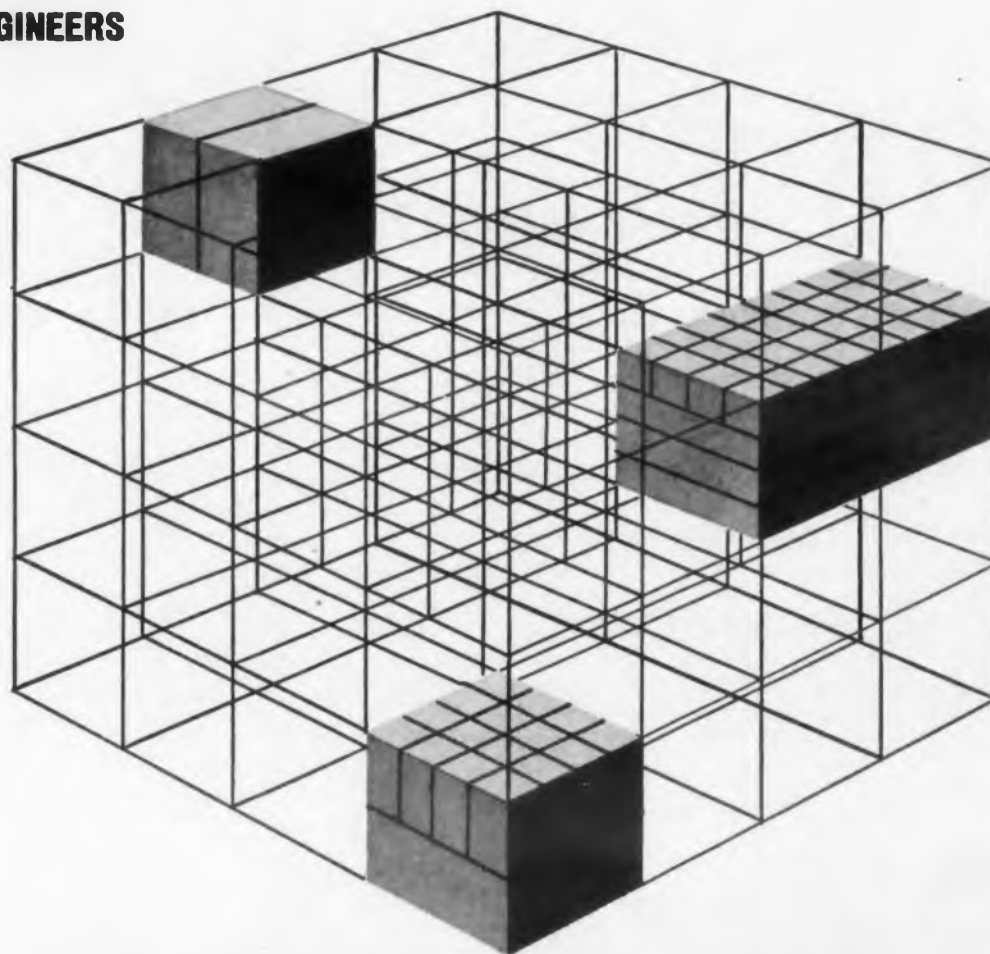


Edgerton, Germeshausen & Grier, Inc., bears the names of its three scientist founders, all graduates of Massachusetts Institute of Technology. Although its headquarters are still in Boston, it carries on large-scale operations half-way around the world. As noted in the company's 20-page brochure, a permanent office and laboratory is maintained in Las Vegas, Nev., where the company has long been a key participant in the planning, firing, instrumentations and photography of the U.S. Atomic Energy Commission's nuclear tests at its Nevada Proving grounds.

Edgerton, Germeshausen & Grier, Inc., 160 Brookline Ave., Boston 15, Mass.

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This is the calibre of the challenges presented to circuit engineers at the Ordnance Dept. of General Electric, where system design, development and manufacture is carried on for some of the nation's most advanced missiles, under-sea weapons and ground support equipment.

Positions are now open for Electrical Engineers with 4 to 10 years experience in circuit development, preferably solid state. Men with thorough knowledge of the most advanced solid state techniques will work directly with Systems Engineering in the early stages of systems planning. The design of high precision computing circuitry utilizing the latest developments in transistors, tunnel diodes, cryotrons and other solid-state devices must often be accomplished before feasibility studies of a proposed system can take place.

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OF THE DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

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CIRCLE 905 ON CAREER INQUIRY FORM

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