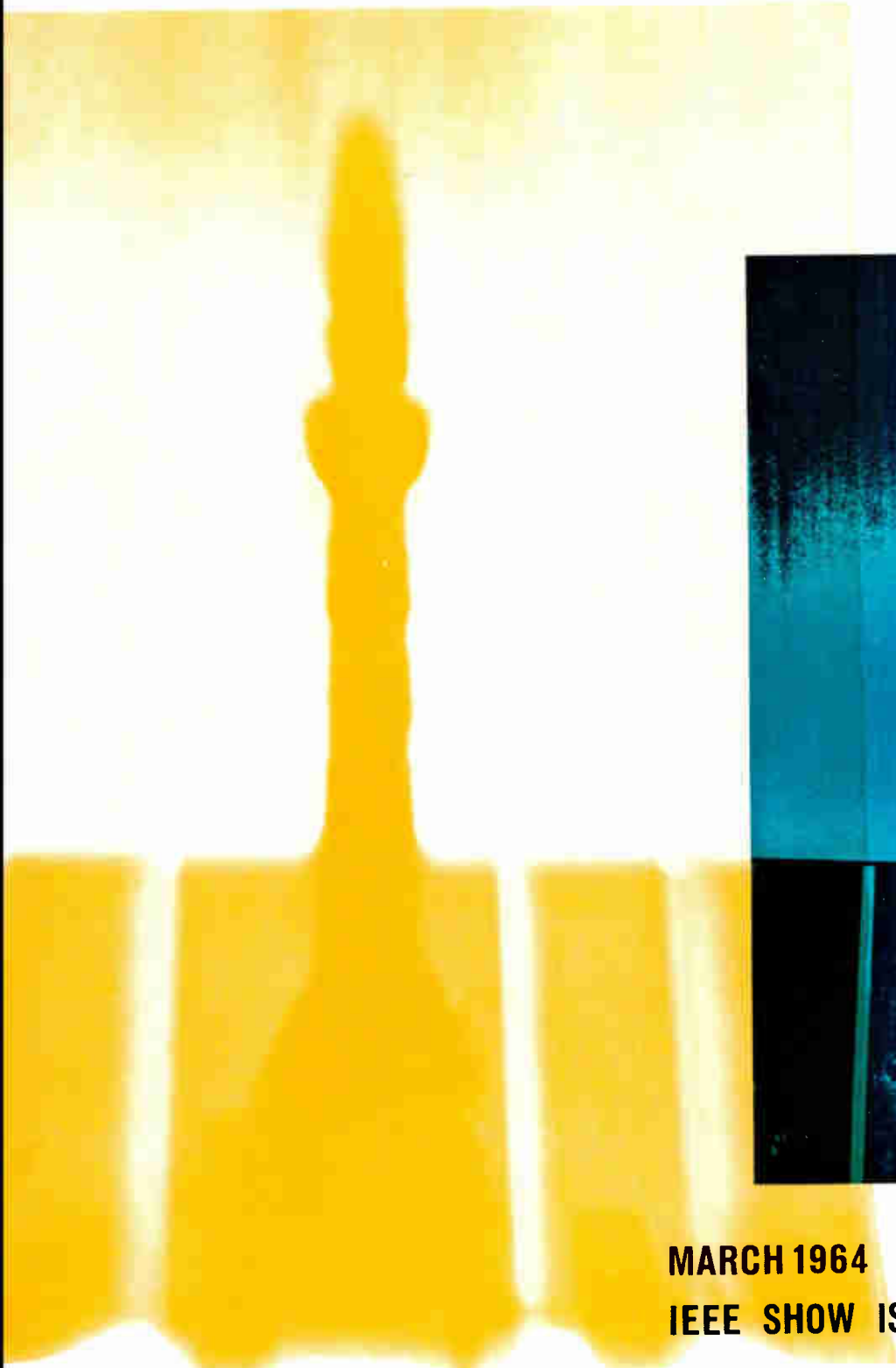


# ELECTRONIC INDUSTRIES

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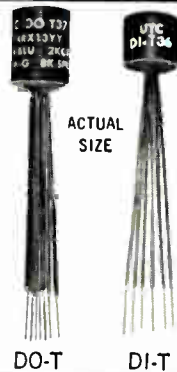


**MARCH 1964**  
**IEEE SHOW ISSUE**

## AUDIO TRANSFORMERS

DO-T No.	Pri. Imp.	D.C. Ma. in Pri.	Sec. Imp.	Pri. Res. DO-T	Pri. Res. DI-T	Mw Level	DI-T No.
DO-T44	80 CT 100 CT	12 10	32 split 40 split	9.8	11.5	500	DI-T44*
DO-T29	120 CT 150 CT	10 10	3.2 4	10		500	
DO-T12	150 CT 200 CT	10 10	12 16	11		500	
DO-T13	300 CT 400 CT	7 7	12 16	20		500	
DO-T19	300 CT	7	600	19	20	500	DI-T19
DO-T30	320 CT 400 CT	7 7	3.2 4	20		500	
DO-T43	400 CT 500 CT	8 6	40 split 50 split	46	50	500	DI-T43*
DO-T42	400 CT 500 CT	8 6	120 split 150 split	46		500	
DO-T41	400 CT 500 CT	8 6	400 split 500 split	46	50	500	DI-T41*
DO-T2	500 600	3 3	50 60	60	65	100	DI-T2
DO-T20	500 CT	5.5	600	31	32	500	DI-T20
DO-T4	600	3	3.2	60		100	
DO-T14	600 CT 800 CT	5 5	12 16	43		500	
DO-T31	640 CT 800 CT	5 5	3.2 4	43		500	
DO-T32	800 CT 1000 CT	4 4	3.2 4	51		500	
DO-T15	800 CT 1070 CT	4 4	12 16	51		500	
DO-T21	900 CT	4	600	53	53	500	DI-T21
DO-T3	1000 1200	3 3	50 60	115	110	100	DI-T3
DO-T45	1000 CT 1250 CT	3.5 3.5	16,000 split 20,000 split	120		100	
DO-T16	1000 CT 1330 CT	3.5 3.5	12 16	71		500	
DO-T33	1060 CT 1330 CT	3.5 3.5	3.2 4	71		500	
DO-T5	1200	2	3.2	105	110	100	DI-T5
DO-T17	1500 CT 2000 CT	3 3	12 16	108		500	
DO-T22	1500 CT	3	600	86	87	500	DI-T22
DO-T34	1600 CT 2000 CT	3 3	3.2 4	109		500	
*DO-T51	2000 CT 2500 CT	3 3	2000 split 2500 split	195	180	100	DI-T51*
DO-T37	2000 CT 2500 CT	3 3	8000 split 10,000 split	195	180	100	DI-T37*
*DO-T52	4000 CT 5000 CT	2 2	8000 CT 10,000 CT	320	300	100	DI-T52*
DO-T18	7500 CT 10,000 CT	1 1	12 16	505		100	
DO-T35	8000 CT 10,000 CT	1 1	3.2 4	505		100	
*DO-T48	8,000 CT 10,000 CT	1 1	1200 CT 1500 CT	640		100	
*DO-T47	9,000 CT 10,000 CT	1 1	9000 CT 10,000 CT	850		100	
DO-T6	10,000	1	3.2	790		100	
DO-T9	10,000 12,000	1 1	500 CT 600 CT	780	870	100	DI-T9
DO-T10	10,000 12,500	1 1	1200 CT 1500 CT	780	870	100	DI-T10
DO-T25	10,000 CT 12,000 CT	1 1	1500 CT 1800 CT	780	870	100	DI-T25
DO-T38	10,000 CT 12,000 CT	1 1	2000 split 2400 split	560	620	100	DI-T38*
DO-T11	10,000 12,500	1 1	2000 CT 2500 CT	780	870	100	DI-T11
DO-T36	10,000 CT 12,000 CT	1 1	10,000 CT 12,000 CT	975	970	100	DI-T36
DO-T1	20,000 30,000	.5 .5	800 1200	830	815	50	DI-T1
DO-T23	20,000 CT 30,000 CT	.5 .5	800 CT 1200 CT	830	815	50	DI-T23
DO-T39	20,000 CT 30,000 CT	.5 .5	1000 split 1500 split	800		50	
DO-T40	40,000 CT 50,000 CT	.25 .25	400 split 500 split	1700		50	
DO-T46	100,000 CT	0	500 CT	7900		25	
DO-T7	200,000	0	1000	8500		25	
DO-T24	200,000 CT	0	1000 CT	8500		25	
DO-TSH	Drawn Hipermalloy shield and cover 20/30 db						DI-TSH

†DCMA shown is for single ended usage (under 5% distortion—100MW—1KC) for push pull. DCMA can be any balanced value taken by .5W transistors (under 5% distortion—500MW—1KC) DO-T & DI-T units designed for transistor use only. U.S. Pat. No. 2,949,591; others pending.  
§Series connected; §§Parallel connected → \*Units newly added to series

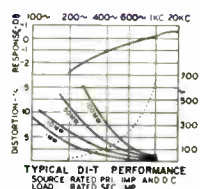
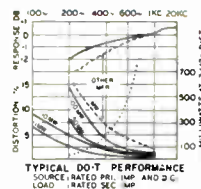


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DO-T No.	Inductance Hys @ ma	DO-T DCR Ω	DI-T DCR Ω	DI-T No.
*DO-T50 (2 wdg.s.)	\$.075 Hy 10 ma, .06 Hy 30 ma \$.018 Hy 20 ma, .015 Hy 60 ma	10.5 2.6		
DO-T28	.3 Hy 4 ma, .15 Hy 20 ma .1 Hy 4 ma, .08 Hy 10 ma	25	25	DI-T28
DO-T27	1.25 Hys 2 ma, .5 Hy 11 ma .9 Hy 2 ma, .5 Hy 6 ma	100	105	DI-T27
DO-T8	3.5 Hys 2 ma, 1 Hy 5 ma 2.5 Hys 2 ma, .9 Hy 4 ma	560	630	DI-T8
DO-T26	6 Hys 2 ma, 1.5 Hys 5 ma 4.5 Hys 2 ma, 1.2 Hys 4 ma	2100	2300	DI-T26
*DO-T49 (2 wdg.s.)	\$.20 Hys 1 ma, 8 Hys 3 ma \$.5 Hys 2 ma, 2 Hys 6 ma	5100 1275		

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## IT'S SHOW TIME AGAIN

LAST YEAR, ON THIS PAGE, we discussed what we felt were serious shortcomings in the planning of technical shows for the electronic industries. We mentioned the International Convention of the Institute of Electrical and Electronic Engineers in particular because it is the largest show of all. This year it opens again at the New York Coliseum on March 23 and its format shows no significant changes over that of previous years.

Editorially, we discussed the show's shortcomings with the hope that our suggestions would result in improvements that would benefit attending engineers and scientists. After all, the goal of a technical show is much the same as that of ELECTRONIC INDUSTRIES magazine. It is to give the engineer, as quickly and as effectively as possible, an up-to-the-minute picture of the State-of-the-Art in each area of technical development. This is not an easy task. It demands unusual attention to selection and correlation of many diverse elements. Our industry is so large that just random presentation of facts is apt to leave engineers groping, trying to assess the significance of each. This year's IEEE show, with its apparent random exhibitor display arrangement, does little to alleviate this problem.

We are, however, greatly encouraged by a recent report from WESCON. They have made an independent exhaustive study along the lines of our suggestion. As a result there will be some radical changes at their show next August.

The WESCON study is based on a survey of 40,000 engineers and scientists who attended the 1963 show. Specifically, it is concerned with their prime interest areas and how the show could be planned to provide them a maximum of information in the time they are in attendance.

The entire industry was divided into 48 technical areas. Engineers were asked to indicate principal interests in descending order. This information was then analyzed by computer to determine those most

closely allied. There are now nine major categories that have been singled out to be special show areas in this year's event. Both visitors and exhibitors will benefit from this since there will be a maximum of interest by both parties in each relatively small, localized area.

The study also turned up some other noteworthy facts. For one, attendees spend only 4 hours on the average touring the exhibits. This, despite the fact that the show is open for 30 hours. Another point is that visitors are unlikely to stop at booths that they had not previously planned to visit. About  $\frac{2}{3}$  of them plan their itinerary in advance. Not surprising, though, if they cover the entire show in only 4 hours.

Last May we published the result of our own survey on "How Engineers Keep Up-To-Date." Our first question asked about time spent reading technical publications at work. Close to 70% said they spent between 1 and 7 hours a week, reading at work, with the great majority reporting from 2 to 4 hours. Trade publications are regarded as the prime source of helpful information.

As editors, we have long been aware of these facts. For this reason we have always given special consideration to both our March and August show issues. Our aim has been to produce a most useful "planning-information" section in each of these issues. For the engineer who will attend, the content of this section enables him to pre-plan his time. For the engineer who cannot attend, the section provides an up-to-the-minute review of what the technical topics will be, what new products will be introduced, and the new State-of-the-Art subjects to be discussed. Show exhibitors, too, are aware of these issues. Many of them announce the products they will be displaying in this section. Our round-up of this year's IEEE show begins on page 38. We hope you will find it informative and useful. Suggestions as to how we can improve our show planning concept are most welcome.

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2N240	2N796	2N1122	2N1744	2N2048	2N2187	2N2377	2N2795
2N344	2N846A	2N1122A	2N1745	2N2095	2N2217	2N2378	2N2796
2N345	2N858	2N1300	2N1746	2N2096	2N2218	2N2398	2N2797
2N346	2N859	2N1301	2N1747	2N2097	2N2219	2N2399	2N2798
2N393	2N860	2N1427	2N1748A	2N2098	2N2220	2N2400	2N2799
2N499	2N861	2N1429	2N1754	2N2099	2N2221	2N2401	2N2942
2N499A	2N862	2N1499A	2N1785	2N2100	2N2222	2N2402	2N2943
2N501	2N863	2N1499B	2N1786	2N2162	2N2274	2N2451	2N2962
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2N502	2N865	2N1676	2N1788	2N2164	2N2276	2N2488	2N2964
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2N502B	2N980	2N1683	2N1790	2N2166	2N2278	2N2787	2N2968
2N768	2N982	2N1726	2N1864	2N2167	2N2279	2N2788	2N2969
2N769	2N983	2N1727	2N1865	2N2168	2N2280	2N2789	2N2970
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World Radio History



The STATE-OF-THE-ART\* Magazine for Electronic Engineers

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STATE-OF-THE-ART FEATURES:

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COVER

Our cover designer took a bit of artistic license with a scene that will be familiar to engineers and scientists attending this year's IEEE Show and Convention. The missile-like object is the statue of Christopher Columbus, which stands directly opposite the New York Coliseum.

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



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# The Original Bullet-Nose Capacitor!



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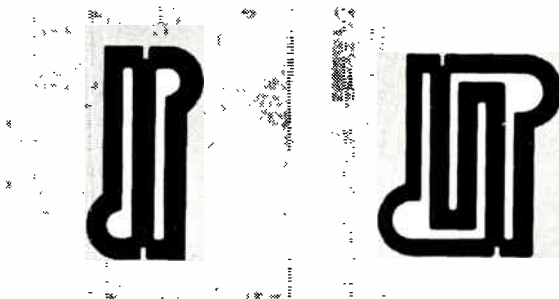
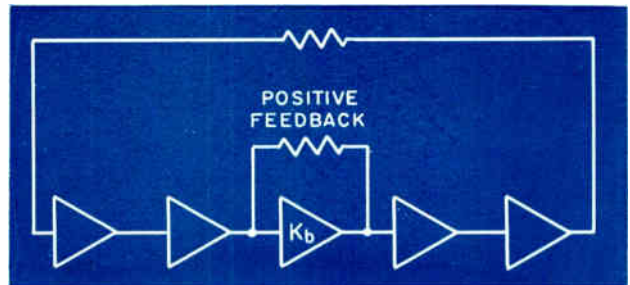
**1964 IEEE . . .**

**A GLIMPSE OF THE FUTURE 38**

The world's largest technical meeting will draw over 75,000 engineers and scientists from 40 countries. Its expanded papers program will feature everything from a flip-flop with one transistor to engineering management.

**"WORST CASE ANALYSIS"  
IN ANALOG CIRCUIT DESIGN 78**

"Worst Case Analysis" is an effective method of calculating the reliability of complex systems. But only the digital industry has taken full advantage of it until now. This article describes how one company has used "WCA" to design power supplies and has thereby achieved Mean Time Between Failure (MTBF) rates in excess of 100,000 hours.



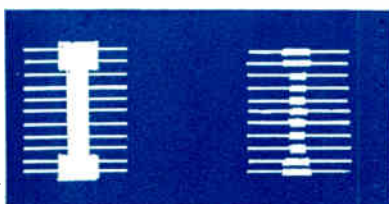
**FIELD EFFECT TRANSISTORS  
UNDER NUCLEAR RADIATION**

**94**

Field effect transistors, like other semiconductors, are affected by nuclear radiation. However, some of the changes are not the same as for conventional transistors; in fact, they are exactly the opposite.

**BUILDING AN ELECTRONIC CAPABILITY  
BY ACQUISITIONS 118**

Many old line U.S. Industrial firms wishing to diversify, and acquire an R & D aura, turn to the electronic industry as a new area. Taking on several small firms involves risks. Despite problems, the move has long-range advantages as Singer Company is finding out with Singer Metrics.



**FOR COMPUTERS . . .**

**A HIGH SPEED CHARACTER GENERATOR 174**

The increasing use of high speed digital computers has created a demand for high speed readout. This demand has stimulated the development of methods for generating alpha-numeric and symbolic information from coded digital inputs. An economical, high speed generator with good legibility is described here.



# NEW

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# RF Power Standards

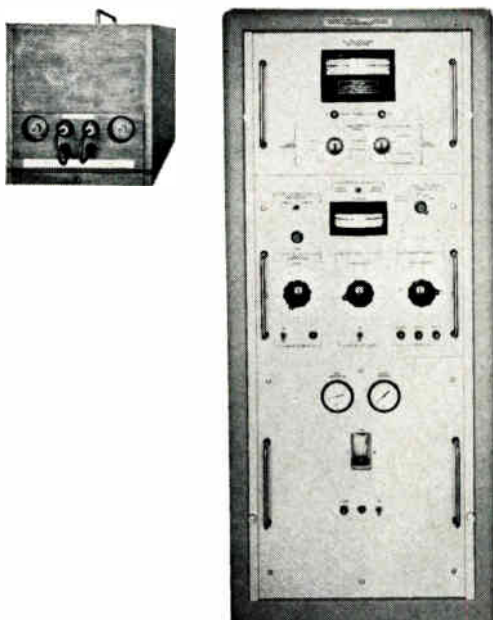
## FOR THE LABORATORY

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Ability to pick your measuring mode—**null-balance** for best accuracy, **direct-reading** for 30 to 60 second readouts, or **differential** for expanded-scale readings—gives you a test instrument with unusual versatility. Model 290's price, excluding Dual Water Loads, is \$4,500. The technical bulletin contains complete system prices with loads plus a comprehensive statistical analysis of performance.



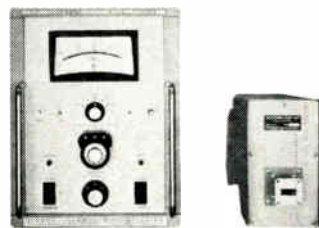
## FOR THE FIELD

If you're reading power levels of 10 watts and greater with a bolometer or thermistor bridge, a power splitter, and possibly an attenuator, you're courting potential errors of 10% or more. Witness this simplified tabulation:

Bolometer or thermistor . . . . .	2-3% limit of error
Directional Coupler . . . . .	2-3% limit of error
Attenuator . . . . .	2-3% limit of error
Error contribution due to drifts in calibration . . . . .	1-5% limit of error
<b>Total limit of error . . . . .</b>	<b>7-14%</b>

This kind of guessing game could have embarrassing results. Contrast it with the predictable end results you could enjoy with Sierra's compact Model 430A RF Calorimeter. This trim little 58 pounder reads from 50 to 1500 watts with 97% accuracy—guaranteed! And, you'll probably be getting 98% or better. A precision internal a-c wattmeter provides a built-in standard.

With the Model 430A, Sierra offers a group of five Coaxial and Waveguide Water Loads covering the frequency range of DC to 12.4 Gc. They range in price from \$725 to \$925. Price of the Model 430A is \$2,300. For full information, write to us, or get in touch with your Sierra sales representative.



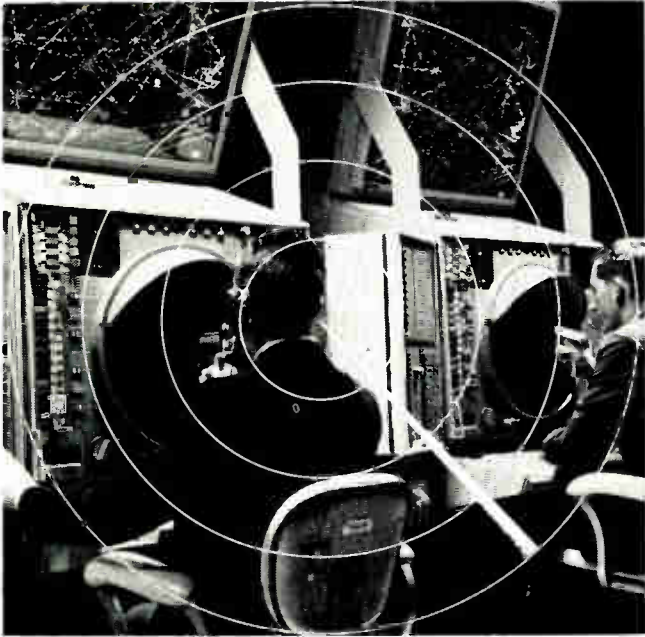
**SIERRA ELECTRONIC DIV.**

OF  
**PHILCO**

A SUBSIDIARY OF *Ford Motor Company*

Sierra Electronic Division/ 3879 Johannon Drive/Menlo Park, California

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



#### EN ROUTE AIR FLIGHT CONTROL

New en route air traffic control system delivered for test to FAA by Mitre Corp. for air collision prevention. Model 200 is a computer-display complex with large-scale programs that cover radar input conversion, tracking, teletype input conversion, fix time, flight plan, present position, conflict forecast, and conformance.

**NOVEL TV CAMERA TUBE** designed by Westinghouse has promise for TV exploration of space. Called "Sec-Vidicon," it can almost see in the dark, engineers report. It shows no blackout or flare from sudden bright light. Tube performance depends on secondary electron conduction (SEC) to convert image into signals that can be amplified and telecast. SEC occurs in tube materials so light and porous that only 2% of volume is solid matter. The rest is vacuum; SEC takes place there.

**SPACECRAFT TAPE RECORDER**, with nine channels to work for as long as 12 months in space, is a new development at RCA. In two casings and weighing only 17 lbs., the advanced recorder will be used in several of NASA's orbiting observatories. High reliability, the key to the design, has been achieved according to RCA spokesmen. The "rugged" recorder has a very low flutter level. Values down to 0.01% rms between one-half and 250 cps have been recorded. RCA-developed tape tensioning permits storage of 1,200 feet of tape on smaller reels; high packing density of 375 bits per inch per track of tape is maintained.

**LASER STATE-OF-THE-ART** continues to advance on a broad front. R. W. Terhune and P. D. Maker, two of Ford's team that forged major breakthroughs in laser research, said that we can expect to find materials that can store much more energy per unit volume than the ruby now used. Lasers can cause breakdowns of solids and liquids and in some cases have destroyed optical parts. A giant pulsed ruby laser can vaporize a small surface area in a flash strong enough for spectroscopic analysis. The effect may be useful in micro-analytical work. A single flash is enough for a spectroscope; analysis can be done at a distance, said the Ford researchers. Meanwhile, NASA is tapping industry's shoulder, looking for a deep space laser tracking system. Ideally, the system would track from launch to a mean 50,000,000 nautical miles out. It would handle two-way telemetry and voice, as well as space/ground TV. Carnegie Institute of Technology disclosed some upgrade in high repetition rate, high average power lasers. A test set-up was pulsed at rates up to 60 pps; average output was 15 w. but peak topped one megawatt. Carnegie used a  $Nd^{3+}$ -glass laser rod with only ambient cooling. The ring discharge circuit was coupled to a resonant-charging power source of 30 kv, 6 kw. Carnegie researchers W. T. Haswell, J. S. Hitt, and Dr. J. M. Feldman, suggest that test results are only a fraction of the ultimate power of the ring discharge. Bell Telephone Laboratories has come up with a triode-like gas laser, modulated by varied grid E. Excited by nearly identical energies from a hot oxide cathode, the laser oscillates minus glow discharge. Ping King Tien, Donald MacNair, and Harold L. Hodges, of Bell Labs, report that the laser tube has a cathode, grid and anode as parallel ribbons along the laser's X axis. Cathode flow is grid-controlled; energy spread is only a volt fraction. In triode lasers, efficiency of excitation per electron is increased a hundredfold, according to the research team. Maser Optics, Inc., has produced a 1500 joule pulsed ruby laser. The firm claims the output is four to five times greater than that of any other known laser. Maser Optics President Dr. H. E. Franks reports that the laser can blast a hole through the toughest tool steel. It can also powder a diamond. IBM has announced a test-stage device to control laser beam direction. It uses potassium dihydrogen phosphate (KDP) crystals, covered by semitransparent electrodes, as optical switches; deflectors are birefringent calcite crystals. With ten pairs of crystals, a single beam can be directed to any one of more than a thousand positions. IBM says the device is not yet fast enough for EDP use. Further work should cut time needed to deflect a beam to less than a  $\mu$ sec.

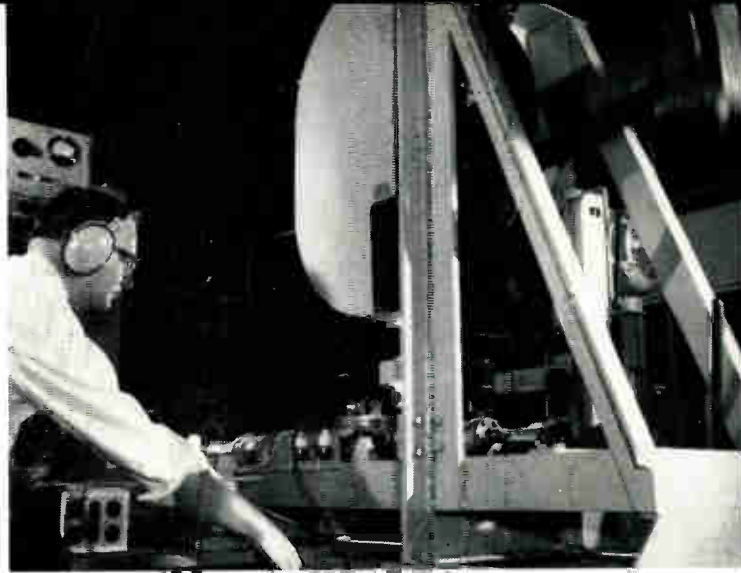
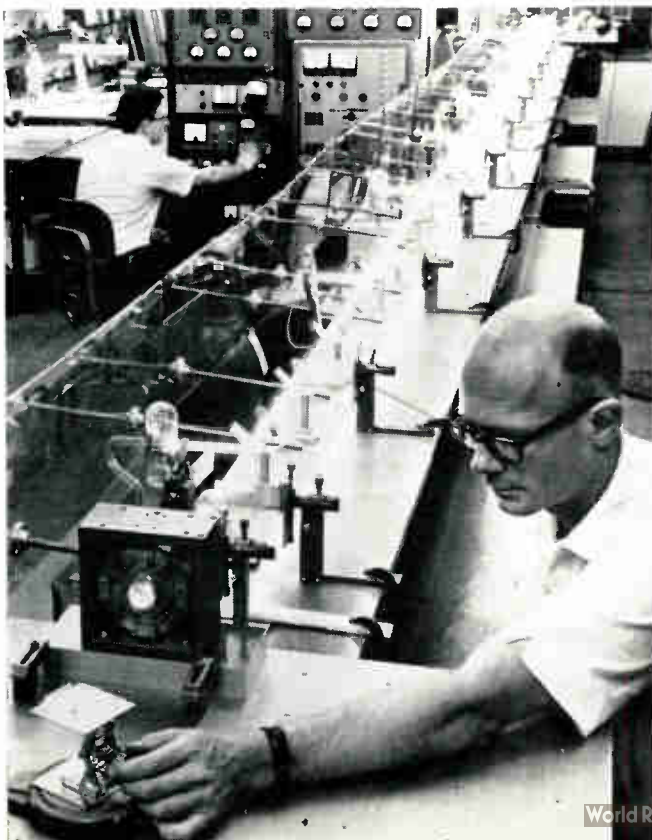
## COMPUTER SPEEDS 100 TIMES FASTER

may now be possible with a new coaxial circuitry packaging technique researched by Sylvania. The technique—used in locked pair tunnel diode logic circuits—cuts circuit parasitic inductance. It permits current gains of 20 at phase rate of 800 mc, with four phases operating at a clock rate of 200 mc. Engineer Frederick Anderson said that mutually coupling inductances of each circuit half reduces total self-inductance.

**MAGNETOPLASMA DYNAMIC (MDP) GENERATOR** by Martin Company has verified effect of magnetically induced non-equilibrium ionization of gas. Martin scientists who tested the generator look on it as a scientific breakthrough that may result in a revolutionary system of continuous power. They say that low temperature, closed cycle MDP power generation could lead to a more reliable and economical way to produce electricity. Generators using MDP effect could be used on ships, spacecraft, lunar bases and entire cities. An MDP generator produces current by shooting an ionized gas (helium seeded with cesium powder) through a magnetic field. Dr. Mostafa Talaat, project head, says non-equilibrium ionization means electrons in the gas at a higher temperature than the gas itself. This increases conductivity.

## LONG, LONG LASER

Tube of 33-foot gas laser at Bell Telephone Labs, Murray Hill, N. J., can be emptied and refilled with varied gases. Robert N. Zitter and George C. Douglas use helium-neon laser to measure power of light beam. Extra length makes possible a greater amplification. Mirrors at each end reflect the beam. Weak oscillations can be observed.



## VOLTAGE TUNABLE MAGNETRON

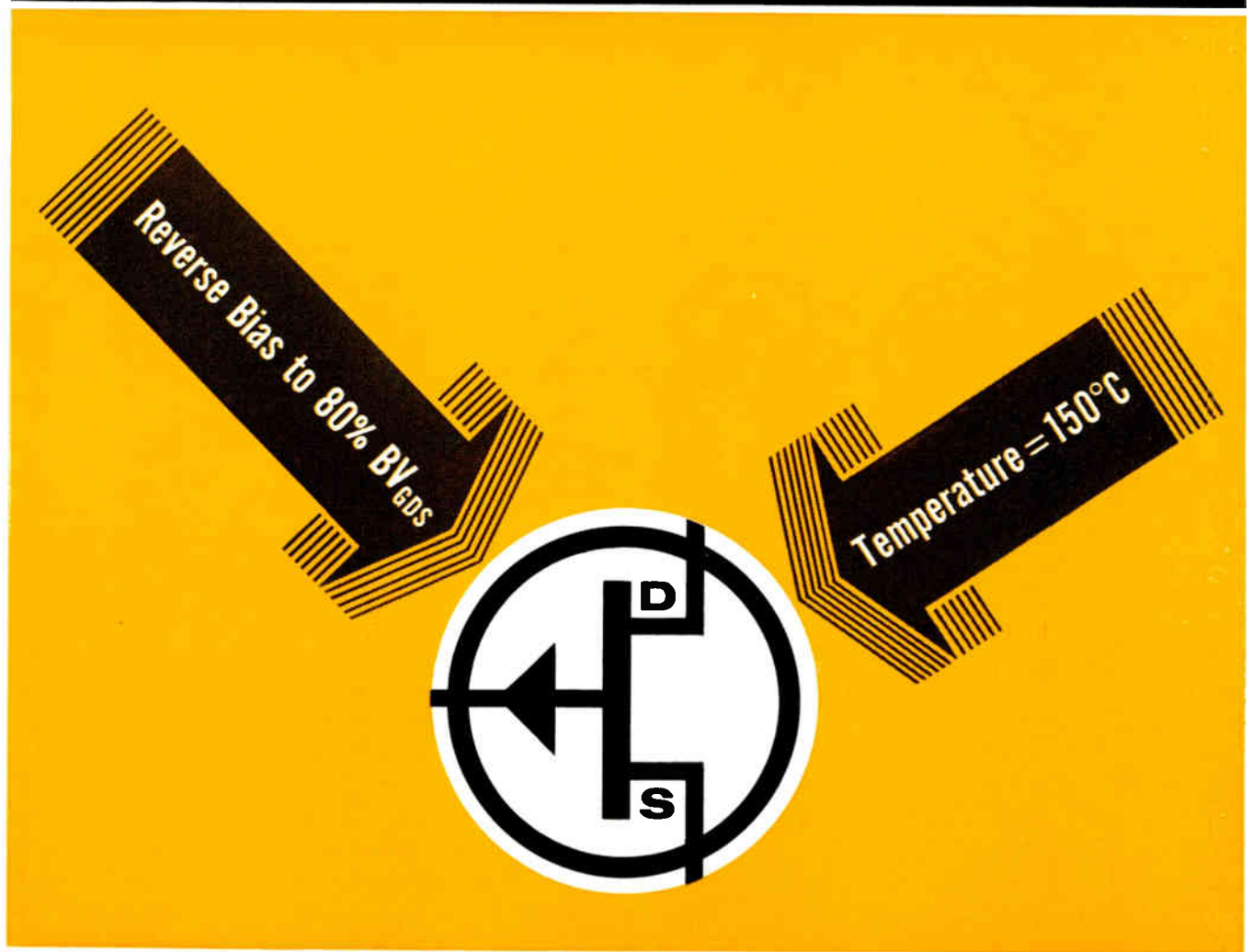
Just below center a General Electric voltage tunable magnetron is about to get a pounding of 1600 g's. Environmental test and design specialist Fred Ward drops the large hammer which accelerates the table to which the magnetron is bolted. The tube withstood as many as 45 hammer blows with no negative effect on performance.

**SELF-HEALING CIRCUITS** that repair themselves after failure under stress have been developed and tested with success, says Honeywell. Of two approaches to self-healing, one involves growth of metallic whiskers by the conductor across circuit breaks. The second uses a remeltable alloy coating over conductors. Work is being done for the Air Force. Honeywell said that whisker growth is best with an alloy of hard and soft metals to create *hard-matrix-soft-fill* alloys. Greatest whisker density and fastest growth occurred with alloys of tin, aluminum and magnesium. Engineers also used a flexible indium-gallium alloy in *ohmic resoldering*. Melting of the alloy from a nearby failing connection caused the alloy to flow into the break and close the circuit again.

**NEW MULTI-COMPUTER SYSTEM**, in which two or more computers solve hard science problems by *talking together*, is the latest advance in the state-of-the-art in EDP systems. Now in use at Argonne National Laboratory, each computer can handle an aspect of a problem; machines compare results before reaching an answer. One unit may act as *supervisor*, telling employee what to do, rejecting answers it does not like. They also work apart on unlike problems. The system is GUS (GEORGE Unified System.) It includes two computers. One is GEORGE, large digital unit made by Argonne six years ago. The other is FLIP, newer and larger unit that does fast, accurate work in floating point arithmetic. A very high-speed memory is common to all units, at times as many as seven. Data is instant from three banks of tiny magnetic cores. Each bank stores at least 8,000 words or numbers for GEORGE, or 4,000 for FLIP.

(More RADARSCOPE on Page 11)

After 2,000,000 unit hours of punishment...



## UNIFET\* STABILITY PROVEN

YOURS FOR THE ASKING: THE FIRST REALLY COMPLETE REPORT ON UNIFET STABILITY. IT TELLS HOW, AFTER TWO MILLION UNIT HOURS OF PUNISHMENT BEYOND THE CALL OF DUTY, SILICONIX UNIFETS STILL PERFORM THE WAY THEY MUST. WRITE FOR THE UNIFET RELIABILITY REPORT.

\*Unipolar Field-Effect Transistors



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**SOVIET ELECTRONIC RESEARCH** is emphasizing lasers, microcircuits and radiation-proof materials. Laser work may include further work on organic chelate, glass crystal, and semiconductor materials. Microcircuits are being spurred to help bridge the Soviet lag behind the U. S. Radiation-resistant materials are being sought for orbital and nuclear environments. Work will probably center on non-corrosive plastics and metals, with emphasis on pneumatic components. Data is based on excerpts culled from Russian publications and published by Electro-Optical Systems, Inc.

**INDUSTRIAL AFFILIATES RESEARCH PROGRAM** in Electronic Control and Communication Systems has been set up at Iowa State University. Main object is to give industry a lever so it can support research and help raise states-of-the-art. The program also allows industry to have quick access to research results. Two other affiliate programs—solid state science and electric power—are already working at Iowa State. Officials say the programs are a success.

**PROTECTIVE WINDOWS FOR IR** instruments and other sensors may be possible with a new photochromic (light-sensitive) glass researched by Corning Glass Works. The glass darkens in strong light and clears when light fades. According to Dr. S. Donald Stookey, head of chemical research at Corning, the glass is the first to retain indefinitely the ability to darken within 1/1000th of second, and then clear. Glass contains submicroscopic silver halide crystals. Thrown down during making process, crystals make glass react to light. Pair of glasses showed no wear in color-change quality after two-year tests. Some possible uses are instrument controls and optical memory devices.

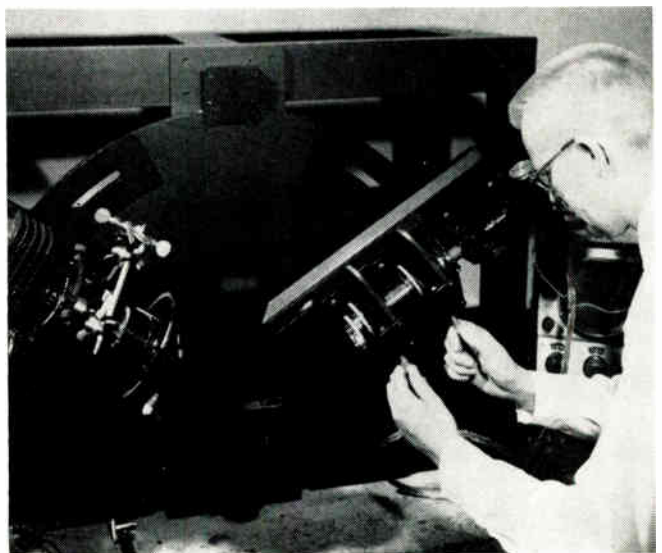
**SOLID-ELECTROLYTE FUEL CELL** has been developed under Air Force contract. Three-cell units, 6 g. and 6.2 cu.cm. each, have given 2.1 watts at electrolyte current densities of 750 ma./sq. at 1000°C, according to a report issued by Department of Commerce. This state-of-the-art addition represents performance of 150 w/lb. and 9500 w/cu.ft. of actual battery components. Self-sustaining systems can weigh less than 50 lb./kw. They can also take up only 0.3 cu.ft./kw. in plant sizes of 0.5 kw. or larger. Hydrogen is the fuel and oxygen the oxidant. Electrolytes are zirconium oxide-calcium oxide and an improved zirconium oxide-yttrium oxide. These materials can conduct a current by passing ions through crystal lattice, though impervious to gases and have little conductivity.

**A LASER** was used by Univ. of Illinois physicists to disprove part of a light theory advanced by Lord Rayleigh in 1871. The theory relates to a straight beam of light passing through a chamber full of gas (at given T and P); the gas molecules scatter light out of the beam's path. Part of the theory predicts that intensity in the horizontal plane of vertically polarized light scattered from the beam will be the same at any angle from 35° to 130°. By using a pulsed ruby laser, it was found that the light actually has different intensities at different angles. The physicists found, however, that the rest of Lord Rayleigh's theory seems to hold firm.

**CABLE OF THIN INNER AND OUTER CONDUCTORS** may be the answer to AEC's problem of how to receive data before underground test blasts destroy the cable. Purdue engineers knew very thin conductors were needed. They are best for constant behavior for both high and low frequencies on wide bands. They also break easily. Researchers came up with inner and outer very thin conductors backed up with thicker metals. They found that thicker metals—iron, steel or steel alloy—would conduct some current. But this would not affect much greater currents carried by copper, silver or aluminum. Purdue's Prof. C. M. Evans feels the cable design has a future in other broad band uses. This includes computer-to-computer talk. The design may in fact set a standard for cable for any frequency band.

#### MEASURES MAGNETO OPTICAL EFFECTS

A specially designed ellipsometer, built at Burroughs Laboratories, Paoli, Pa., is used to measure Kerr magneto optical effects. This research, part of the basic physics studies now underway at the Laboratories for Burroughs Communication Division, is examining the interactions of electromagnetic fields and ferromagnetic crystals.





**Have you heard the one about the heavy-duty connector that got dragged over 10 miles of rough road and still worked perfectly?**

Probably you haven't. Mostly because it was our QWLD connector that was involved, and you aren't likely to find any of our competitors talking it up.

It really happened. A missile unit was moving to a new firing position ten miles away. In the dismantling of the equipment, someone forgot to secure a length of cable to which was attached half of our heavy-duty connector. After being dragged and bounced over ten miles of concrete highway and dirt road to the new location, the connector mated and performed perfectly.

We were not too surprised. Designed especially for rugged

environments in which an electrical failure would be unthinkable, our QWLD is well suited for missile launching equipment, ground radar, power and control circuits, and for mining, oil field and countless other applications.

It can be positively mated even in blind locations. It is waterproof. It features closed entry socket contacts and self-ejecting coupling action. The QWLD comes with standard solder or solderless contacts. A variation has provisions for grounding one contact to the shell.

For additional information write us, Bendix Scintilla Division, Sidney, New York.

**VISIT US AT THE IEEE SHOW—Booth 2331**

**Scintilla Division**



Circle 7 on Inquiry Card

**STABLE MAGNETIC FIELD** that can be changed is now possible, according to Bell Telephone Labs. The field is obtained with a thin-walled superconducting tube of niobium-zirconium alloy. Before this, stable fields were hard to come by because the field varied with power supplied to the coil. Bell engineers report that the new method permits easy and accurate control of the field inside the tube. For higher intensity, the applied field is increased until the internal field reaches desired strength. For lower fields, the process is reversed.

**HOME TV TAPE RECORDER** to sell for less than \$200 has been announced by Cinerama, Inc., developed jointly with Rutherford Engineering of Bermuda. Norman Rutherford, Managing Director of the Bermuda firm, said the unit, Telscan, has a simplified recording-head. The head is fixed and records on half-inch tape. Commercial units, ranging as high as \$30,000, have rotating heads and record on two-inch tape. The unit is about the size of a sound recorder. Recording of TV programs is electronic, with no developing needed. It can play back pre-recorded movie tapes.

**LETHAL GASES AND DEADLY DUST** can now be safely monitored by a device developed at Illinois Institute of Research. The monitor is designed to detect poisonous boron compounds used in rocket propulsion research. Monitor pumps air through self-contained gas pilot light. Flame is colorless until contaminant passes. Characteristic color is observed. Electron photomultiplier tube measures intensity of color, which is translated electronically to meter display. Alarm switch closes when meter reading reaches pre-set point.

## Connector reliability as related to economics.

**One of a series of three technical discussions about reliability and the things you ought to be considering when you buy electrical connectors. This one explores the effects of reliability on economics.**

Reliability denotes a statistically determined Mean Time Between Failure with stated confidence levels for a specific set of combined performance parameters. To obtain this MTBF, testing to failure is the usual route. With hardware items, extended life testing is relatively simple and not too expensive. Electrical connectors, however, are not pieces of raw hardware, but are in reality small systems comprised of a number of components assembled or combined through complex processing methods. It follows that a slight variation in the number or type of components will create a totally different connector "system."

Standard line electrical connector assemblies are almost always assembled from stocked component parts. These components are manufactured on highly efficient machines with continuous or high volume runs. The key then to the economic supply of connectors is in these large runs and inventoried component stocks. It then stands to reason that efficient use of standardized component parts must be made to achieve true economy. Connector users, however, request performance in accordance with exact specifications, sometimes exotic, and often stipulate that for high reliability parts, design and process change approvals must be obtained prior to incorporation. They ask for control discipline, including manufacturing, processing, and assembly routines. In order to supply the user with electrical connectors that meet his requirements, unique and specialized assemblies, including separately and individually controlled component part numbers, must be established. In addition, the assembly documentation also requires separately numbered special procedures and sequences. This automatically dictates that components must be manufactured "to order" since maintenance of a component inventory necessary to achieve economical prices is not feasible unless accurately forecasted. This is almost always impossible since the forecast would necessarily have to be identified to the particular unique program.

Custom made components do not enjoy the benefits of standardization. The practical large volume components inventory system must be maintained, not only to

provide a stock on hand, but to offer realistic deliveries and stable parts costing from which sensible assembly prices might be generated.

The Scintilla sensitive components approach to reliability is based on the premise that almost all connector failures are caused by a small percentage of the components and a very few of the assembly processes. By picking the sensitive components, sensitive materials and sensitive processes, exacting controls can be instituted. This eliminates the inefficiency that complete and absolute controls on all components, materials and processes entail. Some necessary controls would be: machine capability studies; fixed, no option process sheets or layouts; documented lot control procedures; and generation of purge capability cross references.

The sensitive component approach can add 10-25% cost to the standard connector not having high reliability requirements.

The high reliability concept as outlined will provide connectors that are considerably less costly than some of the present day custom made programs. Reasonable cost reliability is now available and when coupled with initial qualification and extended life testing, for actual reliability demonstration, provides a truly practical approach. The necessity for User/Vendor specification cooperation cannot be overstressed as mutual agreement on sequence, performance, and method is mandatory.

The homogeneous sensitive component connector approach for high reliability allows utilization of the benefits of standardization and also allows multiple source procurement with a minimum of duplication. Realistic deliveries and continuing economy are assured. Scintilla is proceeding with this practical high reliability program for general availability and it does not stop with delivery. We feel that input contracting reliability must continue through installation, use and servicing. We offer comprehensive operator training programs and extensive service facilities for users of Scintilla's high reliability connectors.

Further discussions will deal with control disciplines and design evolution. Watch for them.

**Scintilla Division**





## News Briefs



**Room temperature curing** Sylgard® 185 resin, companion product to Sylgard 184 resin, provides added heat conductance for circuit "hot spots" and opaqueness where transparency is not desired. A black, solventless silicone resin, it cures to form a tough, flexible embedment that assures environmental protection and cushioning for electronic components. Sylgard 185 resin cures in deep sections in 24 hours at room temperature . . . or in 15 minutes at 150 C.

CIRCLE 22 ON READER SERVICE CARD



**Dip, brush or spray** Dow Corning® 630 protective coating. This solution of silicone polymers air dries to a flexible, wax-like film that is highly water repellent. The excellent surface resistivity of the clear protective coating makes it ideal for the protection of printed circuit assemblies and components operating under heat and humidity conditions. High volume and surface resistivity are maintained even after prolonged exposure to harsh environmental conditions.

CIRCLE 23 ON READER SERVICE CARD



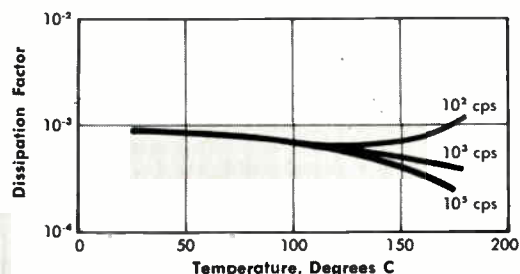
## Now... a room-temperature-curing transparent packaging material, that's easy to use, easy to repair

Transparent and tough . . . firm and flexible . . . new room-temperature-curing Sylgard® 184 resin cures without applied or exothermic heat. It can be used to package and protect the most heat-sensitive components.

Sylgard 184 resin is a virtually colorless, solventless silicone material designed for the potting, filling, embedding and encapsulating of electronic circuits. Applied as a low viscosity fluid, Sylgard 184 resin flows easily around the most intricate parts. It cures, even in deep sections, in 24 hours at room temperature . . . or in 15 minutes at 150 C.

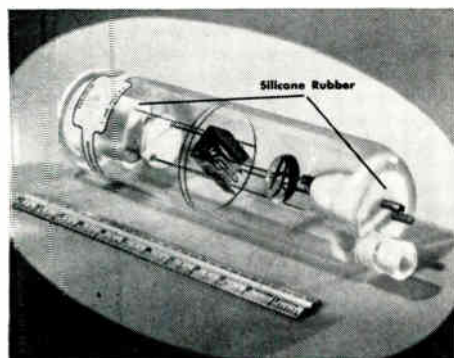
When cured, Sylgard 184 resin has a resilient, penetration resistant surface. To repair or replace defective components, the resin can be cut away and new resin poured in place and cured to re-form the embedment.

Sylgard 184 resin cushions and protects components from mechanical shock — can be twisted and bent . . . withstands elongation of nearly 100 percent. Its tensile strength ranges from 800 to 1000 psi, and it has a long service life at operating temperatures of -65 to 200 C.



Dissipation factor of cured Sylgard 184 resin at 10<sup>2</sup>, 10<sup>3</sup> and 10<sup>5</sup> cps.

CIRCLE 21 ON READER SERVICE CARD



**Seal, bond, insulate** in one operation with Silastic® 502 RTV silicone rubber. The Flash-X Ray tube shown utilizes it to insulate against high voltage at one end and to provide flexible support between glass and power cable at the other.

Its adhesive quality and the typical silicone properties of moisture resistance and heat stability make it suitable for use in a wide variety of applications.

CIRCLE 24 ON READER SERVICE CARD

We'll be pleased to forward full information on these and other materials that aid reliability and performance. Just write Dept. F303, Electronic Products Division, Dow Corning, Midland, Michigan.

# Dow Corning



## Wow!!! 84% use Kester Solder!

Frankly, it even surprised us as we tabulated the results of our brand preference studies. But we can't argue with figures . . . 84%! These are the results of actual brand preference studies that show Kester is preferred by 84% of the design engineers.

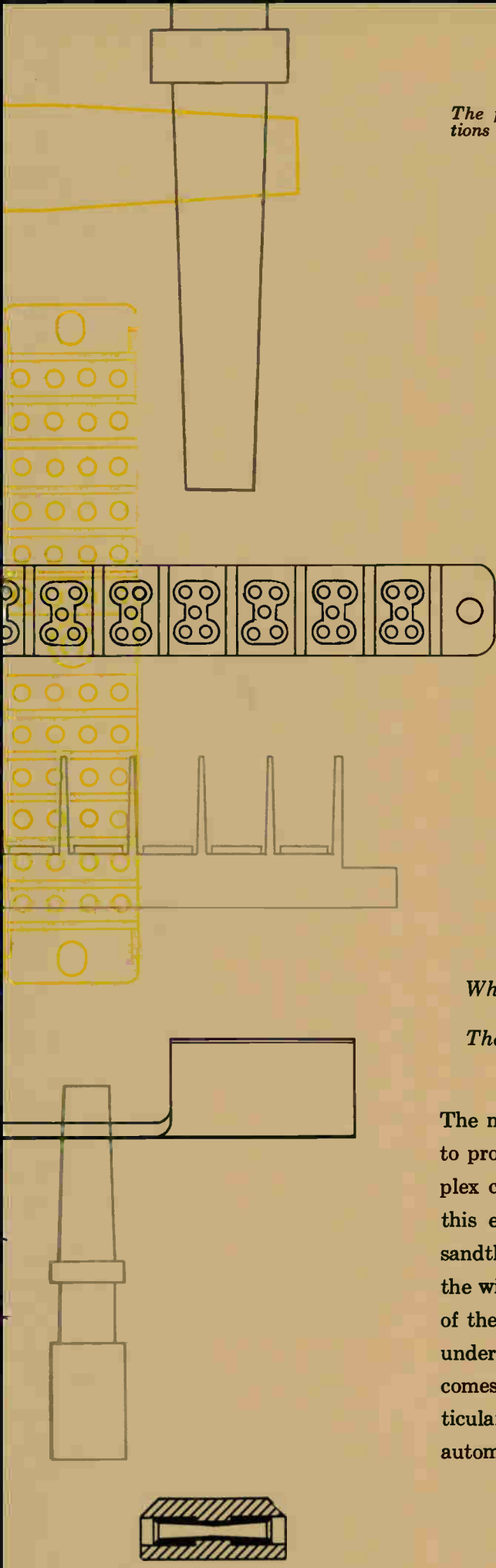
What makes us the unchallenged leader in solder? How did we get that way? For over 65 years Kester Solder Company has been producing the finest solder and fluxes. We've continually provided technical counsel and

personal assistance. And we're still solving soldering problems and establishing soldering procedures every day.

Wonder what happened to the other 16%? If you happen to be one of them, let us send you one of our engineers. He'd like to explain our product line and services in detail and help you with any soldering problems you may have.

**KESTER SOLDER**  
KESTER SOLDER COMPANY

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1899-1964 - 65 years manufacturing highest quality solders and fluxes



# Special Report from AMP on the **TAPER TECHNIQUE** of Terminations and Connections

*Why the wedging principle is applied to the taper technique.*

*Ways in which the matched terminal-tool concept contributes to reliability.*

*Why precise control of plating is proportionately important.*

*The basic advantages of taper products now in common use.*

The most conspicuous advantage of the Taper Technique is to provide the user with ability to connect even highly complex circuits at a substantial saving of cube and weight. To this end, the area of the termination is only a few thousandths of an inch thicker than the outside diameter of the wire itself. A second important advantage is the capacity of the products used to give high-standard performance even under adverse operating conditions. A third major benefit comes in the form of lowest possible installation costs, particularly on product runs which permit the use of high-speed automated crimping equipment.

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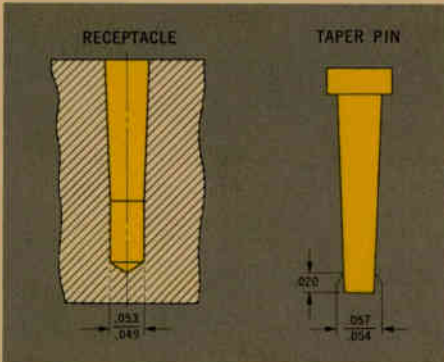
## The TAPER Technique Explained

While taper products differ considerably in size, shape and ultimate end-use, they all have an identical function: to conduct electrical current with the least possible resistance, from a power source through a mechanical connection, to equipment operated in accordance with pre-planned circuit requirements. Toward this end, we apply to the Taper Technique: (1) The Wedging Principle, (2) The Matched Terminal-Tool Concept, (3) The AMP Special Plating Technique.

### The Wedging Principle

It is common knowledge that the wedging principle, originally used to fasten gears to shafts by driving the tapered members into correspondingly tapered openings in solid steel, forms an extremely tight self-locking connection. Applied to A-MP\* Taper Products, this principle works with exceptional stability to form reliable connections even under severe stress conditions.

Some years ago we began selling taper products to one of the largest computer manufacturers and then, later, to industry and the military. The taper pins and blocks for these new uses were designed with suitable variations fully adapted



to diverse needs. During this transition, after much research and experimentation, the engineering staff agreed upon a 16 to 1 taper design which represents a .001" change in diameter for every .016" in length of the product—usually a pin or tab. This is still the accepted standard for taper pins and tabs that are not only self-locking but also self-cleaning. Both produce connections of excellent electrical and mechanical reliance.

Insertion tools of proved performance are used to apply a uniform pressure when inserting a taper pin into a tapered receptacle. So tight and uniformly secure is the fit that the variance per unit in pull-out force is extremely small. It is, in fact, well below the requirements of both military and commercial stipulations.

### The Matched Terminal-Tool Technique

The second factor contributing to the reliability of A-MP Taper Products is compression crimping of wire leads to the barrels of taper pins, and receptacles. Here the basic concept consists of precise matching of the crimping tool and the pin or tab or receptacle terminal barrel. Every tool is accurately calibrated to produce the exact amount of pressure required to form terminations of optimum electrical conductivity, and tensile strength that nearly equals the strength of the conductor itself.

Toward this end, all hand and automatic crimping tools are equipped with

dies made of finely tempered tool steel. These dies imprison the conductor within the terminal barrel and exert enough pressure to form what virtually amounts to a voidless "cold weld" type of termination. Since the dies in every crimping tool, whether hand-operated or automatic, are regulated so as to bottom fully before pressure can be released, each termination for a given size contact is identical. This applies with equal validity to performance characteristics as well as appearance, with all terminal connections high in vibration and corrosion resistance.

Hand tools of the proper caliber are available for experimental and prototype work, whereas automatic machines are recommended to connect formed, con-



tinuous strip contacts at high production speeds. Screw-machined taper pins may be tape-mounted and terminated either with a reel-mounted hand tool or reel-mounted bench type automatic machine.

### The AMP Special Plating Technique

A-MP Taper Pins and associated products are supplied with AMP standard gold over nickel plating. They are also available in silver plating or tin plating. Gold and Rhodium plating (generally over nickel) represent the ultimate standards in these directions. For economic and other valid reasons gold over nickel is most universally used on a wide variety of contacts for sensitive to critical applications. With its extremely low electrical resistance and correspondingly high resistance to corrosion, humidity and oxidation, gold applied with a precision technique over a sub-plating of nickel, has been found to be most practical and effective.

Many of our experiments were devoted to the reduction of porosity, with the result that today porosity in AMP gold over nickel plating has reached negligible proportions. In a parallel effort to reach what might be termed as near-absolute control of plating application, our engineers have evolved an exclusive quality-control X-ray technique which measures plating thickness to a millionth of an inch. With this technique, we are able to meet all thickness specifications with unusual accuracy and to satisfy all other plating requirements regardless of the geometry of the product.

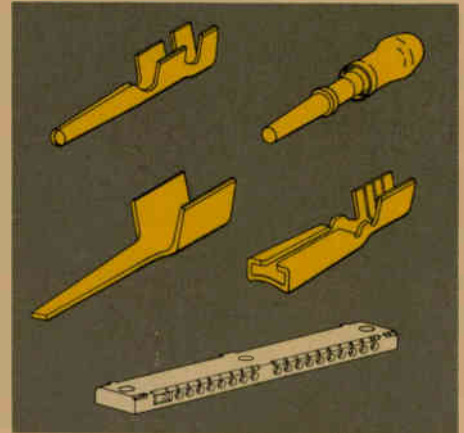
What has been said of the gold over nickel plating process is true, to a relative degree, of silver plating, tin plating

and to any special plating that may be called for from time to time. In each case the common denominator is the ultimate in the control of the application process. This assures that the third link in the chain of essentials is as reliable as the wedging insertion technique and the AMP precision method of matched terminal-tool crimping.

### A-MP TAPER Products in Common Use

This is the industry's broadest line of Formed Taper Pins, Screw-Machined Taper Pins, Taper Contacts, Taper Pin Inserts, Taper Tab Receptacles, Taper Blocks, as well as other items and a number of variations of standard components.

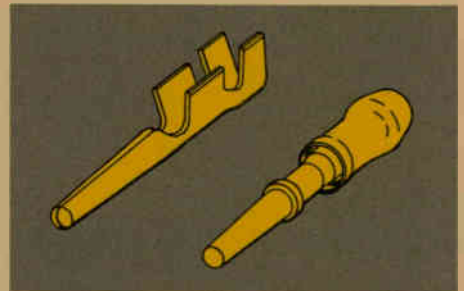
These various products are divided into series, each of which bears a number



that corresponds to the diameter of each pin or the width of each of the tabs in question. Thus the "53" series Taper Pin has a tip diameter of .053", while the "78" formed taper tab receptacles mate with tabs .078" wide at the tip.

### TAPER PINS—Two General Types

A-MP Taper Pins are either formed from flat metal sheets of high-grade brass, electro-plated to prevent corrosion; or screw-machine processed from brass or phosphor bronze. The former is a high-production, high-application speed item; the latter a solid component



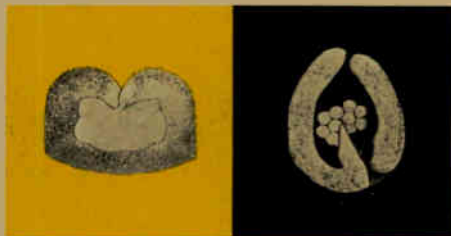
suited to the needs of highly critical circuits. Both achieve the objectives for which they were designed, at lowest applied cost.

### FORMED PINS

These pins are uninsulated but may be had either with or without insulation support. They exceed commercial and military specifications for vibration, heat, and corrosion resistance.

Two types of crimps are available. One is the widely utilized "F" crimp—two wings wrapped around the wire strands and butted together in a tight seam. The other is an insulation-piercing design

specially well suited for terminating small, stranded and tinsel conductors. This technique eliminates the need for stripping. Attachment is accomplished by driving two perpendicular lances through the insulation. Because of this, the tensile strength of the termination depends largely on the type of wire insulation specified. This high-speed, low-cost method of terminating A-MP Taper



Pins is not intended for use where mechanical loads are heavy nor where high currents are needed and excess vibration present. Wire range size is 24 to 12 AWG.

#### "53" SERIES TAPER PINS

These pins, designed for wire sizes 24 through 16 AWG, come with or without insulation support, and are suitable for the insulation-piercing type of attachment.



Their wide acceptance by industry has made them the standard taper pin. Plating is AMP standard gold over nickel, gold over silver, or tin, as required.

#### "88" SERIES TAPER PINS

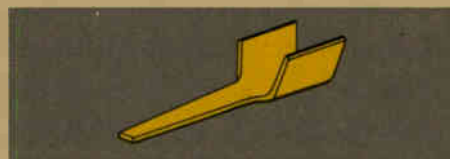
The "88" Series is available in wire sizes 14 through 12 AWG. It is designed for non-insulation support applications and has three serrations in the wire bar-



rel to increase tensile strength. It was made available as the need for pins carrying heavier current loads came into demand. Plating is AMP gold over nickel, silver, and tin.

#### TAPERED CONTACTS

These formed contacts are the smallest of all A-MP tapered products. Especially designed for 5 ampere connections, they are a non-insulation support type contact

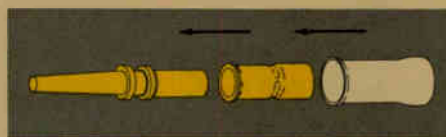


measuring only .029" in width at the tip and .390" in length after crimping. Our standard gold over nickel, silver, and tin plating is available.

#### SCREW-MACHINED PINS

All A-MP Screw-Machined Taper Pins are made to close tolerances from solid high-conductivity brass or phosphor bronze. They meet the most exacting standards in electrical and mechanical

reliability and offer exceptionally strong resistance to vibration and corrosion. Insulated and uninsulated types are avail-



able. Both are designed with double shoulders for easier, no-damage extraction of pin. Total wire range is 26 through 16 AWG, while insulation measurements start at .040" and range up to .115".

#### "53" Series PIDG\* Taper Pins (Pre-Insulated)

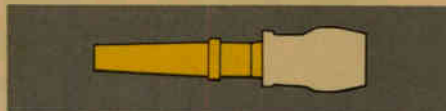
Insulation of this pin is uniformly thick, specially bonded nylon which provides exceptionally high dielectric strength. The line also features a copper sleeve



which provides insulation support for the conductor. The pins are color-coded for easy wire size identification. Choice of standard or special plating.

#### TAYP-AIR\* Taper Pins

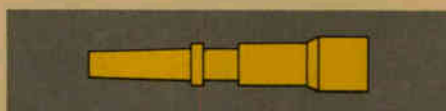
This last addition to the PIDG line features a single shoulder. They are fabricated from special leaded bronze with an elongated pin section (which fits into special TAYP-AIR blocks), and are able



to withstand severest vibration forces encountered in airborne electronic equipment. They are available in color-coded wire size ranges of 24 through 16 AWG, with insulation diameter range varying from .040" to .115".

#### Solid Uninsulated Insulation Support Pins

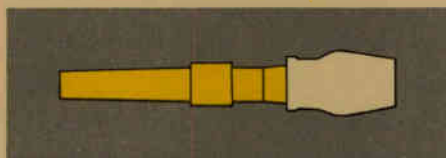
This pin is identical to the standard PIDG pin body except for the addition of an insulation support barrel. The insulation support barrel recommends it for



use wherever vibration is a factor and pre-insulation is not required. Standard gold and special platings are available.

#### Patchcord Programming Systems Taper Pins

These are screw-machined pins with a single long shoulder which keeps the insertion tool from spreading the contact springs in the rear board of the system.



Patchcord Programming Pins are available in PIDG, Pre-Insulated pins.

#### Solid Non-Insulation Support Taper Pins

This pin is specially designed for higher temperature performance than can be demanded from any other type of A-MP Taper Pin. Moreover, since insulation support is lacking, it affords more dense



wiring capabilities. Two single shoulders in one of two variations are intended for use with wire sizes 26 through 22 AWG; the other, with one small and one extended shoulder, is designed for use with wire sizes 20 through 16 AWG.

#### TAPER PIN and TAB RECEPTACLES

A-MP Taper Pin Receptacles fall into two classifications: for taper pins, and taper tabs. Both provide the same high degree of conductivity and mechanical strength for recommended uses. Both can be relied upon for high-reliability performance. Taper tab receptacles are so designed that when mated with the tab, they wedge and make interlocking contact with the wide variety of tab thicknesses commonly found on commercial electronic components such as relays, stepping switches, etc.

#### "37" SERIES FORMED TAPER PIN RECEPTACLES

Receptacles in this series mate with miniature taper pins with tip diameter of .037". They are terminated with the "F" crimp and are available with or without insulation support. Mating pins



may be either insulated or uninsulated. These receptacles are made from beryllium copper to accommodate wire size range from 26 to 20 AWG while insulation range extends from .048" to .071". Available in long and short types, receptacles mate with pin lengths of .200" and .250". Only the long type offers insulation support.

#### "78" SERIES FORMED TAPER TAB RECEPTACLES

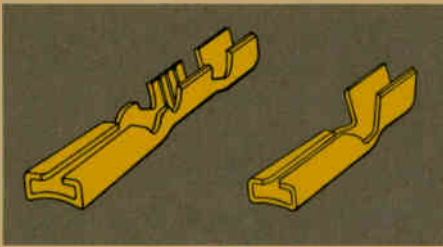
Designed to mate with taper tabs .016" to .023" thick and .078" wide across the tip, the A-MP Series "78" Receptacle is designed for the "F" crimp or as an insulation-piercing receptacle. For the former it accommodates wire ranges of 24 through 18 AWG, or 24 to 22 AWG, with insulation range of .040" to .105".



With the latter, it accepts either tinsel wire, or stranded wire in the 24-22 AWG range. Serrations have been added to all "F" crimp wire barrels to improve both electrical and mechanical performance. Tin, silver, and AMP standard gold over nickel plating is available.

#### "98" AND "196" SERIES TAPER TAB RECEPTACLES

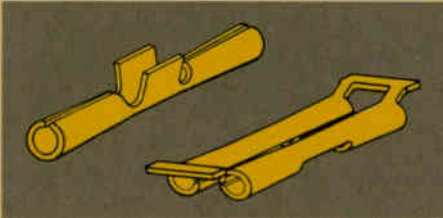
The "98" receptacle mates with a tapered tab measuring .098" at its tip, while the "196" is designed for .196" wide



tab at its tip. The "98" accepts wire range size 24 to 20 AWG and is either tin, silver or gold over nickel plated. The "196" accommodates only wire range 22 to 18 AWG and, unless other plating is specified, is available only in tin plate.

#### TAPER PIN INSERTS

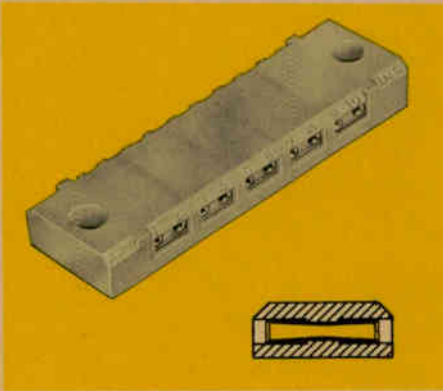
Taper pin inserts are round, metal receptacles mounted into taper blocks for receiving taper pins. AMP makes available both single and dual types



made of either brass or beryllium copper. Both types accommodate "53" series formed or solid taper pins.

#### TAPER PIN BLOCKS

In addition to the standard line of two-piece nylon blocks, AMP has recently introduced a series of one-piece solid blocks, of the same material. This basic material was chosen for its all-round dielectric performance, strength and resistance to heat. It also resists most



organic chemicals and oils and provides good protection against grease and electrolytic corrosion. The second material made available for taper pin blocks is linear polyethylene which also has excellent insulating properties, superior resistance to moisture and good resistance to most organic chemicals, excluding strong acids.

Most A-MP Taper Blocks come in basic units of 10, 20, 30 and 60 cavities with any combination of single, dual or command taper pin receptacles in each block. Many other variations with a wide range of configurations, sizes and colors are also available.

Recessed brass or bronze inserts plated with gold, silver or tin, are an important feature of the A-MP solid Taper Block. Recessed design helps as a barrier to voltage creepage. Every cavity in this type of

block is identified by raised numerals. Special cavity design prevents moisture entrapment and resulting warpage.

#### TAPER Technique Application Tooling

A variety of tooling is provided to meet every kind of application need. But regardless of type—whether hand or power operated—every A-MP crimping device completes a "bottoming" cycle which exerts a precisely calculated pressure to prevent over-crimping or under-crimping. Every termination for any given wire range size is therefore identical in appearance and electrical performance.

#### HAND CRIMPING TOOLS

Two basic types are available: (1) double action, (2) straight action. Both feature color and assembly coding to assure use of correct tool for each taper



item and wire size combination. Alignment positioners control proper placement of termination barrels in tool.

#### PNEUMATIC HAND FEED TOOLS



A number of taper items are adapted to use in several types of pneumatically actuated tools.

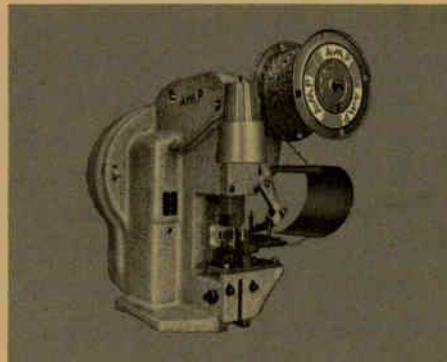
#### AMP-TAPEMATIC\* PNEUMATIC TOOL

Plastic tape holds properly positioned taper pins. An indexing device moves the pins into crimping position. Operator merely inserts wire and triggers the



cycling action. Capacity: up to 800 terminations an hour.

#### AUTOMATIC CRIMPING MACHINES

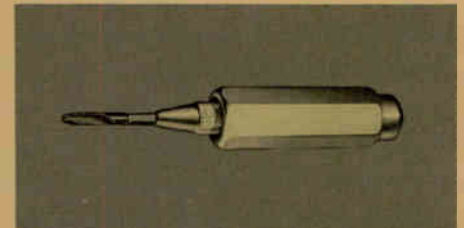


Three types of automatic machines are available: (1) AMP-O-LECTRIC\* machine (above) crimps auto-strip taper

pins at rates of up to 4,000 consistently uniform terminations per hour; (2) AMP-O-MATIC\*, machine actuated by foot control, delivers up to 3,000 terminations per hour; (3) STRIPPER-CRIMPER machine combines stripping of the wire and crimps at speeds of up to 2,000 per hour. All speeds are approximate, depending on operator dexterity.

#### CERTI-LOK\* Insertion Tools

The critical factor in inserting taper pins is to provide just the right amount of impact force for proper seating. This is accomplished with any of three A-MP insertion tools. All of them contain a calibrated spring that applies a force to the hammer which delivers the proper amount of impact to the tip of the insertion tool. The three tools referred to include: (1) Standard Insertion Tool for proper insertion; (2) Pull-Test Tool which inserts and provides a gauged trip pull for testing retention force; (3) Captive Tool that cannot be released from the taper pin until the pull-test has been made.



Illustrated here is the CERTI-LOK Insertion Tool that permits a pull-test to be made on the inserted pin to determine adequacy of retention force.

#### TAPER PIN EXTRACTION TOOLS



Shown is the tool used to extract Standard "53" Series Taper Pins. A pistol type tool is available for extracting TAYP-AIR Pins. Both are compact types that permit easy access to tight areas.

These, then, are the basic facts concerning the most extensive line of taper products available in the industry. They are supported by voluminous test data which gives conclusive evidence of performance capabilities in a wide range of applications. Our research, testing and product development engineers stand ready to assist you in applying test and performance data to your requirements. Your inquiry will be passed along to the right men, properly processed and promptly answered.



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

# COMING EVENTS

## APRIL

- Apr. 12-17: 95th Tech. Conf. of Soc. of Motion Picture & TV Engineers, SMPTE; Ambassador Hotel, Los Angeles, Calif.  
Apr. 13-15: Annual Mtg. & Expos. of Inst. of Environmental Sciences; Sheraton Hotel, Phila., Pa.

## MAY

- May 4-6: 10th Nat'l Aerospace Instrumentation Symp., ISA; Biltmore Hotel, New York, N. Y.  
May 4-6: Annual Mtg. & Tech. Conf., Region III, IEEE; Jack Tar Harrison Hotel, Clearwater, Fla.  
May 5-7: Electronic Components Conf. (ECC), IEEE, EIA; Marriott Motor Inn, Washington, D. C.  
May 7-8: S.E. Textile Industry Conf., IEEE; Atlanta, Ga.  
May 11-13: NAECON (Nat'l Aerospace Electronics Conf.), PTG-ANE, Dayton Sec., AIAA; Biltmore Hotel, Dayton, Ohio.

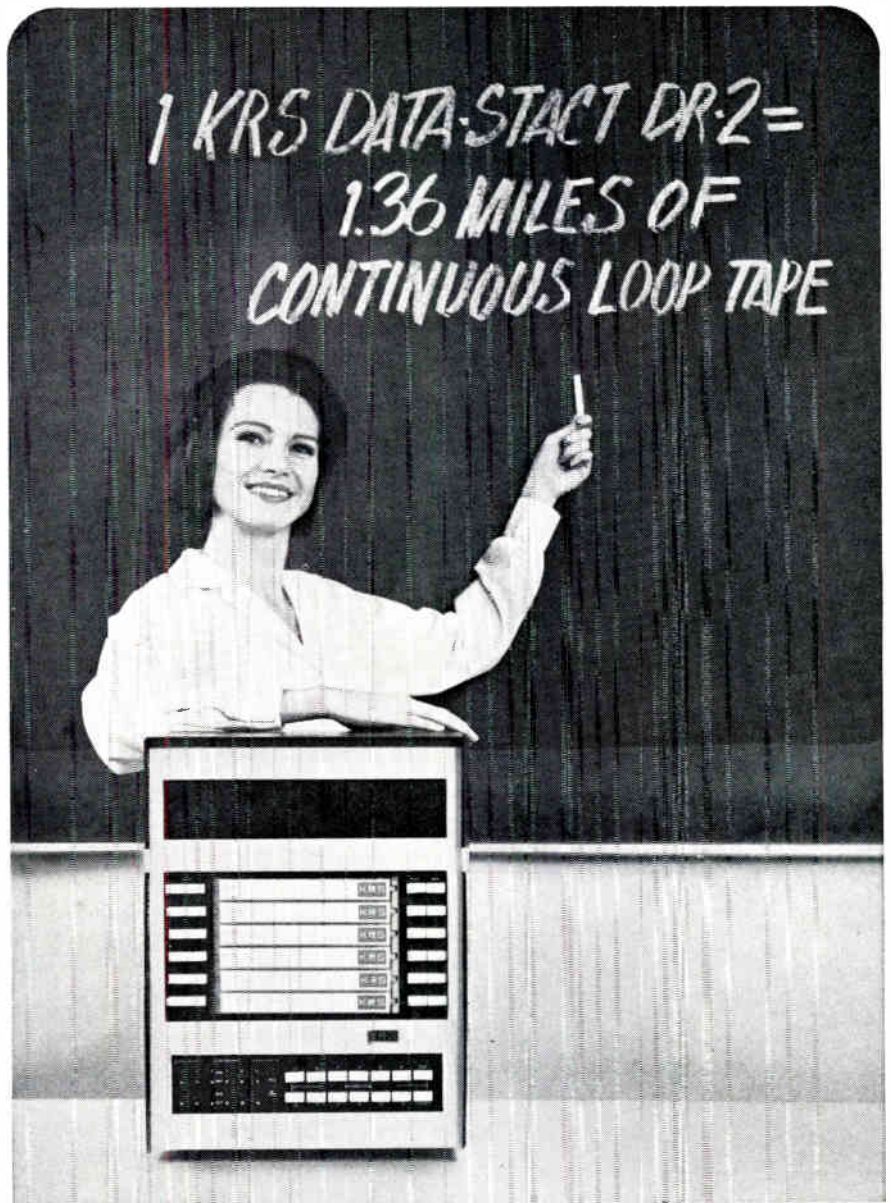
## '64 Highlights

- WESCON, Western Electronic Show and Conv., Aug. 25-28, IEEE WEMA; Sports Arena, Los Angeles, Calif.  
Nat'l Electronics Conf., Oct. 19-21, IEEE, et al; McCormick Place, Chicago, Ill.  
NEREM, Northeast Research & Eng. Mtg., Nov. 4-6, IEEE; Boston, Mass.  
May 11-14: Design Eng. Show & Conf., ASME; McCormick Place, Chicago, Ill.  
May 18-20: Electronic Parts Distributors Show; Conrad Hilton Hotel, Chicago, Ill.

- May 19-20: Nat'l Appliance Technical Conf., IEEE; Ben Franklin Hotel, Philadelphia, Pa.  
May 19-21: Int'l Symp. on Microwave Theory and Techniques, PTG-MTT; Int'l Inn, Int'l Airport, Idlewild, N. Y.  
May 20-22: Pulp & Paper Industry Conf., IEEE; Netherland Hotel, Cincinnati, Ohio.

## INTERNATIONAL

- Int'l Conf. on Magnetic Recording, July 6-11, British Inst. of Radio Engineers, IEEE, et al; Institution of Electrical Engineers, London, England  
Int'l Conf. on Microwaves, Circuit Theory, and Information Theory, Sept. 7-11, IECE of Japan, IEEE, et al; Akasaka Prince Hotel, Tokyo, Japan  
Third Canadian IEEE Symp. on Communications, Sept. 25-26; Queen Elizabeth Hotel, Montreal, Canada



A good fact to remember! One 60-pound KRS DATA-STACT™ DR-2 is equal to almost any instrumentation record/reproduce function you could give it between DC and 100 kc. And, it's the only Cartridge Instrumentation Recorder able to log 1 1/3 miles of two-channel data without reloading.

**SIX RECORDERS IN ONE** It's true! Each DATA-STACT DR-2 Recorder operates a stack of six KRS STACTape™ Cartridges. Each cartridge holds a two-channel, 1,200-foot continuous-loop roll of 1/4-inch tape. Used sequentially, they provide 7,200 feet of two-channel data-logging capacity at any one of six selectable tape speeds. Operated simultaneously, they can record up to 1,200 feet of 12-channel data.

**NO MECHANICAL ADJUSTMENTS** Extreme simplicity of the DATA-STACT DR-2 Recorder eliminates the critical parts that cause adjustment headaches. All-solid-state circuitry contributes to its exceptional reliability. Complete system price range from \$2,500 to \$10,000.

For more facts on KRS DATA-STACT DR-2 Cartridge Instrumentation Recorders, write for Instrumentation Div. Bulletin DR-2.

Dept. E.I., KRS Electronics, 4035 Transport Street, Palo Alto, California



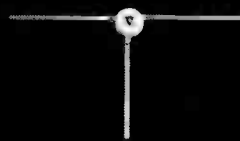
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**NOW...**

# **PNPN**

**SILICON EPITAXIAL PLANAR SWITCHES**

**in TO-46 or TO-51 Co-Planar**



	2N3254	2N3255	2N3256	2N3257	2N3258	2N3259
Anode Voltage (V)	15	30	60	15	30	60
Triggering Current (uA)	20	20	20	200	200	200

## **NEWEST ADVANCE FROM SYLVANIA— SOLID IN SILICON**

offering advanced integrated logic • NPN and PNP core drivers • Micro-power 12 nsec switches and 1 Gc amplifiers • Microplanar high-current switches and 850 Mc amplifiers • general purpose logic transistors • diodes



**TRIGGERING PULSE**— 30 ns width @ 1.2 V peak  
100 ns width @ 0.9 V peak

**LOW HOLDING CURRENT**—1.0 mA @ 25°C,  $R_{gk} = 1K$  ohms

$V_{supply} = 50$  V

$R_L = \frac{50V}{I_{Anode}}$

$I_{Anode}$

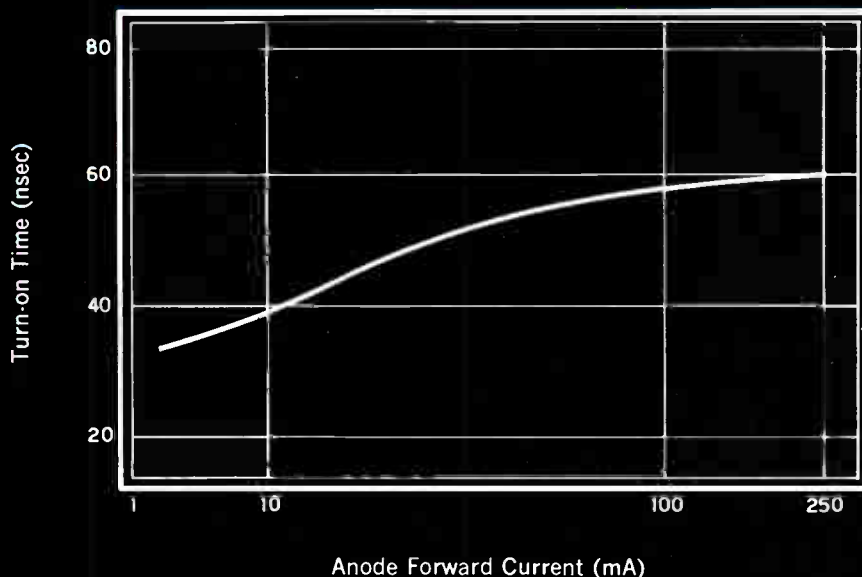
$R_G = 100$  ohms

$V_{in} = 3$  V

With performance beyond any now available, Sylvania's new PNP three-terminal bistable switch family is ideal for cross-point matrix switching, digital information switching, core driving, memory elements, ring counters, time delay circuits, limit detectors, pulse generators, arming and detonating circuits, protective systems and other low-level triggering applications.

Again Sylvania's leadership in epitaxial planar technology pays off—in excellent reliability and performance that can only be summarized here. For more complete information on Sylvania PNP silicon switches, please contact your Sylvania Semiconductor sales engineer, or write direct to Semiconductor Division, Sylvania Electric Products Inc., Woburn, Massachusetts.

## WORLD'S FASTEST 4-LAYER SILICON SWITCHES



**SYLVANIA**  
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NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS  
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■ If smaller size, lighter weight, utmost reliability and realistic costs are part of your product cosmos, take a long, hard look at Stevens *Certified* Thermostats.

■ Because Stevens makes the broadest line of bimetal thermostats in the industry, you can get all the special features to fit your special requirements exactly right from a proven, standard production-line Stemco thermostat, or from a minor modification thereof. This also gets your product off the ground faster . . . by cutting lead time, slashing engineering and development costs.

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**STEMCO**

**THERMOSTATS**



#### **Type MX Hermetic**

Snap-acting to open on temperature rise only. Copper housing expands more readily than steel types. Standard tolerances  $\pm 3^\circ\text{F}$  with 2 to  $6^\circ\text{F}$  differentials; 1 to  $4^\circ\text{F}$  differentials on special order. Temperature  $10^\circ$  to  $260^\circ\text{F}$ . Various terminals and mounting brackets. See Bulletin 6100.



#### **Type AX Hermetic**

Similar to Type MX but to close on temperature rise. Wide selection of terminals and mounting provisions, highly responsive non-ferrous metal housing. 2 to  $6^\circ\text{F}$  differential. Bulletin 3200.



#### **Type C Hermetic**

Field-adjustable, positive-acting. Electrically independent bimetal strip type for operation from  $-10^\circ$  to  $300^\circ\text{F}$ . Nickel-silver case with or without plating, depending on specifications. Turret terminals or wire leads. For ratings, etc., Bulletin 5000.



#### **Type A Hermetic**

Electrically independent bimetal disc and high-response brass case for quick, snap-action control from  $-10^\circ$  to  $300^\circ\text{F}$ . Various non-ferrous metal enclosures, wide variety of terminal arrangements and mounting provisions, including brackets. Bulletin 3000.

\*Above Stemco Thermostats are designed and manufactured to meet most requirements of applicable MIL specifications.

# WASHINGTON TRENDS

**COMSAT NEARS FIRST CONTRACTS**—Communications Satellite Corp. is about ready to hand out first contracts. COMSAT asked 15 firms to submit bids for engineering designs. It seems that two contracts will be awarded. One will be for design of a high-altitude satellite, the other a medium-altitude craft. COMSAT will need cost data and satellite capacity of at least 270 channels at first and more later. The medium-altitude vehicle will orbit in 1966, the high-altitude one will follow a year later.

**IMPORTS A GROWING WORRY**—Rising imports of tungsten mill products (used in electron tubes and in missile-rocket components) are deepening the facial lines of many U. S. manufacturers and workers alike. U.S. Office of Emergency Planning is looking into the tungsten situation, directly at the request of General Electric's Lamp Division. To date, the White House has extended only sympathy (no corrective action) to firms and unions hard hit by imports. If the import situation gets worse, Congress may act to limit imports of many goods.

**CONTRACTING CHANGES COMING**—The government's cost-cutting program is causing massive changes in defense contracting. Shifts are egged on by charges that industry is making "undue profits" from contracts. Some charges of defense profiteering come from Vice Adm. Hyman Rickover. He tells Congress that some firms make excess profits through such devices as overhead charges and subcontracts with divisions of their own firms. The Admiral calls for new procedures under which the U. S. could study in advance cost estimates and other factors in a contractor's sales offer.

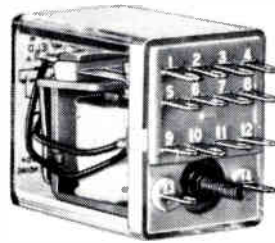
**ASPR RULING STIRS FEAR**—A recent court ruling gives the government complete power to end a contract when it pleases. Now, defense firms, particularly electronic, are preparing countermoves should the ruling be broadly accepted. Pressures on DOD to alter a key phrase, or on Congress to remove it, are under study. The Supreme Court refused to review a Court of Claims ruling; the lower court decided that a part of the Armed Services Procurement Regulations does have force of Law. The phrase, in effect, says that a standard clause allowing the government to end the contract for convenience "shall be inserted" in all contracts over \$10,000. Contract officers had thought of this as permissive, but the court rules it to be mandatory.

**GOVERNMENT BUYING PLAN TO BE REVEALED**—Industry soon will get to know how to gear its output to the foibles of defense buying. Pentagon planners will kickoff a series of private briefings for major industries early this Spring. Top echelons from the electronic industry will be among the first. Past briefings never before called for management planning aid via disclosing of defense trends. Briefings will be for prime military suppliers.

**R&D FUNDS KEEP TRENDING UPWARD**—Despite Senate and House probes, federal R&D budgets asked for Fiscal Year 1965 have gone up by about \$400 million. The total now is about \$15.3 billion. Though the DOD cut about \$500 million in fund requests, NASA has asked for more than that in addition. Overall 1964 R&D costs in the U. S., including government and private funds, may reach \$20 billion, so say Battelle Memorial Institute economists. They conclude that 1964 should be the third year in a row that more than \$1.5 billion have been added to R&D funds after Congress has said "no!"

**RESEARCH CENTER FIGHT STILL ON**—A lengthy justification by NASA head James E. Webb for renewed efforts to locate NASA's electronic research center in Boston keeps the squabble going. Some members of Congress still look with disfavor on the move, mostly because they want the fifty-million-dollar lab in their own states. Others are critical because they believe a political plum is being given to Sen. Edward Kennedy (D-Mass.) Senate and House space committees have just a few more weeks to turn down the Boston location "45 days from the date the report from Webb was made." Webb's report says that Boston is favored because of concentration of universities, industry and scientists in the area.

**FIGHT FOR PATENT RIGHTS ABROAD**—Industry is making some progress in the uphill battle to protect U. S. patents in overseas operations. A strong drive is building up in Congress. Protection of patents against foreign expropriation may be tied to the foreign aid bill. Sen. Bourke Hickenlooper (R.-Iowa) is pushing for an amendment to the foreign money bill to cut off U. S. funds to any country that takes over an American-owned patent unless the U. S. firm is paid for it. The State Department and the internationalist bloc in Congress usually puts up a bitter fight against efforts to tie strings to the foreign aid bill.



# Should YOU specify this small four-pole relay by P&B?

*Here is why so many engineers have*

An extraordinary combination of features distinguish the KH relay. Small size (only slightly larger than one cubic inch), 4-poles, exceptional electrical stability over a long life, a wide choice of mountings . . . all of these and more are found in the KH.

**SWITCH  
FOUR CIRCUITS  
FROM LOW LEVEL TO 3 AMPS**

This is a four-pole relay normally used in a 4 Form C arrangement. It can be supplied with a 2 Form Z (DPDT-DB) configuration or, by not wiring certain contact terminations, any four-pole combination of Forms A or B may be achieved. Beryllium copper is used for the contact arms for excellent conductivity and long mechanical life.



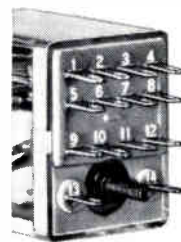
Both AC and DC relays are

available. Minimum power requirement for AC relays is 0.55 volt amperes at 25°C. DC relays will operate on only 0.5 watts at 25°C. KH relays are rated at 3 amperes, as shown below. Under certain favorable conditions, AC relays will switch up to 5 amperes providing extended life is not required. Expected mechanical life is exceptionally great: 100 million cycles for DC relays; 50 million for AC relays.

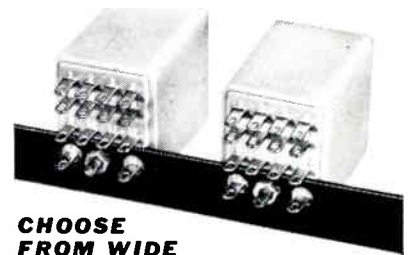
**TERMINAL BLOCK  
CONSTRUCTION  
CONTRIBUTES TO RELIABILITY**

Glass reinforced alkyd, a material of exceptional dimensional stability and dielectric properties, is used for the terminal block. The terminals are molded into the block. This construction serves to keep the relay in precise adjustment throughout its life.

The pierced solder terminals are easily accessible, speeding hook-up. Each terminal is identified with a



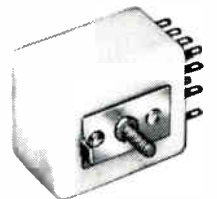
number molded in the block to simplify wiring. Taper tab terminals are also available on dust covered relays.



**CHOOSE  
FROM WIDE  
VARIETY OF MOUNTINGS**

The terminal block is uniquely embossed to allow for mounting KH relays on metal strips or angles. This embossing, around the two bottom terminals, keeps the relay from turning when the nut is tightened on the stud.

The KH may be mounted in a variety of ways, all compatible with modern production techniques. A tab-and-stud mounting plate on any side or the



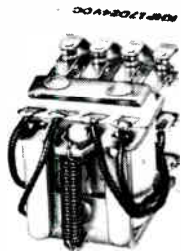
top of the dust cover is available. Also, a choice of three sockets may be used to make the KH a plug-in relay. One socket has printed circuit tabs, the other two have pierced solder terminals. These measure  $\frac{3}{8}$ " and  $\frac{3}{16}$ " long. Hermetically sealed relays (KHS) can also employ the sockets.

A hold-down spring, for socket-mounted relays in applications subject to high shock and vibration, is also available.



### ARMATURE TAIL SPRING ASSEMBLY DESIGNED FOR RELIABILITY

To achieve optimum specifications for the armature return spring, we used our Instron Force-Displacement Tester. The carefully determined and controlled spring rate contributes to the reliability and long life of the KH.



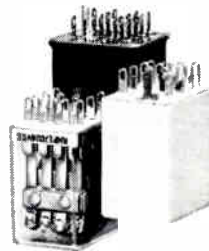
The tail spring holder itself exerts a forward bias on the armature, keeping it precisely positioned on its fulcrum point. This bias reduces wear caused by friction, aids in maintaining the relay's adjustment and serves to extend the life of each unit.

Long armature stops, extending

down the back of the relay, ward off damage caused by severe shocks.

### CHOICE OF ENCLOSURES TO MEET ALL REQUIREMENTS

Dust covered KH relays (KHP) can be ordered with translucent nylon or clear Lexan cases. Hermetically sealed relays are designated KHS, and are enclosed in a steel cover. The nylon cases are available on special order in red, blue, green, yellow or black so that relays in various circuits may be color coded.



### RELIABILITY OF KH SERIES FIELD-PROVED IN MANY APPLICATIONS

The KH was first used three years ago in telephone carrier equipment. Since then it has found its way into such diverse gear as citizens band transceivers, dictating machines, walkie talkies, computers, aircraft communications equipment, scoreboards, alarm systems, and many others.

For full information about America's fastest growing general purpose relay, call your local P&B authorized distributor, your P&B Sales Representative, or write: Technical Information Section, Potter & Brumfield, Princeton, Indiana.

STANDARD COIL DATA					
KH AC Relays			KH DC Relays		
Voltage	Resistance in Ohms (Approx.)	Average Current in ma	Voltage	Resistance in Ohms ±10% @ +25°C	Inductance in Henrys (approx.)
6	10.5	200	6	40	.08
12	43	100	12	160	.28
24	160	52	24	650	1.0
48	668	25	48	2,600	4.5
115	3,900	10.5	90	9,000	13.5
			110	11,000	17.0

### KH SERIES SPECIFICATIONS

#### CONTACTS:

Arrangements: 4 Form C (4PDT). 2 Form Z (DPDT-DB).

Material:  $\frac{3}{32}$ " diameter silver is standard. Silver cadmium oxide, gold alloy and palladium available.

Rating: 3 amps @ 30 volts DC or 115 volts AC resistive for 100,000 operations.

#### COILS: (See Coil Data Chart.)

Power: AC: 1.20 volt amperes nominal @ +25°C., .550 volt amperes minimum @ +25°C.

DC: 0.9 watt nominal @ +25°C., 0.5 watt minimum operate @ +25°C., 2.0 watts maximum @ +25°C.

#### TIMING VALUES:

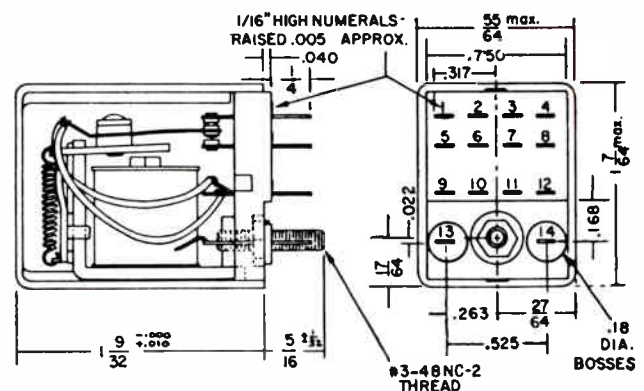
Nominal Voltage @ 25°C Max. Values  
Pull-in time 13 ms  
Drop-out time 10 ms

INSULATION RESISTANCE: 1500 megohms min.

#### DIELECTRIC STRENGTH:

500 Volts rms 60 cycles between contacts.  
1000 Volts rms 60 cycles between other elements.

MECH. LIFE: DC: In excess of 100 million cycles. AC: In excess of 50 million cycles.



RIDE THE AMF MONORAIL AT THE NEW YORK WORLD'S FAIR

STANDARD P&B RELAYS ARE AVAILABLE AT LEADING ELECTRONIC PARTS DISTRIBUTORS



**POTTER & BRUMFIELD**

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY

PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD, DIVISION OF AMF CANADA LIMITED, GUELPH, ONTARIO



CHOOSE FROM THE BROADEST LINE IN THE INDUSTRY

Cinch offers over

# 1500

# TYPES\*

## of "Jones" BARRIER TERMINAL BLOCKS

- 22 Basic Styles
- All Popular Terminal Variations
- 1000 to 4000 V. maximum, r.m.s.
- 15 to 90 amp. current capacity
- Competitively priced



You can have exactly the unit you need when you specify "Jones" barrier terminal blocks by Cinch. You can even specify the insulation; G P black phenolic is standard on all 1500 types, but other materials can be supplied on special order. A wide variety of terminals are available to meet nearly every requirement, including screw, wrap-post, solder, solderless and "Quick-Clamp."

For immediate delivery—over 450 types are in stock at your Cinch distributor's warehouse—at factory prices in quantities up to 999 pieces.

FREE: A new 24 page catalog containing detailed electrical and mechanical specifications on "Jones" Barrier Terminal Blocks. Write for your copy.

\*Available from standard production.

### CINCH MANUFACTURING COMPANY

1026 South Homan Avenue, Chicago, Illinois 60624  
Plants located in Chicago, Illinois; Shelbyville, Indiana;  
City of Industry, California; and St. Louis, Missouri



A DIVISION OF UNITED-CARR FASTENER CORPORATION, BOSTON, MASSACHUSETTS

## FEDERAL ECONOMIES TO PLACE BURDENS ON MANagements

Tight government buying measures in 1964 will combine with growing technological challenges to "place unprecedented premiums on management excellence;" the prediction is by Charles L. Davis, Honeywell Vice President, Military Products Group.

Mr. Davis believes that demands by government officials, military leaders and taxpayers for economy and efficiency will produce a fierce wave of competition in 1964. Those demands can be met profitably through good management, he added.

Spending for defense and space electronic goods will go on rising even though total defense budgets decline. Electronic spending may increase by as much as \$3 to \$6 billion in the next three to four years, Mr. Davis predicted. Management's ability to control operating costs and cut high overhead can produce improved profits. Such profits could be as much as 50% more if DOD carries out its incentive policies at the contracting level.

The electronic industry has depended on R&D contracts to fill gaps between big production jobs, Mr. Davis pointed out. Now, emphasis will be on smaller programs. The government will want only the best R&D.

## RESEARCH AND DEVELOPMENT BECOMING A BUSINESS ITSELF

Research and development—once a principal means to production business—is now more of a business itself. For 1964, some experts predict a government-funded R&D bill of \$14 billion or more.

D. C. Sayles, Directorate of R&D, Army Missile Command, made a brief analysis of R&D efforts by the military services. He describes the Army as relying more heavily on its own R&D than any other service. In 1961 the Army handled some 43% of R&D work "in house," compared with about 30% for the Navy; the Air Force took on 13%. In all cases more than 50% of the R&D market was contracted outside the military services.

The percentage of R&D allotted to the industry by the Army's Missile Command, however, far exceeds that of all the rest of the Army. This is mostly because giant-sized facilities are needed for major missile systems.

Its allotted research, development, test and evaluation (RDT&E) funds come to more than \$500 million. Of this, some 91% is spent in industry, 8% in-house, and 1/2 of 1% in educational institutions.

## ESTIMATES OF WORLD ELECTRONIC OUTPUT

(In Billions of Dollars)

### "ELECTRONIC INDUSTRIES" ESTIMATES

	1960	1961	1962	1963	1964	1965
United States .....	\$10.6	12.1	13.8	15.3	16.3	17.1
Common Market Nations*	3.0	3.3	3.7	4.1	4.5	5.0
Japan .....	1.2	1.4	1.8	2.2	2.6	3.0
United Kingdom	1.3	1.4	1.5	1.6	1.7	1.8
All Other Nations Including Canada	1.1	1.2	1.3	1.4	1.5	1.6
U. S. Firms Producing Electronic** Goods in Free Europe .....	.69	.93	1.2	1.7	2.2	2.8
Estimated Total World Output of Electronic Products .....	17.2	19.4	22.1	24.6	26.6	28.5

\*Belgium, France, West Germany, Italy, Luxemburg, Netherlands

\*\*Not added to total output

Sources for basic data: Electronic Industries Association; BDSA—Department of Commerce; Stanford Research Institute

## TAX CUT MAY SPUR TV SALES BUT COLOR CRT'S LAG DEMAND

Color television will get a major boost from a \$5 billion gain in consumer spending from Federal tax cuts, predicts Raymond W. Saxon, President, RCA Sales Corp. He forecasts a rise of at least 9% in total home entertainment retail dollar volume in 1964, including imported goods.

The RCA executive recalled that color TV, already enjoying record sales, helped lead the television industry to a new record in both unit and dollar volume in 1963.

Meanwhile, a shortage of color picture tubes is holding down the output of color sets while the demand mounts, according to major set producers. They complain that RCA, which puts out more than 90% of all color tubes, is unable to fill requests for additional tubes. RCA admitted that demand is exceeding producing capacity.

RCA currently sells color tubes to more than 25 color set makers, keeping at least 50% of its output for its own use. Among other producers, Zenith is believed to be second to RCA in color set output.

Until last year, RCA produced all color tubes. Three other firms have begun pilot runs but their output is limited, so far. The new producers are National Video Corp., which is producing a tube developed by Motorola;

Sylvania, subsidiary of General Telephone; and Rauland Corp., a Zenith subsidiary.

Motorola and National Video had difficulties with their new tube but both firms say "the bugs are being worked out." Several firms expect to relieve the pinch later in 1964 by buying color tubes from any of the new producers.

Joseph Wright, Zenith President, said that the company's output of its new color tube by December 1963 was several thousand beyond quota. Zenith color tubes may be available to set makers by April or May.

Sylvania expects to be in steady production of color tubes this year for its own use, and for sale to others.

## NEW AD-PHONE DEVICE DIALS 50,000 CALLS, GIVES 'PITCH'

Here's a new one for the market. A telephonic-electronic device threatens to create an army of irate customers as well as a new market.

Called "Electro-Com," the device can call as many as 50,000 telephone numbers automatically. When a callee answers, the device throws a tape-recorded sales pitch, says goodbye, and "hangs up."

It's very patient. With a busy signal, or no answer, it will call back later. For telephone interviews, the device could also tape-record answers to questions. Typists could transcribe answers—until another device is made to do the transcribing.

To complaints that people will resent being harangued by an advertising machine, its backers say most people don't feel guilty about hanging up on a recorded message now.

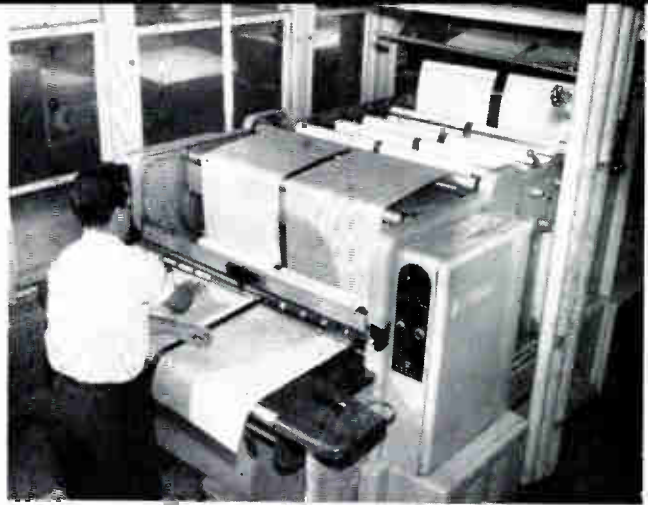
## AM, FM, TV BROADCASTERS TOP \$2 BILLION REVENUE IN '62

The FCC reports that the AM-FM-TV broadcasting business made a little more than \$2 billion in total revenue for calendar 1962.

Sales rose to \$4,122.1 million, which is \$213 million, or 11% over 1961 revenue of \$1,909.0 million.

## LASER FINGERPRINTS

Photo represents a method, developed at Electro-Optical Systems, Inc., Pasadena, Calif., for identifying spatial coherency of a laser beam. Individual prints are light reflections from a gas laser after emitting ray was split, then rejoined with the original beam. Resultant lines (third row from top) represent interference of bottom row of original beam upon top row of secondary beam. Existence of interference pattern proves light in top and bottom rows of original beam have fixed phase relationship (coherency).



## AUTOMATIC PRINTS

Reduced negatives of engineering drawings are fed to a Revolute M4 automatic blueprint machine at Northern Electric Co.'s Montreal facility. The machines, made by Charles Bruning Co., allow negatives to be reduced either 38.5 or 50% in each dimension.

## ELECTRONIC SNAPSHOTS...

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

### CONTROLLER

Bendix Corp's Dyna-Path-24, four-axis numerical contouring system (right) is shown installed on a profile milling machine. Four machine motions are controlled by commands from binary-coded decimal, punched tape mounted on a 300 line/sec. photoelectric tape reader in the machine control unit.



### CONDITIONER

Signal conditioner is compared in size to a cigarette lighter. The signal conditioner is the heart of a Project Gemini blood pressure measuring system developed by Garrett-AiResearch, Los Angeles. Earlier Project Mercury unit is shown above.







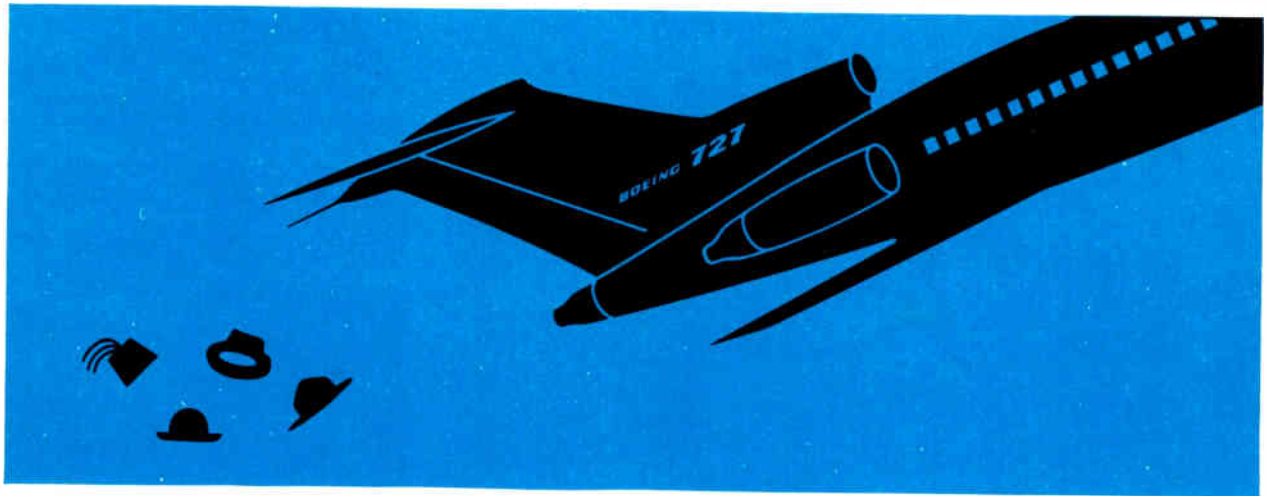
#### PINPOINT WELDING

Aerojet-General Corporation's (Azusa, Calif.) Microwelder Mark II finishes welding a series of gold and silver wires to a thin circuit (gold on chrome on glass). Diameters of wires welded are, from left, 0.001 in., 0.0007 in., 0.001 in., and 0.0005 in. The dime was placed under the circuit for size comparison.

#### EXPERIMENTAL TRACKER

Engineers at White Sands Missile Range are dwarfed by 60-foot AMRAD (Advanced Research Projects Agency Terminal Measurements Radar) antenna. The radar, developed by Raytheon Co., Lexington, Mass., will be used to obtain basic reentry physics phenomena of ballistic missiles. Peak power of the transmitter is 10 megawatts.





**HATS OFF TO BOEING** . . . congratulations to the men at Boeing for dramatically demonstrating their engineering skills by the global reliability test flight of the 727. Hats off too to the many equipment manufacturers who have contributed their best efforts to the success of the amazing turbofan transport.

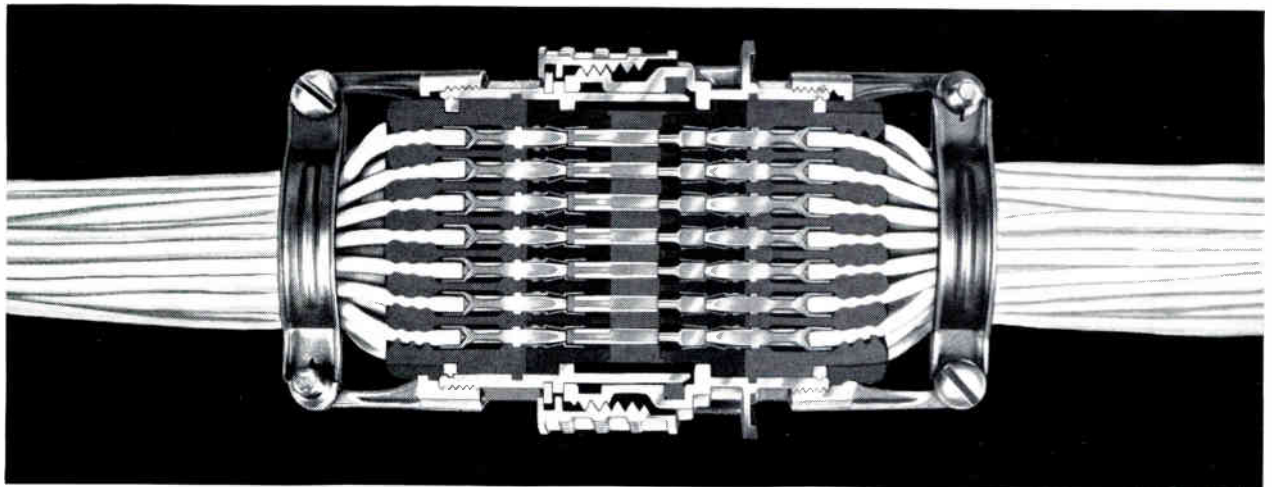
Pyle-National can take a modest bow too, since we have supplied the stainless steel circular miniature connectors which link the electronic and control circuits into a functioning system. Pyle-Star-Line Mercury Series connectors have a reputation for providing measurable reliability

over and above MIL-C-26500 specifications where the ultimate in performance has been required.

Pyle-National has supported its exemplary environmental-resistant connectors with notable engineering service—from design to delivery.

Soon to be released will be MIL-26500 miniature connectors with aluminum shells which will broaden applications into possible new areas.

Please call our representatives, or see us in booths 74 and 2205 at IEEE, for full particulars.



CONNECTOR DIVISION, THE PYLE-NATIONAL COMPANY, 1334 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS  
 Also manufactured in Canada by: Pyle-National (Canada) Ltd., Clarkson, Ontario

# Pyle-National

ELECTRICAL CONNECTORS    LIGHTING EQUIPMENT    CONDUIT FITTINGS

## SNAPSHOTS (Concluded)

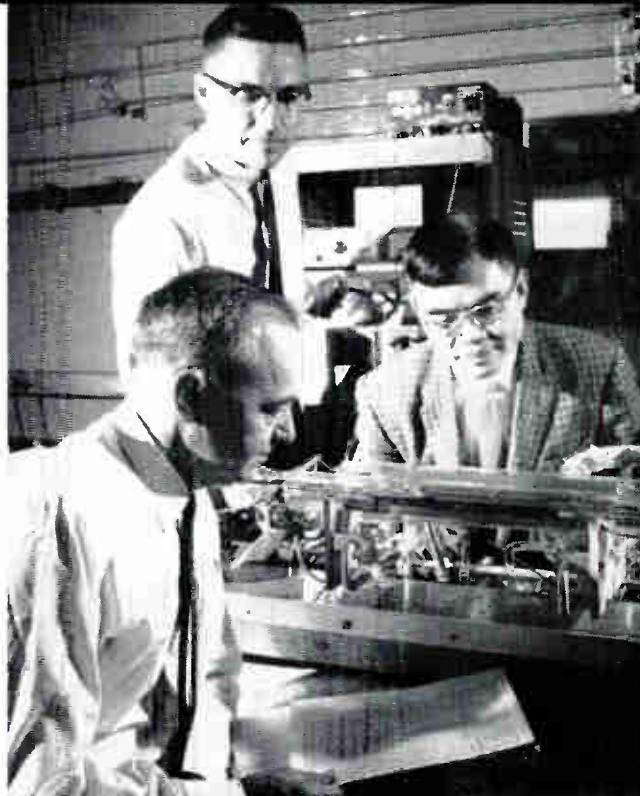


### OMNI-DIRECTIONAL

Horizontally polarized, omni-directional, log periodic antenna is built of lightweight aluminum. Made by Dorne and Margolin, Inc., Westbury, N. Y., it will withstand winds of 100 mph. Frequency range is 30 to 260 MC.

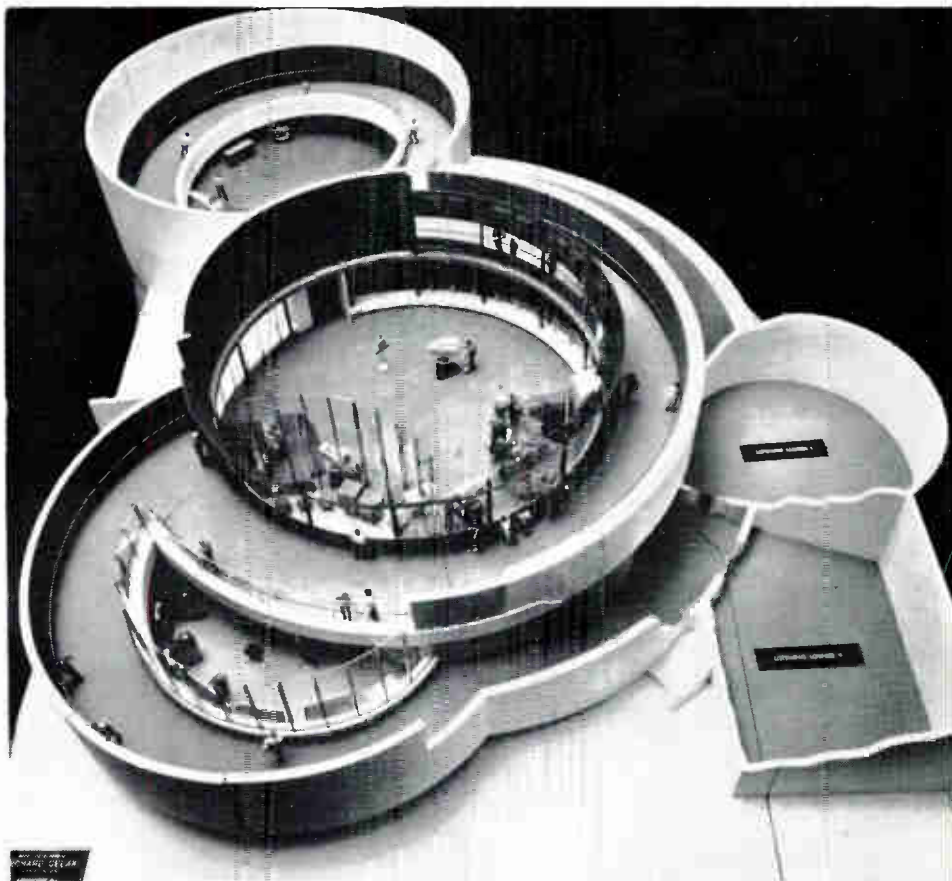
### ELECTRONIC CONTROL

Miss U.S.A. of 1960, Loretta Powell, demonstrates an electronic speed control developed by International Electronics, Ltd., Trumbull, Conn. The unit will allow dialing any speed desired on any product powered by a universal ac-dc or series dc motor used on 110-120 volt current. A feedback circuit keeps tool under full torque at even lowest speeds.



### TRIODE LASER

Bell Telephone Laboratories scientists P. K. Tien (r), D. MacNair (l) and H. L. Hodges (center) examine new triode laser. Intensity of the laser light can be modulated by varying the voltage of a grid inside the laser tube. Photo shows two lasers in parallel.



### AT THE FAIR

Cut-away of the RCA pavilion at the 1964-65 New York World's Fair shows the three major areas of interest. Concentric circles are production and control areas of the color TV facility. Circular and rectangular areas to the right are lounges for visitors. Area in the upper left hand corner is the reception area where visitors will be able to see themselves on color TV and view representative displays of other RCA products and services.

Do you have a new idea you think will shake the electronic market? If you maintain a know-it-all attitude, lack a sound financial plan, are undercapitalized, chances are that your venture into the electronic business will fall on its face. Charles Salik, Electronics Capital Corp., tells what will probably happen and why.

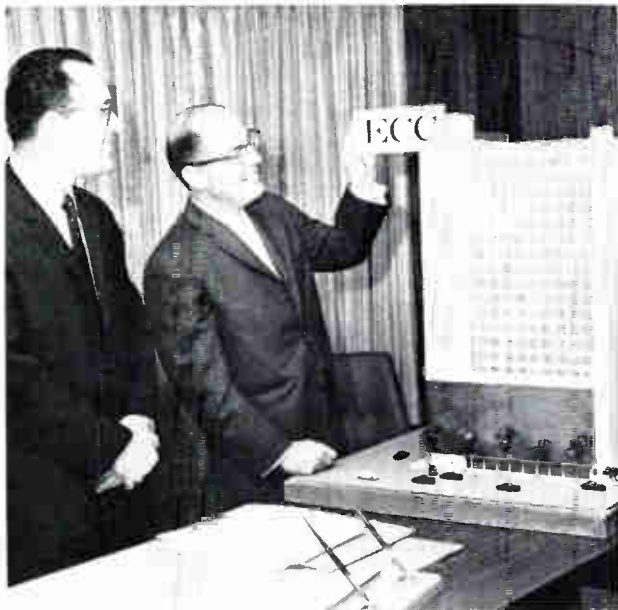
## WHY SMALL ELECTRONIC FIRMS FAIL!

By **PHILIP GEDDES**  
Editor-at-Large  
ELECTRONIC INDUSTRIES



"Many small firms are not structured to take part in tomorrow's electronics," says Charles Salik, president of Electronics Capital Corp. "They have a problem in meeting the payroll today. Of some 1500 small firms we examined about 1200 are doomed to failure."

"One aspect of failure is poor financial planning, whether firms are well capitalized or not. We have found that most small companies are very poorly organized financially. They have no realistic financial plan."



Charles S. Salik, right, ECC president, and Richard T. Silberman, executive vice president, with model of ECC building in San Diego. "We have learned from bitter experience that you cannot be too exact in your judgment of management and its potential."

HOW MANY ELECTRONIC COMPANIES SUCCEED in proportion to those that start? Charles E. Salik, president of Electronics Capital Corp. answers, "Less than 5/10th's of one percent."

Over a four-year period ECC looked at 1500 small electronic firms with an eye to investing in them. Out of that number, Mr. Salik predicts that 1200 are doomed to immediate failure. Of the 300 remaining, his company chose to invest in only 20. Three of that 20 are already listed as unlikely to succeed, in ECC's terms.

Investment banker Salik suggests that it may be too easy to get into business. There are too many people still willing to put money into any electronics company. Despite the market shakeup of nearly two years ago, two or three engineers can easily form a group, make some plans, maybe build a prototype, raise money, and then they are in business.

Mr. Salik points out that despite the gloomy statistics, there is a continuing need for small business in electronic technology and aerospace. In addition to valuable contributions to technology, small companies also contribute to their customers' financial health by allowing better net profit per invested dollar.

The small business has to take all the risks in terms of delivery and cost, while the large companies risk their good name in the end product of the joint efforts. This does not mean that big companies do not have responsibilities to small concerns to enable them to operate on limited capital.

If it is any consolation to the would-be entrepreneur, the failure rate in electronics, Mr. Salik points out, is lower than in the total small business segment of the economy. This is attributed to the high degree of obsolescence in electronics giving more people a chance to participate in business.

### **Growing Large**

Mr. Salik has no choice but to be a realist in his survey of small business. ECC's health is dependent on sound business judgment of others. He admits that many large concerns are poorly managed but points out that large companies have room for maneuvering into better positions. They can recover from mistakes.

No small business operator to his knowledge wants to remain small; small investment business companies exist to help them grow larger. He says, "Many small businesses are not structured to participate in tomorrow's electronics. They have a problem in meeting the payroll today.

"They try to get into established market, establish a wedge, then eventually build enough cash flow to be able to spend money on some research and development in the future."

He adds that with the proper capital backing them, the chances of doing this are considerably greater. "We in all honesty finance them to become large business. In order to initially finance them we must make sure that they meet all the criteria to qualify as small business but the hope and objective of this capital bank is to make sure that they do everything possible to become larger."

Help for the small business operation is also often forthcoming from large firms, usually not out of altruism but for sound business reasons. As Mr. Salik says, "They don't do it because it is a good and nice thing or because they want to help the general economy of the area in which they live. They do it because it is profitable." It goes without saying that ECC's motives are comparable.

### **Failure Patterns**

Business failures have common elements running through them. As obvious as the basic patterns may seem, they occur over and over again. First on Charles Salik's list is under-capitalization. He says, ". . . this takes two forms, dollar and personnel. If you under-capitalize in dollars your chances of success are almost zero. The reason being that if you get to a certain point in development and run out of money, it's almost impossible to get any more. In the eyes of the investor you have already lost too much.

"It's true of everybody who has ever invested in small business, that some have patience, others do not. The small businessman has the problem of constantly being heckled by the fellow who put \$25,000 together with his relatives and friends and who wants performance. A big company automatically expects a certain amount of loss. We know how to minimize the losses of the early stages and move into the profit area as soon as possible.

"The second part of under-capitalization is management. If you cannot afford management: a marketing man, a good general manager, a good technical manager, and perhaps a good manufacturing manager, the chances of success are again quite limited.

"A management organization is structured from the financial. In other words, how much can I afford to pay for a first rate engineer? How many engineers can I afford? Can I do all the engineering myself? If I do, who is going to do the general management? Who is going to worry about the planning and control? Who's going to worry about manufacturing techniques? Can I be in engineering while equipment is going through the manufacturing facility?

"One other aspect of failure is poor financial planning, whether companies are well capitalized or not.

## SMALL BUSINESS (Continued)

We have found that most small businesses are very poorly organized, financially. Almost all of them have no realistic financial plan. They have no budgets. They have no cash flow estimates. Their plan rarely goes beyond six months, at most a year. Where they might start with a plan, it is soon discarded and ignored.

"They give no credence to their budget. They vary from the budget so widely that it has no effect whatsoever. Their spending is based solely upon that state of nirvana when they get their first order. If that order does not materialize or there is a delay, their chance for success just slowly drifts away until eventually they fail.

"You cannot budget high hopes. You can only budget facts and be realistic. Small businessmen rarely understand financial planning. Many times they understand technical planning and marketing but they usually come out of big companies where they are used to plenty of capital. And they proceed to spend money in almost the same manner as they did in the large company."

### Planning for Error

Small business investment companies such as ECC must have criteria to evaluate the capabilities of the embryo company. ECC itself has no guarantee of success. Intuition is not enough in making judgments on investments. Mr. Salik and his band of legal, technical and management experts have to investigate thoroughly the creative, managerial, and market potential in any company they survey.

Most companies in Mr. Salik's experience rarely ask for enough money to get started. He says, "They are usually far below what they need. This doesn't necessarily disqualify them. If anything when we go over their affairs thoroughly we begin to show them how to plan financially. Since management is not an exact science you have to have wide good judgment with regard to the risks that are involved, or how much error you can afford.

A REPRINT OF THIS ARTICLE CAN BE OBTAINED  
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The Editor  
ELECTRONIC INDUSTRIES  
Chestnut & 56th Sts., Phila., Pa. 19139

"Most people in small business do not plan for error, that is, errors in judgment, design, or marketing, and so forth. And, if they don't plan for it, if they have not made sufficient allowance, or have no capital by a factor of almost one to one, or one to two, then they are more than likely to fail."

### Personality Problems

A small company turns around the personality and experience of the key founding figure. ECC finds it essential to make a profile of the key figure since problems in his makeup are likely to be reflected in his company. Mr. Salik with customary frankness draws an outline of desirable personal traits in the top man.

"We have found that the most highly educated engineer is not necessarily the best operator of a business. With some glowing exceptions, there are few PhD's who are heads of successfully run companies. For some reason the heavily academic-oriented individual has difficulty in dealing with the daily problems of running a business.

"He's apt to fail if he has just a technical background, even though it is recognized that in order to compete you must be an innovator. He has to develop a sense of values and a sense of *time*. All the heads of large electronics companies that I know, speak in terms of buying time when they buy a company. A good manager has to have a sense of time and a sense of timing. They are two different things. And he must recognize the importance of the other arms of his business."

Mr. Salik noted that many a technical man looks down his nose at a good financial officer. A technical man can turn to a financial man and say, 'figure out what it's going to cost to make this item and don't be influenced by my enthusiasm, then I'll tell you how much we can get for it.' Ignoring this contribution of the financial expert, Mr. Salik feels, is courting disaster.

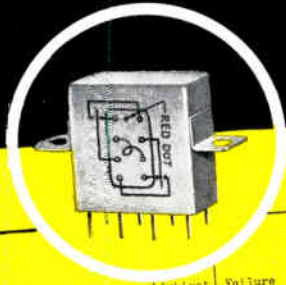
### Wheelers and Dealers

"Another part of the man's profile," Mr. Salik continues, "must be his ethical concept of business. When a man comes to us and tells us how he can in effect, cheat, slip by, shoot for overruns, is usually a big flash in the pan. He looks good at first and sometimes if he's already in business he has a rather spectacular beginning record. He does not necessarily violate the law but perverts the intent between parties and squeezes by.

"We have found that this man invariably fails because it is the mutual trust between buyer and seller, between the small business and the large business that usually carries it through in the long run. This is not to say that a man should not use careful planning and techniques in his planning and practices. When he tries to cheat we find often in this business that many investors are encouraged by his plans . . . he doesn't call it cheating but it gets down to that. This is a personality trait that we try to discover as early as we can.

(Continued on page 186)

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



C. P. CLARE & CO.  
TYPE F RELAY CONTACT LIFE RELIABILITY

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

**draw your own conclusions!**

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

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

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

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

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

What does this Reliability Report

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

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

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

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

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

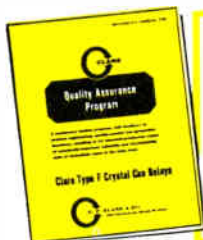
Operate times: 3.5 ms nominal, 5.0 ms maximum (including bounce), at nominal coil power.

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

Sensitivity: Just-operate power 250 mw.

(All ratings at +25°C ambient)

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# 1964 IEEE CONVENTION ...

## A GLIMPSE OF THE FUTURE

The world's largest technical meeting will draw over 75,000 engineers and scientists from 40 countries. Its expanded papers program will feature everything from a flip-flop with one transistor to engineering management.

THE 1964 IEEE INTERNATIONAL CONVENTION will be held from March 23 through 26 at the New York Hilton Hotel and New York Coliseum. This year's IEEE encompasses a full scope of technical activities. The Convention features a 20% increase in the number of technical papers as well as about the same increase in the number of exhibitors. This year's Convention theme is, "A Glimpse of the Future."

The world's largest technical meeting and exhibition is expected to draw 75,000 engineers and scientists from 40 countries. Convention headquarters will be in a new location, the recently completed New York Hilton Hotel, located at 6th Avenue and 53rd St.

### Registration

All IEEE members may register any day of the Convention at either the Hilton or Coliseum from 9:00 AM to 9:00 PM. Registration fee is \$1.00 for IEEE members and \$3.00 for non-members.

### Technical Program

The increased technical program, consisting of 320 papers covering the latest developments in every area of electrical and electronics engineering, will be presented in 64 technical sessions. High point of the program will be a special symposium on "Modular Magic" to be held Tuesday evening, March 24 at the Hilton.

A panel of outstanding authorities moderated by Patrick Haggerty, President, Texas Instruments Incorporated, will discuss the impact of processes and techniques for fabricating microelectronic integrated circuits.

### Exhibits

More than 1000 exhibitors will display some \$20 million worth of equipment, most of it for the first time. The Show will be in two locations. Electrical equipment will be on display at the Hilton and on all four floors of the Coliseum.

More than 1000 exhibitors will display their latest equipment at both the Coliseum and the Hilton.







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Editor



### Banquet

Charles F. Horne, President, General Dynamics/Pomona Div. and President, Electronic Industries Association, will be the principal speaker at the annual banquet to be held on Wednesday, March 25, in the Grand Ballroom of the Hilton. This year's banquet will also feature the presentation of the following major IEEE awards: Medal of Honor, Edison Medal, Founders Award, Lamme Medal, and the Education Medal. In addition, the 118 recently elected Fellows will be recognized.

Those receiving the year's awards are: Harold A. Wheeler, President and Director of Wheeler Laboratories, the **Medal of Honor**; John R. Pierce, Bell Telephone Laboratories, the **Edison Medal**; Andrew G. L. McNaughton, Ottawa, Canada, the **Founders Award**; Loyal V. Bewley, General Electric Co., the **Lamme Medal**; and B. Richard Teare, Carnegie Tech., the **Education Medal**.

Field awards and prize paper awards will be presented at a special reception given by the IEEE Board of Directors on Tuesday, March 24.

The Cocktail Party will be held on Monday evening, March 23, from 5:30 to 7:30 in the East Ballroom of the Hilton.

### Technical Papers Highlights

This year 320 papers will be presented at 64 technical sessions. These sessions, listed on *page 43*, will be held in both the Hilton and Coliseum.

The fidelity of nanosecond pulse transmission in laminated coaxial structures will be discussed in a paper entitled, "Improvement in Pulse Transmission on Coaxial Transmission Lines by Reduction of Skin Effect." The ideal situation in which the laminated conductors exhibit a constant surface impedance is investigated, and criteria for specifying maximum allowable distortion associated with a given length of line are determined. This paper will be presented at Session 1 on Monday morning.

Computer-related topics will be given at Sessions 3 and 11. The computer man should find everything to his liking at both sessions.

Leading off Session 3 will be a paper on the "Tunnel Diode Memory." This paper will describe a

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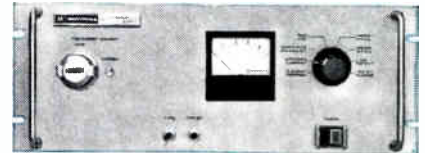
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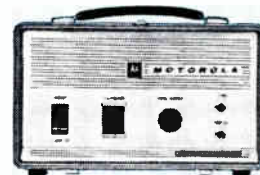


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## IEEE (Continued)

memory subsystem which uses a **two-tunnel-device memory** cell matrix and is completely compatible with a tunnel diode logic subsystem. Two other papers to be presented at the same session will be "High-Speed Threshold Logic A/D Converter with Error Correction" and "Ferroelectric-Photoconductive Image Storage." The system described for the A/D converter is capable of quantizing analog signal data into a 12-bit binary coded decimal word having a conversion speed and accuracy of 200 kc and 0.1% respectively. The paper devoted to "Photoconductive Image Storage" will describe the work directed toward fabrication of a new device capable of image storage by exclusively solid-state means.

At Session 11 the second part of Computer Related Topics will be covered. The "Design of a Digital Waveform Identifier" will describe a device that performs the following function: given a set of reference waveforms, it analyzes a long segment of an input waveform to find which reference waveform is contained in the segment. **The identifier uses digital techniques.** The waveforms are sampled at a fixed rate and identification is based on samples.

The increased interest in the use of **optics in character and pattern recognition** is exemplified in the "Application of Electro-Optical Filtering to Object Recognition." This paper shows that problems such as unsharp focusing of images can be remedied by electro-optical networks. It also shows how signal-to-noise items of optical data can be improved.

A **high-speed communication system** that checks for errors without the need for redundancy in the original data will be discussed at Session 4. A paper entitled, "Correlative Digital Communication Techniques" will discuss a concept of transmitting data by means of a signal having certain correlation properties.

A system developed for the U.S. Weather Bureau uses a slow-scan vidicon to convert the optical image of a PPI weather radar display to a narrow-band TV signal. This signal can be transmitted over conventional facsimile-grade telephone circuits. **Scan conversion equipment** using a Permachon storage vidicon converts the slow-scan TV signal to a 625-line TV display. A paper entitled, "A Slow-Scan TV System Using the Permachon for Scan-Conversion," given at Session 5, will explain the advantages of this system over a microwave system. Also discussed will be equipment failures and performance details.

**Coherent radar systems** for airborne uses place stringent requirements on the extreme short-term phase stability of the carrier-frequency generator.

If the carrier frequency is controlled by a quartz-crystal unit in an oscillator circuit, serious difficulty can be encountered with the phase modulation of the carrier frequency due to vehicular environment. "Measurement of Phase Stability of Quartz Crystal Oscillators for Airborne Radar Applications," given at Session 6, will discuss a method of making measurements of modulation indices. This method **permits measurement directly at the oscillator** without prior frequency multiplication to the SHF range.

The requirements for **higher reliability** in components have caused most manufacturers to subject their components to exhaustive life tests. This, unfortunately, doesn't solve the headache of the reliability engineer when he is choosing components. You see, advertised failure rates for components designed for aerospace uses are generally low, due partially to the fact that test samples are small. This results in confidence-band spreads of several orders of magnitude. Furthermore, these failure rate estimates are not made under operational conditions. One method of obtaining useful data and analyzing the results to permit intelligent design trade-offs will be given in "Selecting Most Reliable Electronic Components," being presented at Session 8.

"Reliability Screening Using Infrared Radiation," also at Session 8, offers another **method of determining component failure.** The infrared radiation emitted by all component parts may possibly be used to identify short-life or faulty parts, and predict the degradation or drift of part parameters. It has been shown that parts emitting abnormal amounts of infrared radiation under the same stress conditions tend to fail earlier.

Logic circuit designers and power-supply specialists will find "Power Distribution Systems for High-Speed Computers," Session 10, well worth attending. In the past the logical circuit designer gave little, if

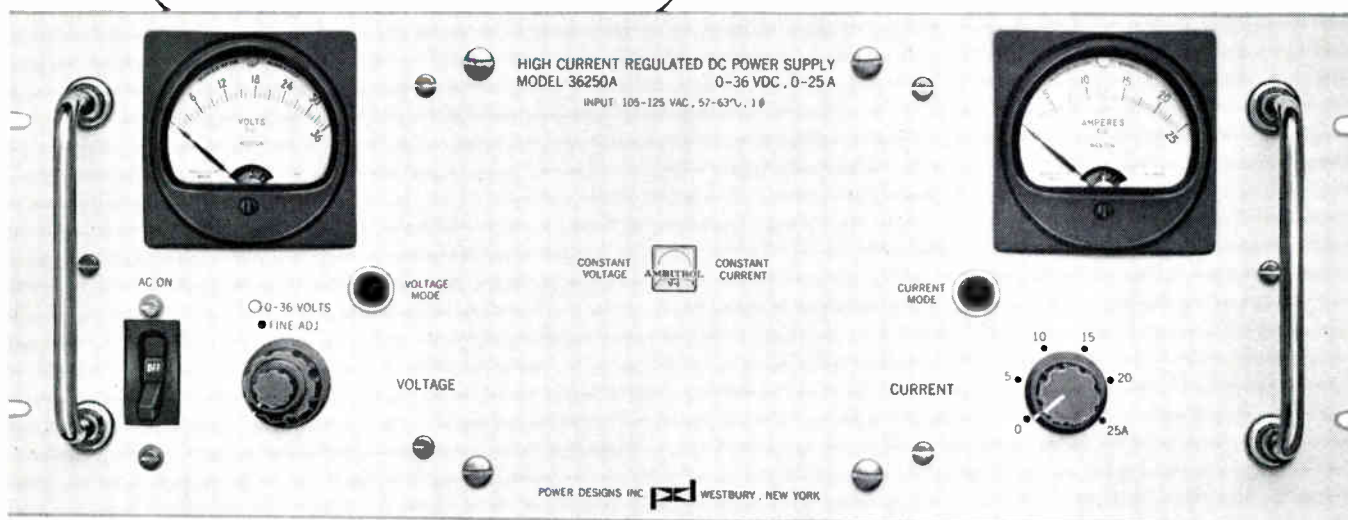
At 64 technical sessions, 320 papers—many of which are tutorial—will be given.



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## IEEE (Continued)

any, consideration to the problems of providing and distributing well-regulated dc power. However, the new generation of computers with nsec. speeds must use new approaches to the problems of dc power distribution if adequate system performance is to be achieved. These new approaches will be discussed at this session.

Transmitting power without wires will be discussed in "Experiments in the Transportation of Energy by Microwave Beam." This paper, given at Session 13, will tell how several hundred watts of power were transmitted over a distance of 25 feet with a 25% efficiency, including transmission and rectification losses. State-of-the-Art components involved are such that both the power level and distance could be increased more than a thousandfold.

Engineers who may not be familiar with Hall-effect devices will find "Hall Generators, What, Why, and How Much" most helpful. Given at Session 14, this paper is intended as a brief tutorial introduction to the Galvanomagnetic effects, the Hall effect, and the magnetoresistive effect. The characteristics of the Hall effect of interest in engineering uses are outlined.

In the last ten years there has been a trend towards

automation in test and checkout equipment. As a result of this trend, certain procedures have been accepted by the RFI/EMC Community, and action has been taken to automatize RFI/EMC specification measurement instruments. A paper entitled, "Trends in RF Interference Measurements," given at Session 16, reviews the events which lead to automated RFI instruments. It also discusses the techniques to be used in achieving interim and long-term automation of RFI measurement.

Presently modeling techniques have been established for r-f interference prediction in search radars. Modeling techniques for tracking radar are relatively new. The nature and aspect of a tracking radar prediction model depends upon the various forms of degradation the system experiences when exposed to interference. In "Methods for Predicting Interference Effects in Tracking Radars," to be given at Session 16, the results of an analyses to find interference effects will be presented. Also discussed will be the methods derived for designing mathematical models that can be used for predicting the effects.

Did you ever hear of a flip-flop circuit using only one transistor? A paper entitled, "A Single Transistor FF Circuit" describes a circuit that uses one ordinary bipolar junction transistor. One of the two

(Continued on page 186)

## TECHNICAL SESSIONS

	NEW YORK HILTON					NEW YORK COLISEUM		
	Tristan Ballroom	Mercury Ballroom	Sutton Ballroom North	Sutton Ballroom South	Regent Room	Room A	Room B	Room C
MONDAY, MARCH 23 10:00 A.M. — 12:30 P.M.	SESSION 1 Wire Communication I	SESSION 2 Marine and Industrial Electrical Applications	SESSION 3 Computer Related Topics I	SESSION 4 Data Communication and Telegraph Systems I	SESSION 5 Television Systems	SESSION 6 Instrumentation I	SESSION 7 Feedback Control System	SESSION 8 Reliability
MONDAY, MARCH 23 2:30 — 5:00 P.M.	SESSION 9 Wire Communication II	SESSION 10 Electrical Applications In Industry	SESSION 11 Computer Related Topics II	SESSION 12 Data Communication and Telegraph Systems II	SESSION 13 Microwave Theory and Techniques	SESSION 14 Instrumentation II	SESSION 15 Is Measurements Training a Neglected Area of the Engineering Curriculum	SESSION 16 Electromagnetic Compatibility
TUES., MARCH 24 10:00 A.M. — 12:30 P.M.	SESSION 17 Electrical Engineering Education	SESSION 18 Instrumentation III	SESSION 19 Space Electronics and Guidance	SESSION 20 Space System Design Techniques	SESSION 21 Switching Systems	SESSION 22 Symposium on High Energy Research and New High Energy Accelerators	SESSION 23 Nonlinear and Linear Control	SESSION 24 Electronic Technologies in Industry I
TUES., MARCH 24 2:30 — 5:00 P.M.	SESSION 25 Aeronautical Electronics and Navigation	SESSION 26 Instrumentation IV		SESSION 28 Switching Systems and Techniques	SESSION 29 Information Retrieval, IEEE and You	SESSION 30 Optimal and Adaptive Control	SESSION 31 Microcircuits and Processing Techniques	SESSION 32 Electrical Technologies in Industry II
TUES., MARCH 24 8:00 — 10:30 P.M.	SESSION 27 — SPECIAL HIGHLIGHT EVENING SYMPOSIUM ON MODULAR MAGIC NEW YORK HILTON — EAST BALLROOM							
WED., MARCH 25 10:00 A.M. — 12:30 P.M.	SESSION 33 Telemetry	SESSION 34 Electron Devices	SESSION 35 Syncom II Satellite	SESSION 36 Semiconductor Devices	SESSION 37 Instrumentation V	SESSION 38 Improving Written Communications	SESSION 39 Radas	SESSION 40 Rotating Machinery
WED., MARCH 25 2:30 — 5:00 P.M.	SESSION 41 The West Ford Experiment	SESSION 42 Instrumentation VI	SESSION 43 Power Generation	SESSION 44 Circuit Theory I	SESSION 45 Radio Communication Systems	SESSION 46 Packaging and Interconnections	SESSION 47 Audio and Acoustics	SESSION 48 Systems Science
THURS., MARCH 26 10:00 A.M. — 12:30 P.M.	SESSION 49 Transmission	SESSION 50 Radio Propagation	SESSION 51 Recording and Audio Measurement	SESSION 52 Circuit Theory II	SESSION 53 Electronic Components and Materials I	SESSION 54 Antennas	SESSION 55 Human Factors	SESSION 56 Basic Sciences I — Circuits and Systems
THURS., MARCH 26 2:30 — 5:00 P.M.	SESSION 57 The Electric Power System of Tomorrow	SESSION 58 Communication and Modulation Techniques	SESSION 59 Engineering Management	SESSION 60 Symposium on Data Transmission	SESSION 61 Electronic Components and Materials II	SESSION 62 Arrays and Ionosphere	SESSION 63 Defense Systems	SESSION 64 Basic Sciences II — Fields and Systems

# 1964 IEEE 'FELLOWS' LOOK AT THE FUTURE . . .

Exclusive statements from the nation's leading electrical and electronic engineers summarize the future for the electronic industry.

## Communications

**R. G. Elliott, Southern Bell Telephone and Telegraph Co.**—"We have entered the 'Data Age' of communications successfully. Sophisticated data systems will continue to appear at a spectacular pace—helping private and public sectors solve many diverse problems through local, nation-wide and world-wide communications. In the forefront of new communications will be methods of instantaneous reporting and information retrieval, and quick, accurate predictions of the future effect of changing variables on business and governmental operations. The need for speed in our management decision and thinking processes will continue to increase as will the need for more technical talent."



R. G. Elliott



R. C. Benoit, Jr.

**Richard C. Benoit, Jr., Telecommunications Section, USAF**—"Within the next decade we can expect many technological advances in the communications field. For example, by minimizing the transmission of redundant information contained in speech, significant bandwidth reductions may be obtained, thus, perhaps a 100-fold increase in spectrum utilization may become a reality. Computer techniques and automatic functions will be widely applied in adaptive communication networks, for military and civilian use. In these configurations network terminals will automatically sense and react instantly to ever-changing operating conditions (i.e. traffic density, routing, propagation, and the nature of the communications), to provide optimum performance and utilization of the available facilities."

**Richard P. Gifford, General Electric Co.**—"Among Engineers, Legislators and Government Leaders there is arising a growing awareness of the economic potential in effective 'farming' of the radio spectrum. Evaluation of the impact of the use of this natural resource on our gross national product (GNP) will become another tool in assigning the resource among the many classes of petitioners. When 'farming

effectiveness' measurements are applied, there is indication that there is still tremendous economic potential available—provided application of the spectrum to a multiplicity of uses is actually encouraged. Concurrently, of course, there will be increased need for attention to problems of electromagnetic compatibility (EMC) to keep the 'farming' effective."



R. P. Gifford



Frank A. Gunther

**Frank A. Gunther, Radio Engineering Labs**—"The most significant trend in wideband tropospheric scatter radio communications is the evolution from tube-state to solid-state circuitry. The stability of transistors and other solid-state components used with modular circuit design concepts has resulted in simplified, compact and high performance wideband communications equipment. This new equipment, easier to operate and maintain, will, in many cases, permit the use of technicians of reduced skills. Systems using such equipment will be more economical, as it is expected that eventually solid-state manufacturing costs can be reduced below conventional tubes. Further, the new equipment will require less power, less fuel and fewer replacement parts. These features, with higher performance in wideband operation, provide one solution to the pressing need for communication systems of high reliability, at moderate cost. This is especially so in those areas of the world where skilled technicians are scarce, and where economic and cultural progress is delayed by a lack of modern communications."

**Fredrick E. Hanson, Western Electric Co.**—"In the next decade there will be a marked evolution in communications concepts. More complex switching and transmission systems are a necessary part of the future. These systems will need more components and many more interconnections. Attractive new kinds of telecommunications services will be available. There will be introduced new products and many changes in manufacturing technology. Major attention will be directed to continuing improvement of product quality and service reliability."



F. E. Hanson



L. R. Kahn

**Leonard R. Kahn, Kahn Research Labs.**—"One may expect major improvements in acclimating signals to their environment and reducing such problems as selective fading and multipath. It should also be expected that continued efforts will bear fruit in bandwidth compression and other techniques for allowing a greater communications flow per unit bandwidth. Single-Sideband techniques should loom large in furthering these aims and should not only find use in communications but in standard broadcasting."

**Eric M. Leyton, London University**—"The next few years will see the rapid expansion of color television in the U.S.A. and Europe. Transmitting equipment will be improved particularly in the area of color cameras and color tape recorders. A practical standards converter for color TV will be developed to allow interchange of program material between the U.S.A. and Europe."



E. M. Leyton



W. C. Morrison

**W. C. Morrison, R.C.A.**—"The last few years have brought us the commercial development of many items important to the broadcasting industry. These include magnetic tape recording of video signals, Peltier coolers, separate luminance channel color cameras, custom-contoured antenna patterns, and stereophonic broadcasting. To the average engineer, and certainly to those in the broadcasting business, the

list contains nothing new. However, time is a very selective filter which frequently surprises engineers with its wide reject band or its great delay! On the other hand, these same characteristics put zest into our lives. What can we predict for the future? We have electronic data processing to give us seven-league boots for computations; such things as active communication satellites give us new horizons; and integrated circuits completely change the equipment picture. From these will come: (1) many ideas of limited scope, (2) the achievement of some things we have been predicting for years, and (3) a few ideas that will change the course of the world."

**Harold F. Meyer, Aerospace Corp.**—"The impact of new technology on military communication systems is expected to be evolutionary rather than revolutionary. Commercial carrier systems with modifications and supplements will continue to satisfy a large proportion of military communication needs. Such modifications and supplement would include increased alternate routing, automatic switching, increased capacity, circular by-passing of industrial and transportation centers, hardening and modulation flexibility. Systems solely for military purposes will be expanded and implemented where economics, politics, or needed technical aspects rule out integration with commercial systems. Emphasis regarding military systems will be placed upon increased capacity, flexibility, reliability and survivability. This will be particularly true with respect to service for mobile, transportable and other isolated terminals."



H. F. Meyer



T. F. Rogers

**Thomas F. Rogers, Massachusetts Institute of Technology**—"Exploitation of radiowave 'scatter' propagation modes and employment of amplifiers in undersea cables have provided recent major improvements in long distance communications. Large national efforts to advance rocket, satellite and surface terminal technology have now reached the stage where development of long distance satellite communications circuits has become clearly possible. High capacity point-to-point circuits using large fixed terminals will probably be established initially; they may soon be supplemented by lower capacity circuits between transportable and, perhaps, mobile terminals as well."

**K. G. McKay, Bell Telephone Laboratories, Inc.**—"The ancient goal of effective, efficient communications on a global scale is within our reach; the technology of transmission has achieved maturity. The more drastic

evolution will come from the widespread application of programmed electronic controls in switching centers. The consequent impact of communications will be more pervasive than anyone can now imagine."



K. G. McKay



H. A. Samulon

**H. A. Samulon, TRW Space Technology Labs**—"Real breakthroughs in space guidance and communication are becoming increasingly rare. The most important of recent developments have been in the relatively unglamorous field of reliability. Improvements in reliability have been truly spectacular. Sophisticated electronics equipment will now work unattended in the hostile space environment for many months without failure. Improvements in reliability can be expected to continue and to be of major consequence in the design of spaceborne electronic equipment."

**Keeve M. Siegel, Conduction Corp.**—"I predict that radar power will be increased sufficiently so that radars on earth operating at long wavelengths will be able to map the surface of Venus. They will use coherent processing so that we will be able to know what the Venus surface looks like underneath the clouds. Similar experiments will allow a mapping of the Lunar surface, which is underneath a low dielectric constant-type material. Long wavelength lunar radar mapping, when superimposed on optical wavelength maps, will predict landing sites to support human life support systems of lower cost and higher utility than presently conceived. Radar burglar alarms and discrimination systems will become commonplace. The major market for radar sets in the 1980 time period will be in inexpensive commercial sets in the price range of the more sophisticated children's toys of today."



K. M. Siegel



C. E. Schooley

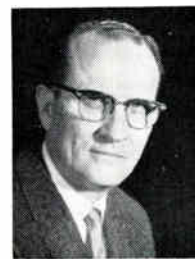
**C. E. Schooley, American Telephone & Telegraph Co.**—"Accomplishments in electronic communications during the past decade have been remarkable. Transoceanic telephone cables, new cable carrier and microwave transmission systems, and solid-state switching systems for domestic service are only

a few of the outstanding achievements. But each step forward simply opens wider the horizon of things yet to be accomplished—challenges for the future. . . . Commercial use of satellites, pulse code modulation, wave guides and perhaps even masers will enable us to further enlarge and advance our domestic communications systems. With cooperation of other countries, such applications will enable us to establish a truly integrated global communications network."

**J. L. Jatlow, ITT Federal Laboratories**, "Tropospheric scatter propagation has become the predominant means for providing multi-channel communication over beyond-the-horizon paths where because of terrain, logistics or political considerations, it is impractical to provide line-of-sight repeaters or wire transmission. For tropo hops having long effective distances, however, the useful intelligence bandwidth is very seriously limited by the effects of multi-path distortion. Systems engineers are investigating this problem and it is expected that modulation means and other circuit techniques will be developed to extend the range over which 60 or 120 voice channels may be transmitted via tropospheric scatter propagation."



J. L. Jatlow



W. L. Doxey

## Components

**W. L. Doxey, U. S. Army Electronics R&D Labs**—"Electronic components and devices will continue on an accelerated basis to be upgraded in electrical performance. Less maintenance will be required as a result of increased reliability and improved production techniques. In the forefront are semiconductor integrated circuits, thin films, and the entire technology of microelectronics. Test data in evidence already support high reliability claims; particularly, digital circuit demands will within five years result in mass production of reliable circuit functions at a cost far below certain discrete elements now in use. Energy conversion devices by thermoelectric and thermionic emission techniques within five years will be practical for military uses. Long-life, reliable fuel cells giving 500 watts from hydrocarbon fuels and with efficiencies up to 30% will be practical for military uses. Basic and applied research on materials and technologies for lasers and masers will result in practical application for military and civilian needs. During the next decade results of R&D in electronic materials, components and devices will require new concepts in the maintenance and logistic support of electronic equipments."

(Continued on page 47)

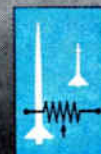
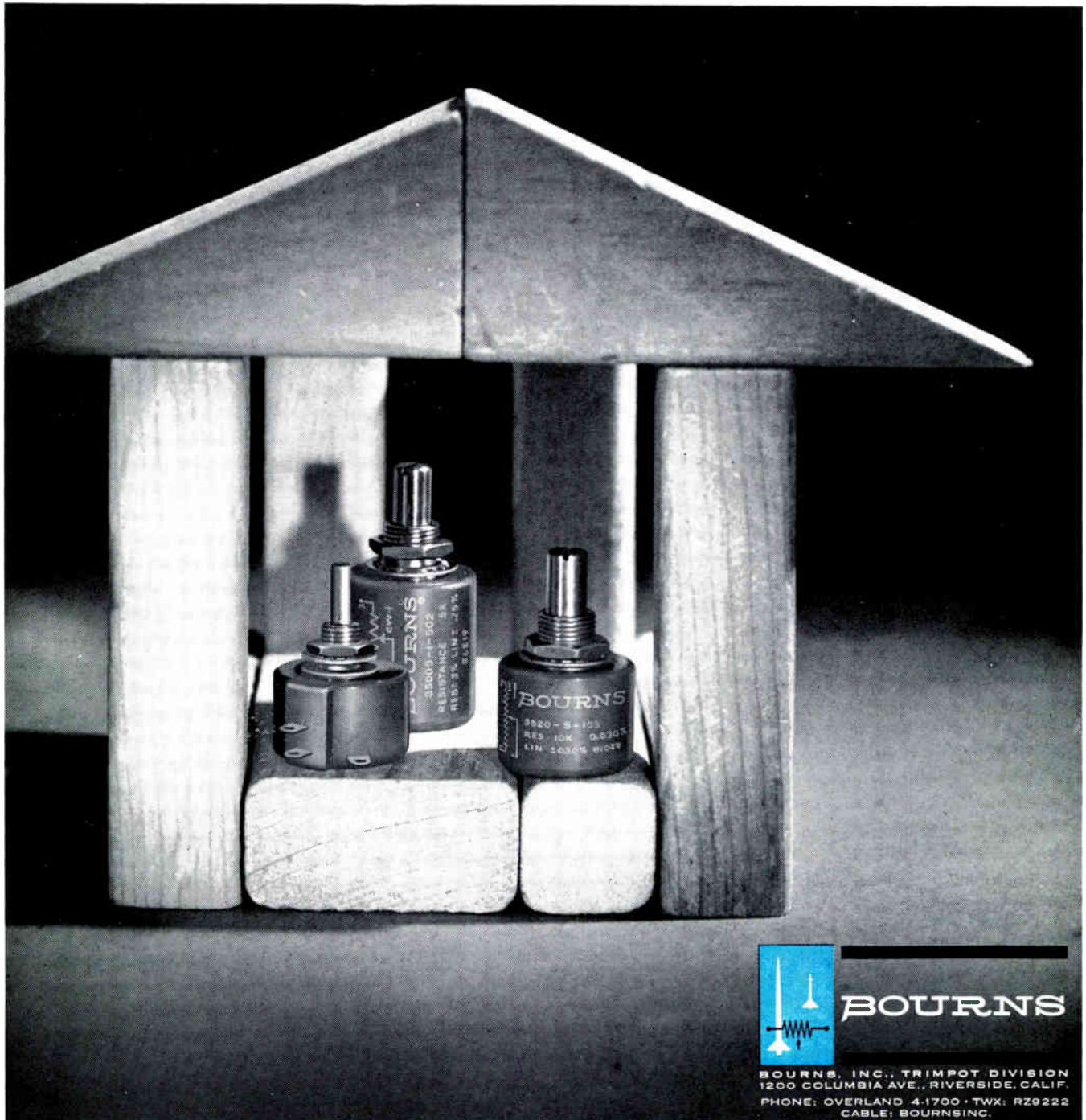
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Meets Steady-State Humidity Requirements (optional feature meets MIL-STD 202B, Method 106 Cycling Humidity)	Yes	Yes	Yes
Standard Linearity	$\pm$ 0.30%	$\pm$ 0.30%	$\pm$ 0.20%
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Operating Temp.	-65° to +125°C	-65° to +125°C	-65° to +125°C
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## Computers

**R. B. Blackman, Bell Telephone Laboratories, Inc.**—"During the last four or five decades, data processing has played an increasingly important role in many fields of science and technology. There is probably no better indication of this than the acceleration of technological progress following the application of some of this progress to improvements in methods of data processing. Continual improvements in methods of data processing will be needed for future progress in science and technology."



R. B. Blackman



A. A. Cohen

**Arnold A. Cohen, UNIVAC Division, Sperry Rand Corp.**—"Watch on-line data processing gather momentum. Watch techniques develop for multiple terminal time-sharing of central computational facilities. Watch growth taper off for voluminous printouts and other intermediate paper, due to tighter man-computer interaction. Computer system design will benefit from continuing progress in integrated circuits, film memories, and mass fabrication techniques. Watch these arts demonstrate dramatically their potential for speed, reliability, compactness, and economy. Though born of aerospace necessity, they will attract serious attention for systems large and small, and may well open door of economic feasibility to highly parallel multiprocessor systems. In short, watch computer technology start to turn an important corner."

**Kenneth R. Eldredge, Stanford Research Institute**—"Ways and means to improve our fight against the snowstorm of paper, information, and data need to be found. We are being inundated. The exponential growth of data leads one to believe that this will be a never-ending task to develop more and more sophisticated devices and systems. We will increasingly rely on computational and retrieval systems together with the newer self-organizing machines for decision-making purposes."

K. R. Eldredge

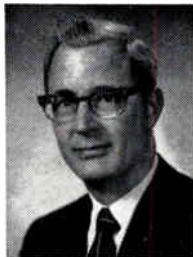


R. L. Frank



**Robert L. Frank, Sperry Gyroscope Co.**—"Radio navigation systems will be closely integrated with non-radio systems and with other data-processing in ships and aircraft. Digital microcircuit techniques will become widespread, with emphasis on clever use of standard modules, since these will cost much less than special circuits. Flexible automated wiring and packaging will permit ready modification of standard device designs to special applications. Simplification in data processing will make practical the application of optimum information theory techniques, and extend the range, accuracy, and reliability of navigation systems under adverse conditions. Navigation devices will be directly coupled to vehicle controls, but simplified displays will permit human monitoring."

**C. D. Morrill, Goodyear Aerospace Corp.**—"During the next decade, the impact of associative or content-addressable memories and their quasi-analog counterparts will be felt in all areas of high-speed data handling. Improvements in speed of one to three orders of magnitude in information storage and retrieval, intelligence data handling, communications, command and control, traffic management, and logistic control systems will be realized. These improvements along with continued improvements in deposited circuitry and new control theory will result in systems which will learn and adapt to changes in their data environment and even to changes in their internal structure."



C. D. Morrill



M. T. Lebenbaum

## Control and Instrumentation

**Matthew T. Lebenbaum, Cutler-Hammer, Inc.**—"The last ten years have witnessed the birth and development of the tunnel diode amplifier, the parametric amplifier and the maser; receiver noise, in many cases, is no longer the limiting factor in system sensitivity. This has been a materials revolution, with the new materials being used in 'conventional' circuit structures. The next decade will see the circuit and material merge to produce integrated multifunction microwave elements, such as combined oscillator-amplifier-limiters, with possible applications in low cost cryogenic environments."

**B. E. Lenehan, Westinghouse Electric Corp.**—"Instrumentation is the means by which unobservable things are able to communicate with people. The trend is in the direction of greater sensitivity and durability. Mechanization of processes adds requirements for communication with machines. This field is inadequately developed at this time."



B. E. Lenehan

IEEE Fellows  
(Continued)

## Lasers

**Louis R. Bloom, General Telephone & Electronics Laboratories Inc.**—"The next few years should see much of the glamour of laser research wear off and a hard look taken at its useful applications for science and for industry. Space-to-space and space-to-ground telemetry and communications using light should become a reality within the decade. However, because of absorption and scattering, it appears unlikely that optical links will displace many microwave or radio beam links for point-to-point communication on earth. Open air links of this type may come into use for special military or private purposes. Complex arrangements of pipes and optical systems may also be used for guiding the light. Lasers will certainly take their places among the basic instruments of the laboratory and the classroom. Techniques using coherent light will permit demonstration of optical phenomena previously observable only with great difficulty. Pulsed lasers providing large energy densities to small areas should also find many important applications in medicine."



L. R. Bloom



K. J. Germeshausen

**K. J. Germeshausen, Edgerton, Germeshausen & Grier, Inc.**—"The newest and most rapid growing area of use for flash lamps and associated driving equipment is in optical laser pumping. These applications demand higher power density and a rather narrow spectral output tailored to the needs of the laser. In the next decade it should be possible to improve optical pumping systems by a factor of 4. Another growing area is the use of flash lamps for signals and beacons. Here the objectives are improved visual efficiency, reliability and freedom from service."

## Microwaves

**John C. Cacheris, Motorola, Inc.**—"... During the next decade the development of ferrite devices will become more complex, sophisticated, and more costly. The most important advances will be made in switches, circulators, phase shifters, and materials that are capable of handling high power levels and that are suitable for operational

# If you build power amplifiers or any UHF equipment . . .

if your higher-frequency communications designs use the planar or concentric-electrode vacuum tubes, investigate Erie's new line of mica screen grid bypass, blocking and coupling capacitors that are:

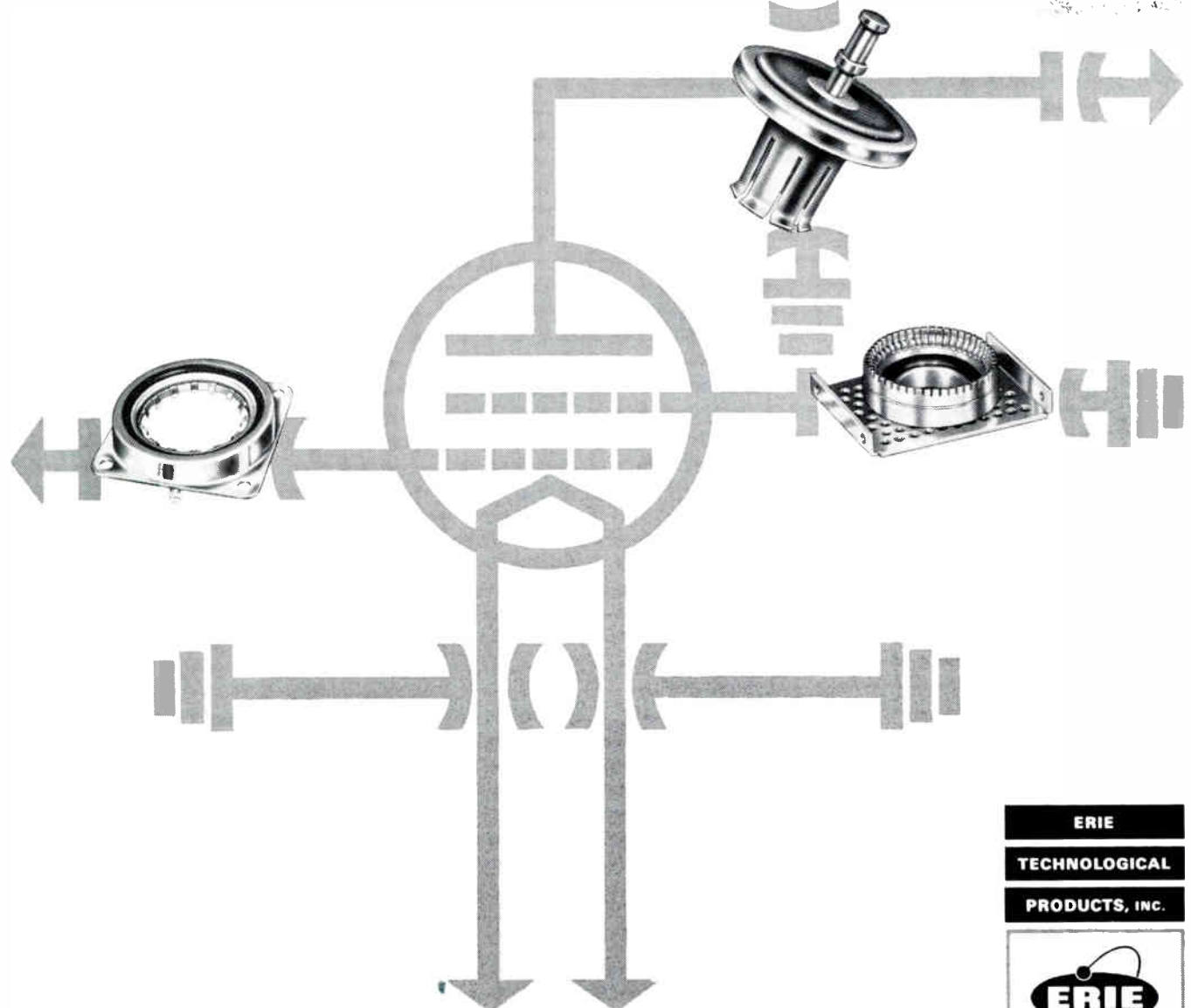
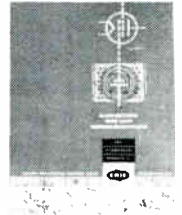
*Smaller in size . . . from 50% to 300% reduction in space required.*

*Broader in capacitance range . . . up to 10,000 pf.*

Erie's unique use of ruby mica as the dielectric keeps series resistance at a minimum. Heavy, short, flat terminals help keep inductance low, keep resonant frequency high. Minimum Q of 1000, as high as 3000 and up typically. Excellent stability of frequency, even under severe vibration and mechanical and electrical shock. Near-zero temperature coefficient.

Eight different types, configurations, and ratings of Erie UHF screen grid bypass capacitors now in stock. Special, custom-designed units can be quickly and economically developed for your special needs.

Write for *Bulletin 525*, with illustrations, design and performance data, and specifications on all the *new* Erie capacitors for UHF communications. Also ask for information on Erie's 486 other styles of HF mica capacitors.



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## Microwaves (Continued)

electronically scanned antenna arrays. Lumped constant devices will be used more widely for frequencies down to 30 mc. Applications at millimeter wave frequencies will increase. The application of magnetic single crystals and devices such as microwave acoustic amplifiers and delay lines will receive considerable attention and may become practical."



J. C. Cacheris



Dr. D. L. Jaffe

**Dr. D. L. Jaffe Polarad Electronics Co.**—"Competitive pressures from realistic government buying together with continuous changing technology will harden our industry. Events will forge a new group of financially and technically sound organizations in electronics. Creative engineering talent used to fill government prescriptions for defense items must be redirected by sound marketing concepts to industrial applications. Design engineers educated in a climate where cost considerations were secondary will have to adjust to the commercial pressures of price competition. Those of us in the microwave instrument field will find increased application for quantum electronic devices, i.e., varactors, ferrites, tunnel diodes, etc., which will result in a new generation of standard instruments. Ingenuity, competence in new techniques and a sensitivity to industry needs are required today for the development of tomorrow's marketable new products."

**Arthur L. Schawlow, Stanford University**—"The really large scale applications of lasers will have to wait until ways are found to combine high efficiency with high power and energy output. You can afford to waste power and dissipate heat only if the total amount is small. Power and efficiency can surely be combined, but it will take a lot of work and considerable ingenuity. Meanwhile, there are applications where large numbers of small lasers could be used, if the price were more commensurate with the simplicity of the devices."



A. L. Schawlow



T. G. Mihran

## R & D

**Theodore G. Mihran, Cornell University**—"R-F electron beam devices, both linear and crossed-field, continue to

have a virtual monopoly on the efficient generation of high average power at microwave frequencies. The power-frequency frontier will continue to advance in the future as a result of improved technology and new combinations of principles already known. On the research frontier, the electron beam is proving to be an extremely interesting member of the general class of plasmas. The electron beam can be 'purified' to the extent of almost completely removing perturbations, such as random motion and non-laminar motion. By then introducing such 'impurities' in a controlled fashion, I anticipate that new properties of beam plasmas will be uncovered which will form the basis for radically new families of electron beam devices in the future."

**Gifford White, White Instrument Labs**—"In the physical instrumentation field, as in most others, the time gap between theoretical investigation and its application to hardware will become shorter. Increasing numbers of engineers will have the desire and the mathematical ability to reduce abstract models to practical devices. Sophistication at the design level will increase. The engineer must prepare against his own obsolescence by continuous self training."



G. White



G. J. Lehmann

**Gérard J. Lehmann, Compagnie Generale d'Electricite, Paris, France**—"Electronics has changed from a specialized field of science and technology into the form of a common tool widely used in research and industry. It now resembles the field of mechanics, so basic to engineering activities. Most electronics people must realize this fact, and become more closely associated with their technical environment than before. The birth of I.E.E.E. is a direct result of this metamorphosis, which announces even more glorious days for Electricity and Electronics closely united."

**Charles A. Desoer, University of California**—"We live at a time that is far more exhilarating than the Renaissance; the exponential progress of science and technology on all fronts has a time constant much smaller than the useful span of a human life. For example, the number of pages of publication in science and technology approximately doubles every 11 years. It is therefore of great importance for universities, R&D laboratories and industry to develop individual and collective methods for using effectively this flood of information. For example, system theory is an attempt in the direction of looking at features of several subfields from a unified point of view. This facilitates the learning of these subfields and enhances cross-fertilizations among them."



## IEEE Fellows

### Semiconductors

J. J. Suran

**J. J. Suran, General Electric Co.**—"The impact of solid state devices has virtually revolutionized the electronics field. Coupled with advances in system concepts, the rate of technological change triggered by the development of the transistor is increasing. Integrated solid state circuit production portends a solution to the economic and reliability problems associated with both the commercial and military uses of highly sophisticated and complex equipments. Novel solid-state devices, such as the laser, will continue to introduce new degrees of freedom in the design of communication and data processing systems."

**George Abraham, U.S.N. Research Lab.**—"Major improvements in microelectronics will come with the development of multifunctional devices operating at extremely low power levels and fabricated by bulk and thin film combinations. As fewer functional components are required for system design, improved performance with decreased need for redundancy and adaptive networks is implicit. The development of functional devices requires an interdisciplinary approach among the systems engineer, the device specialist, and the physicist to identify and utilize those properties of matter applicable in designing subelements of future systems."



G. Abraham



M. Shepherd, Jr.

**Mark Shepherd, Jr., Texas Instruments Inc.**—"Discrete semiconductor brought the first major revolution in the electronics industry in 30 years. Now, a further development—semiconductor integrated circuitry—is well under way. Its timing and scope of acceptance is exceeding all expectations of the circuit manufacturing industry. We predict that the device market alone—exclusive of R&D expenditures—will exceed \$150 million annually in five years, and five times that within a decade. Integrated circuits already are capable of 25% of all circuit functions for new equipment designs. By 1968-72 this will increase to 75%. Integrated circuitry also will be less expensive than discrete component circuitry. System reliability already is several times greater. Our studies indicate that this new approach will make it possible to save up to \$1 billion annually within a decade in government electronics expenditures alone."

# WHAT'S NEW

## at the IEEE show ?



### NEW COHERENT DECADE FREQUENCY SYNTHESIZERS... the first two of a series

Dial any signal from . . . dc to 100 kc continuously or in 0.01-cycle crystal-locked steps, with the Type 1161-A Synthesizer.  
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Seven convenient modular decades plus a continuously adjustable unit that permits either stepped or continuous frequency selection. At least 9-figure readability including two significant figures provided by the continuously adjustable decade, which can be self-calibrated to three figures or more. Frequency can be varied by an external dc voltage — can be swept, fm modulated, or phase-locked to other signals. Operates from self-contained crystal standard or from external standards. Up to 2v output into 50 ohms. Fits into only 5¼ inches of rack space.

Price will surprise you — to be announced at the IEEE Show.

### NEW Type 1115-B Standard-Frequency Oscillator . . . \$2,050

#### 5Mc, 1Mc, and 100 kc Outputs

All silicon transistor circuits — rugged, fiberglass-epoxy, etched circuit boards throughout. Built-in battery supply and charger for emergency operation up to 35 hours. Oscillator frequency can be conveniently shifted by external voltage — ideal for use with phase-lock systems. Uses a proportional-control crystal oven. Excellent spectral purity.



### NEW Type 1396-A

#### Tone-Burst Generator . . . \$490

A coherent gate for the simulation of pulsed audio and ultrasonic signals over a dc to 500-kc range with external oscillators. Timing of burst is adjustable up to 128 cycles of input signal for both on and off condition. In addition, off time may be varied from 1 millisecond to 10 seconds.

### NEW

#### Type 1644-A Megohm Bridge . . . \$625

Measures 1000 ohms to 1000 teraohms ( $10^{15}$  ohms) in ten decade ranges. Accuracy is  $\pm 1\%$  to  $10^{13}$  ohms. Has  $\Delta R$  dial for measuring small incremental differences. Built-in null detector and self-checking internal standards. Has seven test voltages from 10v to 1000v — ideal for leakage measurements. Useful for two- or three-terminal, grounded or ungrounded measurements.



### ... PLUS over 16 other recently announced products

**WAVE ANALYZER** 20c to 50kc range . . . 3-, 10-, and 50-cycle bandwidths . . . adapts readily for automatic recording of spectra.

**SOUND AND VIBRATION ANALYZER** A one-third and one-tenth octave-band analyzer operating over a 2.5c to 25kc range.

**MEGOhmmETER** Direct reading to 2,000,000 megohms with 500v test voltage and to 200,000 megohms at 100v.

**SLOTTED-LINE RECORDER SYSTEM** For automatic recording of VSWR from 1.001 to 1.20 over a 300Mc to 9Gc range.

**PRECISION COAXIAL CONNECTOR** A low-VSWR connector — less than 1.002 to 1Gc; 1.01 to 9Gc.

**ELECTRONIC VOLTMETER** A 2%-of-reading instrument useful to 1500Mc.

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**DATA PRINTER** 12-digit-per-line printer capable of printing rates up to 3 lines per second.

**AUDIO OSCILLATOR AND POWER AMPLIFIER** A 20c-to-20kc solid-state oscillator and amplifier with 200-wa output.

**CAPACITANCE BRIDGE** A 0.01% direct-reading bridge with 6-figure resolution.

**REFERENCE STANDARD CAPACITORS** 1000pf and 100pf units adjusted to  $\pm 5$  ppm accuracy.

**DECADE RESISTANCE BOXES** Two new units covering 11,111,000 ohms in 100-ohm steps and 11,111,100 ohms in 10-ohm steps.

... many of the other G-R old reliables will also be on display, so make it a point to see us at Booths 3201-3208.

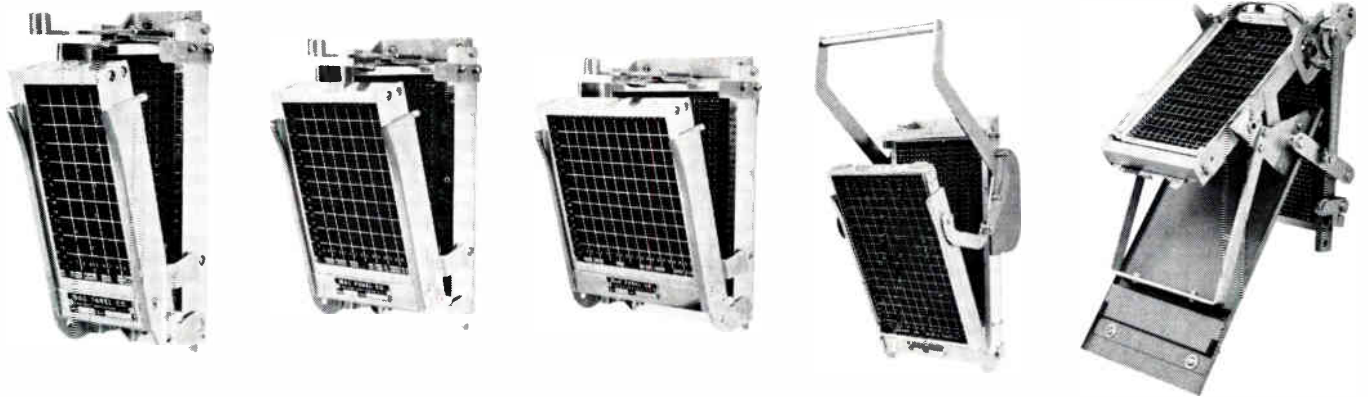
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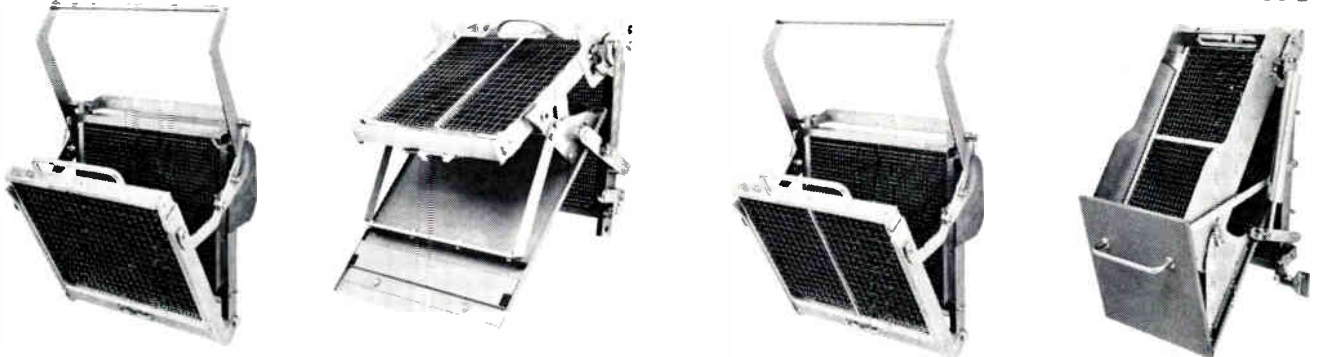
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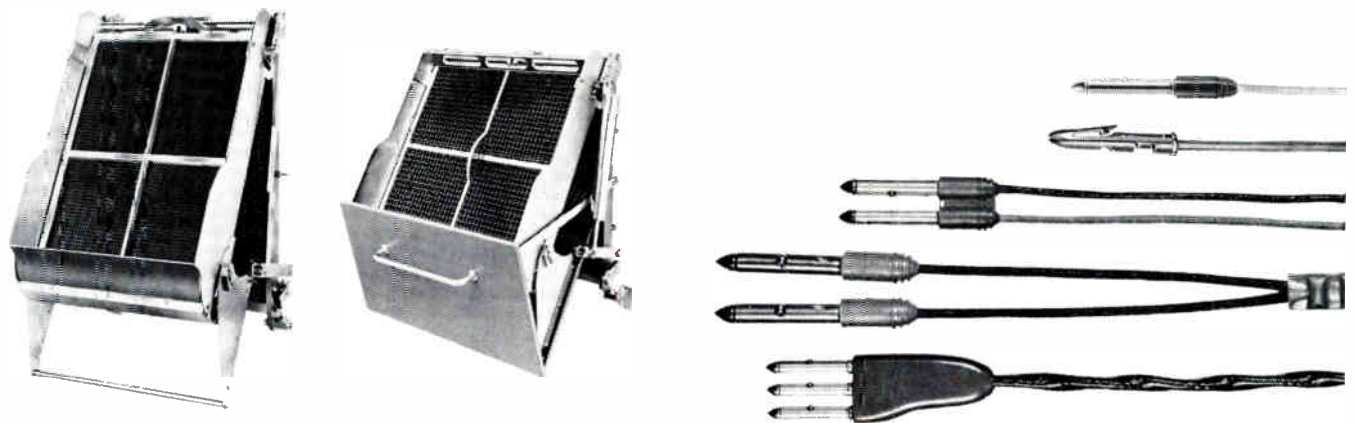
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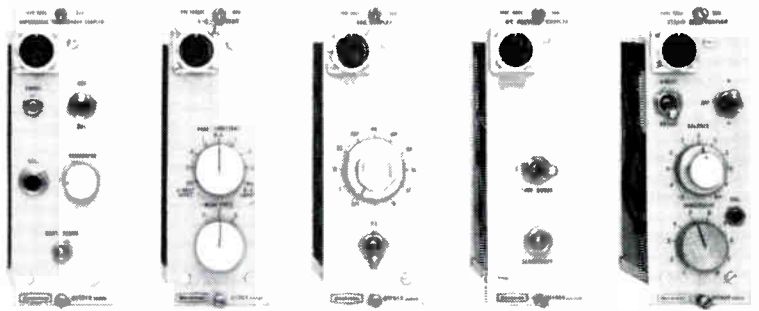
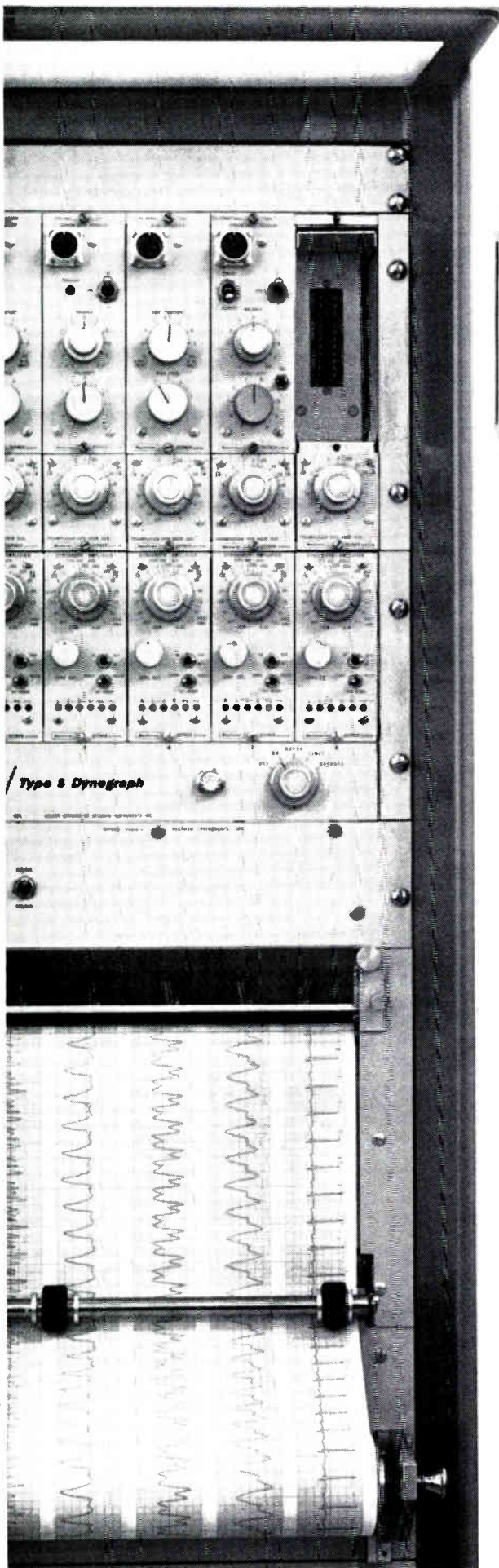
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### why your recorder should be an Offner

Each reason is an Offner Coupler—a small, efficient “conditioner” which takes transducer signals and prepares them for faithful recording on the Offner Dynograph® recorder.

Why couplers? They are the simplest, most efficient, least expensive way to change recording parameters. No special amplifiers or preamplifiers to buy, just slip out one coupler and slip in another.

How many do you need? A half dozen, maybe, no matter how varied your recording needs. The 9803, for instance, is used for strain gages; the 9806A for dc and ac signals, etc. Both couplers cost only \$60.00 each.

But couplers aren't the only reason for selecting an Offner Dynograph recorder. Others are: the superior circuitry you'll find (fully solid-state since 1955); the widest choice of recording methods, including ink rectilinear, ink curvilinear, heat, and electric; and the superb performance which has made Offner Dynograph recorders the perennial choice of the electronically appreciative. For complete data, see your Offner representative or write us.

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OFFNER DIVISION  
SCHILLER PARK, ILLINOIS

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Some ups and downs  
just don't need SOLATRON® regulation..

...but nothing else  
regulates the "ups and downs"  
of voltage fluctuation like  
**THE NEW COMPACT  
SOLATRON®  
VOLTAGE  
REGULATOR\***

As modern electronic equipment becomes more extensive and complex, the need for closely regulated voltage is of increasingly crucial importance. This is especially true in cases involving whole systems, or mixed systems, of electronic apparatus. To operate such systems in the past, it was necessary to settle for piecemeal regulation of individual component-assemblies—using regulators such as Sola's CV transformer. Other available regulators contained moving parts, resulting in slow response and undesirable maintenance.

All of which led Sola to the development of the new compact SOLATRON line-voltage regulator.

What is it? Basically, a highly-engineered adaptation of the standard accessory-type SOLATRON regulator—a smaller, more rugged, more sophisticated regulator *specifically designed for component use*. Operating in the range of .5 kva and up, the compact SOLATRON regulator provides continuous corrective action to any combination of line, load and frequency fluctuations—action that is extremely fast, economical and *precise*, with standard regulation in most instances better than  $\pm 1\%$  of nominal rating.

The SOLATRON regulator is *not* a ferroresonant constant voltage transformer, like the Sola CV. Smaller in size and weight, it features remote sensing and feedback, and adjustability of output voltage. Unlike the CV, the SOLATRON regulator is insensitive to frequency variations.

Correction is 90% complete in 5 cycles or less; 100% in 10 cycles or less! Regulation is maintained over a voltage fluctuation range of  $\pm 10\%$  or  $\pm 20\%$ , depending on the model ordered. Response times of 3 to 5 cycles may be accomplished by using a  $\pm 20\%$  SOLATRON for control of  $\pm 10\%$  voltage fluctuations. Frequency of input can be 60 cycles, 50 cycles, 50/60 cycles or 400 cycles. The range of ratings is from 500 va up.

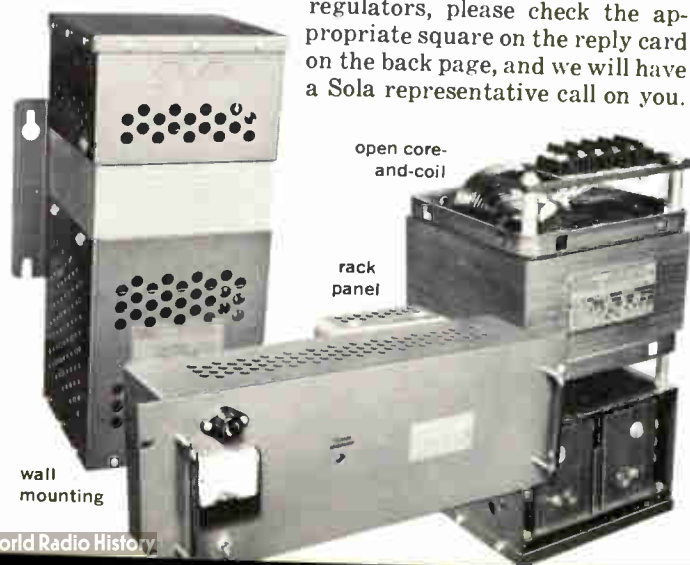
*Because the new, compact SOLATRON regulator features no moving parts, it is maintenance-free.* Control circuitry is all solid state.

The new, compact SOLATRON regulator is available in three configurations:

- exposed core with end housings for wall or external mounting
- rack panel mounting for 19" relay rack
- open core-and-coil for component use

The SOLATRON regulator presented here is a basic regulating unit which can be adapted to a great number of customer requirements. Standard designs are available on an "assemble-to-order" basis, and special configurations to meet your own individual requirements can easily be made from these standard designs.

For further information on SOLATRON voltage regulators, please check the appropriate square on the reply card on the back page, and we will have a Sola representative call on you.



\*patent applied for



## SOLATRON regulators have a way of "fitting in"

SOLATRON regulators are inherently "alterable" — that is, they are designed so that their shape can be altered to fit into various housings, in different applications. For the electronics OEM, this means that SOLATRON regulators give him the right combination of weight, size, shape and *superlative voltage regulation* — all in one package.

Each day the electronics industry finds more and more applications for the new, compact SOLATRON regulator. Just a few current applications: in ground support equipment; as the final regulator for inverters; in countless shipboard applications; in process control equipment; to furnish precise voltage for instrument calibration; and as a preregulator for power supplies, videotape recorders, photographic printer-enlargers (military), and testing equipment.

### SOLATRON FEATURES

1. **Output Regulation:**  $\pm 1\%$  from nominal, for any combination of line, load, and frequency change within specified parameter ( $\pm 10\%$  or  $\pm 20\%$  input voltage range).
2. **Fast Response:** 90% correction in less than 5 cycles; complete correction 10 cycles for 20% line voltage changes and load variations of 0-100%. Response times of 3 to 5 cycles can be achieved by using a  $\pm 20\%$  SOLATRON for control of  $\pm 10\%$  voltage fluctuations.
3. **Frequency Insensitive:** Normal design range for 60 cycle unit is 57-63, 47-53, or 47-63 CPS and 380-420 CPS for 400 cycle unit.
4. **Local or remote sensing** to maintain local or remote voltage constant.
5. **Electronic-magnetic design:** No moving parts, maintenance free.
6. **Low Harmonic Content:** Harmonic content less than 3% total rms.
7. **Ultra Compact:** Smaller and lighter than other standard regulators. The 1 KVA unit for wall mounting measures 6x6x14, weighs 32 pounds.
8. **Complete Flexibility:** May be horizontally or vertically mounted. Large terminal compartment contains heavy duty terminal panel.
9. **"Adjustomatic" Voltage Control:** Output is continuously adjustable to  $\pm 10\%$  of the nominal rating.
10. **98% Efficiency:** at rated load and rated output voltage.

## "CV transformers prolong component life by 200%!"

— Vendtronics, Inc., Cincinnati, Ohio

Vendtronics Incorporated manufactures the only money changer that changes dollar bills as well as half dollars, quarters and dimes. Because it is all-important that their changer be able to withstand short-term overloads and operate efficiently under widely varying voltage conditions, Vendtronics management decided for the Sola CV transformer. How did it work out?

"Perfectly," states Mr. Alan Foster, president of Vendtronics. "Not only did the Sola CVS give us excellent regulation, but I estimate that it increased the component life of our changer by about 200 per cent."

This is what we mean by Sola reliability — performance that consistently goes beyond requirements. And does so not by accident either — but by "design" — the built-in excellence that can come only from sound, imaginative engineering.



## Sola's standard CVDC power supplies save you money...time.

On the back page we have listed Sola's standard CVDC power supplies. It is the longest list of ratings in the industry. For you — the design engineers and electronics components purchasers — this means one thing: *economy*. Time and money saved. Ordering a power supply that has already been designed and produced eliminates the costly process of engineering an entirely new unit. Also, it means that the buyer is getting a design of proven performance — with all the "bugs" engineered out of it. Many of these CVDC power supplies are available right off Sola distributors' shelves; many others are in stock at the Sola factory . . . ready for prompt delivery wherever the power supply is needed.

The Sola CVDC power-supply story is more than just availability, however. It is basically a story of *quality*. CVDC power supplies offer extremely fast, reliable voltage regulation from a relatively simple, low-cost source. And let us stress that, in addition to stocking the widest range of standard CVDC power supplies, Sola maintains its considerable capacity for designing special power supplies — CVDC, saturable-reactor type, and transistorized — to meet the requirements of any customer.

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World Radio History

# Standard CVDC Power Supplies

Line regulation:  $\pm 1\%$  at full load. (All inputs 110-130 v. 60 cycles 1% total rms ripple except where noted.)

Catalog Number	Volts Out	Amps	VA	Load Regulation		Catalog Number	Volts Out	Amps	VA	Load Regulation	
				20% - F.L.	50% - F.L.					20% - F.L.	50% - F.L.
28313	1.5	2	3	0.5	0.3	281797 (100-130, 200-260 v. in. 50 c.)	48	4	192	6	3
281868	4	10	40	9	7	281887 (100-130, 200-260 in.)	48	6	288	5	3
28316	5	4	20	10	8	281561*	48	10	480	4	2
281513-1*	6	10	60	9	7	28186	50	6	300	1.5	1
28317	10	4	40	9	7	28314	60	1	60	6	3
281904	10	12	120	7	5	281214-1	60	1	60	6	3
28318	10	20	200	10	8	281476	62	5	310	10	8
281280	12	3	36	9	7	281232	65	.384	27	5	4
281514-1*	12	5	60	6	5	28315	90	1	90	3	2.5
281845*	12	15	180	7	5	28154	90	3	270	1.5	1
281841	12	20	240	9	7	28155	90	5	450	1.5	1
281915	14	5	70	4	3	281099	100	.4	40	4	2
281934	14	10	140	5	4	28307	100	2	200	2.5	2
281515-1*	18	5	90	5	4	28662	100	7	700	1.5	1
28185	20	1	20	0.7	0.5	281233	115	.5	57.5	2.5	2
281272	20	8	160	3.5	2.5	28140	120	1	120	1	0.7
28319	20	20	400	6	3	28747	120	8	960	3	2
281097	20	22	440	5	7	281125*	125	2	250	2.5	1.5
281201	24	2	48	6	4	28663	125	4	500	5	3.5
281481 (380-520 v. in.)	24	6	144	5	4	281343-1 (50 c.)	125	6	750	6	4
281024-1*	24	6	144	5	4	281537	130	.200	26	3	2
28632 (50 c.)	24	6	144	5	4	28162	130	.5	65	2.5	2
281794 (50 c.)	24	6	144	7	5	281150*	150	2	300	2	1.5
281008-1	24	10	240	5.5	4	281798 (100-130, 200-260 v. in. 50 c.)	150	2	300	3	2
281203*	24	15	360	5	4	28127	150	4	600	1.5	1
281387 (50 c.)	24	15	360	5	4	28660	150	5	750	1.5	1
281949	24	20	480	8	5	281800	160	1	160	1	0.7
281092	24	22	528	8	5	281503	170	3	510	1	0.7
281925	24	25	600	5	4	281200*	200	1	200	3	2
28262	28	2	56	6	3	281799 (100-130, 200-260 v. in. 50 c.)	250	1	250	3	2
281874	28	5	140	7	4	281250*	250	1	250	3	2
28626*	28	8	224	6	4	28721	250	3	750	2.5	2
281820	28	15	420	6.5	5	281875 (414-506 v. in.)	250	6	1500	3	2
28671	28	20	560	6.5	5	281914	300	1	300	3	2
281947	28	25	200	7	5	28816	350	.6	210	1.5	1
281890	28	50	1400	9	7	28171	400	2	800	1.5	1
281905	30	2	60	4	3	28421	450	3	1350	1.5	1
28283	48	2	96	3	2	28352	500	2	1000	1.5	1
281048*	48	4	192	3.5	2.5	28430	600	1	600	1.5	1
281469 (50 c.)	48	4	192	7	5						
281360 (100-130, 200-260 v. in. 50 c.)	48	4	192	6	3						

\*available off-the-shelf at Sola, or from Sola distributors

Please send me:

- SOLATRON bulletin VR-160
- Sola CV transformer catalog CV-150
- CVDC power supply catalog DC-145

Or, to have a Sola sales engineer call for appointment regarding SOLATRON regulators, check here:

NAME \_\_\_\_\_

TITLE OR POSITION \_\_\_\_\_

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

## With Sola distributors "off-the-shelf" availability is the rule!

Throughout the US, electronics distributors generally carry two major Sola product lines: CV transformers and CVDC power supplies. These distributors naturally do not stock every number in these Sola lines; however, they do try to keep in stock those units in greatest demand, especially in the small-order category.

For our customers across the country, this off-the-shelf availability of Sola products at the distributor level *always* means a savings in time over factory purchases. And frequently, where shipping costs are a factor, buying from the distributor means a cost savings as well. Just as important, the customer will find Sola distributors have the background and product knowledge to help him fill his requirements out of stock. So consult your electronics distributor, or ask the Sola office nearest you for the name of the Sola distributor in your vicinity.

# NEW PRODUCTS

At I.E.E.E.

## RESETTABLE EVENTS COUNTER

This electromagnetic unit resets by pressing the reset button. To indicate an event, 23 to 29vdc is applied to the 2 terminals. Pulse duration 0.075 sec. A.W. Haydon Co. Booths 1405-07.

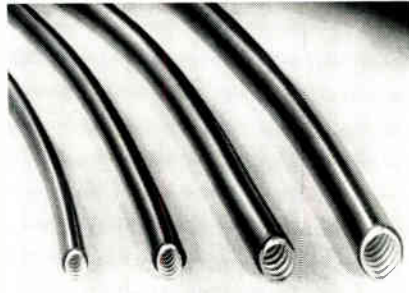
Circle 218 on Inquiry Card



## ELLIPTICAL WAVEGUIDE

These waveguides are pressure-tight and feature performance comparable to rigid rectangular systems. Freq. is 4.4 and 8.6gc. They are covered with polyethylene. Andrew Corp. Booths 1502-04.

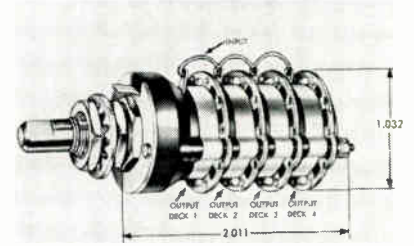
Circle 221 on Inquiry Card



## CODED SWITCHES

No. 42 provides decimal conversion to special computer codes. Rated to make and break 1a., 115vac resistive load, or carry 10a. continuously. Normal life is 100K cycles. Grayhill Inc. Booth 2302.

Circle 224 on Inquiry Card



## SOLID-STATE CHOPPER

Type 7030 may be driven from dc to 5kc with isolation between signal and drive circuits. No drive transformer or external isolating circuitry is needed. Airpax Electronics. Booth 2306.

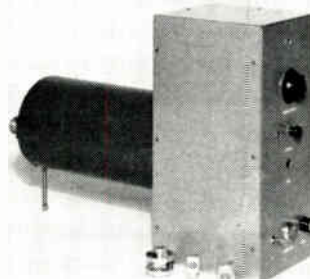
Circle 219 on Inquiry Card



## LASER Q-SWITCH

The Model 3346 is used with solid-state lasers. Has a 0-20,000 rpm continuously-variable rotor speed. Pulse height is -10v. at less than 50Ω impedance. Energy Systems, Inc. Booth 3303.

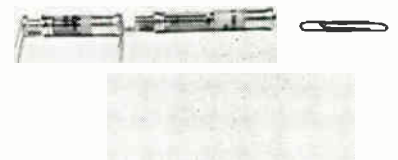
Circle 222 on Inquiry Card



## CAPACITOR

The N-series precision piston trimmer offer the Hi-Life drive mechanism for a longer adjustment life (over 600% greater than required by Mil-C-14409B). JFD Electronics Corp. Booth 1515.

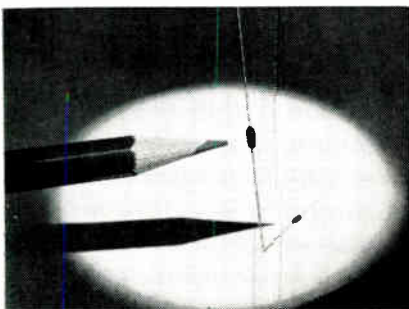
Circle 225 on Inquiry Card



## PRECISION RESISTOR

The 1/20w. WLC 50 precision, metal-film resistor has end cap construction and exceeds Mil-R-10509E. Resistance from 30.1 to 100KΩ. Ward Leonard Electric Co. Booth 2231.

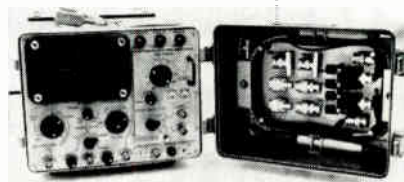
Circle 220 on Inquiry Card



## OSCILLOSCOPE

Model 725 has sq.-wave voltages of 40 and 400mw, and a rise time less than 1.5μsec. Display allows a 4μsec. pulse at a rate of 10pps. American Electronic Labs, Inc. Booth 1105.

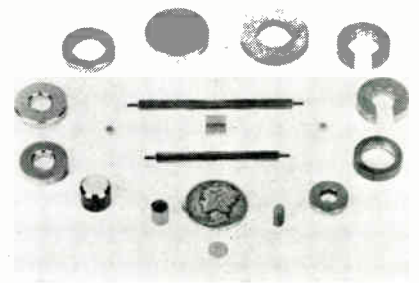
Circle 223 on Inquiry Card



## PERMANENT MAGNET

Placovar® is a platinum-cobalt alloy that is ductile and can be fabricated into strip, rod, and wire. Coercive force is over 4000 Oersteds. Hamilton Watch Co. Booth 2128.

Circle 226 on Inquiry Card



# 6 MORE NEW LAMPS

SCR GATING, RELAY LOGIC CIRCUITRY	SWITCHING, MEMORY CIRCUITS	LOW VOLTAGE USE, TRANSISTOR INDICATOR LIGHTS
<b>LAMP #A057 B</b> Breakdown voltage .... 90 V.D.C. Max. in Total Darkness Design current Avg. .... 10 MA. Peak .... 80 MA. Maintaining voltage .... 65 V.D.C. Max.	<b>LAMP #T2-27-1W760</b> Breakdown voltage .... 170-200 V.D.C. in Light Design current ..... 6 MA. Maintaining voltage ..... 60-70 V.D.C.	<b>LAMP #A079</b> Breakdown voltage .... 70 V.D.C. Max. in Light Design current ..... 0.3 MA. Maintaining voltage .... 58 V.D.C. Max.
VOLTAGE REFERENCES, X-Y MATRICES	PHOTO-CHOPPERS, PHOTO-CELL DRIVERS	TIMING CIRCUITS, RELAXATION OSCILLATORS
<b>LAMP #A059 SERIES</b> Breakdown voltage ..... 65-75 V.D.C. in Light Design current ..... 0.3 MA. Maintaining voltage .... (Available to within one volt from the range of 52 V.D.C. to 60 V.D.C.)	<b>LAMP #A074</b> Breakdown voltage .... 85 V.D.C. Max. in Total Darkness Design current ..... 0.3 MA. Maintaining voltage ..... 50-60 V.D.C. *See Schematic Below	<b>LAMP #A078</b> Breakdown voltage ..... 66-74 V.D.C. in Light Design current ..... 0.3 MA. Maintaining voltage ..... 50-60 V.D.C. Leakage resistance ..... 10,000 Megohms Min.

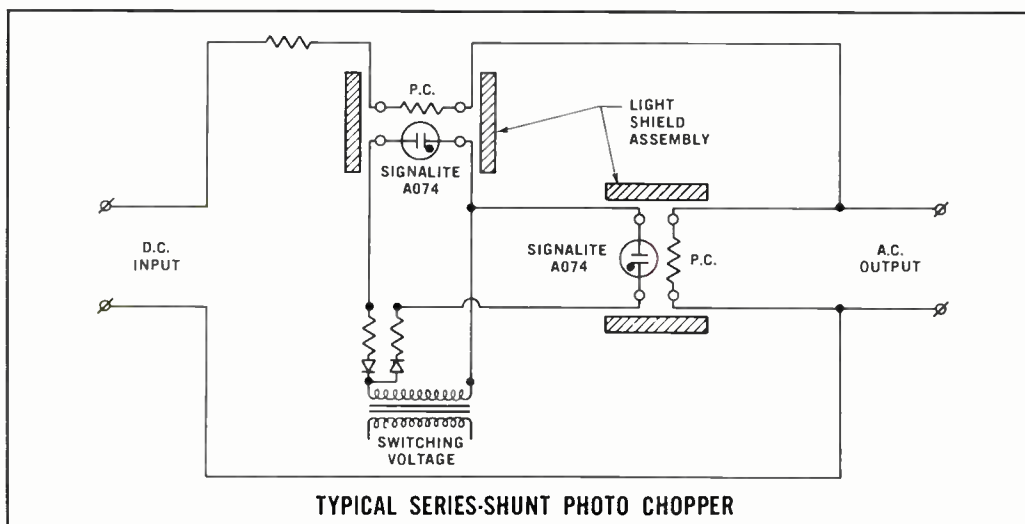


APPROXIMATE  
SIZE



APPROXIMATE  
SIZE

## PROVEN IN SOLID STATE CIRCUITS



## TO REDUCE COSTS AND INCREASE RELIABILITY

The circuit technique above was created to improve performance and reliability while eliminating mechanical relays — it is completely discussed in Vol. 2 No. 2 of Signalite Application News . . . available on request. This example illustrates but one of the many innovations which designers have developed with the six new Signalite glow lamps.

Signalite has been serving designers with the highest quality glow lamps for over 20 years and is today the single source for all glow lamps. Write today on your company's letterhead describing your particular application. If there is a glow lamp to meet your needs — we'll have it — if there isn't, we can design it.

THE single source  
for all glow lamps

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 NEPTUNE, NEW JERSEY  
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 TWX-775-2255 • Dept. "J"

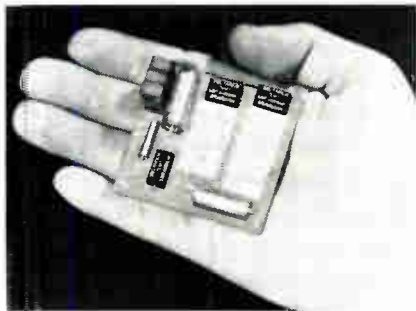
# NEW PRODUCTS

At I.E.E.E.

## MICROMINIATURE CAPACITORS

The Dearborn "LM7" line is a 0.018-mfd, 200vdc unit. Available in axial or radial leads. Temp. range is  $-55^{\circ}$  to  $125^{\circ}$ C. Dearborn Electronic Labs. Booth 2933.

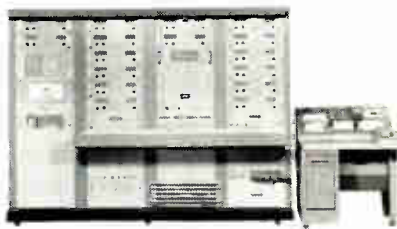
Circle 227 on Inquiry Card



## INTEGRATED CIRCUIT TESTER

Model 2500 performs data logging or GO, NO-GO tests on integrated-circuit and micromodule parameters. Accuracy is  $\pm 1/2\%$  of reading. Speed is 200 ms/test. Optimized Devices, Inc. Booth 3120.

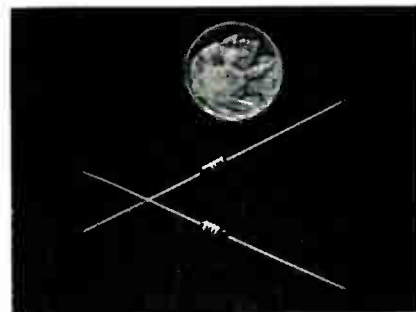
Circle 230 on Inquiry Card



## COMPUTER DIODE

The FD 700 can be used in ultra high-speed logic circuits. It has low capacitance, psec recovery times, and controlled forward conductance. Fairchild Semiconductor. Booths 2701-07.

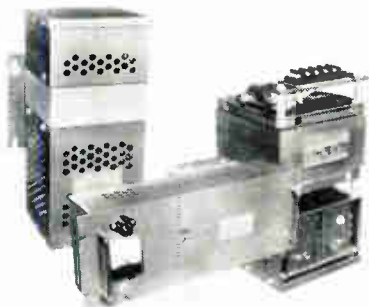
Circle 233 on Inquiry Card



## LINE VOLTAGE REGULATOR

The component-type Solatron regulator is available in 3 basic configurations. Standard units range from 0.5 to 2kva; additional ratings can be provided. Sola Electric Co. Booths 2311-15.

Circle 228 on Inquiry Card



## R-F FLUID SEALS

This gasketing material consists of a highly conductive plastic reinforced with a 30-mesh aluminum screen. High attenuations are obtained. They shield AN connectors. Chomerics, Inc. Booth 4025.

Circle 231 on Inquiry Card



## DIGITAL INSTRUMENTS

Series 990 provide the choice of freq. and dc voltage measurements in 1 instrument. Measurement ranges from 0 to 750vdc and 2 cps to 1mc. Electro Instruments, Inc. Booths 3803-05.

Circle 234 on Inquiry Card



## CATHODE-RAY TUBE

The D13-26 5 in. mesh tube is usable over 10mc with a sensitivity of 2.5v./cm. Post acceleration is 15kv. Envelope is 18.4 in. Amperex Electronics Corp. Booths 2522-26.

Circle 229 on Inquiry Card



## PRINTED-CIRCUIT CONNECTOR

This connector is for edge-type applications. An accordian spring provides constant pressure through repeated insertions and withdrawals. Burndy Corp. Booths 1733-37.

Circle 232 on Inquiry Card



## FAST-CHARGING BATTERIES

This nickel-cadmium space cell has a double-diode system, a fast charging and deep-discharging development. Recharges at fast rate. Allows more working capacity. Sonotone Corp. Booth 1902.

Circle 235 on Inquiry Card



now — it'll work

No more checking needed — that "last" glance is for satisfaction. A 125V PNP complement did the trick — it eliminated one stage . . . reduced the size and power just enough.

	TO-46 Case	MAXIMUM VOLTAGES			I <sub>CEO</sub> Max. @ 25°C (μA)	h <sub>FE</sub>		V <sub>CE(SAT)</sub>		f <sub>T</sub> (MC)		TO-46 Case	MAXIMUM VOLTAGES			I <sub>CEO</sub> Max. @ 25°C (μA)	h <sub>FE</sub>		V <sub>CE(SAT)</sub>		f <sub>T</sub> (MC)
		BV <sub>CEO</sub> (Volts)	BV <sub>CEO</sub> (Volts)	BV <sub>EB</sub> (Volts)		Min.	Max.	@ I <sub>C</sub> (mA)	Max. (Volts)				Typ. (MC)	BV <sub>CEO</sub> (Volts)	BV <sub>CEO</sub> (Volts)		BV <sub>EB</sub> (Volts)	Min.	Max.	@ I <sub>C</sub> (mA)	
NPN	2N2518	125	80	8	005	40	100	5	0.5	175	NPN	2N2460	100	60	8	002	70	130	5	0.3	200
PNP	2N2599	-125	-80	-7	-025	40	100	-5	-0.5	90	PNP	2N2591	-100	-60	-7	-025	70	135	-5	-0.4	100
NPN	2N2519	125	80	8	005	80	200	5	0.5	200	NPN	2N2461	100	60	8	002	120	180	5	0.2	225
PNP	2N2600	-125	-80	-7	-025	80	200	-5	-0.5	120	PNP	2N2592	-100	-60	-7	-025	115	200	-5	-0.4	125
NPN	2N2459	160	60	8	002	40	80	5	0.3	175	NPN	2N2462	100	60	8	002	170	230	5	0.3	250
PNP	2N2590	-100	-60	-7	-025	40	80	-5	-0.4	75	PNP	2N2593	-100	-60	-7	-025	160	275	-5	-0.4	150

**Thorough evaluation leads to a good decision.** Many problems involving high voltage complementary transistors can be answered with the type numbers listed above — they represent the industry's largest high voltage line of complementary planar transistors. In fact, Sperry Semiconductor produces the industry's first full line of PNP/NPN Complementary Silicon Planar Transistors. Notice the close matching characteristics — we make them that way (not just pick a PNP that is close to an NPN). This is another example of Sperry's leadership of PNP low level silicon planar transistors. Our record of reliability is important — it validates our credentials for the future. Question them, inspect them, use them — they can help on your military projects and in your industrial control work. Whether you need volume production or personal attention in custom engineering — contact Sperry Semiconductor. □ Eastern Regional Office: 69 Hickory Drive, Waltham, Massachusetts; Midwest Regional Office: 3555 West Peterson Avenue, Chicago 45, Illinois; Western Regional Office: 1680 North Vine Street, Hollywood 28, Calif. Sales Representatives: Orbit Electronics, 250 Carroll Street, Fort Worth, Texas; Perrott Associates, Incorporated, 2321 East South Street, Orlando, Fla. □ Keep in touch — with **SPERRY SEMICONDUCTOR**, Norwalk, Connecticut.



DIVISION OF SPERRY RAND CORPORATION

SEE US AT IEE — BOOTH #1712-14  
Circle 38 on Inquiry Card

# NEW PRODUCTS

At I.E.E.E.

## NOISE FIGURE METER

Model 792-A has a continuously variable i-f input. It tunes from 10 to 120Mc and has 10 to 900Mc hot-wire source for  $\pm 5$ db overall accuracy. Kay Electric Co. Booths 3512-3518.

Circle 236 on Inquiry Card



## NICKEL CIRCUITRY WAFERS

These chemically-clean, weldable wafers are for miniature cordwood modules. They are mounted on a glass-epoxy substrate. Sanders Associates, Inc. Booths 2535-36.

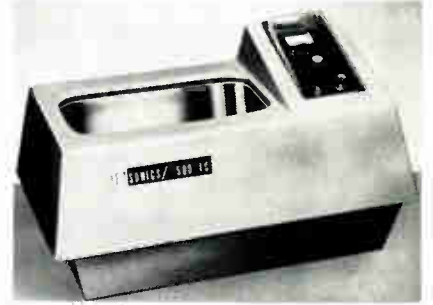
Circle 239 on Inquiry Card



## ULTRASONIC CLEANERS

Model 500-1C cleans small electrical parts, instruments, ball bearings. It operates at 40kc. Weight of the laboratory unit is 40 lbs. Jetsonic Industries Inc. Booth 1922.

Circle 242 on Inquiry Card



## NYLON BUSHING

Richlok is made in 2 dissimilar halves joined on 1 side by an integral nylon hinge. When installed, the 2 halves are forced together on the lead wire. Richco Plastic Co. Booth 4023.

Circle 237 on Inquiry Card



## MICROWAVE ABSORBER

Space Net is a resonant absorber. It performs at any freq. from very low to 1gc. Reflected energy below 1% from that of incident at resonance. B.F. Goodrich. Booth 3041.

Circle 240 on Inquiry Card



## SCR

Series 72RC-A diffused alloy SCR operates from 25 to 800v. Provides bulk avalanche characteristics in both directions. Capable of 70 amps. International Rectifier Corp. Booths 2633-37.

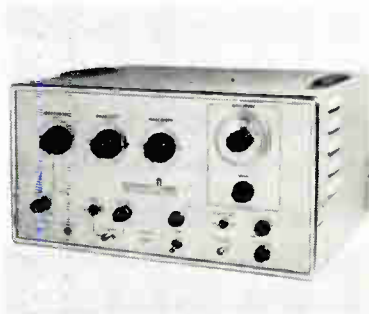
Circle 243 on Inquiry Card



## PULSE GENERATOR

Model 108 has a pulse output of 50v. into 50 $\Omega$  at 10Mc, and less than 2% overshoot at 7nsec. rise time. Variable rise time from 7nsec. to 0.05 $\mu$ sec. Data-pulse Inc. Booths 3108-11.

Circle 238 on Inquiry Card



## SOLID-STATE COUNTER

Model 40-89 has 8-digit in-line display storage readout, automatic decimal, and units positioning. It has BCD printer output. Input impedance, 1 meg. Northeastern Engineering, Inc. Booth 3807.

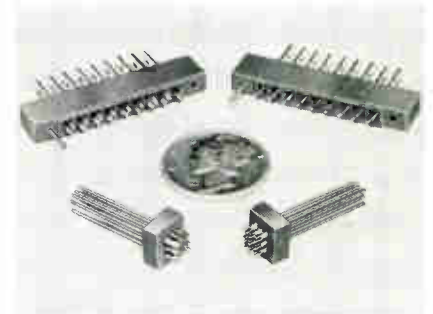
Circle 241 on Inquiry Card



## ULTRA-MINIATURE CONNECTOR

The BI/CON<sup>®</sup> concept allows substrating of units previously integrated or unitized. For magnetic-core memory stacks with no stack assembly. Elco Corp. Booths 1420-1422.

Circle 244 on Inquiry Card





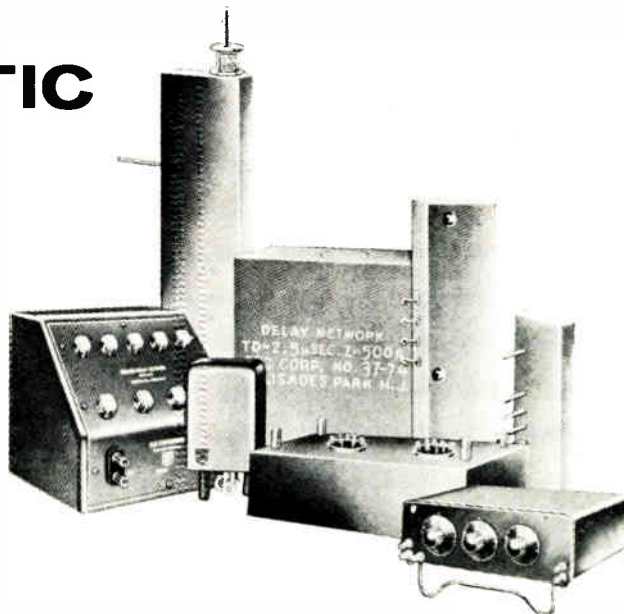
# ESC

## ELECTRONICS CORPORATION

# ELECTROMAGNETIC DELAY LINES AND FILTERS

Designed to your electrical, mechanical and environmental specifications. ESC is staffed and equipped to supply a single part to your sketch or high volume production to formal specifications.

ESC, the Leading Supplier of Custom-Designed Electromagnetic Networks maintains its position in the industry by offering the services of the largest staff of design specialists in the field; continuous evaluation of new components, materials and packaging techniques; approved quality control procedures to MIL-Q-9858B; complete laboratory reports with every prototype; units that meet specifications and reliability requirements; and sales representatives throughout the U.S.A., Canada, and Europe.



Available off the shelf, you can select from our catalog fixed and variable lines with delays from nanoseconds to milliseconds, impedances from 50 to 2000 ohms, and delay-to-rise time ratios up to 50. Some of these items are shown below.

### LUMPED CONSTANT DELAY LINES

**Standard LC Series** — Delay time/rise time ratios from 10 to 30 for delays of 0.25  $\mu$ sec to 50  $\mu$ sec.

**Millisecond Series** — Long delay, low attenuation characteristics with delay time/rise time ratios from 20 to 50 for delays of 10  $\mu$ sec to 5 millise.

(Custom-built Lumped Constant Delay Lines available with delay time/rise time ratios as high as 170/1.)

### DIRECT READOUT VARIABLE DECADE DELAY LINE

- Model 101 — a total delay of 9.99  $\mu$ sec
  - Model 102 — a total delay of 99.9  $\mu$ sec
  - Model 103 — a total delay of 999  $\mu$ sec
- Resolution:  $\frac{1}{1000}$  of total delay  
Delay/Rise: 33:1  
Impedance: 1,000  $\Omega$

### CONTINUOUSLY VARIABLE DELAY LINES (6 $\frac{1}{32}$ " x 5 $\frac{1}{8}$ " x 1 $\frac{1}{4}$ " )

No.	Delay (Max.)	Rise Time (Max.)	Impedance (Ohms)
401	.10 $\mu$ sec	.025 $\mu$ sec	100
402	.20 $\mu$ sec	.030 $\mu$ sec	200
403	.70 $\mu$ sec	.090 $\mu$ sec	500
404	.50 $\mu$ sec	.055 $\mu$ sec	750
405	.40 $\mu$ sec	.040 $\mu$ sec	1000
406	.25 $\mu$ sec	.030 $\mu$ sec	1300
407	.20 $\mu$ sec	.030 $\mu$ sec	1500

### DISTRIBUTED CONSTANT DELAY LINES

Cylindrical or rectangular shapes for printed board mounting. Delays varying from 0.02  $\mu$ sec to 1.2  $\mu$ sec covering impedance ranges from 100 ohms to 1,800 ohms, exhibiting excellent pulse characteristics, at low cost.

### MINIATURE VARIABLE DELAY NETWORKS (4 $\frac{1}{2}$ " x 1 $\frac{1}{2}$ " x 1 $\frac{1}{2}$ " )

Model No.	Time Delay	Impedance	Pulse Rise Time
701	0.125 $\mu$ sec	1500 ohms	0.03 $\mu$ sec (max.)
702	0.25 $\mu$ sec	1800 ohms	0.06 $\mu$ sec (max.)
703	0.50 $\mu$ sec	1000 ohms	0.10 $\mu$ sec (max.)
704	0.75 $\mu$ sec	680 ohms	0.15 $\mu$ sec (max.)
705	1.0 $\mu$ sec	560 ohms	0.20 $\mu$ sec (max.)
706	1.25 $\mu$ sec	470 ohms	0.25 $\mu$ sec (max.)
707	1.50 $\mu$ sec	390 ohms	0.30 $\mu$ sec (max.)
708	0.65 $\mu$ sec	93 ohms	0.10 $\mu$ sec (max.)

Pulse Attenuation—1.0 db (max.) all units DC Working Volts—500 volts (max.)

### MINIATURE TRIMMER DELAY LINE "TRIMLINE"™

Model	Delay* (nsec)	Char. Impedance (ohms)	Approximate TD/TR Ratio	Size (inches)	Approx. # of Revolutions
801	50	200	4:1	2.25 x 1.800 x .35	6
802	75	1000	4:1	2.25 x 1.800 x .35	6
803	100	200	7:1	4.00 x 3.500 x .35	12
804	125	500	4:1	2.25 x 1.800 x .35	6
805	150	1000	7:1	4.00 x 3.500 x .35	12
806	250	500	7:1	4.00 x 3.500 x .35	12
807	10	100	4:1	2.25 x 1.800 x .35	6
808	20	100	7:1	4.00 x 3.500 x .35	12

\*Min. delay at max. position



# ESC

## ELECTRONICS CORP.

534 BERGEN BOULEVARD  
PALISADES PARK, NEW JERSEY • WINDSOR 7-0400



For the complete catalog call your local representative or drop us a card.

SEE US AT BOOTH #2601 IEEE SHOW



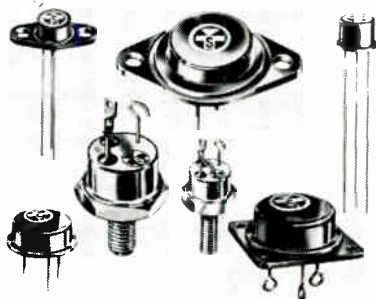
# NEW PRODUCTS

At I.E.E.E.

## POWER TRANSISTORS

These silicon-power transistors are in TO-3 package. Current, 7.5 to 20a. Power, 45 to 200w., and breakdown voltage, 60 to 160v. Silicon Transistor Corp. Booth 1328.

Circle 245 on Inquiry Card



## PANEL METER

Model .5-E can be stacked without interaction. Ranges from 50 dc  $\mu$ a to la., 10mv dc to 300v., 10vac to 300v. It has a core-magnet movement. Triplett Electrical Instrument. Booth 2428.

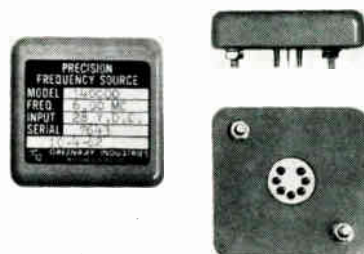
Circle 248 on Inquiry Card



## CRYSTAL OSCILLATORS

Model 140000 has an output of 1v. rms min. into 1K $\Omega$  load. Freq. stability: 3kc to 900kc,  $\pm$ 0.015%; 900.1kc to 150mc,  $\pm$ 0.005%; input: 28vdc,  $\pm$ 10%. Greenray Industries Inc. Booth 2917.

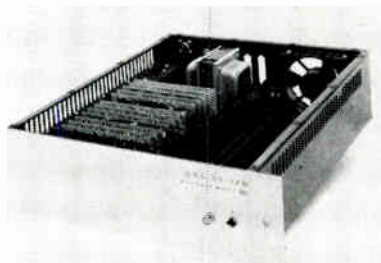
Circle 251 on Inquiry Card



## D-A CONVERTERS

DAC20 are circuit cards that fit 19 in. chassis assemblies. Models available: 10 channels of 10-bit converters; 9 channels of 12-bit converters, or 8 channels of 14-bit converters. Packard Bell. Booth 3308.

Circle 246 on Inquiry Card



## FREQUENCY SYNTHESIZERS

Type 1162-A combines the advantages of step and continuous adjustment. Output voltage is adjustable up to 2v. into 50 $\Omega$ . Freq. to 1Mc. General Radio Co. Booths 3201-08.

Circle 249 on Inquiry Card



## MICROCIRCUIT KITS

Two evaluation microcircuits allow designers to test circuit under actual operating conditions. Each 12-resistor microcircuit is on a wafer 7/16 x 11/16 in. Corning Glass Works. Booths 2326-2332.

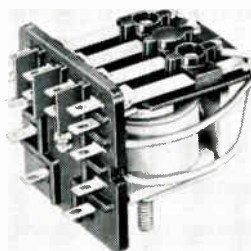
Circle 252 on Inquiry Card



## RELAY

The GPR is a 4 PDT unit available in contact ratings of 5a. and 10a. Stock coil voltages range to 230vac 110vdc. Ohmite Mfg. Co. Booths 2627-31.

Circle 247 on Inquiry Card



## DECADE OSCILLATOR

Model K-126-A oscillator features h-f accuracy, low-harmonic content, and high stability. Freq. range: 1cps to 222.2kc. Muirhead Instruments, Inc. Booth 3230.

Circle 250 on Inquiry Card

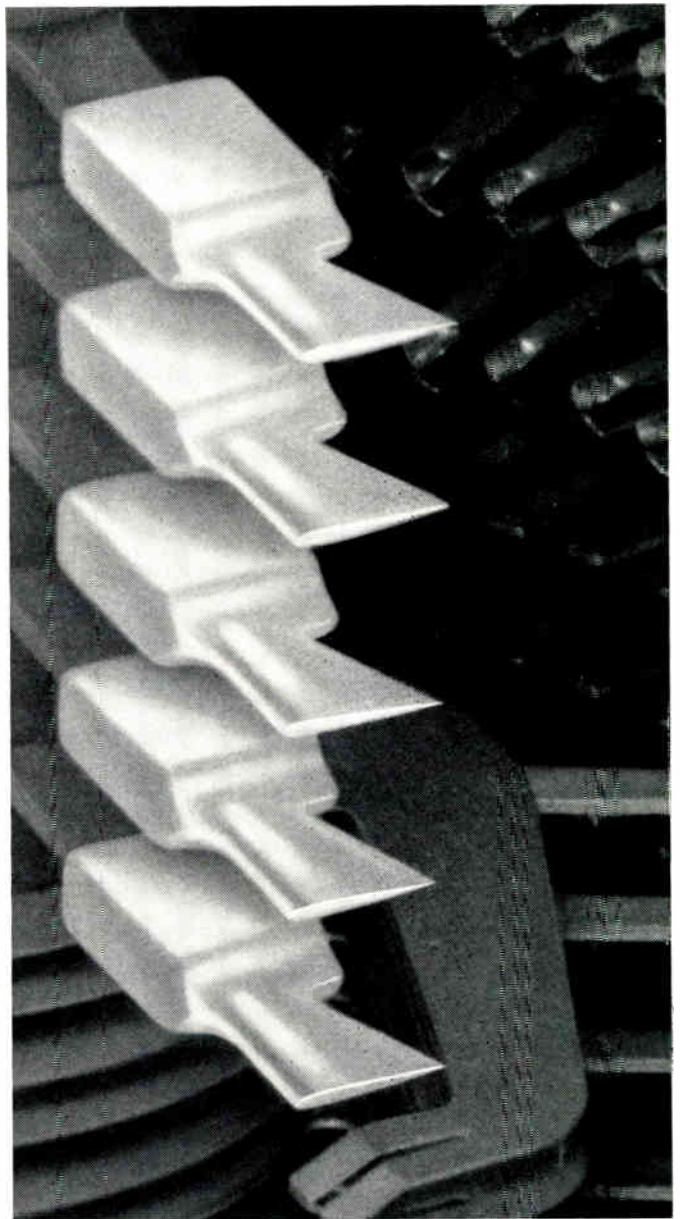
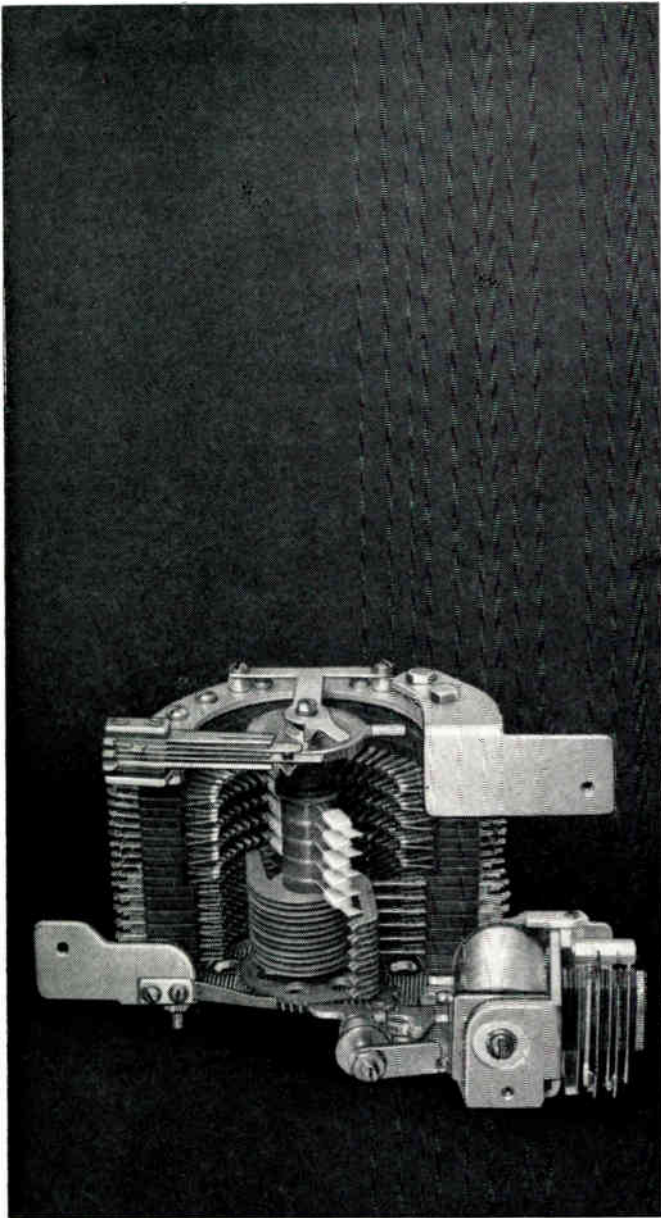


## AUTOCOLLIMATOR

The Mineac is for automatic position measurement. Resolution is better than 0.05 arc-sec. Contains photoelectric autocollimator. Barnes. Booths 3226-28.

Circle 253 on Inquiry Card





## so, what's new?

This is AE's new Type 45NC Rotary Stepping Switch. Each bank is made up of two standard levels tensioned together so that each set of bank contacts forms a closed circuit. The wiper assembly, tipped with a molded Delrin insulator, opens the contacts one at a time as it rotates. Normally open and normally closed banks may be specified on the same switch. ■ Contacts are gold-plated phosphor

## normally closed contacts, that's what

bronze, providing contact resistances of only 10 to 20 milliohms measured at 6 volts, 100 milliamperes. ■ The 45NC is ideal for self-interrupted hunting or testing circuits. In either case, no auxiliary relays are needed to initiate operation. For full information, ask for our "Product News: 45NC." Write Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

# ***AUTOMATIC ELECTRIC***

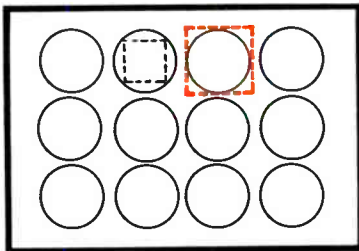
Subsidiary of

***GENERAL TELEPHONE & ELECTRONICS***



# WHY A SQUARE THAT'S OUT IS "IN"

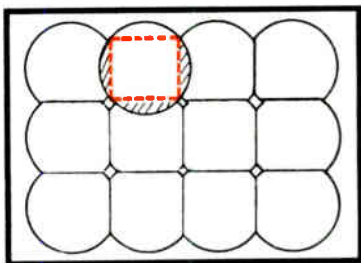
HOW IEE SQUARED THE CIRCLE TO GET 4-TIMES BRIGHTNESS FROM A REAR-PROJECTION READOUT



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

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

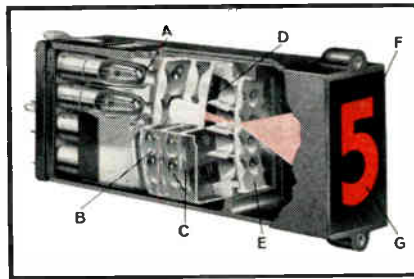
Next, we made the individual lenses larger to encircle the larger square. Now we had an overlap problem. This we solved by squaring the circles to leave off the unused portions, shown below. It's a bit unconventional, or so our lens-maker tells us. The results, however, are most rewarding.



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

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

## CUT-AWAY SHOWS HOW NEW SERIES 10 READOUT OPERATES:



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

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

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

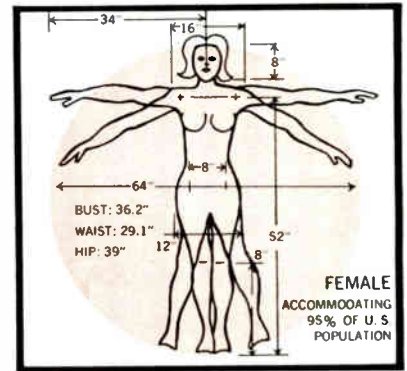
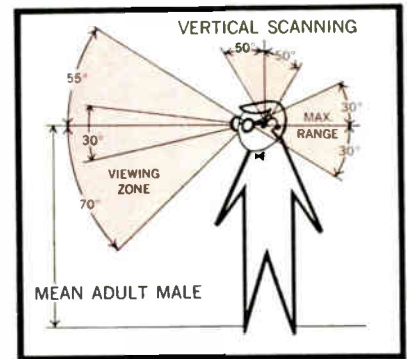
For visual translations, EAI relies on IEE. That's why so many EAI digital instruments are equipped with our rear-projection readouts. Where else can you get such an impressive array of important advantages? Visual clarity, wide-angle readability, single-plane display for crispness (instead of visual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

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



EAI SERIES 5620  
REMOTE  
VISUAL DISPLAY

EAI SERIES 5100  
DIGITAL  
VOLT-OHMMETER



## HUMAN FACTORS:

The scanning male & standing female

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

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

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

This little box isn't quite 2 1/2" x 2" yet it replaces 12 indicator lights! With it, you can display the status of just about anything with just about any combination of colors, symbols, numbers, letters, words; up to 12 individual messages all in a single plane and for as low as 80¢ per indication. If you're interested, it's called "Status Indicator"® and we supply it ready-to-use with message configurations custom-designed to your requirements.



© 1963 IEE

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

## INDUSTRIAL ELECTRONIC ENGINEERS, INC.

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

Representatives in Principal Cities



## ***Stoddart attenuator stability begins with temperature-cycling!***

There's a unique procedure behind the unmatched stability of Stoddart's attenuators, and temperature-cycling is just one phase. We platinum-coat, fire, and anneal each tube and disc resistor at 400°F. for an hour. Then we carefully calibrate, varnish, and bake the resistors at the same temperature for another hour. Temperature-cycling and subsequent shelf-aging for at least 30 days give final assurance of true stability.

This every-aspect approach to aging means you get attenuators which are

accurate up to 10 Gc and reliable (guaranteed to remain within published specifications indefinitely in normal use). Stoddart attenuators are available immediately in pads with 1-watt rating; turrets of 2, 6, 10, and 12 positions; and RF step attenuators in 2- and 3-turret models. Calibrations as high as 0.02 db per 10 db up to 1 Gc are available for attenuations through 60 db. Contact Component Sales, Stoddart Aircraft Radio, 6644 Santa Monica Blvd., Hollywood 38, California. A subsidiary of Tamar Electronics, Inc.

**STODDART**



VISIT STODDART AT THE IEEE  
Booths 3054 and 3055

**ANOTHER SPECIALIZED CAPABILITY OF TAMAR ELECTRONICS, INC.**

Circle 41 on Inquiry Card

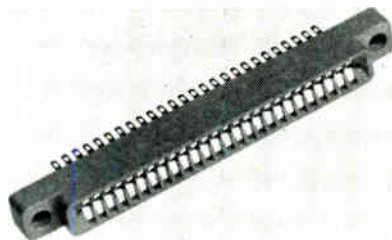
# NEW PRODUCTS

At I.E.E.E.

## PC CONNECTOR

Type 600-121-26 is a 26-dual contact connector. Allows off-tolerance board sizes. Current rating is 3a continuous. Continental Connector Corp. Booths 2307-2309.

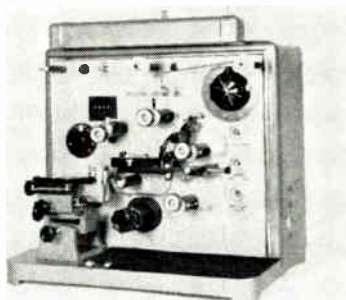
Circle 254 on Inquiry Card



## TOROID WINDER

The D-7 winds heavy wires on small cores, thus eliminating hand wiring. Finished core size range from 0.055 to 2 1/2 in. OD, 2 in. high. Wire sizes range from 20 to 50 AWG. Electro Devices Inc. Booth 4104.

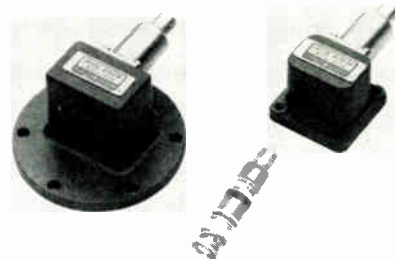
Circle 257 on Inquiry Card



## CRYSTAL DETECTORS

With Model 424A response is flat within  $\pm 2$ db from 2.6 to 10gc,  $\pm 0.3$ db from 8.2 to 12.4gc. SWR is under 1.35 through X-band. Output impedance not above 15K $\Omega$ . Hewlett-Packard Co. Booths 3402-3414.

Circle 260 on Inquiry Card



## STRIPPING/SOLDERING

This control console for wire stripping and soldering contains 3 panels: 1 for thermal wire stripping, 1 for resistance soldering, and 1 for conduction soldering. American Electrical Heater Co. Booth 4033.

Circle 255 on Inquiry Card



## FAULT-CHECKING SYSTEM

The JACS-31 reports and pin-points failures in microwave systems. Alarm is sent over an unused portion of microwave band. For local or remote locations. Jerrold Electronics Corp. Booths 3904-14.

Circle 258 on Inquiry Card



## POWER SUPPLIES

Series HTA consist of 120 different supplies with voltages from 6-32v, and currents from 0.5 to 4a. Regulations are  $\pm 0.5\%$  or  $\pm 0.05\%$ . Consolidated Avionics Corp. Booth 1324.

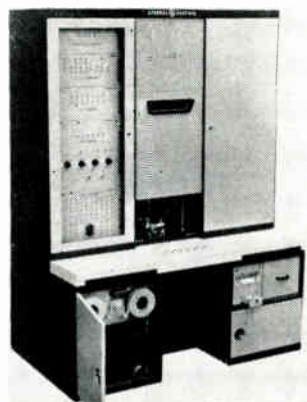
Circle 261 on Inquiry Card



## PC TEST SYSTEM

This system analyzes the components on printed-circuit boards. It evaluates individual components at rates up to 2/sec. General Electric Co. Booths 2928-30.

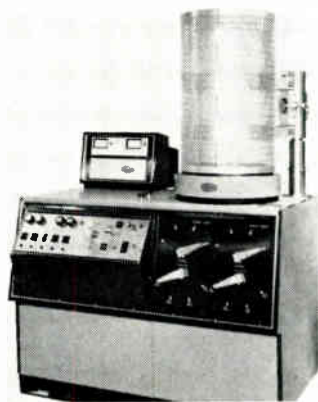
Circle 256 on Inquiry Card



## EVAPORATOR

The VE-775 is a high-vacuum station. It achieves an ultimate vacuum less than  $10 \times 10^{-7}$  Torr in the bell jar. It has 400 liter/sec. pump speed at baseplate port. Vacuum-Electronics Corp. Booth 3508.

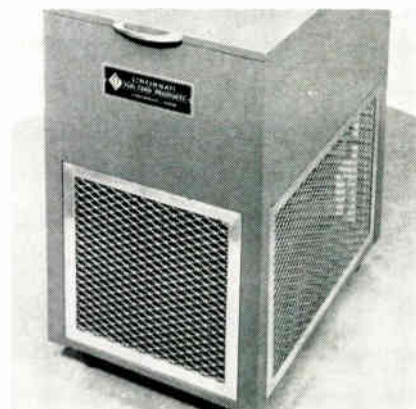
Circle 259 on Inquiry Card



## LOW-TEMPERATURE CHAMBER

Tempo-Trol produces 70° to -100° F. A 400 BTU/hr. cools approx. 10 lbs. of metal/hr. For small electrical components or mechanical parts. Cincinnati Sub-Zero Products, Inc. Booth 3052.

Circle 262 on Inquiry Card



# NEW

## REEVES SIZE 11

### RESOLVER-BOOSTER COMBINATION

▶ **0.1%** FUNCTIONAL ACCURACY

TOTAL WEIGHT LESS THAN

▶ **8** OUNCES

TOTAL VOLUME UNDER

▶ **ONE** CUBIC INCH



Reeves designed and produced the first combination Resolver-Booster Amplifier, the RBT151-102, which quickly became the standard for the industry. Now, we offer the new Size 11 Combination, incorporating all the accuracy and reliability features of the original design, in a unit occupying one-third the volume.

The amplifier Modules are individually encapsulated, and can be supplied in either welded cordwood or conventional printed circuit assemblies.

Of course, we can supply either the resolver or the dual amplifiers as separate assemblies. But, for those applications where accuracy, space and weight are all significant, the new Size 11 Combination is the ultimate design answer. Write for Data File 103.

NOTE: The Size 11 Combination can be supplied with either lead type or terminal connections, as required.

#### S P E C I F I C A T I O N S

AMPLIFIER		SYSTEM PERFORMANCE	
Feedback Gain (min):	60db	Transformation Ratio:	1.000 ± 0.001
Input (rms):		Phase Shift:	0° ± 6'
@ 28vdc B+:	0-14v	Functional Accuracy:	0.1%
@ 45vdc B+:	0-20v	Noise (max):	0.3mv, rms
Input Impedance (min):	1 meg	Temperature Range (°C):	-55 to +100
Current input/amp.:		Power Supply Noise Rejection:	
@ 28vdc:	6ma	@ 400cps:	54db
@ 45vdc:	8ma	@ 1000cps:	44db
		Recommended Rotor Load: 50K resistive.	
		Weight: Less than 8 oz.	

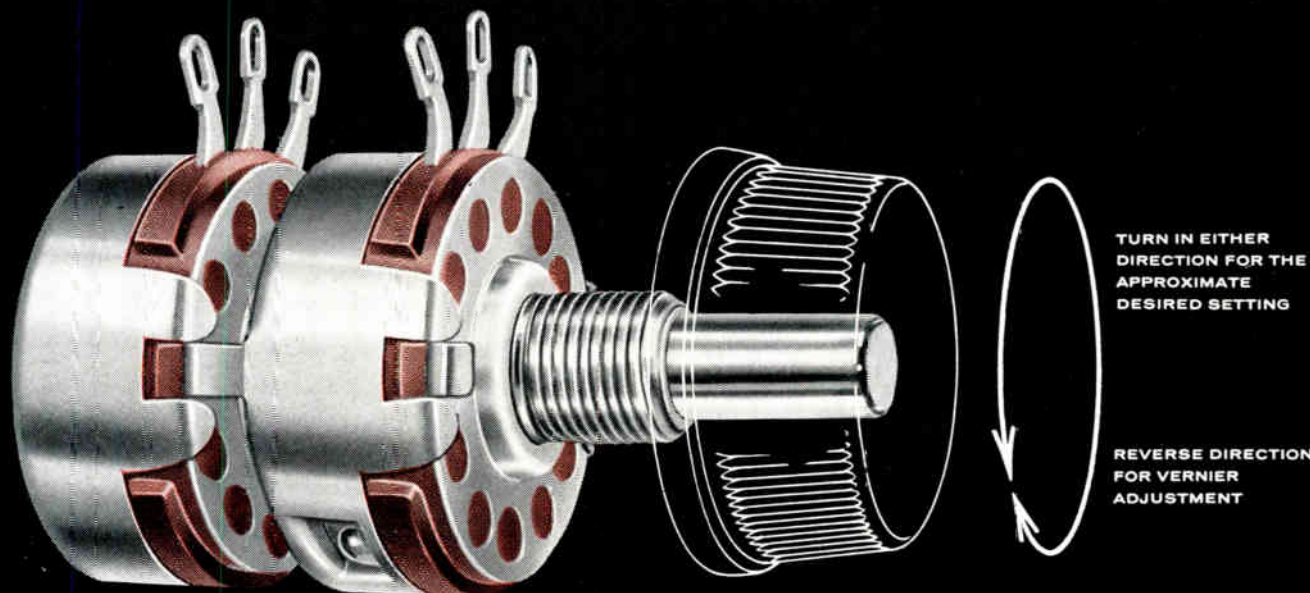
See us at the I.E.E.E.  
Booths 1307-1309

REEVES INSTRUMENT COMPANY

Division of Dynamics Corporation of America • Roosevelt Field, Garden City, New York



# **new** Allen-Bradley Type JJV Hot Molded Variable Resistors with "built-in" vernier



TURN IN EITHER DIRECTION FOR THE APPROXIMATE DESIRED SETTING

REVERSE DIRECTION FOR VERNIER ADJUSTMENT

**TYPE JJV VERNIER CONTROL**  
Shown Twice Actual Size

**TURN ONE KNOB**—you obtain both the approximate setting and the fine resistance adjustments . . . *in the panel space of only one control.* A unique coupling arrangement allows the approximate setting to "idle" when the operator is making the vernier adjustment. More than 12% of total rotation is available for the independent vernier adjustment, thus providing up to 20 times better resolution than is obtainable with a single element control.

**VERSATILE**—All standard tapers and resistances are available to satisfy virtually any control requirement. Can be used as a rheostat or as a modified potentiometer in a three or four terminal circuit. A triple control, having two units locked together with the third unit

providing the vernier adjustment, is available where true potentiometer circuitry is required.

**FAMOUS TYPE J PERFORMANCE**—The exclusive hot molded resistance element with its built-in stability is a guarantee of long operating life and having a low initial noise level, which is further improved with use. The control is always smooth and during adjustment is completely free of sudden changes or "steps."

Try this new Type JJV control—surprise yourself with the vernier resistance adjustment that is obtainable over a wide range. Allen-Bradley Co., 102 W. Greenfield Ave., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

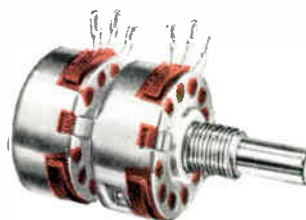
## ALLEN-BRADLEY TYPE J HOT MOLDED VARIABLE RESISTORS



Type J  
with encapsulation



Type JS  
with line switch



Type JJ  
standard dual unit



Type JJJ  
standard triple unit



# ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS



# Instant Logic

## THOUSANDS OF PACKAGED ANSWERS TO YOUR SYSTEM DESIGN NEEDS

Make your block diagrams, and we'll fill your needs exactly from the industry's widest line of digital circuit modules. The design problems have been solved, the headaches eliminated, the performance

proved. You save untold engineering hours and dollars. (And the circuits you use are guaranteed.)

If the specs are demanding and the need is now, the answer is EECO.

### GERMANIUM-TRANSISTOR DIGITAL CIRCUITS (T- AND CT-SERIES)

T-Series units are in cylindrical packages, identical CT circuits on cards. Available in commercial and military versions. Write for Catalog T-113.

### EXTENDED-SERVICE CIRCUITS—TO 10 MC (G-SERIES)

A family of economical, compatible transistor circuits on etched cards. Four frequency sub-groups: 0-100 kpps, 0-1 mpps, 0-5 mpps, 0-10 mpps. Get exactly the speed you want, pay only for the speed you need. Write for Catalog G-53.

### UNIVERSAL NOR-NAND DIGITAL CIRCUITS (U- AND UC-SERIES)

Silicon-transistor modules in welded, transfer-molded, modular form or on circuit cards. Two frequency sub-groups: 0-1 mpps and 0-10 mpps. Units perform logic and active functions to 125°C.; cards exceed

temperature requirements of MIL-E-5400F, Class II. Write for Catalog U-93.

### TRANSISTORIZED DECADES (N-SERIES)

Miniaturized counters, converters, storage units in cans or on cards for medium-speed (250 kc) and high-speed (5 mc) application. Write for Catalog NR-13A.

### MINISIG® TRANSISTORIZED INDICATORS (R-SERIES)

High-gain filament and neon indicators with built-in transistor driver-amplifiers. Principal use is to indicate signal levels or the state of storage elements. Cylindrical and rectangular packages. Write for Catalog NR-13A.

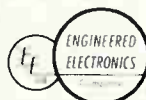
### ROTARY THUMBWHEEL EECOSWITCHES AND ASSEMBLIES

Manually operated rotary switches with direct readout to coded electrical outputs—decimal, BCD, BCD with parity,

many others. One-third the volume of conventional rotary switches. Exclusive detent makes accidental hang-up impossible. MIL-quality construction. More than 560 possible configurations. Write for EECOSWITCH Catalog 014.

### DIGITAL SYSTEM BREADBOARD EQUIPMENT

Fastest, surest way to breadboard digital systems. Available in standard and high-speed (to 10 mc) versions, portable and rack-mounted styles. Uses standard EECO modules, permits pushbutton tests at operating frequencies. Designer can hook up, take down or change circuitry at will, using patchcords and plugs. No soldering, no waste of time or materials. Write for T- or G-Series breadboard brochures.



### ENGINEERED ELECTRONICS Company

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EN14/17/1

For Catalog T-113, circle 15 on inquiry card; for Catalog G-53, circle 16; for Catalog U-93, circle 17; for Catalog NR-13A, circle 18; for Catalog 014, circle 19; for breadboard brochures, circle 20.

See EECO products in booth 1425 at IEEE Show



# what's new in Ohmite's famous Brown Devil® resistors?

NEW SMALL SIZES

NEW 3-WATT

NEW 5¼-WATT

HIGHER RATINGS FOR OLD SIZES

8 WATTS (formerly 5)

12 WATTS (formerly 10)

20 WATTS (no change)

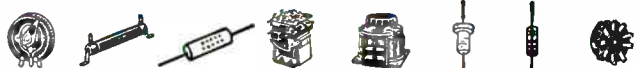
ACTUAL SIZE

## Brown Devil Vitreous Enameled, Wire-Wound Resistors—Type 200

RATING	OHMS RANGE	Standard Values Stocked in Depth Nationally by Distributors
3 Watts	1.0 to 10,000	Special Values Available Quickly
5¼ Watts	1.0 to 20,000	
8 Watts	1.0 to 25,000	
12 Watts	0.5 to 50,000	
20 Watts	0.5 to 100,000	

■ Now you'll find Brown Devil® resistors more widely "applicable" than ever. Two new sizes, 3 and 5¼ watts, fill designers' needs for smaller wattage ratings and sizes for miniaturized equipment. ■ With the latest engineering operating-temperature practices in mind, Ohmite has carefully reassessed the ratings of Brown Devil resistors. The result is a substantial boost in ratings for two sizes which realizes more fully the inherent capability of these popular resistors. ■ The new ratings apply to units now in the possession of industry. ■ Brown Devils are normally mounted by their leads, but the three larger sizes can also be mounted by brackets or through-bolts. Standard tolerance is ±5% for one ohm or higher; ±10% below one ohm. Closer tolerances available. Standard leads are tinned wire, 1½" long. Write for Bulletin 105.

See All of Ohmite's New Product Developments at the IEEE Show—Booths 2627-2631



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

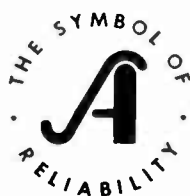


# DEMONSTRATION OF NEW DIODE RELIABILITY AT BOOTH M-4, IEEE SHOW



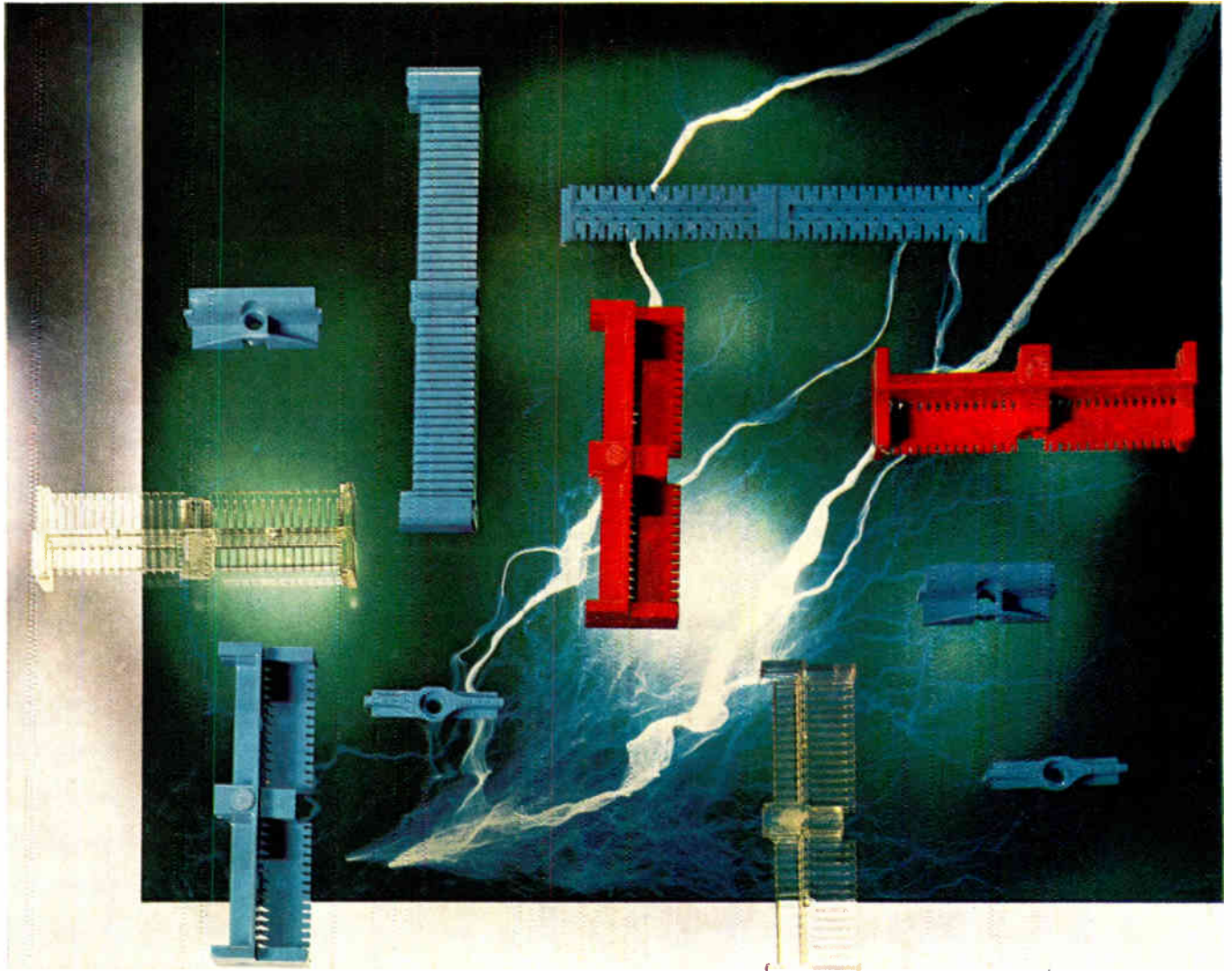
*Repeated blows show absolutely no change in curve trace.*

**Solid mass construction of new Zener diodes  
eliminates all shock and vibration problems!**



**AMERICAN**  
SEMICONDUCTOR CORPORATION  
3940 N. Kilpatrick Ave., Chicago, Illinois 60641

# How to get connected to the hot-line connector market . . .



## by making a simple switch

The switch we mean is to MERLON® polycarbonate from whatever you've been using. MERLON is now the top engineering plastic for all non-conducting electrical parts, from solderless connectors to supports for current-carrying components.

Among all thermoplastics, *only* MERLON gives you: 1) high-impact strength, 2) good dimensional stability at high and low temperatures, 3) UL-listed

self-extinguishing and electrical properties, 4) transparency and 5) color-coding advantages.

For a quick check against eight other leading engineering thermoplastics, write for the MERLON slide-rule comparator; for the solid technical data on properties, processing and applications, ask for the MERLON Engineering Handbook.

**Mobay Chemical Co., Code EI-1, Pittsburgh 5, Pa.**



Parts shown are molded from MERLON M-50

# Mobay Chemical Company

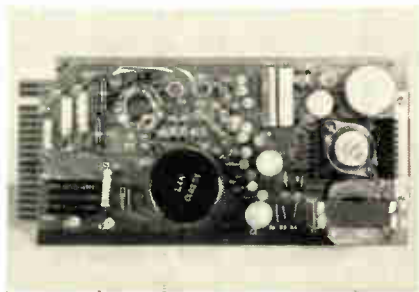


# NEW PRODUCTS

At I.E.E.E.

## SQUARE-ROOT EXTRACTOR

This solid-state device is built around a magnetic amplifier. It produces a dc voltage output signal proportional to the



sq. root of a dc ma input signal. Leeds & Northrup. Booth 1726.

Circle 275 on Inquiry Card

## TANTALUM CAPACITOR

Type MMT is a tantalum capacitor mounted on an alumina substrate. Wafer is rated at 1mfd and 35vdcw to 47mfd and 6vdcw. Temp. range:  $-55^{\circ}\text{C}$  to  $+58^{\circ}\text{C}$ . Cornell-Dubilier. Booths 2721-23.

Circle 276 on Inquiry Card

## TRIMMER

Model 61 is a  $\frac{1}{4}$  in. dia. cermet trimming potentiometer. It is a single-turn unit. Power rating is  $\frac{1}{2}\text{w}$ . at  $85^{\circ}\text{C}$ , derating to 0 at  $175^{\circ}\text{C}$ . Beckman Instruments, Inc. Booths 1201-1203.

Circle 277 on Inquiry Card

## SWEEP OSCILLATOR

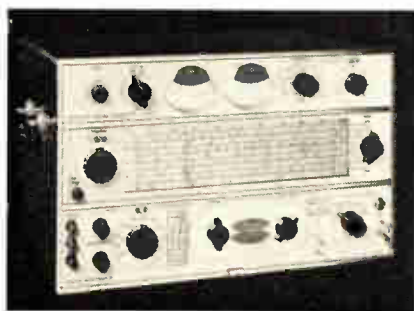
The 64 series covers the 2-4, 4-8 and 8-12.4gc bands. Features CW or swept output leveled to  $\pm\frac{1}{4}\text{db}$ . Sweep and stop freq. independently adjustable. Sperry Microwave Electronics Co. Booths 3713-17.

Circle 278 on Inquiry Card



## SIGNAL GENERATOR

Model 2002 covers a freq. range from 10kc to 72Mc in 8 bands. Crystal calibrator gives check points at 1Mc, 100kc and



1kc. Marconi Instruments. Booths 3701-3705.

Circle 279 on Inquiry Card

## DIELECTRIC COMPOUND

Insulgrease® G-640 is a grease-like silicone for semiconductor manufacturing. It has high-thermal conductivity and low metallic impurities. It is shock resistant. General Electric. Booths 2904-44.

Circle 280 on Inquiry Card

## TERMINATING ELEMENTS

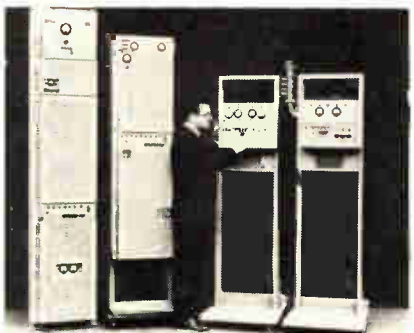
These waveguide elements operate in S- to K<sub>u</sub>-bands. Lossy dielectric absorbing materials are used. A 10:1 pyramid fineness ratio insures low vswr. Emerson & Cuming, Inc., Booth 3213.

Circle 281 on Inquiry Card

## TROPO-SCATTER EQUIPMENT

The 2600 series operates in line-of-sight relay and satellite ground-station modes. Operating freq. 400MC to 50GC. Has 12 to 300 voice channels. Radio Engineering Laboratories. Booths 1301-05.

Circle 282 on Inquiry Card



## SIGNAL SOURCE

Model 2150 provides a CW or sq.-wave modulated r-f from 2.0 to 4.1gc. Serves as antenna-pattern range transmitter, gen-



eral-purpose lab supply, etc. Scientific-Atlanta, Inc. Booths 3933-35.

Circle 283 on Inquiry Card

## DOUBLE UNIT

Model 243 is a BWO and klystron synchronizer. It can be used with certain triode oscillators operating at 25ma. Unit phase locked to crystal stability. Laboratory for Electronics Inc. Booth 3716.

Circle 284 on Inquiry Card

## SPECTRUM ANALYZER

The Panoramic Model TA-2 has interchangeable plug-in modules. Several modules cover the sonic through r-f bands. Unit may be line or battery operated. Singer Metrics. Booths 3818-32.

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## ELECTRON-BEAM EVAPORATOR

No heat is needed in this baked vacuum system. The Internal Electronic Bakeout™ gun directs high-velocity electrons around the vacuum system to produce bakeout through degassing. MRC Mfg. Corp. Booth 3940.

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Licon type 01 lighted  
pushbutton Switches

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MAINTAINED CONTACT



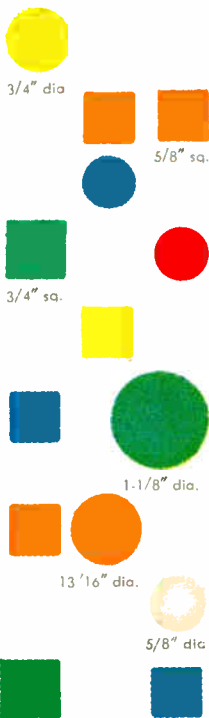
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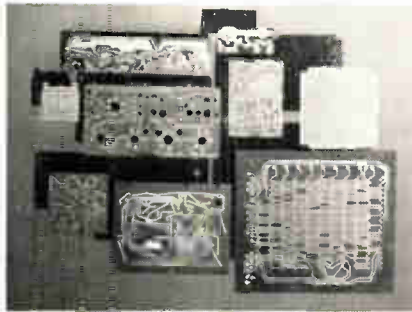
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## CUSTOM CIRCUITS

On-the-spot price quoting will be given by the Photocircuits Corp. at their booths. Visitors or inquirers give a description of their PC board and receive a written



quotation for prices. Photocircuits Corp. Booths 2202-04.

Circle 263 on Inquiry Card

## DIGITAL CONVERTER SYSTEM

Model RDC4162-1000 is a shaft-angle encoding system. It is self-contained and requires 28v., 400cps excitation. Data available in 16-bit parallel-binary form. Reeves Instrument Corp. Booths 1307-09.

Circle 264 on Inquiry Card

## SWITCHES

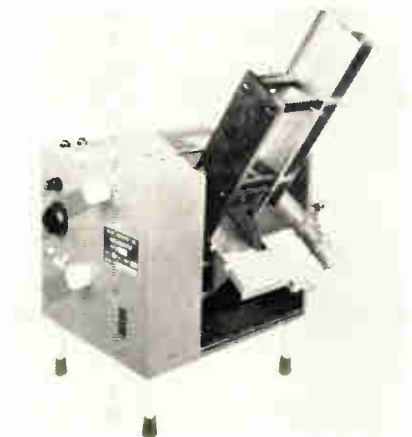
This dry-reed switch is hermetically sealed in dry inert gas. For low-power actuation uses. Offers fast response and no warm-up. No moving parts. Micro Switch. Booths 2511-13.

Circle 265 on Inquiry Card

## WIRE MAKER/TESTER

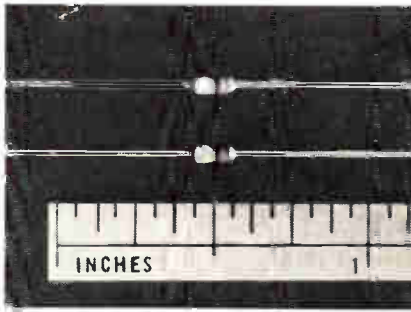
Series T-131 cuts and forms axial component lead wires. It tests the components on a go/no-go basis and sorts them. Speeds up to 7000 components/hr. Heller Industries. Booth 4529.

Circle 266 on Inquiry Card



## RESISTOR

Model MF2C half-watt units derate to 1/20w. @ 125°C and to 0 @ 175°C. Mono-crystalline substrate is used. Resistances from 30Ω to 100KΩ. Tolerance



0.1 to 1%. Electra Mfg. Co. Booths 2741-43.

Circle 267 on Inquiry Card

## SWITCHING TRANSISTORS

The 2N2944-2946 combine epitaxial junction growth with diffusion and oxide passivation techniques. For low-level chopper uses. Operating temp., 200°C. Crystalonics Inc. Booth 2112.

Circle 268 on Inquiry Card

## MICROCIRCUITRY PRODUCTS

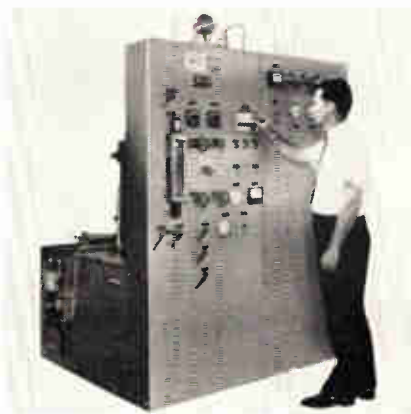
Cut "N" Strip Film is a polyester base material used to prepare the original masks for silicon-circuit blocks used in computer circuits. Keuffel & Esser Co. Booth 4507.

Circle 269 on Inquiry Card

## TEMPERATURE CHAMBERS

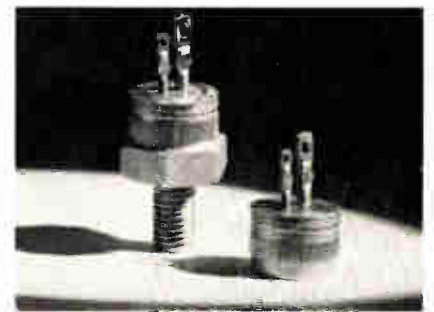
The Tenney Jr. operates from -100° to +350°F (±1/2°F). The Space Jr. provides 1,100,000 ft. (7.5 x 10<sup>-8</sup> Torr) of simulated altitude. Tenney Engineering, Inc. Booth 3118.

Circle 270 on Inquiry Card



## AC CONTROL SWITCH

Triac is a gate-controlled ac switch with 3 leads. It performs like a 2 SCRs or an ac diode switch with associated pulse transformer. Needs less than 3v



and 50ma to trigger. General Electric. Booths 2904-06.

Circle 271 on Inquiry Card

## HYDROGEN GENERATOR

The 1000 CFH unit produces ultra-pure hydrogen at very low cost. No second state is required to compress and preheat dissociated ammonia. C.I. Hayes Inc. Booth 4533.

Circle 272 on Inquiry Card

## LAMINATED MATERIALS

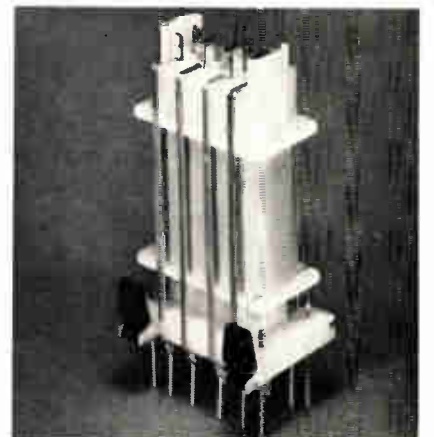
Multi-layer printed circuitry, copper-clad grades, high-temp. peel strength material and flame-retardant laminates for welded PC will be shown by Synthane Corp. Booths 4421-23.

Circle 273 on Inquiry Card

## SWITCHES

These Correed switching devices are designed for max. packaging density. Contacts permit switching from dry circuit to 50va resistive. Automatic Electric. Booths 1908-10.

Circle 274 on Inquiry Card



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### VERSATILITY

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Resistance Values	20 ohms to $1 \times 10^{14}$ ohms
Power Ratings	$\frac{1}{4}$ watt to 100 watts
Voltage Rating	Up to 125 KV
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"Worst Case Analysis" is an effective method of calculating the reliability of complex systems. But only the digital industry has taken full advantage of it until now. This article describes how one company has used "WCA" to design power supplies and has thereby achieved Mean Time Between Failure (MTBF) rates in excess of 100,000 hours.

## "WORST CASE ANALYSIS" IN ANALOG CIRCUIT DESIGN

AN EQUIPMENT DESIGN APPROACH called Worst Case Analysis (WCA) will give long term reliability under the worst possible operating conditions. WCA originated in the digital computer industry when it was found that standard design procedures produced equipment which was marginal and unreliable. Although now standard for digital computer design, it is not being used to any great extent elsewhere. This article describes how a basically digital method can be applied to analog circuits. Three basic design areas are considered.

### ELECTRONIC INDUSTRIES STATE-OF-THE-ART FEATURE

1. Circuit analysis (a mathematical analysis of each circuit).
2. Component derating (to insure optimum life-time values).
3. Quality assurance (aging, life and sample testing).

WCA is explained by applying it to a transistorized power supply, but the principles can be adapted to any equipment design. Also reviewed are methods for evaluating power supply designs which are a by-product of WCA in the design stage.

\* \* \*

#### By P. A. MILONE

Mgr. of Power Supply Engineering

#### and FRANK J. SPOSATO

Product Mgr.  
Consolidated Avionics Corp.  
Westbury, N. Y.



F. J. Sposato

P. A. Milone

The first step in a Worst Case Analysis is to mathematically define the complete circuit operation. Equations must be set up to establish open loop gain, stability, power dissipation, etc. Each of these parameters is then examined by inserting the worst combination of end-of-life values into the equations.

End-of-life component tolerances are found from vendor data and testing. For example, resistors with a tolerance of  $\pm 5\%$  can vary during their life as much as  $\pm 15\%$  from aging and environmental conditions. Vendor specified current gain tolerance for transistors can vary as much as 30% during their life. After 1000 hrs of operation, collector to base leakage currents can be double the vendor's value. If the circuit can mathematically meet its specs under the worst possible combination of end of life values, the design is approved.

Stability of a power supply differential amplifier (Fig. 1) will be examined for circuit analysis. Assume the resistors are high stability types and thus their effect on amplifier stability is second order. If reliability testing shows an end of life current gain tolerance for the transistors of 2 to 1, then the circuit would be evaluated under the following conditions:

1. Current gain of  $Q_1$  equals current gain of  $Q_2$ .
2. Current gain of  $Q_1$  is twice current gain of  $Q_2$ .
3. Current gain of  $Q_1$  is  $\frac{1}{2}$  current gain of  $Q_2$ .
4. Leakage current  $I_{CO}$  of  $Q_1$  is three times  $I_{CO}$  of  $Q_2$ .
5. Worst combination of the above.

Mathematically, the stability of the amplifier will permit the power supply to stay well within the needed  $0.01\%/^{\circ}\text{C}$ . This type of analysis is done on each power supply stage. Performance characteristics of each section are then combined to produce a total characteristic for the device.

A critical area in a power supply is power dissipation in the series pass transistors. Complete mathematics for a WCA of a pair of parallel power transistors is given in App. I. The analysis shows the



importance and flexibility of WCA. For example, it is usually assumed that there is equal current distribution in a parallel pair of power transistors. WCA shows this to be untrue. It is possible, with a worst case combination of current gain and input impedance, to have a current imbalance of 3 to 1. The imbalance can be reduced with emitter degeneration methods, but even under the best conditions there is a current distribution of 1.2 to 1. Thus, for top reliability transistor power dissipation must be computed from  $P = E_{max} \times 1.2 I$ .

Components also undergo maximum stress during a short-circuit transient period. These stresses must be learned and circuit operation defined for the short-circuit period.

### Prototype Analysis

When the analysis is completed, it is followed by trial. Worst case components are hand selected and an actual worst case power supply is built. The power supply is completely tested under worst case conditions to verify the math findings. Environmental tests are performed. AC gain stability is verified. Voltage levels, current levels and power dissipation are also measured.

### Component Derating

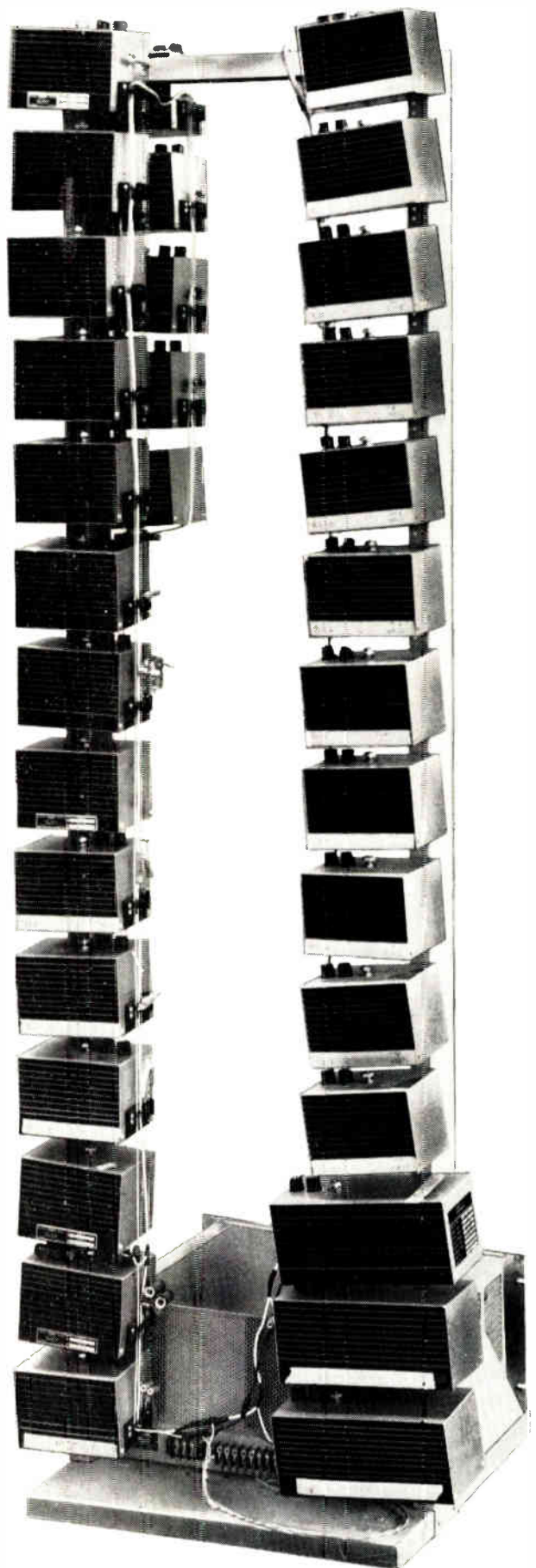
The analysis up to this point will provide an equipment design which will meet its specs under the worst possible conditions. But, nothing has been used in the analysis to insure that the equipment will continue to operate within its specs. To insure lifetime reliability, components must be derated to values which will meet worst case conditions at the end life.

Derating factors used by the Con Avionics Quality Control Dept. are:

1. Carbon resistors derated to  $\frac{1}{2}$  power.
2. Wire-wound resistors derated to 80% power.
3. Electrolytic capacitors derated to 80% power.
4. Transistors derated to 90% of maximum junction temperature.

With these deratings, equipment MTBF (mean time between failure) exceeds 16,000 hrs. To insure these MTBF figures, some components must be aged before they are used. This is true of transistors which are known to have a high infant mortality rate. Transistors should thus be pre-aged for 100 hrs at high temperatures before use.

Power supplies being tested on life rack were designed under WCA. This test follows empirical verification of prototypes. Supplies used for life testing are from production runs. Use of WCA in the design stage leads to high MTBF. These supplies have run 24,000 hrs. continuously without a failure.



## WORST CASE ANALYSIS (Continued)

### WCA Conclusions

An important feature of WCA is that it spots and eliminates all of the marginal design procedures now used in power supplies. WCA shows that positive feedback in a closed loop, current feedback and the use of devices for compensation of temperature drift are poor practices when long term reliability is needed. An example of the disadvantage of positive feedback is shown in App. II.  $K_a$  is the gain of the overall system, or closed-loop gain; and  $K_b$  is the gain of the individual amplifier, or open-loop gain. If a 10 mv output voltage change is desired for a 10 to 1 current swing, a closed-loop gain of 100,000 is needed. To improve the voltage change from 10 mv to 1 mv, the closed-loop gain must be increased to  $1 \times 10^6$ . This can be done by either adding another stage to the amplifier string, or by using positive feedback.

Positive feedback is undesirable, however, because a gain change in any stage within the positive feedback loop results in an overall gain change several times that of the individual amplifier. The math in App. II shows that a 2 to 1 change in the positive feedback loop results in a 6 to 1 change in gain for the overall system.

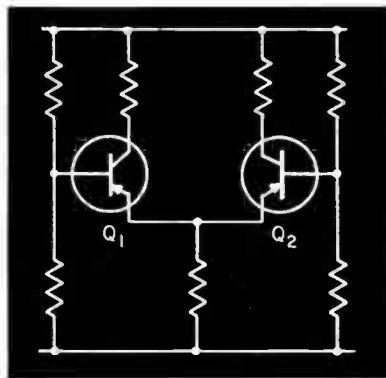


Fig. 1: Power supply differential amplifier. Mathematically, the stability of the amplifier will permit the power supply to stay well within the needed 0.01 per cent per degree C.

With current feedback it is possible to get good load regulation. In fact, it gives either zero or positive load regulation as opposed to standard negative load regulation. But, current feedback varies with open loop gain and must be hand trimmed for each power supply. It also changes drastically with time as the open loop gain of the amplifier decreases. The effect is similar to the gain decay with positive feedback. Overall gain change is several times that of one amplifier.

Power supplies which use poor stability resistors, single ended amplifiers, and low cost zener diodes can be "peaked" to meet temperature stability specs by using thermistors and hand trimming. But, again the degree of compensation varies with time, and

hand trimmed components will not produce long term reliability. To keep temperature stability the power supply has to be checked and calibrated as the resistors drift and the open loop gain changes. This is a difficult procedure.

For long term reliability, stability must be "designed into" a power supply. It cannot be an adjustment. Components must be of good quality (compensated zener diodes and 20 part/million resistors), derated and aged.

### Quality Assurance

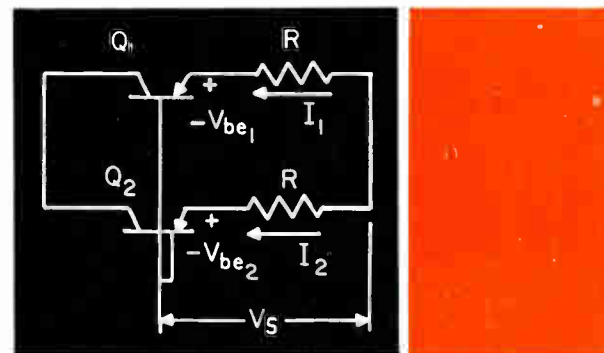
Any equipment is subject to random, catastrophic failures during its early life. These failures usually develop within the first 5 hrs of power supply operation. They can be avoided only through proper aging before delivery. Each supply should be given 24 hrs of testing under worst case conditions as follows:

1. Maximum line voltage to produce maximum unregulated dc and maximum transistor power dissipation.
2. Minimum output voltage for maximum voltage across series transistors and therefore maximum dissipation.
3. Maximum ambient temperatures so that all components are operated near their limits with maximum stress. The above test is equal to 100 hrs of field use.

As a constant check on design and production, random units should be tested until failure. If life testing indicates a design problem, the circuit should be scanned under WCA. Random tests should also be made on stability performance and other areas which are not subjected to regular testing.

### Appendix 1

Current sharing in 2 parallel transistors.



$$V_s = I_1 R + V_{be1} \quad (1)$$

$$V_s = I_2 R + V_{be2} \quad (2)$$

$$G_m = \frac{I_c}{V_{be}} = \frac{\infty I_e}{V_{be}} = \frac{\beta I_e}{(\beta + 1) V_{be}} \quad (3)$$

$$H_{ie} = \frac{\beta}{G_m} \quad (4)$$

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## Appendix 2

$$G = \frac{K}{1 - \beta K}$$

If  $K = 50$  and required  $G = 250$

$$\beta = \frac{1}{K} - \frac{1}{G}$$

$$\beta = \frac{1}{50} - \frac{1}{250} = \frac{4}{250}$$

If  $K = 25$ , then

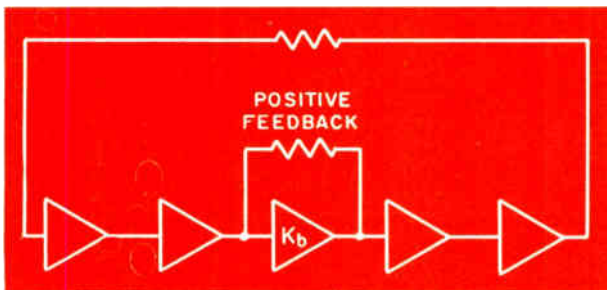
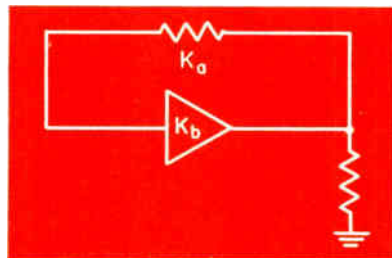
$$G = \frac{25}{1 - \frac{4}{250}(25)} = 41.66$$

$G$  has changed from 250 to 41.66 with a  $K$  change of 50 to 25 or a  $K$  change of 2/1 produces a  $G$  change of 6/1

$G$  = overall gain of amplifier system

$K$  = gain of individual amplifier

$\beta$  = feedback



$$\text{Let } V_{be_1} = V_{be_{\min.}} - 0.003 \text{ v}/^\circ\text{C} \times V_{ce} \times I_1 \times \Theta_{j-s}$$

$$V_{be_2} = V_{be_{\max.}} - 0.002 \text{ v}/^\circ\text{C} \times V_{ce} \times I_2 \times \Theta_{j-s}$$

where  $\Theta_{j-s}$  is the thermal resistance from junction to heat sink and  $V_{ce}$  is the voltage collector to emitter.

Hence rewriting Eqs. 1 and 2.

$$V_o = I_1 R + V_{be_{\min.}} - 0.003 \text{ v}/^\circ\text{C} \times V_{ce} \times I_1 \times \Theta_{j-s} \quad (5)$$

$$V_o = I_2 R + V_{be_{\max.}} - 0.002 \text{ v}/^\circ\text{C} \times V_{ce} \times I_2 \times \Theta_{j-s} \quad (6)$$

Equating (5) and (6) results in

$$(I_1 - I_2) R + V_{be_{\min.}} - V_{be_{\max.}} + (-0.003 \text{ v}/^\circ\text{C} I_1 + 0.002 \text{ v}/^\circ\text{C} I_2) \cdot V_{ce} \Theta_{j-s} = 0 \quad (7)$$

$$V_{be_{\min.}} = \frac{\beta_1 I_1}{(\beta_1 + 1) G_{m_1}} \quad \text{where } G_{m_1} = G_{m_{\max.}}$$

$$V_{be_{\max.}} = \frac{\beta_2 I_2}{(\beta_2 + 1) G_{m_2}} \quad \text{where } G_{m_2} = G_{m_{\min.}}$$

Rewriting Eq. 7

$$(I_1 - I_2) R = V_{be_{\max.}} - V_{be_{\min.}} + (0.003 I_1 - 0.002 I_2) V_{ce} \Theta_{j-s}$$

$$(I_1 - I_2) R = \frac{\beta_2 I_2}{(\beta_2 + 1) G_{m_2}} - \frac{\beta_1 I_1}{(\beta_1 + 1) G_{m_1}} + (0.003 I_1 - 0.002 I_2) V_{ce} \Theta_{j-s} \quad (8)$$

Let  $I_1 = K_a I_2$

So that

$$I_2 (K_a - 1) R = \left( \frac{\beta_2}{(\beta_2 + 1) G_{m_2}} - \frac{\beta_1 K_a}{(\beta_1 + 1) G_{m_1}} \right) I_2 + (0.003 K_a - 0.002) I_2 V_{ce} \Theta_{j-s}$$

$$(K_a - 1) R = \frac{\beta_2}{(\beta_2 + 1) G_{m_2}} - \frac{\beta_1 K_a}{(\beta_1 + 1) G_{m_1}} + \underbrace{(0.003 K_a - 0.002) V_{ce} \Theta_{j-s}}_P \quad (9)$$

$$\text{Since } G_{m_2} = \frac{\beta_2}{H_{i_{e_2}}} \text{ and } G_{m_1} = \frac{\beta_1}{H_{i_{e_1}}}$$

$$(K_a - 1) R = \frac{H_{i_{e_2}}}{\beta_2 + 1} - \frac{H_{i_{e_1}} K_a}{\beta_1 + 1} + P \quad (10)$$

Solving for  $R$  in Eq. 10.

$$R = \frac{\frac{H_{i_{e_2}}}{\beta_2 + 1} - K_a \frac{H_{i_{e_1}}}{\beta_1 + 1} + P}{K_a - 1} \quad (11)$$

let  $\beta_1 = K_b \beta_2$

and  $H_{i_{e_2}} = K_c H_{i_{e_1}}$

$$R = \frac{\frac{H_{i_{e_2}}}{\beta_1 + 1} - K_a \frac{H_{i_{e_2}}}{K_c (\beta_1 + 1)} + P}{K_b}$$

$$R = \frac{\frac{H_{i_{e_2}} K_b}{\beta_1 + K_b} - \frac{K_a H_{i_{e_2}}}{K_c (\beta_1 + 1)} + \frac{P}{K_a - 1}}{K_a - 1}$$

$$R = \frac{H_{i_{e_2}}}{K_a - 1} \left[ \frac{K_b}{\beta_1 + K_b} - \frac{K_a}{K_c (\beta_1 + 1)} \right] + \frac{P}{K_a - 1} \quad (12)$$

Typical Example

$$I_2 = 2.0 \text{ a}$$

$$K_a = 1.2 \quad 20\% \text{ unbalance}$$

$$\beta_1 = 30$$

$$K_b = 2 \quad (2 \text{ to } 1 \text{ "}\beta\text{" spread})$$

$$H_{i_{e_2}} = 10$$

$$K_c = 2 \quad (2 \text{ to } 1 \text{ Input } Z \text{ spread})$$

$$V_{ce} = 3 \text{ v}$$

$$\Theta_{j-c} = 1^\circ\text{C}/\text{w}$$

using Eq. 12

$$R = \frac{10}{1.2 - 1} \left[ \frac{2}{30 + 2} - \frac{1.2}{2(30 + 1)} \right] + \left( \frac{0.003(1.2) - 0.002}{1.2 - 1} \right) 3 \text{ v} \times 1^\circ\text{C}/\text{w}$$

$$= 50 \left[ \frac{2}{32} - \frac{1.2}{62} \right] + \frac{0.0016(3)}{0.2}$$

$$= 50 [0.0625 - 0.0193] + 0.024 = 2.16 + 0.024 = 2.184 \Omega$$

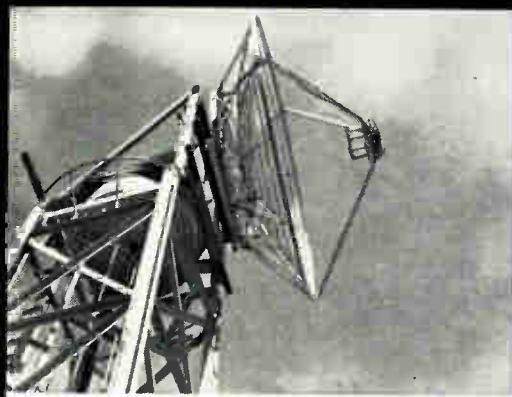
## Conclusion

The power dissipated in the sharing resistors is 13.6 w. This means using a 20 or 25 w. resistor. But, if a tighter specification were placed on  $K_b$  and  $K_c$ , the value of resistance needed to maintain unbalance to 20% would be lower (as shown by Eq. 12). Thus, the wattage dissipated would be lower.

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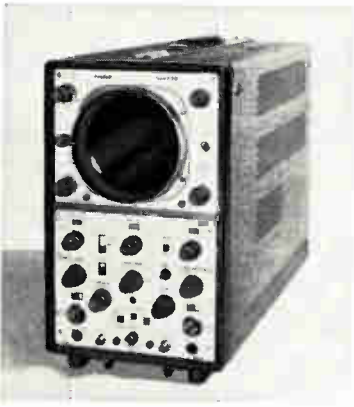
JERROLD ELECTRONICS rf sweep generators, such as the famous wide-plus-narrow-band Model 900-B, are trusted by discerning engineers for all their if, vhf, and uhf testing needs.



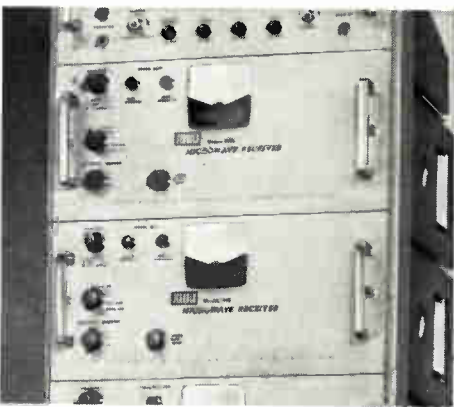
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## #72 EQUATIONS FOR MANIPULATING TOLERANCES

MODERN DAY COMPUTER TECHNOLOGY has placed increasing emphasis upon performance reliability unheard of ten years ago. Computer applications, particularly in the missile instrumentation field and other associated military projects, have placed an emphasis upon component reliability to assure total systems reliability of performance. One of the circuit design methods frequently used to assure the high performance required is called "Worst Case" design. In Worst Case design, end-of-life values are assigned to individual nominal values of components. These limits are obtained by specifying very close tolerances on the individual components.

The design engineer, when confronted by complex circuit analysis using the Worst Case technique, is required to manipulate component values having  $\pm$  tolerances. It is often not sufficient in a critical analysis to use accumulated tolerance estimates. Equations for design of the circuits quite often involve all of the simple algebraic mathematical manipulations. To provide tools in readily usable equations, the following examples and their solutions are presented.

### Addition

1. Where it is desired to add two quantities of certain tolerances the following will hold:

a. *Example:*

$$A(1 \pm x) + B(1 \pm y)$$

(where  $x$  and  $y$  are tolerances)

b. *Solution:*

$$(A + B) \left( 1 \pm \frac{x + \frac{B}{A}y}{1 + \frac{B}{A}} \right)$$

2. If three quantities are to be added, use the following:

a. *Example:*

$$A(1 \pm x) + B(1 \pm y) + C(1 \pm z)$$

b. *Solution:*

$$(A + B + C) \left( 1 \pm \frac{x + \frac{B}{A}y + \frac{C}{A}z}{1 + \frac{B}{A} + \frac{C}{A}} \right)$$

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### Subtraction

1. For two quantities:

a. *Example:*

$$A(1 \pm x) - B(1 \pm y)$$

b. *Solution:*

$$(A - B) \left( 1 \pm \frac{x + \frac{B}{A}y}{1 - \frac{B}{A}} \right)$$

2. For three quantities:

a. *Example:*

$$A(1 \pm x) - B(1 \pm y) - C(1 \pm z)$$

b. *Solution:*

$$(A - B - C) \left( 1 \pm \frac{x + \frac{B}{A}y + \frac{C}{A}z}{1 - \frac{B}{A} - \frac{C}{A}} \right)$$

### Multiplication

1. For two quantities:

a. *Example:*

$$[A(1 \pm x)] [B(1 \pm y)]$$

b. *Solution:*

$$\begin{cases} (AB)(1 + x + y + xy) \leftarrow \text{upper limit} \\ (AB)(1 - x - y + xy) \leftarrow \text{lower limit} \end{cases}$$

2. For three quantities:

a. *Example:*

$$[A(1 \pm x)] [B(1 \pm y)] [C(1 \pm z)]$$

b. *Solution:*

$$\begin{cases} (ABC)(1 + x + y + z + xy + xz + yz + xyz) \\ \text{Upper limit} \\ (ABC)(1 - x - y - z + xy + xz + yz - xyz) \\ \text{Lower limit} \end{cases}$$

### Division

1. For two quantities:

a. *Example:*

$$\frac{A(1 \pm x)}{B(1 \pm y)}$$

b. *Solution:*

$$\begin{cases} \frac{A}{B} \left( 1 + \frac{x + y}{1 - y} \right) \text{ upper limit} \\ \frac{A}{B} \left( 1 - \frac{x + y}{1 + y} \right) \text{ lower limit} \end{cases}$$

By G. HARRY ASHBRIDGE

Product Planning Section Manager  
Ampex Computer Products Co.  
P. O. Box 329  
Culver City, Calif.



### WHO TOOK THE SPECIAL OUT OF STAINLESS PARTS?

We did! With so many designers specifying stainless it was inevitable, we had to. It's not enough to stock the world's largest variety of stainless fasteners; our reputation was at stake. We were making special parts in stainless and super alloys, why not stock them, or at least tell designers about them? We were forced to act. Our pride was at stake. Next time the spec's call out stainless, check our BIG CATALOG. It's a storehouse of information. For your personal copy, call or write.

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Circle 50 on Inquiry Card

### PORTABLE TV CAMERA

THE CLOSEUPS OF THE PARTICIPANTS in the Winter Olympics were provided by the Newschief, which was designed by Sylvania Electric Products, Inc.

The 30 lb. portable system includes a camera, audio and video transmitter, and a rechargeable battery pack. The transmitter and power units are strapped to the cameraman's back. The transmitter uses frequency modulation and operates in the 2Mc band. It develops about 1 watt of power output into an omnidirectional antenna. The antenna, mounted on top of a 2 ft. mast protruding from the top of the back-panel, permits reception from any direction. The system transmits a signal up to one mile.

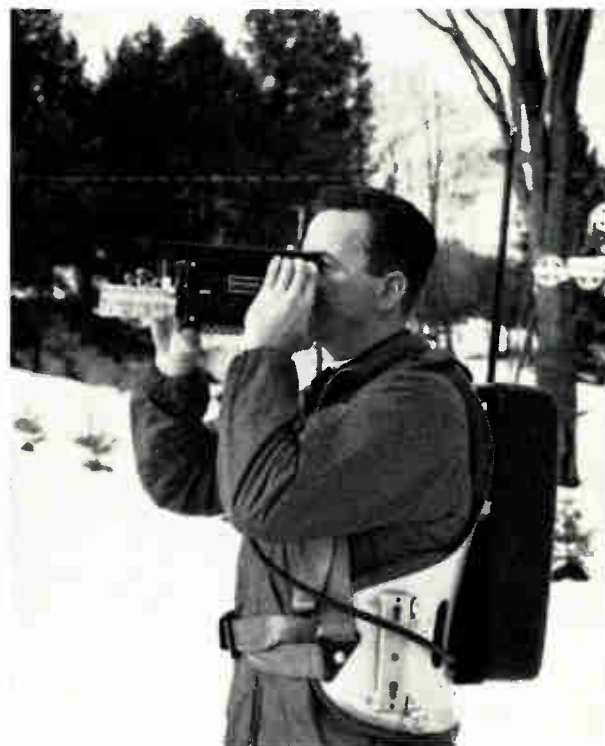
The camera, a modification of Sylvania's 800 line closed-circuit television camera, measures 3 by 4 by 8 inches and weighs about five pounds, including lens and view finder.

A rechargeable nickel-cadmium battery powers the Newschief. It supplies power for one hour. The unit can also be connected to a car battery if an auxiliary source is needed. The total power consumption for the unit is 40 watts—20 each for the camera and transmitter.

Other components in the system include plug-in modules, a complete EIA synchronizing generator, and video and sound amplifiers. All components are housed in the back-pack.

The equipment was designed specifically for civilian use and is not expected to have any military applications.

The Newschief allows the cameraman the freedom and mobility of a spectator. The unit weighs about 30 lbs.



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FORM "C"



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**FREE CARD**  
with magnet  
and switch

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DEPT. E1 • LAKE AND GROVE STREETS • LAKE MILLS, WISCONSIN

Circle 51 on Inquiry Card

# Only xerography can copy engineering drawings on ordinary paper.

## And that's the least unusual thing about the prints.

**1. Fact:** The 1824 Printer makes perfect, sharp, dry prints on bond, offset master stock, vellum, you name it. Even plain brown wrapping paper. How's that for a start?

**2. Fact:** Xeroprints from unitized microfilm cost so little in time and money you can use them for reference and then throw them away.

**3. Fact:** You don't have to buy the machine. Xerox will lend it to you (and maintain it of course).

**4. Fact:** Because these prints are on plain paper, you can make notes on them. Fold them without cracking. Store them; they won't deteriorate.

**5. Fact:** You can make prints from aperture cards, roll film, or jacketed film.

**6. Fact:** It's fast. Position the film, feed in the paper. That's all. Out comes a perfect print in seconds. What could be simpler? Or faster?

**7. Fact:** We'll prove it. Just ask your Xerox representative to demonstrate the 1824. Operate it yourself. Wonder why you didn't put in an 1824 Printer long ago. (You hadn't heard about it? You have now.)

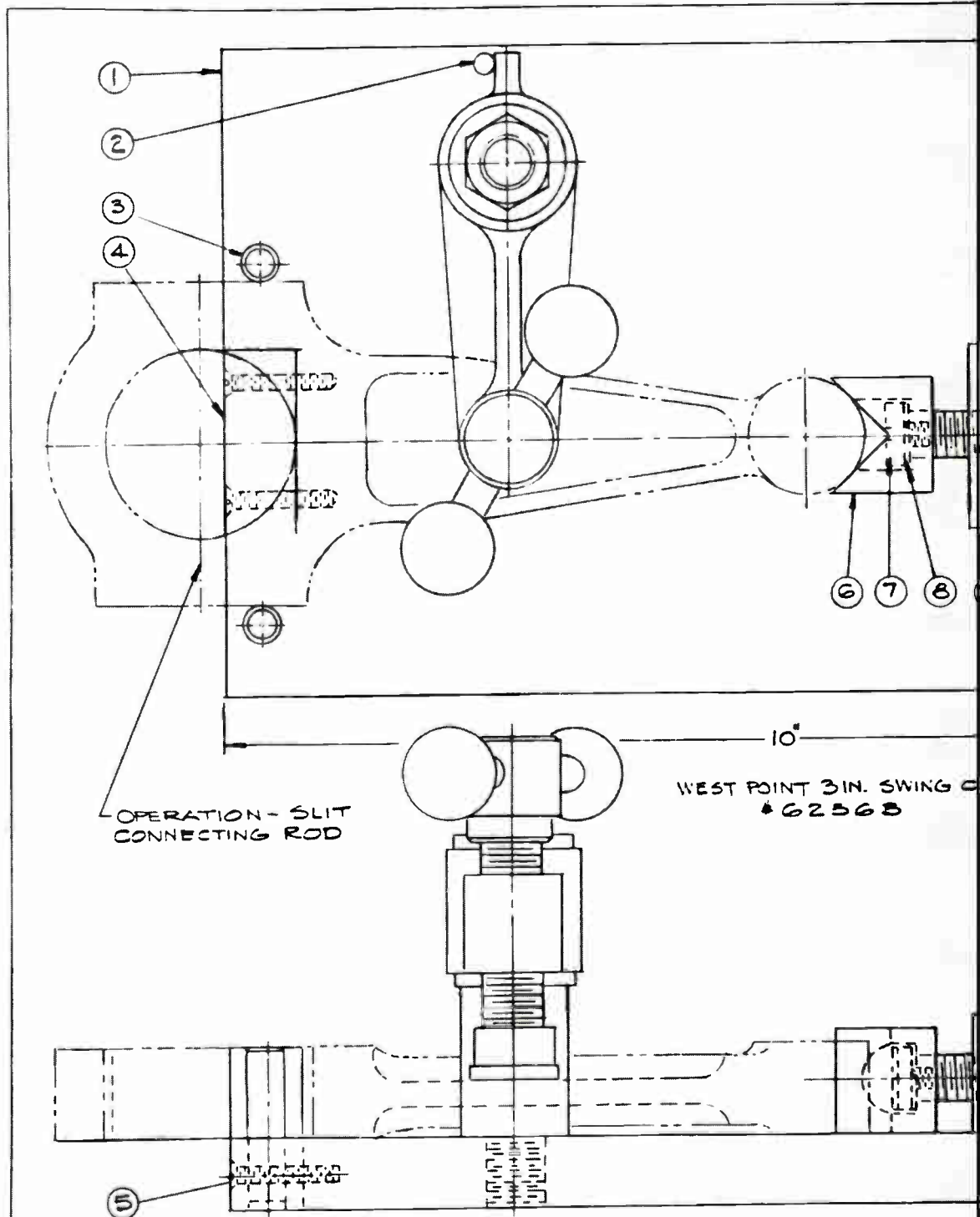
*Xerography makes microfilm practical.*

Xerox Corporation,  
Rochester 3, N.Y. Offices  
in principal U.S. cities.  
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Fuji-Xerox Co., Ltd., Tokyo.

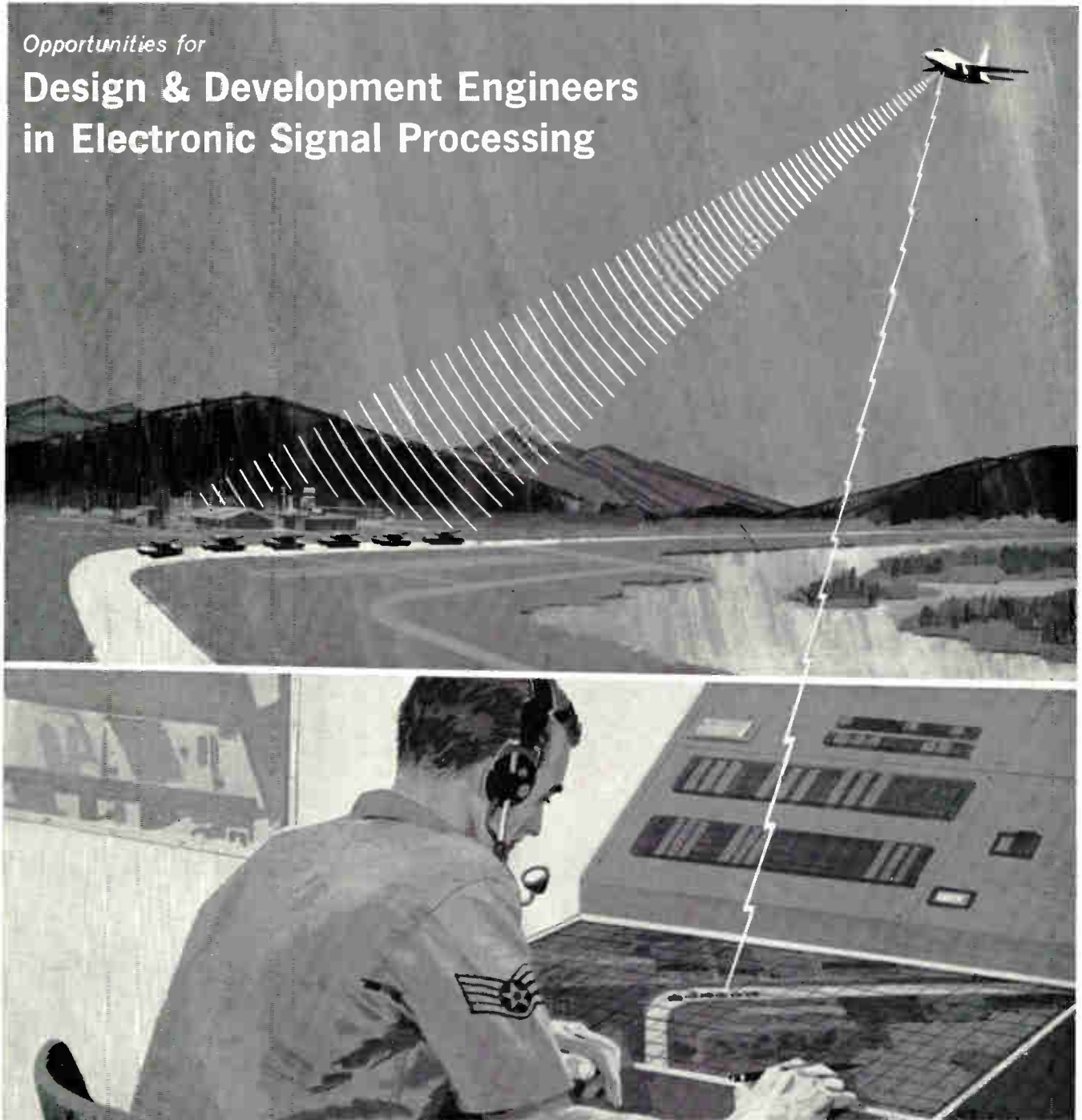
# XEROX

XEROX 1824 IS A TRADEMARK OF XEROX CORPORATION.

Circle 52 on Inquiry Card



Opportunities for  
**Design & Development Engineers  
in Electronic Signal Processing**



Design and development activities in the field of Electronic Signal Processing are rapidly expanding today at HUGHES Aerospace Divisions.

Development of systems utilizing advanced correlation and matched filter techniques for *High-Resolution Radar*, *Acoustic Detection & Classification* and *Pulse Doppler Radar* is being accelerated.

Specialists in Signal Processing, Circuit Design, Mechanical Design, Packaging Design, Performance Analysis and Project Engineering will be interested in the outstanding assignments now available.

Graduate engineers with experience in wide-band video amplifiers; high-resolution cathode ray tube circuits and applications (including ultra-linear sweep, gamma correction and dynamic focus); high-voltage power supplies; low-jitter timing circuitry; high-speed analog sampling circuitry; precision film transports; ultra-high speed film development; scan conversion systems; synthetic array radar systems; imagery recording, or similar fields—are invited to submit resumes.

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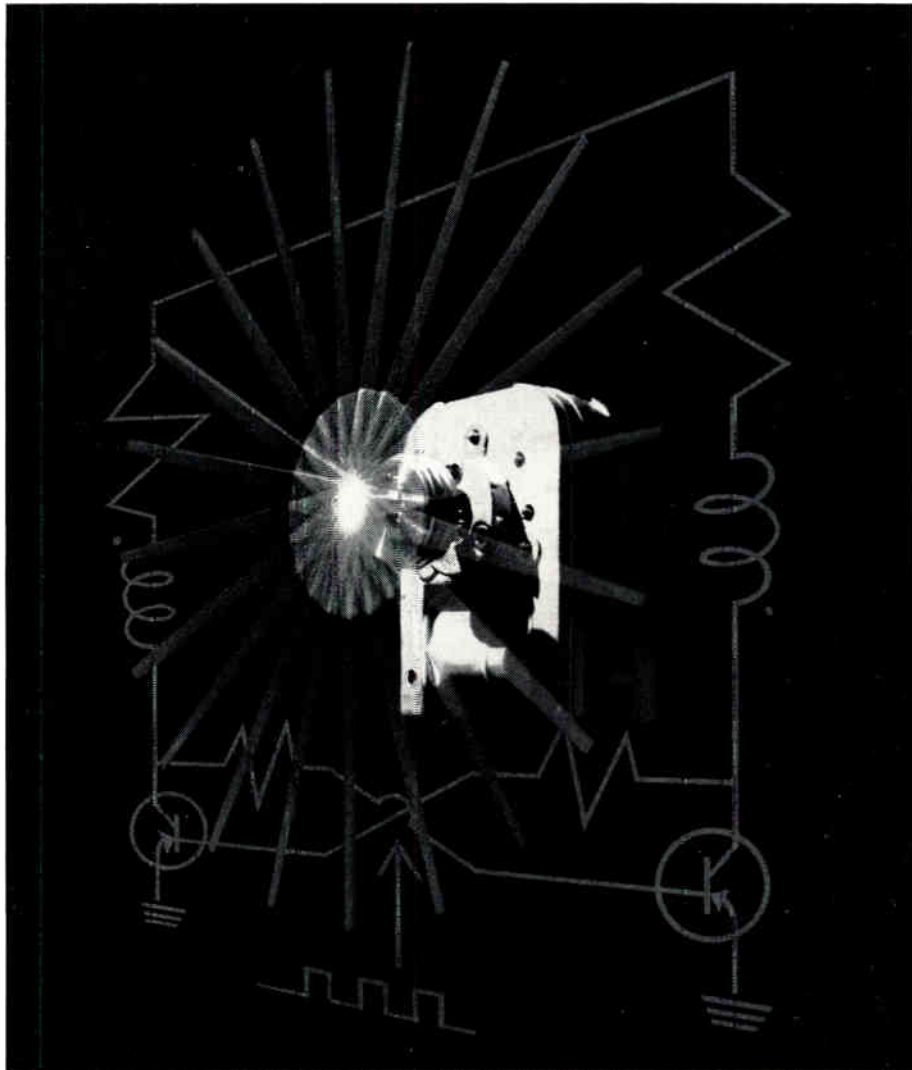
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HUGHES AIRCRAFT COMPANY  
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## Sigma Cyclonome® Stepping Motor

# Even a simple flip-flop can drive it

This is a typical Sigma Cyclonome drive circuit. Uncomplicated. Economical. Reliable. It requires no special input sequencing or phase shifting, thus bypassing the complicated and costly drive sources usually required by other stepping motors. In fact, the motor will operate from any source that provides current reversals or successive pulses—60 cps line, variable frequency oscillators, flip-flop circuits, relay drive, manual switching, commutating.

With any of these unusually simple and reliable drive sources, the Cyclonome Stepping Motor:

- *Delivers* precise 18° steps—at a rate of up to 1,000 steps per second.
  - *Provides* up to 5 inch-ounces of torque.
  - *Maintains* higher holding torque without standby power.
  - *Occupies* as little as 1 cubic inch of space.
- Cyclonome Stepping Motors are at work in

a wide variety of applications... chart and tape drives, analog-digital converting, impulse counting, step servos, remote positioning, timing, synchronizing.

A Sigma Application Engineer will be glad to help you put the Cyclonome Stepping Motor and its drive circuitry to work in your particular application. Or perhaps you would first prefer to read more about it. If so, send for a copy of the Cyclonome Drive Circuit Bulletin. Write to Box 53.

**SIGMA DIVISION**  **SIGMA INSTRUMENTS INC**  
Assured Reliability With Advanced Design/Braintree 85, Mass.

**Sigma's Cyclonome Stepping Motor is reliable because it's simple: only one part moves.**



This cutaway view of the Cyclonome Stepping Motor reveals its unique simplicity. Its only moving part is a rotor without windings, without brushes. The precise, incremental rotation of the rotor is due solely to magnetic force. For a

complete description of the Cyclonome Stepping Motor's design, construction, operating sequence and application possibilities, send for your copy of Cyclonome Stepping Motor Basic Bulletin. Write to Box 53A.

Report from

**BELL  
LABORATORIES**

$$F_S > F_{LV} + F_{SL}$$

Spontaneous spreading of a liquid on a solid occurs when surface tension of the solid ( $F_S$ ) is greater than the sum of the surface tension of the liquid in contact with its vapor ( $F_{LV}$ ) and the interfacial tension between the solid and liquid ( $F_{SL}$ ).

## A NEW WAY OF LOOKING AT ADHESION

It is well known that any two clean solids will form a strong joint if their contacting surfaces are ideally flat and smooth. But real surfaces are rough and do not provide the proper interfacial contact necessary for forming a strong joint.

If, however, one of the materials is a liquid that *spreads* spontaneously over the second material, interfacial contact occurs extensively and rapidly. Thus the key to making strong joints is to have one material

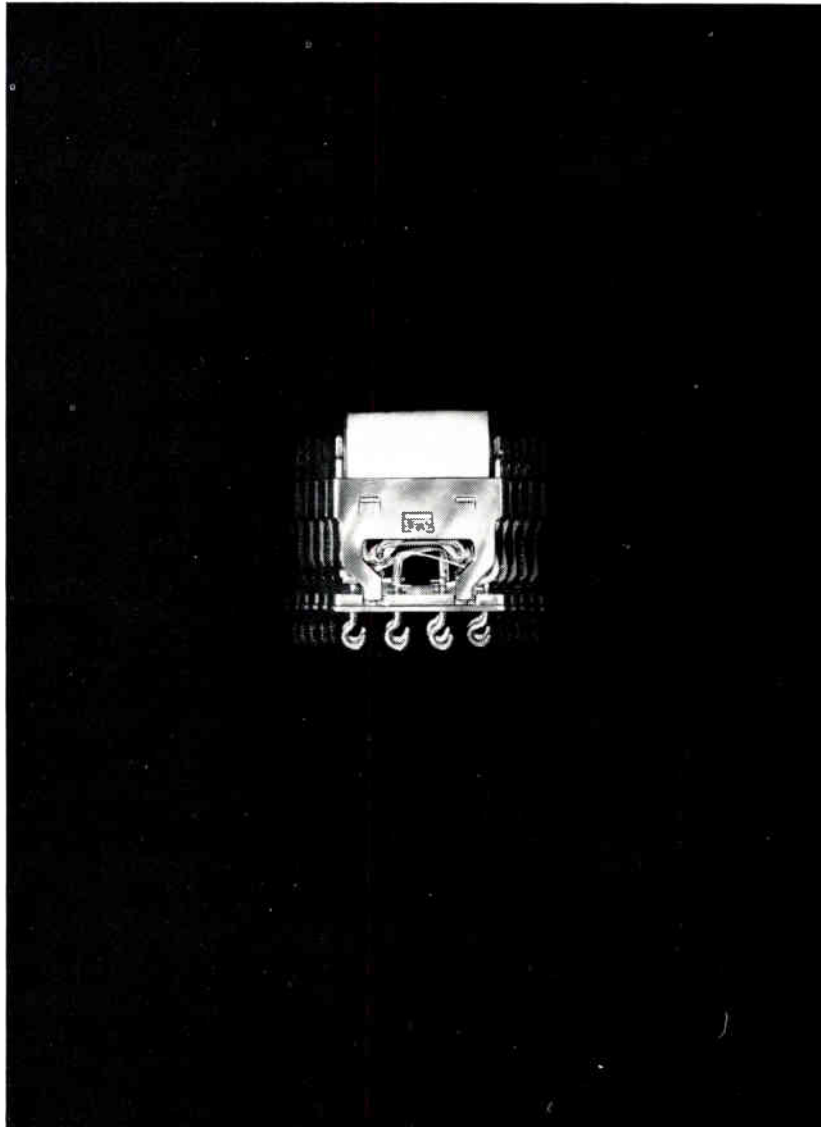
in the form of a liquid which "wets" the second material.

By the proper application of this simple theory of adhesion, research chemists at Bell Laboratories have made strong adhesive joints between what had previously seemed to be "unbondable" materials—for example, epoxy and solid untreated polyethylene. The procedure is first to cure the epoxy to its solid form, and then to bring it into contact with molten polyethylene. The molten polyethylene

spreads on the epoxy and when solidified forms a strong joint.

While a complete understanding of the bonding process must await further research, detailed consideration of the spreadability concept seems to be invaluable in dictating which one of a pair of materials must be put into the liquid state to form the joint. BELL TELEPHONE LABORATORIES, World Center of Communications Research and Development.





## This Relay Obeys A 50-mw Signal...Even at 30 g's

The Sigma Series 32 contacts don't chatter during vibration of 30 g's to 5,000 cycles, or shock of 100 g's. The unique cross-leaf contact structure and magnetic circuit with horizontal coil also result in the 32's ability to switch reliably up to 2 amps, with an input signal as small as 50-mw—pulsed, sustained or gradually changing.

The Series 32 is a polarized, subminiature DC magnetic latching relay. Its con-

tacts are held magnetically in the position last energized—without continuous coil signal.

The relay is rugged, compact and operates at temperature extremes of  $-65^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . So reliable, the Series 32 helps shoot missiles, orbit satellites—and keeps computers and office equipment humming.

To help you take advantage of the outstanding capabilities of this relay, we'd

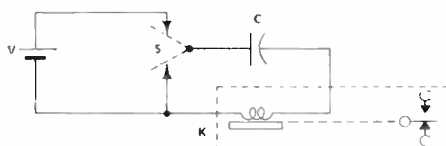
like to send you our Design Bulletin describing nearly 1,000 standard variations of the Series 32. Write to Department #52... or ask our application engineers to help you select the right switching control for your particular need.

You can choose from more than 100,000 different standard Sigma relays—both latching and non-latching, electromagnetic and solid state.

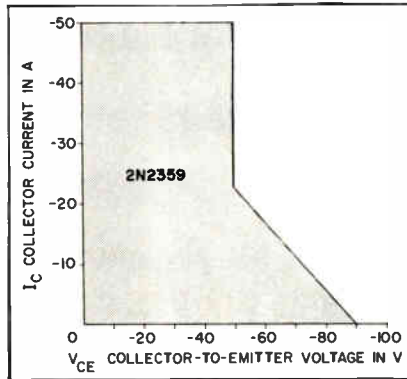
SIGMA DIVISION  SIGMA INSTRUMENTS INC  
Assured Reliability With Advanced Design/Braintree 85, Mass.

### Is your circuit power limited?

Magnetic latching relays can conserve power when used in a circuit like this. For example, the Sigma Series 32 requires only 950 micro-joules with a matching RC constant of 450 microseconds. Single pulse operation of relays is covered more completely in Sigma technical paper APN 2.3. Write Department 52A for a copy.



# Avoid secondary breakdown during switching by using SOAR specified DAP transistors from Bendix.



Our DAP® (Diffused Alloy Power) transistors can handle your fast-switching-at-high-current circuit requirements up to 4500 watts. Built-in reliability is assured by dynamic sweep testing of every DAP before it leaves Bendix. There are 33 DAP transistor types with currents ranging from 3 to 50 amperes and voltages to 200 volts which are SOAR (Safe Operating Area) specified. Switching is accomplished in microseconds or less at temperatures up to 110°C.

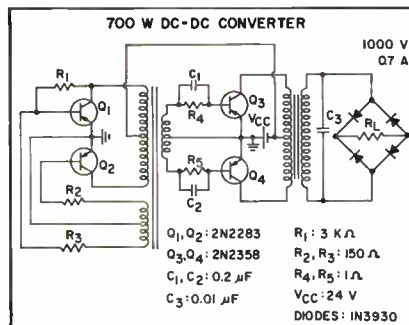
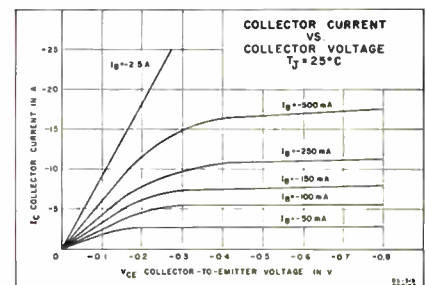
	3 AMP	10 AMP	25 AMP	50 AMP
CHARACTERISTICS	2N2282-84 2N2467-69	2N1073.A,B 2N1430 2N2212 2N2288-96	2N1651-53 2N1751 2N2285-87 2N2636-38	2N2357-59
V <sub>CE</sub> (V)	60-200	40-120	60-120	60-120
I <sub>C</sub> (A)	3	10	25	50
P <sub>c</sub> (W)	5	60	100	170
T <sub>j</sub> (°C)	110	110	110	110
h <sub>FE</sub>	30-90 @ 0.5 A	20-120 @ 5 A	20 min @ 25 A	15 min @ 50 A
V <sub>CE(S)</sub> (V)	0.4 max @ 1 A	0.5 max @ 5 A	0.65 max @ 25 A	0.9 @ 50 A

With the new SOAR principle you can specify the exact DAP transistor for your switching or DC application without worry of transistor failure. How? SOAR takes into consideration any type of load; inductive, resistive or capacitive. SOAR takes into consideration the maximum current and the maximum voltage switched. SOAR eliminates complicated calculations and complex derating for operation at various repetition rates, pulse widths, and case temperatures. See SOAR envelope above for 2N2359.

Inverter circuits using SOAR specified DAP transistors operate more efficiently because of fast collector fall time and low saturation resistance. In horizontal deflection circuits

for TV and CRT applications, DAP transistors excel because of their high breakdown voltage and fast collector current fall time.

Your other low saturation resistance requirements are fulfilled by DAP transistors. For example, the saturation resistance of the 2N2357 through 2N2359 DAP transistors at 50 amperes is 0.018 ohm maximum.



Reliability is improved by using DAP transistors. Failure rates of 0.001% per 1000 hours have been achieved in military and space applications. Ruggedized DAP transistors exceed the mechanical and environmental requirements of MIL-S-19500.

For more data on our DAP line, or for applications information, call your nearest Bendix sales office.

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# WHAT'S NEW

"The changing STATE-OF-THE-ART  
in the Electronic Industries"

## NEW OSCILLOSCOPES

THREE DC-TO-50MC OSCILLOSCOPES—Types 547, 546 and 544 have been announced by Tektronix, Inc., Beaverton, Ore. Primary differences of the scopes are in their horizontal-deflection systems.

Automatic display switching—featured in the Type 547—is provided by alternate electronic switching between two identical wide-range time bases—0.1 $\mu$ sec./cm to 5 sec./cm. In this mode, the vertical signal from a single-channel plug-in can be alternately displayed on two different time bases. With a dual-trace plug-in unit, channel 1 can be locked to one time base, and channel 2 to the other. For many uses, one has dual-beam performance.

When the two time bases are used for delayed sweep operation, a continuously-variable and calibrated delay is available from 0.1 $\mu$ sec. to 50 sec. In this mode, each vertical signal—from a single or multi-channel plug-in—can be alternately displayed on time base B intensified by A, and time base A delayed by B, as shown in Fig. 1.

A front-panel control allows individual adjustment of trace separation when using automatic display switching.

All 3 scopes use an illuminated internal graticule with 6 x 10 cm viewing area. A new CRT with 10kv accelerating potential provides a brilliant trace and small spot size.

Triggering is stable over the full passband of the vertical-deflection system, providing triggered presentations to beyond 50MC. Triggering circuitry includes automatic mode with bright reference trace, regardless of sweep rate.

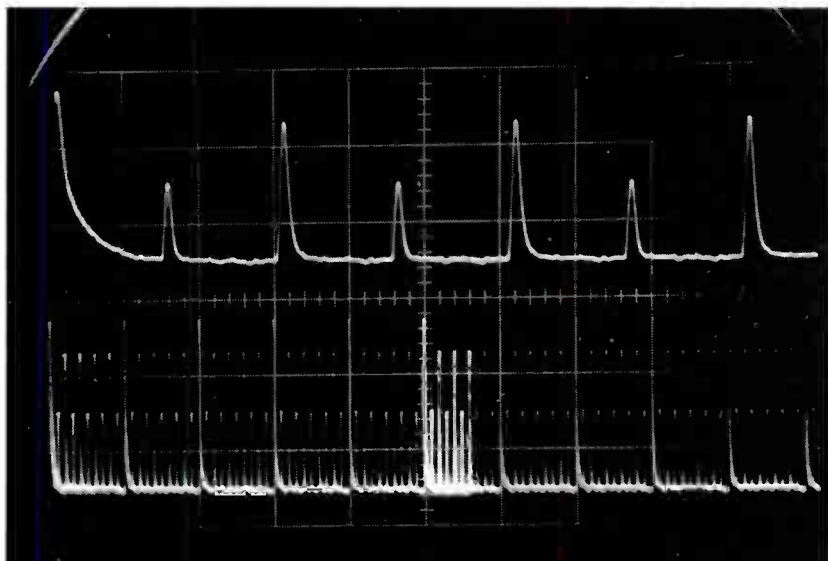


Fig. 1: Simultaneous display (1) of the same pulse train on two display-switched time bases. Brightened portion of lower sweep is displayed on expanded and delayed upper sweep. Signal source is connected to input of a single channel vertical plug-in unit. Photo below shows the 547 oscilloscope in use in the laboratory.



## CATALOG PRINTING BY COMPUTER

A NEW ELECTRONICS COMPOSITION TECHNIQUE, which transfers catalog information from magnetic tape to microfilmed pages, may cut over-all production costs of printed catalogs as much as 40%. Navy tests indicate.

Information stored in one computer is fed into a computer-recorder which converts the data from magnetic tape to letters, figures, graphs and charts. This method is done at a speed of 7,000 lines/min. The system electronically reduces letter width and white space between printed lines and letters with little or no loss in readability.

The Naval Aviation Supply Office, Phila., Pa., applied the technique to printing one section of its stock list catalog. In the test run, the one section of the catalog shrank from 28,000 to 16,000 pages.

A type 1A1 Dual-Trace Plug-In Preamp provides dc-to-50MC passband at 50mv/cm to 20v/cm, and dc-to-28MC passband at 50mv/cm. Channel 1 and channel 2 amplifiers can be cascaded to obtain about 500 $\mu$ v/cm sensitivity at 2 cps to 15MC passband.

Type 546 uses sweep delay with sweep generators identical to those in Type 547, but does not have the automatic display switching feature.

The Type 544 instrument has the same vertical characteristics as Types 546 and 547, but with one time base (0.1 $\mu$ sec./cm to 5 sec./cm) and a X2, X5, X10, X20, X50 and X100 sweep magnifier.

# WHAT'S NEW

## COMPUTERIZED TELEGRAPH SYSTEM

A COMPUTERIZED INTERNATIONAL PUBLIC TELEGRAPH SYSTEM has been announced by RCA Communications, Inc. Now undergoing final tests, the new Electronic Telegraph System (ETS) is to replace the "torn-tape" system now in international use.

The new system will do in a fraction of a second what now takes many minutes to accomplish with the perforated tape relay system. It will receive, examine, store, route and transmit messages to and from customers all over the world.

The system makes use of two high-speed digital computers—one operates the system, while the other is on stand-by. Each can handle 2.5 million characters, or 400,000 words/sec. Messages to and from about 70 countries will move through the electronic complex as fast as the existing 100 receiving and transmitting channels can handle the load.

In addition to automatically receiving and transmitting messages, the on-line computer can identify any one of 7,000 cities, states and countries in three languages and any one of 12,000 internationally registered coded addresses. It can also handle any mixture of h-f radio channels, submarine cable, radio satellite or wireline channels.

The computer can check the status of all messages in transit and point out in advance potential backlog conditions. This enables the operator to call up additional channels to prevent message delays.

Each message entering the system is transmitted by precedence in chronological order. But, if all the



Thompson H. Mitchell, President of RCA Communications, looks on as engineer R. K. Andres demonstrates the command and interrogation features of the new Electronic Telegraph System.

proper outgoing channels to a city or country of destination are busy, the computer will store the messages for these channels until one of the circuits is open. Then it selects, again in chronological order, the highest priority message in its memory drum and sends it along.

All messages enter the complex through the five-unit perforated tape message system. Each message is preceded by an internationally-approved "pilot-line" which contains all instructions for the computer, including a four-letter destination code, two-letter priority, class of service code, original code, and the number of paid words in the message.

A copy of all traffic passing through the system will be recorded on magnetic tape for future reference.

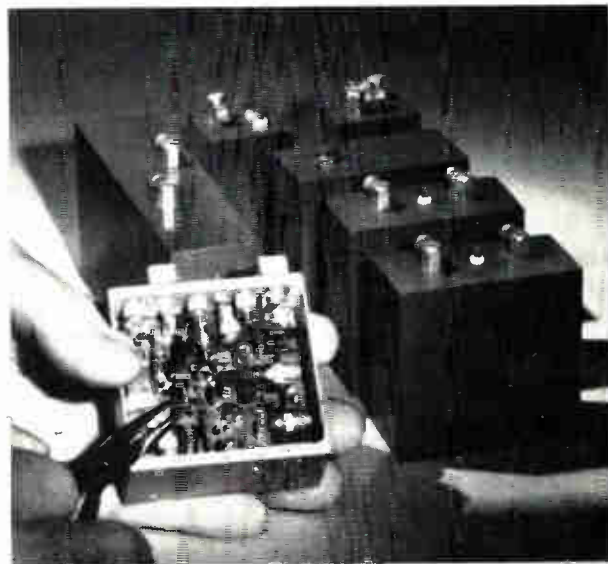
## VHF TELEMETRY TRANSMITTER

A UHF-FM TELEMETRY TRANSMITTER, which operates at 2.2 - 2.3 gc, is being developed by Electronics Communications, Inc., St. Petersburg, Fla., for the Navy.

The UHF transmitter is one of the first to be built in modular form and with wide-band modulation. While the unit is primarily for missiles, spacecraft, and supersonic aircraft, it may also be used in any portable telemetry.

Six separate modules make up the transmitter. Total volume of the modules is 47 cu. in., and the weight is 42 oz. Power output is 2 to 3w. Because of the variety of possible configurations, the transmitter fits readily into cramped rockets and spacecraft. The power supply can be connected to either ac or dc primary sources.

Six separate modules make up the transmitter. State-of-the-Art techniques accomplish modulation fidelity.



# TRYGON Half Racks



Model HR40-5A

New  
higher amp  
models available:

Model	Volt	Amps	Regulation	Ripple	Price
HR20-1.5*	0-20	0-1.5	0.01% line	0.25 mv	\$164
HR40-750*	0-40	0-0.75	0.05% load	0.15 mv	\$149
HR20-5A	0-20	0-5	0.01% line 0.01% load	0.5 mv	\$299
HR20-10A	0-20	0-10			\$379
HR40-2.5A	0-40	0-2.5			\$299
HR40-5A	0-40	0-5			\$349
HR60-2.5A	0-60	0-2.5			\$379
HR60-5A	0-60	0-5			\$449

NEW

NEW

\*Single Meter Units

## ... the most versatile power supplies going!

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

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

**For complete specs**—on the Half Rack Series as well as our catalog showing the complete line of over 100 Trygon Power Supplies, write to us today. Address: Dept. EI-7.



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

### FEATURES

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

# TRYGON

## ELECTRONICS INC.

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# FIELD EFFECT TRANSISTORS UNDER NUCLEAR RADIATION

Field effect transistors, like other semiconductors, are affected by nuclear radiation. However, some of the changes are not the same as for conventional transistors; in fact, they are exactly the opposite.

PREVIOUS LITERATURE ON THE NUCLEAR RESISTANCE of field effect transistors<sup>1</sup> (FET) has not emphasized that certain operating parameters degrade opposite to that secured with conventional transistors exposed to a nuclear environment. Transistors exposed show increased  $I_{CBO}$ , or in grounded emitter operation an increase in  $I_C$ , whereas field effect transistors show a decrease in  $I_{DSS}$ . For the circuit design engineer this is an important, and heretofore undisclosed parameter. Also, it should be noted that the gate voltage required for  $I_{DSS}$  cutoff decreases, and therefore the use of a fixed bias voltage would lower the nuclear resistance of a circuit using the FET.

\* \* \*

While the author did not measure gate current, its value (which reflects input impedance) may be an important design parameter. The literature<sup>2</sup> reports that severe increase in gate leakage current has been observed, probably induced by the high level of ionization. With the high component input impedance, the results observed might have been leakage induced in the instrumentation system, rather than in the test specimen. The FET's used in this test were too badly degraded to permit post irradiation test of input

impedance, and no provision was made for an on site measurement.

## Construction may be the Difference

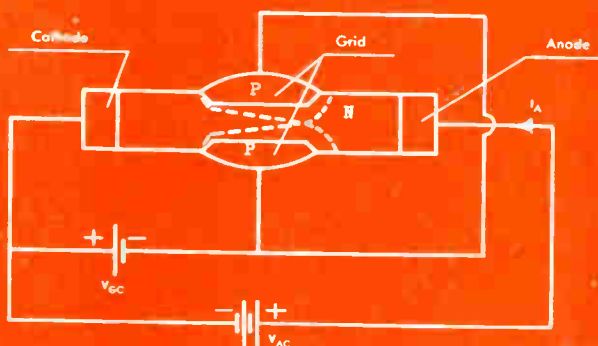
The difference in performance degradation of the parameters may be due to the completely different modes of construction and operation of the FET and transistor. Fig. 1 represents a field effect transistor. The FET consists of an N or P bar of silicon, with two ohmic contacts, cathode and anode, on either end of the bar. Two junctions (p-n shown) are built into the middle of the bar and serve as the grid or gate. Planar made FET's, although of different geometry, basically operate by the same mode.

A negative bias applied to the grid projects a depletion layer, shown in broken lines (Fig. 1), from the junction(s) into the silicon. This increases the resistance between the anode (drain) and cathode (source) of the unit, and gives rise to a triode tube type output characteristic.

As the anode voltage is increased, the grid (gate) is reverse biased by the voltage drop due to the anode current. This reverse bias also causes a depletion layer to extend into the channel from the gate junction. At that point, a further increase in anode voltage will not result in much increase in anode current, causing the output characteristics to closely resemble those of the thermionic pentode. A high impedance voltage signal on the gate is thus made to modulate the low impedance current through the channel. Swapping anode and cathode terminals result in little, if any, change of operating parameters for most FET's, because of their symmetrical construction.

The anode potential, at which the saturation of anode current occurs, is known as the "Pinch-Off Voltage." The anode current flowing through the device after the Pinch-Off Voltage has been reached is known as Pinch-Off Current. With zero grid bias, the Pinch-Off Current is the maximum specified

Fig. 1: Physical construction of a field effect transistor. Negative bias to grid projects depletion layer (broken lines).





anode current of the transistor. The term, Pinch-Off Current and its designation may cause some confusion because of the non-uniformity existing between manufacturers. Siliconix calls this reference  $I_{DSS}$ . Texas Instruments Incorporated (T.I.) calls the same reference, Zero-Gate Voltage, Drain Current. Another term could be, Drain Saturation Current at Zero-Gate Voltage. The term, Pinch-Off Drain Current, is used by T.I. (on their data sheet) to refer to the very low drain current that flows when  $V_{GS}$  is greater than  $V_P$ .

### A Normally "On" Device

Unlike transistors which are normally "off" and must be biased "on," the field-effect transistor is an "on" device which is biased towards "off." Negative voltage is applied to the grid (referenced to the cathode) as with a vacuum tube for the N channel FET. The P channel FET operates similarly, except the gate and anode potentials are reversed.

As shown in Fig. 1, there are no junctions in the current path of this device, unlike the transistor, therefore the major source of noise is the thermal noise of the anode-to-cathode resistance. This is typically 1 to 10 K ohms. Of more importance, in considering nuclear resistance is the lack of emitter and collector junctions. These junctions in the conventional transistor change contact potential and leakage resistance under irradiation, thus producing shifts in their operational specs. Also, the field effect device operation depends on majority carrier characteristics as differentiated from the minority carrier used in transistors.

Five types of field effect devices were selected for the neutron irradiation reported here, as part of a Litton test. Their mutual conductance, gm, was measured during the irradiation. The gm was computed from differential measurements by dividing the

observed change in drain or anode current by a predetermined change in gate voltage, with the device normally turned "on." The anode-cathode voltage ( $V_{DS}$ ) was 6 vdc. Gate voltages used were zero and + 1.5 vdc.

### The Radiation Exposure

The exposure, to which the devices were subjected, was found by Litton using their microfoil techniques. The total gamma-ray exposure, measured in ergs/gm (C), was  $2.7 \times 10^{10}$ . This was not enough exposure to affect the inorganic semiconductor, as discussed later. The FET performance is reported versus an epithermal neutron exposure ( $nv_e t$ ), i.e., all neutrons/cm<sup>2</sup> with an energy above 0.48 ev. The irradiation was carried out at 55°C ambient temperature at General Dynamics ground test reactor (GTR).

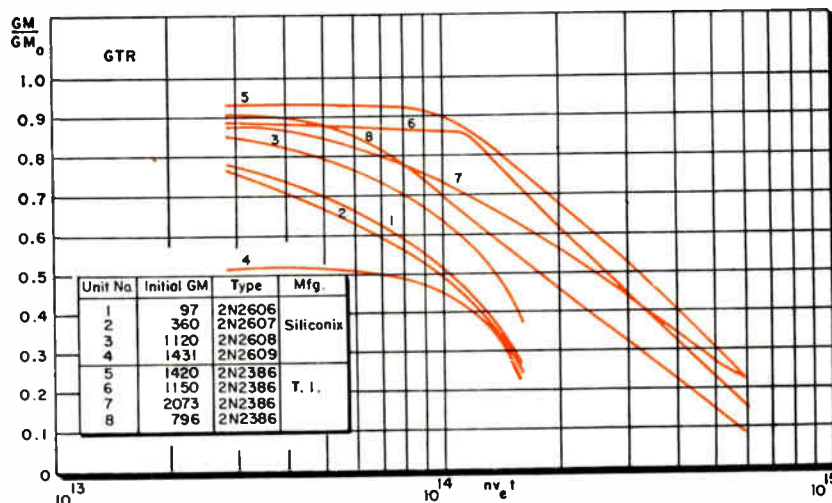
Fig. 2 presents the mutual conductance of the devices tested, as normalized, by dividing the values during irradiation by the baseline values,  $gm_0$ .

The radiation exposure to degrade the average gm of the 8 specimens to 0.7 of the baseline value ( $gm/gm_0 = 0.7$ ) was about  $1 \times 10^{14}$  epithermal neutron/cm<sup>2</sup> ( $nv_e t$ ). This is about the same level of exposure needed to damage high alpha cutoff frequency transistors<sup>3, 4</sup> ( $B/B_0 = 0.7$ ).

The characteristics of field effect devices depend mainly on the majority carrier characteristics of the material, while transistors depend on both carrier properties. The minority carrier properties in transistors are the first to suffer damage, so it appears possible that majority properties are the limiting factor in nuclear resistant semiconductors. If so, it would appear that regardless of the transistor or FET geometry and alpha cutoff (which inversely is proportional to nuclear resistance) that ultimate component resistance could only be from materials other than silicon or germanium. It should be noted

Fig. 2: The mutual conductances ( $gm/gm_0$ ) of 5 types of FET's are shown versus an epicadmium nuclear exposure.

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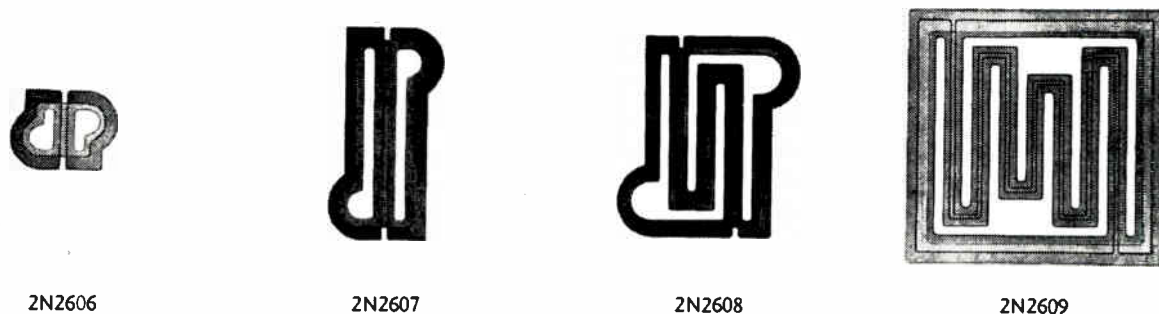


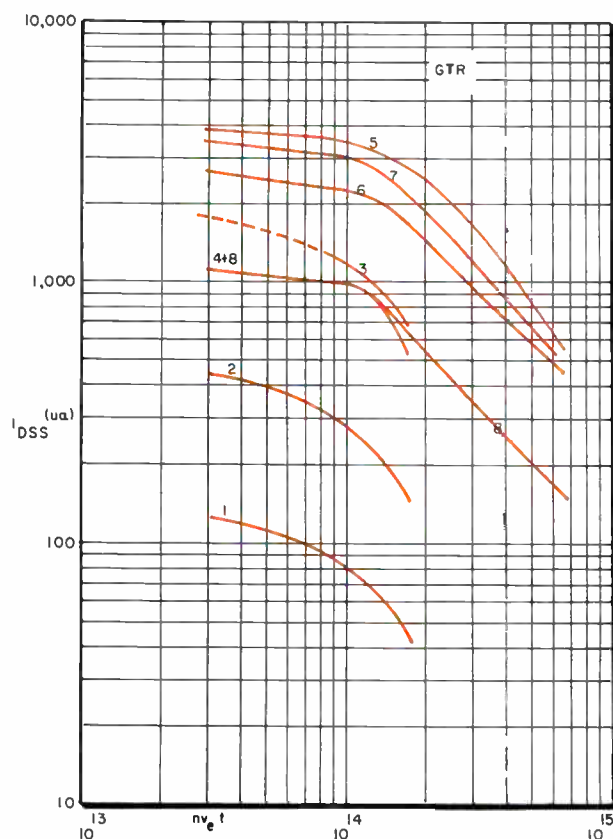
Fig. 3: Micro-photos of four Unifets on 30-mil square silicon dice. They may be operated with source and drain leads interchanged.

## FIELD EFFECT TRANSISTORS (Continued)

that the doping of germanium or silicon, which affects its bulk ohm/cm resistance, controls to some degree the resistance of the material to nuclear damage.<sup>3</sup> Thus some FET devices may have a higher nuclear resistance than others, even though all depend on majority carrier properties (Fig. 2).

That the premise, geometry (of the FET) does not greatly effect nuclear resistance, is shown by the graphs of 4 Siliconix FET's (Fig. 2). Fig. 3 shows their shapes. The scatter between the 4 Siliconix and

Fig. 4: Graph shows the effect of nuclear radiation on drain current for 8 FET's empirically tested. See Fig. 2 for numbers.



T.I. devices (geometry unknown) is probably a function of doping (ohm/cm  $R$ ), and doping material. As for decreasing the ohm-cm with doping to increase radiation tolerance, we should note that when the channel resistance is decreased, so is the breakdown voltage. Note:  $BV_{DGS}$  of 2N2386 is 15 v.;  $BV_{DGS}$  of 2N2606 series is 30 v. minimum.

It is believed the loss of electron mobility is the prime cause of gm degradation. Supporting this assumption is the fact that the bulk material shows an increase in resistance with nuclear exposure. The resistivity changes in silicon are caused by the Frenkel or lattice defects. This tends to decrease the number of majority carriers and increase the minority carriers until the numbers are equal, i.e., when the material becomes intrinsic. This effect is noticed for silicon after a neutron exposure of about 1(14) nvt.

The result of irradiation of the FET results in increased resistance in the bulk silicon material, with a consequent decrease of  $I_{DSS}$ . In the transistor this effect is masked because damage in the collector and emitter to base junctions causes an increase in collector current. The decrease of  $I_{DSS}$  (fixed  $V_{DS}$ ) (gate zero biased) is shown in Fig. 4. This data was measured on the same transistors shown in Fig. 2, at the same temperature and exposure at which gm was recorded. This damage effect is caused by the neutron environment, and similar results may be found with other devices.

### Testing Silicon Thermistors

The data secured with the test of silicon thermistors<sup>5</sup> offers an interesting correlation. The thermistors selected for test were Texas Instruments' Sensistors type P-100 and TC-1/8. Both were rated at  $100 \pm 10\%$  ohms @  $25 \pm 0.2^\circ\text{C}$ . Their wattage rating and casing differed, but both elements were of  $0.019 \times 0.019 \times 0.215$  inch bars of 0.6 to 0.7 ohm-cm arsenic-doped silicon. Contacts are ohmic, and are made with lead-gold alloy. This device approximates the alloy bar FET without gate electrodes.

The data presented hereafter is only capable of limited extrapolation to FET's or other Sensistors, because the ohm-cm resistance and doping agent may be different.

Litton Systems tested the first pair of Sensistors in a Co-60 facility to  $1.25 \times 10^{10}$  ergs/gm(C) ( $\sim 1.5 \times 10^8$  r) at an environmental temperature of  $\sim 25^\circ\text{C}$ . As Fig. 5 shows, throughout and to the conclusion of the irradiation there was no dose rate effect or measurable damage. Inasmuch as the threshold point for minority carrier damage is about  $1 \times 10^8$  R (higher for majority carrier damage) the results secured were not unexpected. A second pair of Sensistors were tested in the combined neutron-gamma environment of Convair's ground test reactor (GTR). Chamber temperature was kept at  $55^\circ\text{C}$ . As seen in Fig. 6, several important damage effects occurred. Almost immediately from the start of irradiation, the Sensistors increased in resistance. After irradiation, both Sensistors had a non-linear negative resistance-temperature coefficient, whereas before they possessed a linear positive coefficient. A possible explanation for this is the change of n-type material to p-type, or *vice-versa* when they are exposed to radiation.

The data shown in Fig. 6 records the exposure in neutrons/cm<sup>2</sup>,  $E_n > 2.9$  Mev (i.e.  $nv_e t$ ). This is approximately corrected to  $nv_e t$  (to conform with the other graphs) by multiplying the  $nv_e t$  values by a constant of 4.5. Thus 1(14)  $nv_e t$  is about 4.5 (14)  $nv_e t$ . The resistance increase shown at this point for the Sensistors approximates that value required for the  $I_{DSS}$  decrease of some of the 2N2386 FET's (Fig. 4) at 1(14)  $nv_e t$ . Better correlation is not obtained, probably because the doping materials and degree of doping are not similar. The manufacturer's of the FET's tested would not divulge the doping material or the channel bulk ohm-cm resistivities, thus comparison with the Sensistor is limited.

### Conclusions

The performance of test samples, as reported here, can be construed to represent only the actual samples, and does not represent a recommendation or condemnation of any specific company or its products. The experimental conditions were not controlled by the manufacturers. Although other tests with like

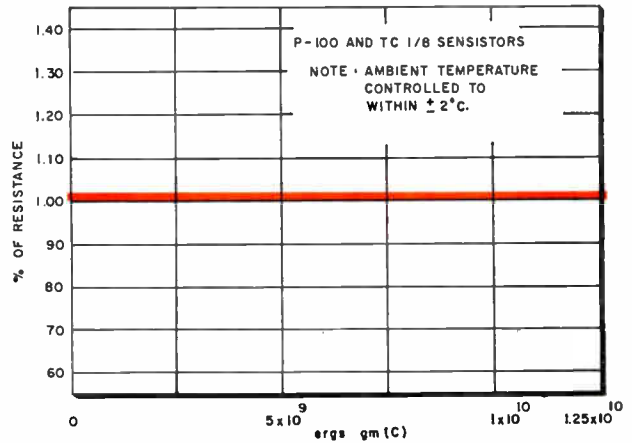


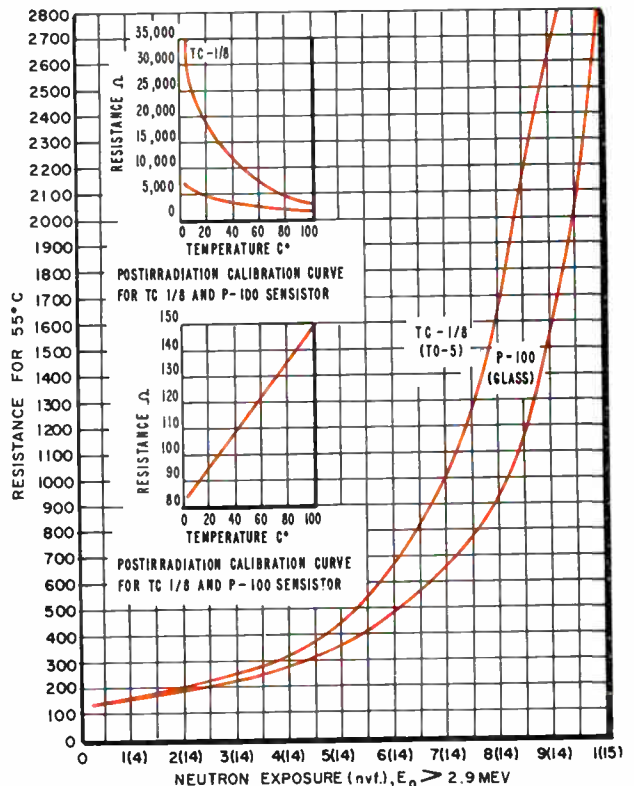
Fig. 5: Co-60 gamma irradiation of Sensistors show no effect.

devices (same manufacturers and part numbers) have given correlation, within one magnitude of exposure for a specified gm degradation, such tests with a limited number of specimens does not reveal the failure distribution. The designer, to be conservative, should derate the exposures shown (for a specified gm/gm<sub>0</sub>) by one magnitude.

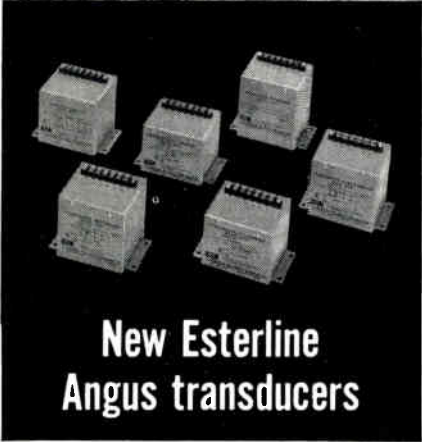
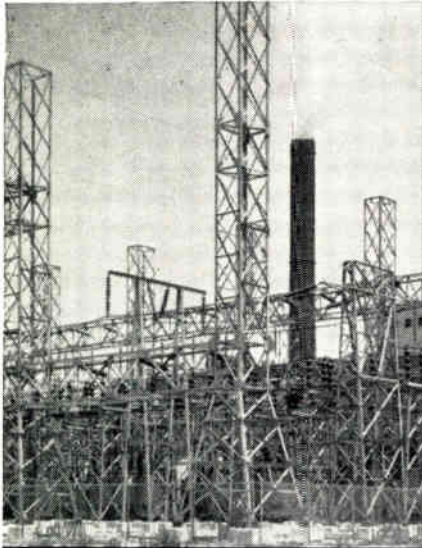
### References

1. Kaufman, Alvin B., "Do Field Effect Transistors Resist Nuclear Radiation?", *Electronics*, July 13, 1962.
2. Babcock, R. V., "Radiation Damage to Unipolar Transistors", *American Nuclear Society Transactions*, Vol. 4 No. 1, June, 1961.
3. Gardner, L. B., and Kaufman, A. B., "NGL Platform Nuclear Radiation Program," Vol. 1, *ASD Technical Report* 61-511.
4. Gardner, L. B., and Kaufman, A. B., "The Feasibility of Nuclear Resistant Inertial Platform and Control Systems," *NAECON* 1962.
5. Kaufman, Alvin B., "Semiconductor Thermistors in Extreme Environments," *Proceedings 6th MIL-E-CON* June 1962, pps. 337-339.

Fig. 6: Sensistor temperature probe variation in resistance as a function of neutron exposure, temperature held at  $55^\circ\text{C}$ .



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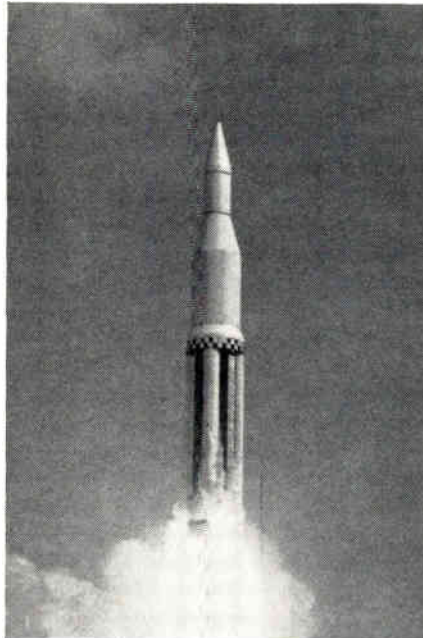
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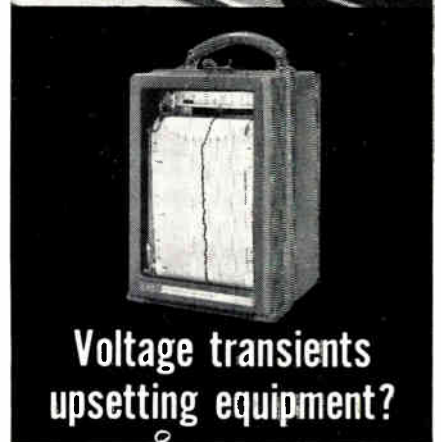
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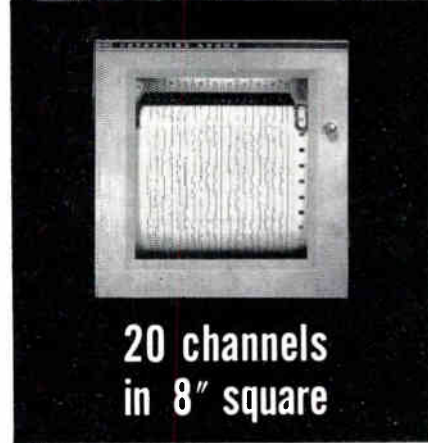
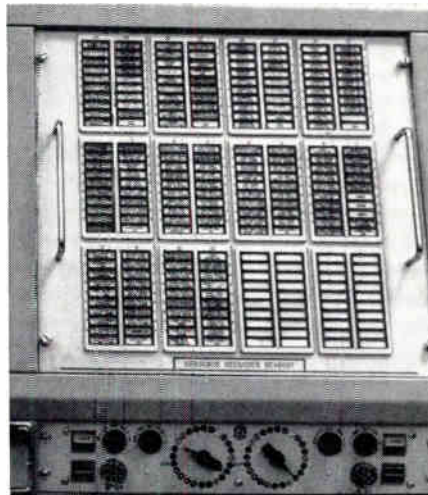
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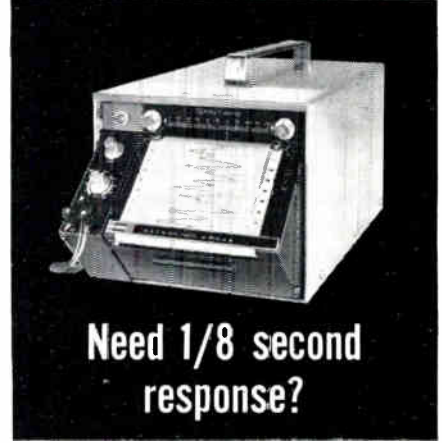
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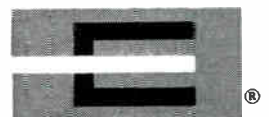
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Radio frequency preamplifiers are usually rated by their Noise Figure. But it would make more sense to rate them by signal level. This can so easily be determined by the few measurements and calculations described here.

# RATING PRE-AMPS BY "MINIMUM DETECTABLE SIGNALS"

WHEN A RADIO FREQUENCY PREAMPLIFIER is to be evaluated, it has been a common custom to pay a great deal of attention to its noise figure. The noise figure has been considered as if this is the only parameter which gives a key for correct evaluation of the r-f preamplifier. This over-emphasis on the noise figure is being realized.<sup>1</sup> There is a more important factor than noise figure for the evaluation, this is the minimum detectable signals (MDS) of the preamplifier.

If the r-f preamplifier of a microwave communication system cannot pick up signals, the system is useless. If the preamplifier of a radar receiver failed to pick up its echo, the radar is not usable. Therefore, the minimum detectable signals (MDS) of the preamplifier is important.

\* \* \*

The purpose here is to propose a method of measuring the minimum detectable signal (MDS) of a microwave preamplifier, or a millimeter wave preamplifier using an auxiliary receiver. In most microwave receivers using microwave preamplifiers, the MDS of the receiver is not that of the preamplifier. The MDS of the preamplifier itself is always masked by the noise of the main receiver, or influenced by the high gain of the following receiving system.

Even if a low noise auxiliary receiver is used for the measurement of the MDS of a preamplifier, the gain and the noise of the auxiliary amplifier tend to more or less influence the MDS of the system. Thus, the MDS of the system is never exactly equal to the MDS of the preamplifier itself. The MDS of the system is therefore not to be used to evaluate the preamplifier itself. The method proposed will give the actual value of the MDS of the preamplifier alone, regardless of the auxiliary receiver used.

## The Theory

If an auxiliary receiver of gain  $G_2$ , noise bandwidth  $B_2$  and noise figure  $F_2$  is connected after a microwave preamplifier of noise bandwidth  $B_1$ , gain  $G_1$ , noise figure  $F_1$  and available noise output  $N_1$ , then the available overall noise output  $N_{12}$ , including

the auxiliary receiver and the preamplifier is given as follows:<sup>2</sup>

(a) when  $B_1 > B_2$

$$N_{12} = \left( N_1 \frac{B_2}{B_1} \right) G_2 + (F_2 - 1) k T_o B_2 G_2 \quad (1)$$

where  $T_o$  is the input noise temperature of the amplifiers and  $k$  is Boltzmann's constant. The MDS of the overall system is defined then as follows:

$$P_{s12} = \frac{N_{12}}{G_1 G_2} \quad (2)$$

substituting (1) into (2),

$$P_{s12} = \frac{N_1}{G_1} \frac{B_2}{B_1} + \frac{F_2 - 1}{G_1} k T_o B_2 \quad (3)$$

The MDS of the first stage alone is defined as

$$P_{s1} \equiv \frac{N_1}{G_1} \quad (4)$$

Combining (3) and (4), and solving for  $P_{s1}$ ,

$$P_{s1} = \left( P_{s12} - \frac{F_2 - 1}{G_1} k T_o B_2 \right) \frac{B_1}{B_2} \quad (5)$$

Thus the MDS of the overall system  $P_{s12}$  is *different from the MDS of the preamplifier alone* and needs some correction.

Eq. 5 is simplified if  $F_2 \gg 1$ . Dropping 1 from (5) and using the definition

$$F_2 \equiv \frac{P_{s2}}{k T_o B_2},$$

$$P_{s1} = \left( P_{s12} - \frac{P_{s2}}{G_1} \right) \frac{B_1}{B_2} \quad (5a)$$

when  $B_1 < B_2$ ,

$$N_{12} = N_1 G_2 + (F_2 - 1) k T_o B_2 G_2 \quad (6)$$

In a way similar to before, it is shown that

$$P_{s1} = P_{s12} - \frac{F_2 - 1}{G_1} k T_o B_2 \quad (7)$$

Here again  $P_{s12}$  is different from  $P_{s1}$  and needs some correction.

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Microwave preamplifiers, such as this one by American Electronic Labs., could be evaluated on the basis of the minimum detectable signals. This may emerge as the method preferred over the noise figure method.



Eq. 7 is simplified if  $F_2 \gg 1$ . In a way similar to (5a)

$$P_{s1} = P_{s12} - \frac{P_{s2}}{G_1} \quad (7a)$$

Examinations:

Eqs. 5 and 7 can be confirmed from a well established relation<sup>1,2,3,4</sup>

$$F_{12} = F_1 + \frac{F_2 - 1}{G_1} \quad (8)$$

where  $F_{12}$  is the overall noise figure of the system, and  $F_1$  is the noise figure of the preamplifier. According to the definition of the noise figure,<sup>2</sup>

$$F_1 \equiv \frac{P_{s1}}{k T_o B_1} \quad (9)$$

$$F_{12} \equiv \frac{P_{s12}}{k T_o B_{12}} \quad (10)$$

where  $B_{12}$  is the overall noise bandwidth of the system. Substituting (9) and (10) into (8) and solving for  $P_{s1}$ ,

$$P_{s1} = \left( P_{s12} - \frac{F_2 - 1}{G_1} k T_o B_{12} \right) \frac{B_1}{B_{12}} \quad (11)$$

If  $B_1 > B_2$ , then  $B_{12} = B_2$ , and (11) is reduced to (5).

If  $B_1 < B_2$  then, <sup>1,2,3</sup> starting with and substituting (9) and (10) into (12) and solving for  $P_{s1}$ , with  $B_{12} = B_1$ , (12) reduces to (7), where

$$F_{12} = F_1 + \frac{F_2 - 1}{G_1} \frac{B_2}{B_1} \quad (12)$$

### The Procedure

The MDS of the preamplifier is obtained by the following procedure.

1. Measure  $B_1$  and  $B_2$ .
2. If  $B_1 > B_2$ , then use (5) or (5a). If  $B_1 < B_2$ , then use (7) or (7a).
3. Measure  $P_{s12}$ ,  $G_1$ ,  $F_2$ , and  $T_o$ . Using (5) or (7), the true MDS of preamplifier *alone* is calculated. If  $F_2 \gg 1$ , then, measure  $P_{s2}$ , the MDS of the auxiliary receiver instead of  $F_2$ . Then the actual MDS of the preamplifier alone is calculated from Eqs. (5a) or (7a). In most cases, the auxiliary receiver is calibrated and  $F_2$ ,  $B_2$ , and  $P_{s2}$  are known. Therefore, the quantities have to be measured are  $P_{s12}$ ,  $G_1$  and  $T_o$ .

Example 1: When  $B_1 > B_2$ .

If  $B_1 = 20\text{MC} = 2 \times 10^7\text{CPS}$

$B_2 = 2\text{MC} = 2 \times 10^6\text{CPS}$

$F_2 = 34.5\text{ db} = 2.56 \times 10^3$

$G_1 = 15\text{ db} = 31.55$

$P_{s12} = -92\text{ dbm} = 6.3 \times 10^{-13}\text{ watts}$ .

then for  $k = 1.3804 \times 10^{-23}\text{ joule/}^\circ\text{K}$

and  $T_o = 290^\circ\text{K}$ ,

from (5),  $P_{s1} = -95\text{ dbm} = 2.525 \times 10^{-13}\text{ watts}$ .

In this example, the high noise auxiliary amplifier masked the MDS of the preamplifier.

Example 2: When  $B_1 < B_2$

If  $B_1 = 2\text{MC} = 2 \times 10^6\text{CPS}$

$B_2 = 10\text{ MC} = 10^7\text{CPS}$

$F_2 = 10\text{ db} = 10$

$G_1 = 30\text{ db} = 10^3$

$P_{s12} = -105\text{ dbm} = 3.15 \times 10^{-14}\text{ watts}$ , then

using (7),  $P_{s1} = 2.01 \times 10^{-14}\text{ watts} = -107\text{ dbm}$ .

In this example the auxiliary receiver with a noise figure of 10 db shows appreciable masking effects on the MDS of the preamplifier.

### Conclusion

Knowing the MDS accurately is important in evaluating a preamplifier. The method proposed shows a way of separating the MDS of the preamplifier from the influence of the rest of the system. The method gives actual MDS of the preamplifier which is not influenced by the auxiliary receiver's noise, or gain.

The author thanks S. Krupnik, Jr., P. J. Tarantino, and D. Simonich for their help in the preparation of this material.

### References

1. N. Houlding, "Noise Factor", *Microwave Journal*, Vol. 5, pp. 74-78; January, 1962.
2. H. T. Friis, "Noise Figures of Radio Receivers." *Proc. IRE*, Vol. 32, pp. 419-422; July, 1944.
3. "IRE Standards on Methods of Measuring Noise in Linear Two Parts," *Proc. IRE.*, Vol. 48, pp. 60-74; January, 1960.
4. C. G. Montgomery "Technique of Microwave Measurements," Radiation Lab. Series, Vol. II, McGraw-Hill Book Co. Inc. New York, N. Y., 1947.

# DESIGN OF HIGH-SPEED DIRECT-COUPLED AMPLIFIERS

The design of a stabilized electrometer amplifier for use with photoemissive detectors is thoroughly described. The unique characteristics of a neon glow tube are used for good stabilization. The design thinking here can be applied to other amplifier designs.

SEVERAL METHODS OF MEASURING very small currents at high impedance are available. Of these methods the negative-feedback, direct-coupled, operational amplifier best satisfies the need for a dc amplifier, with a frequency response extending to about 20 kc, for use with photoemissive detectors.

Electrometer amplifiers with a frequency response of only a few cycles per second, when used with constant current sources, are considered to be fast.<sup>1, 2, 3</sup> Therefore, an electrometer amplifier with 20 kc frequency response is unusual.

A new method of stabilization using a neon glow tube is shown. Design and analysis of an electrometer amplifier with a gain of  $10^3$  and a passband of dc to 20 kc is given.

\* \* \*

## Amplifier Stability

A  $90^\circ$  phase lag occurs at high frequencies in each stage of an R-C coupled amplifier. The phase is shifted by the total effective parallel interstage capacitance and resistance. The R-C coupling also causes the open-loop gain (and the feedback factor  $A\beta$ ), to fall with increasing frequency. If the negative feedback amplifier is to be stable,  $A\beta$  must be reduced to less than unity before an additional  $180^\circ$  phase shift occurs. Since the maximum phase shift of one R-C network is  $90^\circ$ , a one-stage negative feedback amplifier is usually stable. Two R-C networks can cause a phase shift of  $180^\circ$ , thus a two-stage amplifier is potentially unstable.

Several methods of stabilization are given in the literature. Terman<sup>4</sup> presents a simple, first approach method; Valley and Wallman<sup>5</sup> present a method involving the "phase retard network." You should compute the attenuation of each coupling network in the amplifier at the frequency where  $180^\circ$  phase shift occurs, to find if the feedback factor  $A\beta$  is greater or less than unity.

These simple methods can easily be applied to an amplifier with a needed bandwidth of only 10 cps. But, it is necessary to extend or modify these methods to stabilize an electrometer amplifier with a response as high as 20 kc.

## The Gas Tube

Required attenuation can be had at high frequencies without introducing phase shift by using a neon glow tube in the screen grid of a pentode stage. The impedance of a gas tube is almost purely resistive. This resistance varies with frequency and bias current. A family of curves for a General Electric NE-2 neon is given in Fig. 1, and those of a Signalite RTZ-32-1A neon are given in Fig. 2; these curves show how each tube type varies with frequency and bias current.

The attenuation  $\alpha$  introduced by an unbypassed screen grid is given by

$$\alpha = (R_g + r_s)/r_s \quad (1)$$

where  $r_s$  is the dynamic screen resistance and  $R_g$  is the equivalent resistance of the external grid circuit.

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Director

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Authors P. J. Baker (left photo)  
and C. L. Wyatt (right photo)



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To predict the gain of a pentode stage with a neon tube in the screen circuit, you must find  $r_s$ . This can be done by placing an unbypassed resistor in place of the neon tube, noting the decrease in gain at a low frequency, and calculating  $r_s$  from Eq. 1.

The effect of the neon tube is to cause  $R_\theta$  to vary with frequency. The peak attenuation will occur at the point where the neon tube shows maximum resistance. The frequency at which maximum resistance occurs is above 100 kc (Figs. 1 and 2). This is good because a high gain operational amplifier is prone to oscillate at a frequency between 100 kc and 1 mc. An empirical relation for the maximum value of the neon tube resistance  $R_n$  as a function of bias current for the General Electric NE-2 is

$$R_n = 5890 i_n^{-0.71} \quad (2)$$

while for the Signalite neon tube RTZ-32-IA the relation is

$$R_n = 6983 i_n^{-0.76} \quad (3)$$

where  $R_n$  is the maximum resistance in kilohms occurring at 200 to 400 kc and  $i_n$  is the neon tube current in microamperes.

A limiting factor in the use of gas tubes for stabilization is the ratio of the screen grid current to the neon tube bias current. If this ratio exceeds about two, a surge current in the screen grid may cause the neon glow tube to extinguish. The above empirical relations make it possible to predict the attenuation introduced by a neon tube at high frequencies. In some cases, it is possible to introduce an attenuation of 4 or 5 at high frequencies compared with unity at 20 kc without introducing phase shift.

### Practical Design

The frequency response of the electrometer amplifier partly depends upon the gain and input capacitance.<sup>6, 7</sup> The specifications for the use required that the input capacitance be 150 pf or less and the gain at 20 kc be about  $10^3$ . We wanted good stability with feedback resistors of any value greater than 150 kilohms. The circuit shown in Fig. 3 has a midband gain of 5000 and will be analyzed with a feedback resistor of 150 kilohms and an input capacitance of 150 pf.

The first step in the design of stabilizing networks is to find the limiting phase shift characteristic and find the gain at the frequency where  $180^\circ$  phase shift occurs in the uncompensated amplifier. If the feedback factor is unity or greater at the frequency where  $180^\circ$  phase shift occurs, the amplifier will oscillate.

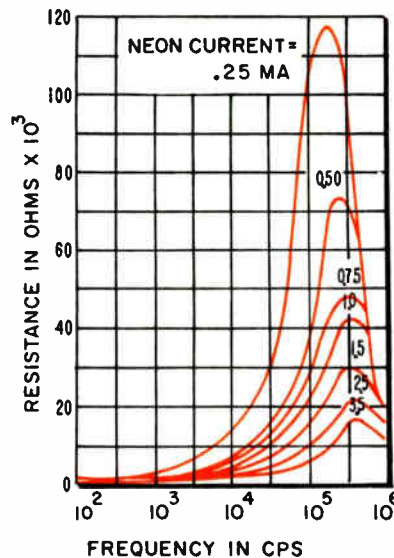


Fig. 1: The resistance of a G.E. NE-2 neon as a function of frequency.

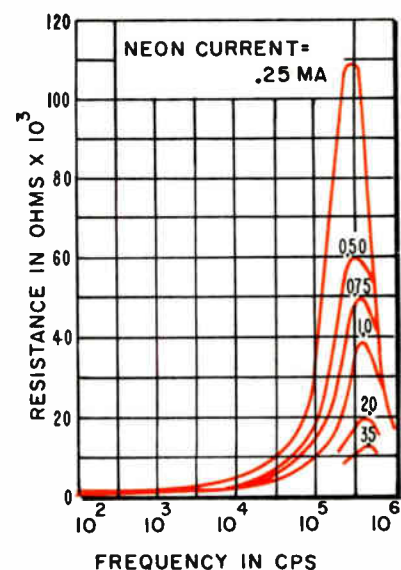


Fig. 2: The resistance of a Signalite RTZ-32-A neon as a function of frequency.

At high frequencies the limiting phase shift is set by the coupling networks between the stages of the amplifier. These networks consist of the output resistance, and the input capacitances of the coupled stages. The amplifier of Fig. 3 contains 3 coupling networks, each of which must be analyzed.

Each network consists of the equivalent output resistance of the preceding stage and the input capacitance of the stage under consideration. The roots of the transfer function of these networks are used with the inverse-tangent curve (Fig. 4). This gives the phase shift of a network or networks (or of the complete amplifier) and is the algebraic sum of all the individual inverse-tangent curves. The location of any curve is found by observing that  $f_2 = p/2\pi$  occurs at the  $45^\circ$  phase shift point, where  $p$  is a root of the transfer function and  $f_2$  is the  $-3$  db frequency.

## AMPLIFIER DESIGN (Continued)

The overall phase shift for the amplifier is shown in Fig. 5. Note that  $180^\circ$  phase shift occurs at about 600 kc. The gain is equal to the product of the gain at low frequencies and the attenuation of each network. At 1 mc this is 7.3, since  $A^{\beta} > 1$  the amplifier will oscillate at 600 kc.

### Compensation

Introduction of the "phase retard network" (Fig. 6) results in the phase response shown in Fig. 7. Note that  $180^\circ$  shift occurs at about 10 mc. Computation of the total gain at 1 mc, as before, yields 1.6. This indicates the amplifier may oscillate at a frequency above 1 mc.

To obtain a desired margin of stabilization safety, it was convenient to use the characteristics of the neon tube in the screen grid of the pentode stage. The value of the dynamic screen-grid impedance was found, experimentally, for the conditions in this amplifier to be 30 kilohms; the screen grid current was 0.4 ma. The ratio of screen current to neon tube current must not exceed two or the neon glow tube may extinguish. With a 300-kilohm bias resistor,  $R_n$  calculated from Eq. 2 is 130 kilohms. The

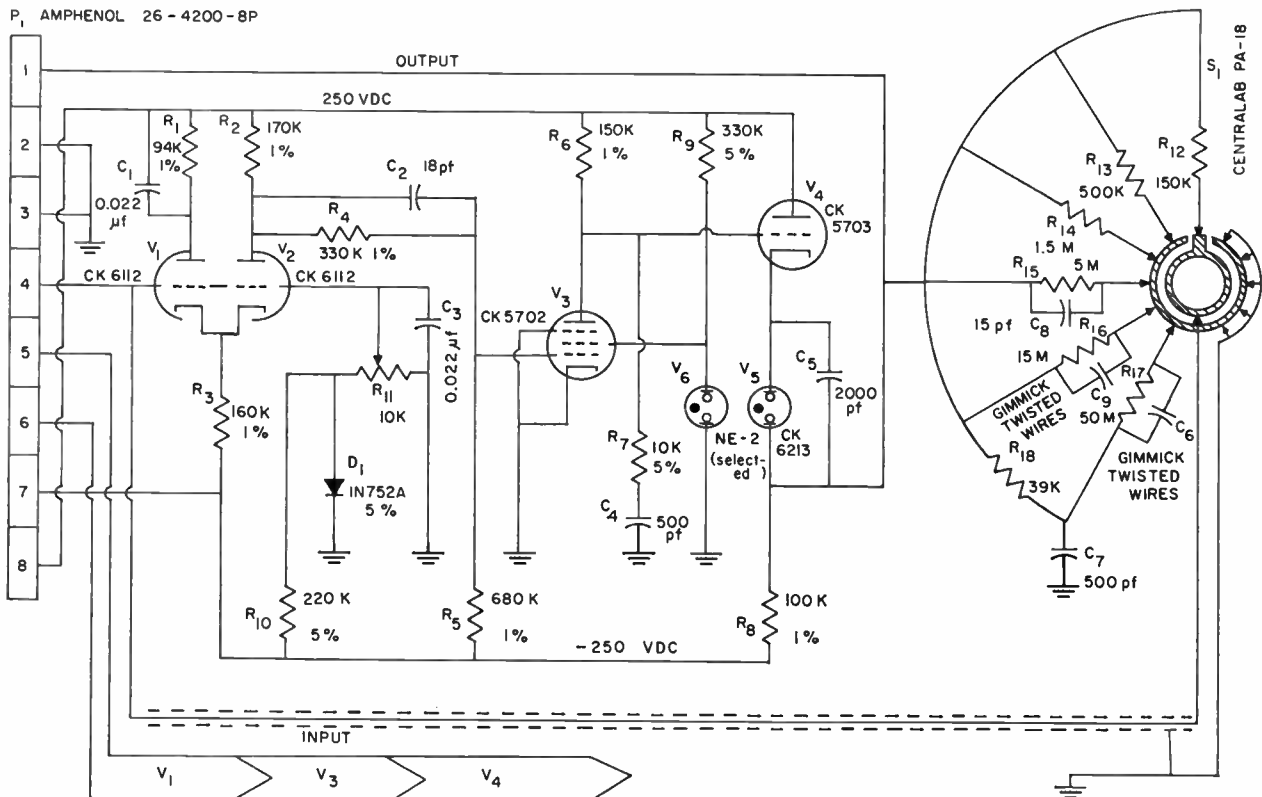
parallel combination of  $R_n$  and the 330-kilohm bias resistor constitutes the external screen resistance  $R_g$  which determines the attenuation. Solving Eq. 1 for these conditions yields an attenuation of 4.17. The total gain is now  $(1.6)/(4.17) = 0.384$ , and stabilization is assured.

### Amplifier Performance

With the neon tube bypass and the compensation network  $R_7C_4$  disconnected, the electrometer amplifier was observed to oscillate at 500 kc. Addition of the phase retard network increased the frequency of oscillation to 1.5 mc and decreased the magnitude of the oscillations. When the bypass was removed from the neon tube, the amplifier did not oscillate. Reducing the input capacitance reduces the stability because the attenuation of the network is less at high frequencies. Only when the input capacitance was reduced to less than 25 pf did the amplifier occasionally break into oscillation. Thus, there is a good margin of safety when the amplifier is operated with 150 pf input capacitance.

An increased value of feedback resistance increases the attenuation of high frequencies, thereby making the amplifier more stable. For some uses it may be desirable to bypass the feedback resistor to reduce the response of the amplifier to frequencies above

Fig. 3: Schematic shows a practical compensated operational amplifier. Note the use of neon tubes for stability.



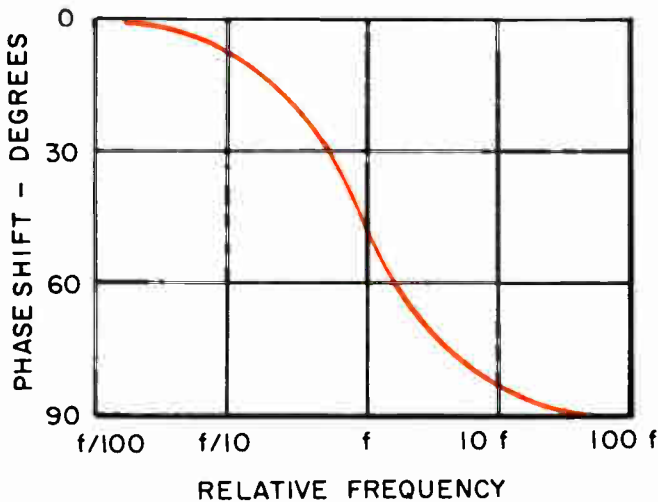


Fig. 4 (above): The inverse tangent curve is used to find shift.

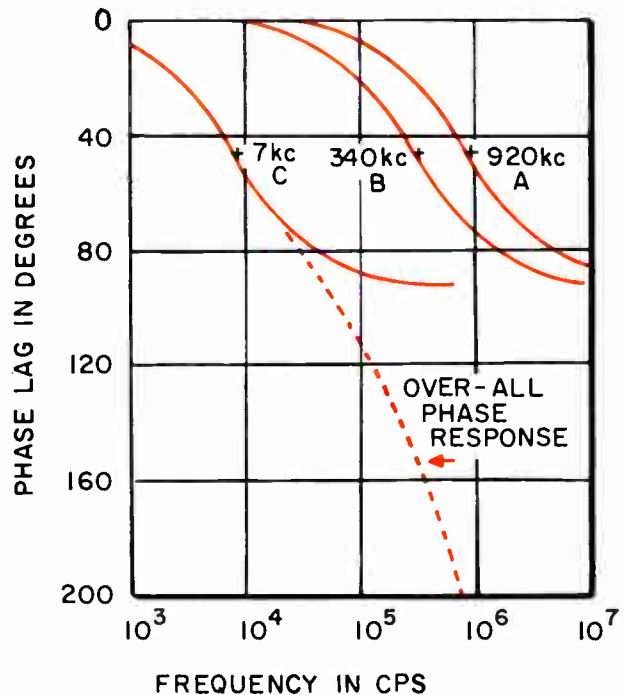


Fig. 5 (right): Phase response of an amplifier uncompensated.

the bandpass. When the feedback resistor is bypassed, the attenuation of the network for high frequencies depends upon the ratio of the capacitances. For a low value feedback resistor, the required shunting capacitance ratio is unfavorable, causing the amplifier to become unstable.

### Conclusions

A stabilized electrometer amplifier for use with high impedance photoemissive detectors was designed using the inverse tangent curve method of analysis of the phase and amplitude properties. The established methods of stabilization were investigated. The phase retard network alone was inadequate for stabilization; but when the unique characteristics of a neon glow tube were used with the retard network, stabilization was achieved. This electrometer amplifier has a dc to 20 kc bandpass with a transfer function (sensitivity) of  $10^{14}$  volts/ampere.

This research was supported by the Air Force Cambridge Research Laboratories. The contributions and suggestions of H. P. Gauvin, A. T. Stair, Jr., L. S. Cole, and F. R. Brown are acknowledged.

### References

1. D. A. Allenden, "Using Feedback in Electrometer Design," *Electronics* 32:71-73, 1959.
2. I. Pelchowitz and J. J. Zaalberg Van Zelst, "A Wide Band Electrometer Amplifier," *Rev. Sci. Instr.* 23:73-75, 1952.
3. J. Praglin and W. A. Nichols, "High Speed Electrometers for Rocket and Satellite Experiments," *Proc. IRE* 48:771-779, 1960.
4. F. E. Terman, *Radio Engineers Handbook*, McGraw-Hill Book Co., Inc., New York; pp. 396-399, 1943.
5. G. E. Valley and H. Wallman, *Vacuum Tube Amplifiers*, McGraw-Hill Book Co., Inc., New York; pp. 409-496, 1948.
6. J. Praglin and W. A. Nichols, op. cit. p. 1, 1960.
7. D. J. Baker, C. L. Wyatt and F. R. Brown, "A Direct Coupled DC Amplifier Compensated to 20 KC for Use With Photoemissive Devices," submitted for publication by IRE.

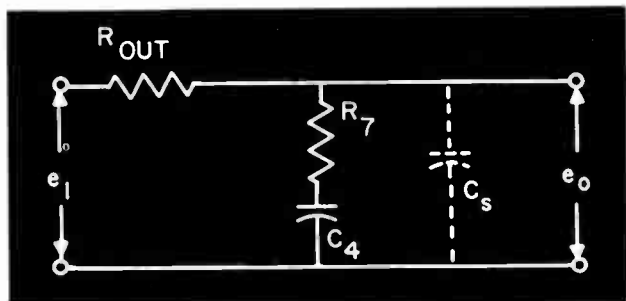
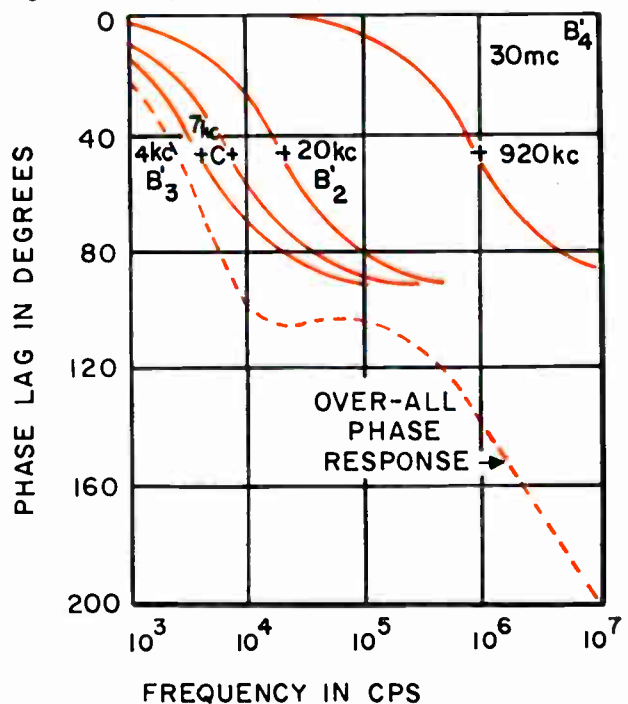


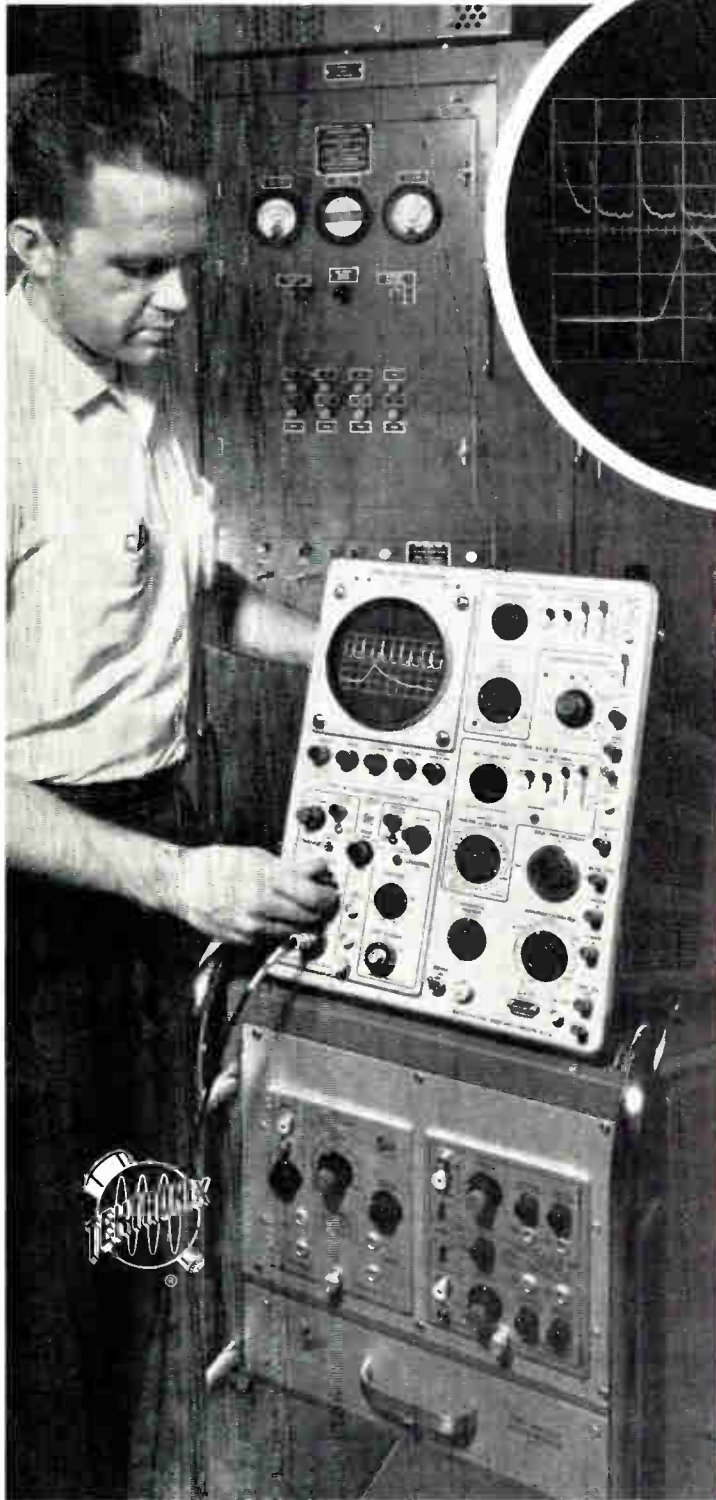
Fig. 6: The 'phase retard' network used for h-f compensation.

Fig. 7: Phase response of an amplifier that's compensated.



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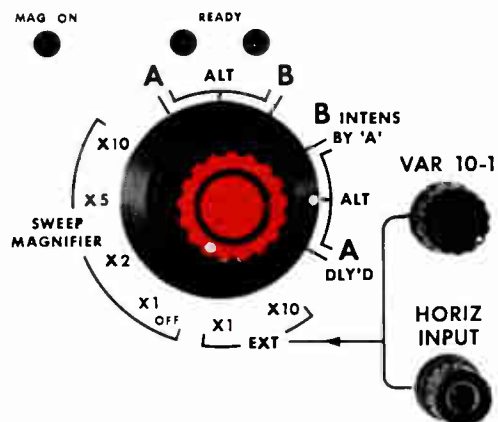
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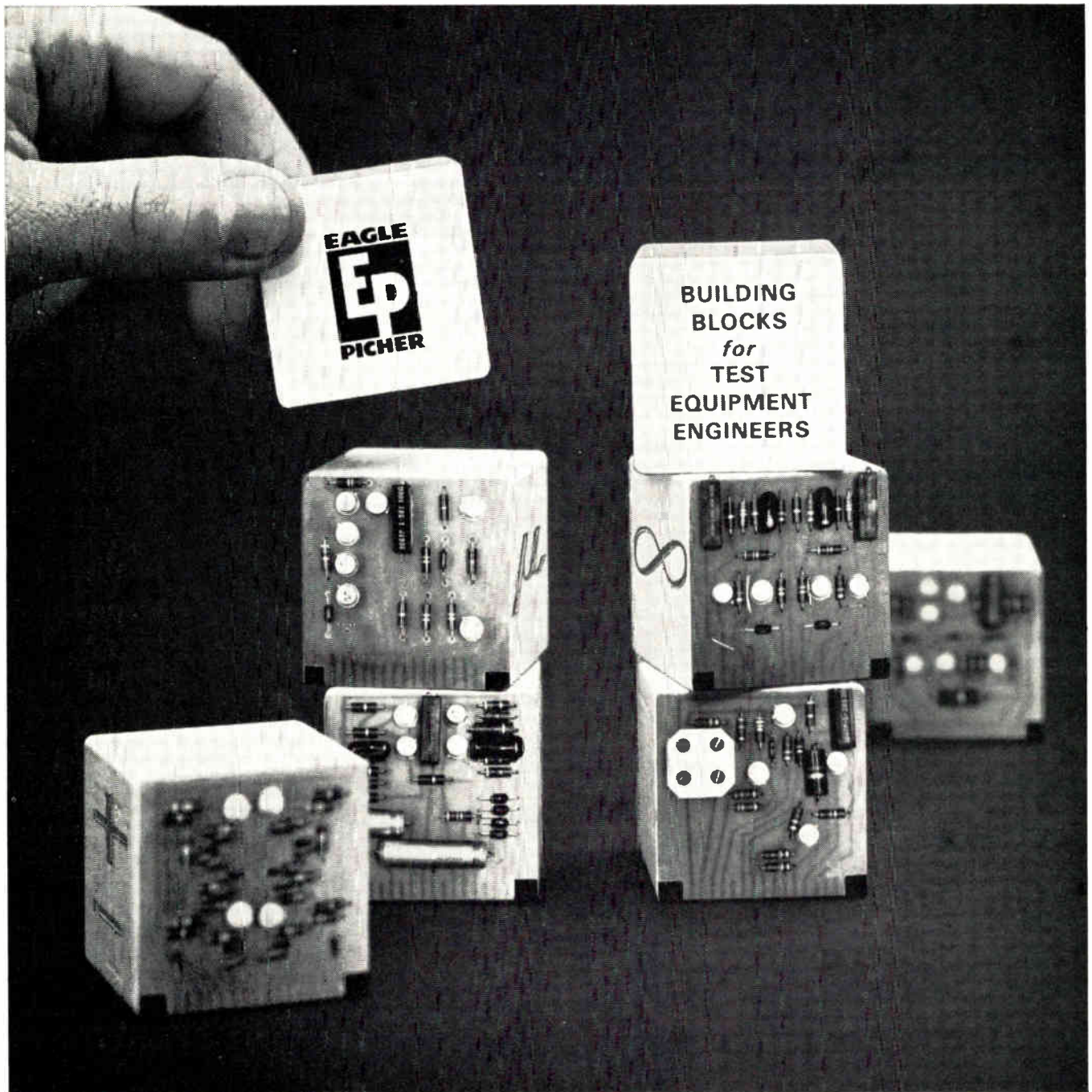


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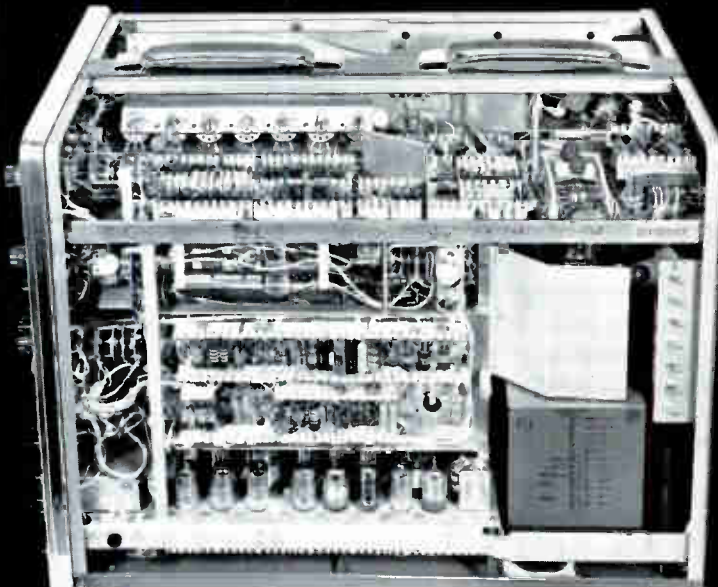


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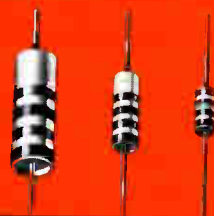
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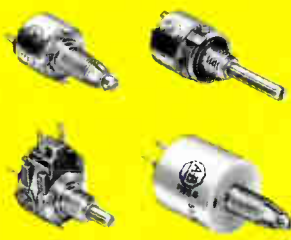
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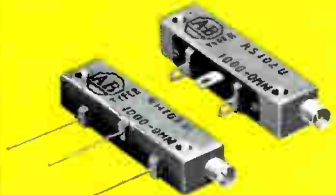
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# CALCULATING SYSTEM LINEARITY

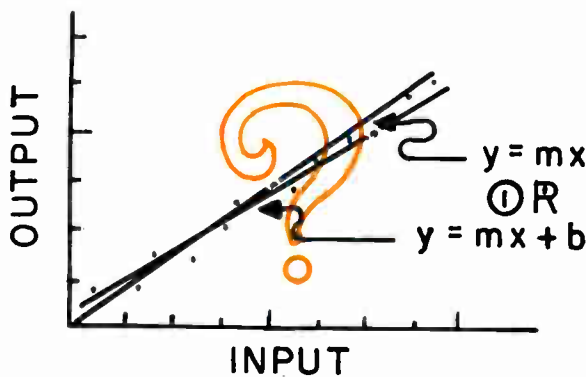
System linearity can be found by means of a best-straight-line approximation using a least-square-error method. This article shows how!

IN NORMAL ENGINEERING PRACTICE, an engineer often must determine the linearity of the linear portion of a component or system. Linearity is often defined in terms of percentage deviation from a best-straight-line.

Ambiguity as to how this best-straight-line can be obtained is a stumbling block for many engineers.

The article shows how to obtain a best-straight-line. It then shows how to use this line to determine system linearity.

\* \* \*



Generally, there are two cases in which a best-straight-line can be chosen so it will pass through a set of points to make maximum deviations with minimum error.

*Case 1. Independent linearity.* This refers to the deviation from a best-straight-line  $y = mx + b$  in which the slope,  $m$ , and the  $y$ -intercept,  $b$ , are chosen to make maximum deviations with minimum error.

*Case 2. Zero base linearity.* This refers to the deviation from a best-straight-line  $y = mx$  such that only the slope  $m$  is chosen to make maximum deviations with minimum error. The  $y$ -intercept,  $b$ , is zero in this case.

Since these two cases will give different results, one must be able to distinguish between them and select the appropriate one for a given problem.

Usually, Case 1 can be treated as a general case for both active and inactive systems, while Case 2 is a special case for the inactive system where zero-offset is practically non-existent.

The following example shows how a best-straight-line can be obtained by using the well known "least-square error" method. It also shows how to find linearity of the system by using the obtained best-straight-line.

Let us assume that input,  $x_o$ , and output,  $y_o$ , of a linear system are given below:

$x_o$	1.0	2.0	3.0	4.0	5.0
$y_o$	1.1	1.9	3.0	4.1	4.9

A best-straight-line for this set of data can be obtained as follows:

1. Find the error between the given and approximated functions. This is defined as

$$\begin{aligned} \Delta &= y_o - y \\ &= y_o - (mx + b) \end{aligned}$$

2. Obtain the sum of the squares of the errors

$$\sum_{k=0}^n \Delta_k^2 = \sum_{k=0}^n [y_k - (mx_k + b)]^2$$

3. Minimize the sum of the squares of the errors by partial differentiating step 2 with respect to  $m$ ,  $b$ , and set equal to zero.
4. Solve  $m$ ,  $b$ , of step 3 and substitute the values into equation  $y = mx + b$ . This equation is the most probable law of the best-straight-line for that particular set of data.

Results of the above are shown in detail in Table 1.

(Continued on following page)

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Table 1

$x_o$	$y_o$	$\Delta_k = y_o - mx_o - b$	$\Delta_k^2 = (y_o - mx_o - b)^2$
1.0	1.1	$\Delta_1 = 1.1 - m - b$	$\Delta_1^2 = 1.21 - 2.2m + m^2 + 2mb - 2.2b + b^2$
2.0	1.9	$\Delta_2 = 1.9 - 2m - b$	$\Delta_2^2 = 3.61 - 7.6m + 4m^2 + 4mb - 3.8b + b^2$
3.0	3.0	$\Delta_3 = 3.0 - 3m - b$	$\Delta_3^2 = 9.00 - 18.0m + 9m^2 + 6mb - 6.0b + b^2$
4.0	4.1	$\Delta_4 = 4.1 - 4m - b$	$\Delta_4^2 = 16.81 - 32.8m + 16m^2 + 8mb - 8.2b + b^2$
5.0	4.9	$\Delta_5 = 4.9 - 5m - b$	$\Delta_5^2 = 24.01 - 49.0m + 25m^2 + 10mb - 9.8b + b^2$

Note: All terms with "b" are zero for Case 2.

Table 2

$x_o$ (input)	$y$ best-straight-line value for case		$y_o$ (output)	linearity $\frac{y - y_o}{y} (100\%)$ % deviation from the best- straight-line for case	
	1	2		1	2
	1.0	1.04		0.996	1.1
2.0	2.02	1.992	1.9	-5.54	-4.62
3.0	3.00	2.988	3.0	0.00	+0.40
4.0	3.98	3.984	4.1	+3.02	+2.91
5.0	4.96	4.980	4.9	-1.21	-1.61

## SYSTEM LINEARITY (Concluded)

Case 1:

$$\sum_{k=1}^5 \Delta_k^2 = E(m,b) = 54.64 - 109.6m + 55m^2 + 30mb - 30m + 5b^2$$

$$\delta E / \delta m = -109.6 + 110m + 30b = 0 \quad (1)$$

$$\delta E / \delta b = -30 + 30m + 10b = 0 \quad (2)$$

$$110m + 30b = 109.6 \quad (3)$$

$$30m + 10b = 30 \quad (4)$$

$$3 \times \text{Eq. 4} \quad 90m + 30b = 90 \quad (5)$$

$$\text{Eq. 3} - \text{Eq. 5} \quad 20m = 19.6 \quad (6)$$

$$m = 0.98 \quad (6)$$

substituting Eq. 6 into Eq. 4 yields:

$$30(0.98) + 10b = 30 \quad (7)$$

$$b = 0.06 \quad (7)$$

Case 2:

$$\sum_{k=1}^5 \Delta_k^2 = E(m) = 54.64 - 109.6m + 55m^2$$

$$dE/dm = -109.6 + 110m = 0$$

$$m = 0.996 \quad (8)$$

$$b = \text{zero}$$

The most probable law of the best-straight-line for this example is now expressed as:

$$\text{Case 1.} \quad y = 0.98x + 0.6 \quad (9)$$

$$\text{Case 2.} \quad y = 0.996x \quad (10)$$

From Eqs. 9 and 10 the linearity of the given system is solved and tabulated in Table 2 for Case 1 and Case 2, respectively.

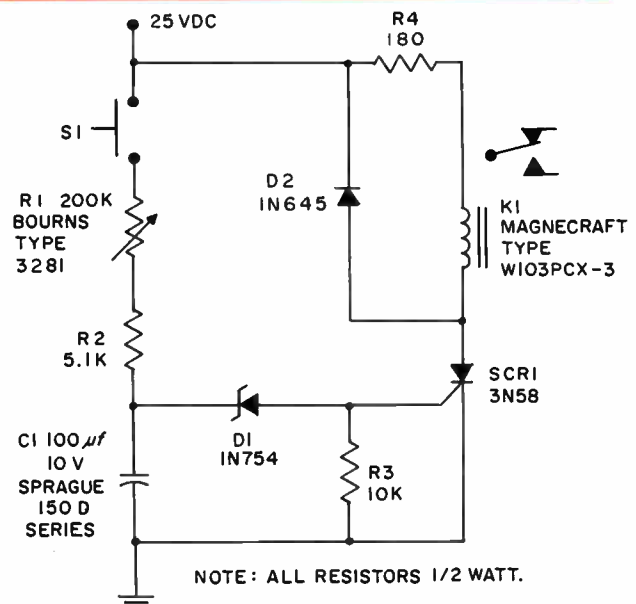
## TIME DELAY RELAY

TIME DELAYS FROM 0.5 TO 5 SECS. CAN BE OBTAINED with the circuit shown. By changing R1 and C1, smaller or greater delays can be obtained.

When S1 is closed, C1 charges until its voltage breaks over the zener diode (D1). SCR1 is biased to an "on" state by the discharge current of C1. The anode current of SCR1 actuates relay K1.

R1 is used to adjust the time delay. If R1 is adjusted to zero resistance, R2 is of sufficient value to protect SCR1. D1 has a positive temperature coefficient and was picked to counter the negative temperature coefficient of the gate firing voltage. C1 must be stable with temperature change and have low leakage current. R4 is used as a voltage dropping resistor and also with D2 to prevent the relay coil from producing high voltage transients that might damage SCR1.

When cycled from  $-20^\circ \text{C}$  to  $+80^\circ \text{C}$ , the delay time change was less than 5%.



Submitted by JOSEPH V. CROWLING, Design Engineer, Warrenton Training Center, P. O. Box 700, Warrenton, Va.

# NOW, PHILCO OFFERS VOLTACAP UNIFORMITY

Four Voltage-Variable Capacitance Diodes  
with a specified one percent maximum tracking error



Philco's expanded line of Epitaxial Silicon Planar Voltacap diodes offers circuit designers high reliability (meets all requirements of Mil-S-19500 C) and uniformity with a specified 1% maximum tracking error for all types.†

Designed and specified for single or multiple electronic tuning applications, Voltacap diodes offer high Q, high usable change ratio, low noise and low leakage at high temperatures. All types now available in new plastic packages for optimum mounting density. For detailed information on Philco Voltacap diodes, write Department EI 364.

## PHILCO VOLTACAP RATINGS AND CHARACTERISTICS

Parameter	V4090	V4091	V4092	V4093
†Capacitance $C_v$ (@ -8V, 1 mc)	47pf ± 20%	150pf ± 20%	250pf ± 20%	500pf ± 20%
Max. Reverse Leakage Current $I_R$ (@ $V_R = -100V$ 85°C ambient)	2.5 $\mu a$	5 $\mu a$	8 $\mu a$	15 $\mu a$
Min. Q (@ $V_R = 8V$ )	90 f = 50 mc	130 f = 25 mc	160 f = 25 mc	200 f = 10 mc
Min. Capacitance Change Ratio ( $V_R = -4V$ to $-100V$ )	4:1	4:1	4.1:1	4.1:1
Max. Reverse Bias Voltage $V_R$	115V			
Max. Temperature Coefficient T = -55°C to +85°C; $V_R = 8$	0.03%/°C			
†Max. Tracking Error $V_R = -4V$ to $-100V$	1%			

†Tighter Tolerances on tracking error & capacitance or matched units available on request.

SPECIAL PRODUCTS OPERATION

# PHILCO

A SUBSIDIARY OF *Ford Motor Company*

LANSDALE DIVISION, LANSDALE, PA.

IN CANADA: Don Mills Road, Don Mills, Ontario



Trademark of Philco Corporation for  
Epitaxial Planar Voltage-Variable  
Capacitance Diode

Circle 61 on Inquiry Card

World Radio History



# CALUT

We're out of stock on about 3 per cent of these

*Actually*

a 3 per cent out-of-stock situation isn't bad — at least not when you have the largest *inventoried* zener diode line in the industry. Specifically, it means only slightly more than 100 out of over 4000 type numbers are temporarily in short supply.

But what's important is that Motorola's *on-the-shelf, ready-for-shipment* inventory of zener diodes (over 3 million units in all) can fill your needs immediately 97 percent of the time! We keep the inventory that big so we can ship *what* you want, *when* you want it, for sure.

And about those occasional hard-to-get items — we worry mightily about them. In fact, we worry about them so much that most of the units get back *into* stock before you even know we had a problem in the first place.

The point is, when you need a zener diode (or a dozen, or a hundred, or a thousand) — either industrial or Mil-type — check with Motorola first. Chances are excellent you'll have to look no further.



Want an extra copy of Motorola's latest Zener Diode Selection Chart? Just drop us a line on your company letterhead. Meantime, tear out these pages and refer to them on your next zener buy.

**MOTOROLA**  
Semiconductor Products Inc.

DEPT. TIC 4310 • BOX 955 • PHOENIX, ARIZONA 85001 • A SUBSIDIARY OF MOTOROLA INC.

Military Types	Nominal Zener Voltage	1/4 WATT		400	
		INDUSTRIAL (NOTE 1)	INDUSTRIAL ±5% TOLERANCE	INDUSTRIAL (NOTE 2)	
ALLOY JUNCTION TYPES	2.4	1/4M2.4AZ			
	2.7	1/4M2.7AZ			
	3.0	1/4M3.0AZ			
	3.3	1/4M3.3AZ		1N746	
	3.6	1/4M3.6AZ		1N747	
	3.9	1/4M3.9AZ		1N748	
	4.3	1/4M4.3AZ		1N749	
	4.7	1/4M4.7AZ		1N750	
	5.1	1/4M5.1AZ		1N751	
	5.6	1/4M5.6AZ		1N752	
	6.2	1/4M6.2AZ		1N753	
	6.8	1/4M6.8AZ		1N754	
DIFFUSED JUNCTION TYPES	7.5			1N755	
	8.2			1N756	
	9.1			1N757	
	10			1N758	
	12			1N759	
	DIFFUSED JUNCTION TYPES	6.8	1/4M6.8Z	1N4099	(NOTE 3) 1N957
		7.5	1/4M7.5Z	1N4100	1N958
		8.2	1/4M8.2Z	1N4101	1N959
		9.1	1/4M9.1Z	1N4103	1N960
		10	1/4M10Z	1N4104	1N961
		11	1/4M11Z	1N4105	1N962
		12	1/4M12Z	1N4106	1N963
13		1/4M13Z	1N4107	1N964	
15		1/4M15Z	1N4109	1N965	
16		1/4M16Z	1N4110	1N966	
18		1/4M18Z	1N4112	1N967	
20		1/4M20Z	1N4114	1N968	
22		1/4M22Z	1N4115	1N969	
24		1/4M24Z	1N4116	1N970	
27		1/4M27Z	1N4118	1N971	
30		1/4M30Z	1N4120	1N972	
33		1/4M33Z	1N4121	1N973	
36		1/4M36Z	1N4122	1N974	
39		1/4M39Z	1N4123	1N975	
43		1/4M43Z	1N4124	1N976	
47		1/4M47Z	1N4125	1N977	
51		1/4M51Z	1N4126	1N978	
56		1/4M56Z	1N4127	1N979	
62		1/4M62Z	1N4129	1N980	
68	1/4M68Z	1N4130	1N981		
75	1/4M75Z	1N4131	1N982		
82	1/4M82Z	1N4132	1N983		
91	1/4M91Z	1N4134	1N984		
100	1/4M100Z	1N4135	1N985		
110	1/4M110Z		1N986		
120	1/4M120Z		1N987		
130	1/4M130Z		1N988		
150	1/4M150Z		1N989		
160	1/4M160Z		1N990		
180	1/4M180Z		1N991		
200	1/4M200Z		1N992		

TEMPERATURE COMPENSATED REFERENCE DIODES	POWER RATING	NOMINAL ZENER VOLTAGE	SERIES TYPE NO.	TEMPERATURE RANGE (°C)
	400 mW 	6.2	1N821 to 1N827A	-55 to +100
8.4		1N3154 to 1N3157A	-55 to +150	
500 mW 	9.0	1N935 to 1N939B	0 to +75 -55 to +100 -55 to +150	
	11.7	1N941 to 1N945B	0 to +75 -55 to +100 -55 to +150	
750 mW 	9.3	1N2620 to 1N2624B	0 to +75 -55 to +100 -55 to +150	
	11.7	1N3580 to 1N3582B	0 to +75 -55 to +100 -55 to +150	

also available to MIL-S-19500/156 specifications

NOTES: 1. Standard tolerances of 5, 10, and 20% are available—no suffix is ±20% tolerance; "10" suffix is ±10% tolerance and "5" suffix is ±5% tolerance

# 100N

MILLIWATT	3/4 WATT	1 WATT		1 1/2 WATT	10 WATT		50 WATT			Nominal Zener Voltage	
	*Surmetic										
MEETS SPECS OF MIL-S-19500/127	INDUSTRIAL (NOTE 3)	INDUSTRIAL (NOTE 2)	MEETS SPECS OF MIL-S-19500/115	INDUSTRIAL (NOTE 3)	INDUSTRIAL (NOTE 2)	MEETS SPECS OF MIL-S-19500/272	INDUSTRIAL (NOTE 3)	MEETS SPECS OF MIL-S-19500/114	INDUSTRIAL (NOTE 3)		
1N746A 1N747A 1N748A		1N3821 1N3822 1N3823	1N3821A 1N3822A 1N3823A			1N3993	1N3993A			2.4 2.7 3.0 3.3 3.6 3.9	
1N749A 1N750A 1N751A 1N752A 1N753A 1N754A		1N3824 1N3825 1N3826 1N3827 1N3828 1N3829	1N3824A 1N3825A 1N3826A 1N3827A 1N3828A			1N3994 1N3995 1N3996 1N3997 1N3998 1N3999	1N3994A 1N3995A 1N3996A 1N3997A 1N3998A 1N3999A			4.3 4.7 5.1 5.6 6.2 6.8	
1N755A 1N756A 1N757A 1N758A 1N759A		1N3830				1N4000	1N4000A			7.5 8.2 9.1 10 12	
<b>REVERSE POLARITIES AVAILABLE IN ALL 10 AND 50 WATT DIFFUSED TYPES.</b>											
MEETS SPECS OF MIL-S-19500/117		(NOTE 3)		(NOTE 3)		MEETS SPECS OF MIL-S-19500/124					
1N962B	1N3680	1N3016 1N3017 1N3018 1N3019 1N3020 1N3021	1N3016B 1N3017B 1N3018B 1N3019B 1N3020B 1N3021B	1N3785 1N3786 1N3787 1N3788 1N3789 1N3790		1N2970 1N2971 1N2972 1N2973 1N2974 1N2975	1N2970B&RB 1N2971B 1N2972B 1N2973B 1N2974B 1N2975B	1N2804 1N2805 1N2806 1N2807 1N2808 1N2809	1N2804B&RB 1N2805B 1N2806B 1N2807B 1N2808B 1N2809B	1N3305 1N3306 1N3307 1N3308 1N3309 1N3310 1N3311	6.8 7.5 8.2 9.1 10 11
1N963B 1N964B 1N965B 1N966B 1N967B 1N968B	1N3681 1N3682 1N3683 1N3684 1N3685 1N3686	1N3022 1N3023 1N3024 1N3025 1N3026 1N3027	1N3022B 1N3023B 1N3024B 1N3025B 1N3026B 1N3027B	1N3791 1N3792 1N3793 1N3794 1N3795		1N2976 1N2977 1N2979 1N2980 1N2982 1N2984	1N2976B 1N2977B 1N2979B 1N2980B 1N2982B 1N2984B	1N2810 1N2811 1N2813 1N2814 1N2816 1N2818	1N2810B 1N2811B 1N2813B 1N2814B 1N2816B 1N2818B	1N3311 1N3312 1N3314 1N3315 1N3317 1N3319	12 13 15 16 18 20
1N969B 1N970B 1N971B 1N972B 1N973B 1N974B	1N3687 1N3688 1N3689 1N3690 1N3691 1N3692	1N3028 1N3029 1N3030 1N3031 1N3032 1N3033	1N3028B 1N3029B 1N3030B 1N3031B 1N3032B 1N3033B	1N3797 1N3798 1N3799 1N3800 1N3801 1N3802		1N2985 1N2986 1N2988 1N2989 1N2990 1N2991	1N2985B 1N2986B 1N2988B 1N2989B 1N2990B 1N2991B	1N2819 1N2820 1N2822 1N2823 1N2824 1N2825	1N2819B 1N2820B 1N2822B 1N2823B 1N2824B 1N2825B	1N3320 1N3321 1N3323 1N3324 1N3325 1N3326	22 24 27 30 33 36
1N975B 1N976B 1N977B 1N978B 1N979B 1N980B	1N3693 1N3694 1N3695 1N3696	1N3034 1N3035 1N3036 1N3037 1N3038 1N3039	1N3034B 1N3035B 1N3036B 1N3037B 1N3038B 1N3039B	1N3803 1N3804 1N3805 1N3806 1N3807 1N3808		1N2992 1N2993 1N2995 1N2997 1N2999 1N3000	1N2992B 1N2993B 1N2995B 1N2997B 1N2999B 1N3000B	1N2826 1N2827 1N2829 1N2831 1N2832 1N2833	1N2826B 1N2827B 1N2829B 1N2831B 1N2832B 1N2833B	1N3327 1N3328 1N3330 1N3332 1N3334 1N3335	39 43 47 51 56 62
1N981B 1N982B 1N983B 1N984B 1N985B 1N986B		1N3040 1N3041 1N3042 1N3043 1N3044 1N3045	1N3040B 1N3041B 1N3042B 1N3043B 1N3044B 1N3045B	1N3809 1N3810 1N3811 1N3812 1N3813 1N3814		1N3001 1N3002 1N3003 1N3004 1N3005 1N3007	1N3001B 1N3002B 1N3003B 1N3004B 1N3005B 1N3007B	1N2834 1N2835 1N2836 1N2837 1N2838 1N2840	1N2834B 1N2835B 1N2836B 1N2837B 1N2838B 1N2840B	1N3336 1N3337 1N3338 1N3339 1N3340 1N3342	68 75 82 91 100 110
1N987B 1N988B 1N989B 1N990B 1N991B 1N992B		1N3046 1N3047 1N3048 1N3049 1N3050 1N3051	1N3046B 1N3047B 1N3048B 1N3049B 1N3050B 1N3051B	1N3815 1N3816 1N3817 1N3818 1N3819 1N3820		1N3008 1N3009 1N3011 1N3012 1N3014 1N3015	1N3008B 1N3009B 1N3011B 1N3012B 1N3014B 1N3015B	1N2841 1N2842 1N2843 1N2844 1N2845 1N2846	1N2841B 1N2842B 1N2843B 1N2844B 1N2845B 1N2846B	1N3343 1N3344 1N3346 1N3347 1N3349 1N3350	120 130 150 160 180 200

### MAXIMUM ZENER VOLTAGE VARIATION ( $\Delta V_z$ ) IN VOLTS

.003 TO .006	.007 TO .009	.010 TO .014	.015 TO .019	.020 TO .029	.030 TO .039	.040 TO .059	.060 TO .089	.090 TO .119	.120 TO .149	.150 TO .239
—	1N827 1N827A	—	1N825 1N825A	—	—	1N823 1N823A	—	1N821 1N821A	—	—
—	—	1N3157	—	1N3156	—	—	1N3155	—	1N3154	—
—	—	—	1N3157A	—	1N3156A	—	1N3155A	—	—	1N3154A
1N938 1N939	—	1N937	—	—	1N936	—	1N935	—	—	—
—	1N939A	1N938A	—	1N937A	—	—	1N936A	—	1N935A	—
—	1N939B	—	1N938B	—	1N937B	—	—	1N936B	—	1N935B
1N945	1N944	—	1N943	—	—	1N942	1N941	—	—	—
—	1N945A	—	1N944A	—	1N943A	—	—	1N942A	—	1N941A
—	—	1N945B	—	1N944B	—	1N943B	—	—	1N942B	1N941B
1N2624	1N2623	1N2622	—	—	1N2621	—	1N2620	—	—	—
—	1N2624A	1N2623A	—	1N2622A	—	—	1N2621A	—	1N2620A	—
—	—	1N2624B	1N2623B	—	1N2622B	—	—	1N2621B	—	1N2620B
—	—	—	1N3582	—	—	1N3581	1N3580	—	—	—
—	—	—	—	—	1N3582A	—	—	1N3581A	—	1N3580A
—	—	—	—	—	—	1N3582B	—	—	1N3581B	1N3580B

2. No suffix denotes  $\pm 10\%$  tolerance. "A" suffix is  $\pm 5\%$  tolerance.

3. Standard tolerances of 5, 10, and 20% are available—no suffix is  $\pm 20\%$  tolerance; "A" suffix is  $\pm 10\%$  tolerance, and "B" suffix is  $\pm 5\%$  tolerance.

**DALE****RELIABILITY**TOTAL CAPABILITY IN  
PRECISION RESISTANCERS Wirewounds...  
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UNIT TEST HOURSPROVE  
**99.991%**  
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## Unmatched performance in a *standard* precision power wirewound resistor

You get a reliability bonus at no extra cost with Dale's RS Precision Power Resistor. Of all the wirewounds outside the specially-conditioned "Hi-Rel" category (where Dale's ARS Resistor is tops) the RS has been conclusively proven to be the most reliable. In tests, patterned after Dale's famous Minuteman High Reliability Development Program, the RS has passed the 22,000,000 hour mark at a 99.991% reliability level (60% confidence level, 100% rated power, 25° C ambient, 1% ΔR failure point). The RS Wirewound is just one example of Dale's *total* capability in precision resistance—a capability which includes giving you both performance and delivery which exactly match your requirements.

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Dale has built over 400 special modifications of the RS Resistor. One of them may be the answer to your problem. If it isn't, we'll build one that is.

### RS SPECIFICATIONS

- Applicable Mil. Spec: MIL-R-26C & MIL-R-23379 (A new Spec, designed especially for precision resistors)
- Wattage Sizes: ¼, ½, 1, 2, 2.5, 3, 5, 7, 10
- Tolerances: 0.05%, 0.1%, 0.25%, 1%, 3%
- Operating Temperature Range: -55°C to 350°C
- Resistance Range: .1 ohm to 240k ohms
- Load Life Stability: 1% max. ΔR after 1000 hours at full rated power
- Moisture Resistance: .5% max. ΔR after MIL-R-26C moisture test for insulated resistance
- Dielectric Strength: 500 volts, RS-¼ through RS-1B; 1000 volts RS-2 through RS-10
- Thermal Shock: .5% max. ΔR after MIL-R-26C thermal shock test
- Insulation Resistance: 100 megohms minimum
- Temperature Coefficient: 20 p.p.m. (high values); 30 p.p.m. (intermediate values); 50 p.p.m. (low values). Specific T.C. chart available on request.

RS RELIABILITY STUDY AVAILABLE. Write for a copy as well as for Dale's expanded Catalog "A".

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Reporting late developments affecting the employment picture in the Electronic Industries

## GOVT. ENGINEERING JOBS DEMAND DEGREE OR EIT TEST

New job standards for Federal engineer jobs, listed by the Civil Service Commission, include an engineering degree or professional registration. The new standards are hailed as a "milestone in efforts to create a truly professional Federal engineering service." The feeling was expressed by Paul H. Robbins, Executive Director of the National Society of Professional Engineers.

The new standards, given to NSPE for comment, say that engineers looking for Federal jobs, who don't have degrees in engineering or a related subject, must pass an Engineer-in-Training test.

## CONCERNED CONGRESS PASSES SCIENCE EDUCATION BILL

The largest program to aid engineering and science education in more than a century has become law. Stemming from Congressional concern over U. S. scientific and engineering manpower needs, the \$1.2 billion higher education bill provides grants for facilities needed to teach engineering, mathematics, physical sciences, foreign languages, and for libraries.

The bill provides assistance for construction of technical institutes. Also, the student loan program under the National Defense Act has been extended for one year. More funds are available to institutions for loans.

## 374,000 STUDENTS ENROLLED FOR ADVANCE DEGREES IN '62

The Department of Health, Education and Welfare reports that in the Fall of 1962 some 374,000 students enrolled in U. S. colleges and universities for advance degrees. This represents an increase of 69,000 (23%) from the Fall term of 1959, according to the Department.

Percent of students pursuing full-time programs of study for an advanced degree was slightly higher than it was for 1959—40% in 1962 as compared to 38% in 1959.

## SCHRIEVER FORECASTS MORE ENGINEERS THAN SCIENTISTS

Most of today's students will be engineers and relatively few will become pure scientists, according to Gen. Bernard A. Schriever, Air Force Systems Command.

He said that their primary task will be to translate new knowledge into usable hardware. As technology advances, engineering becomes more sophisticated. Some universities now have courses in space satellite engineering.

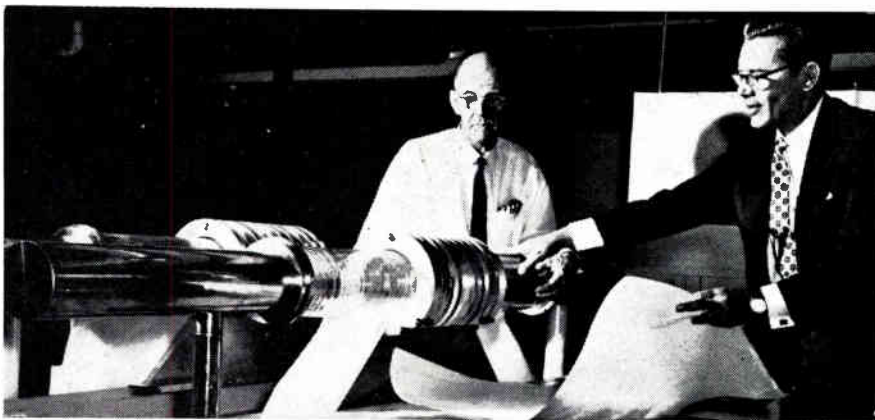
He notes that today the U. S. is training 45,000 engineers yearly, as compared to 58,000 ten years ago.

"The need for more engineers and scientists is generally recognized; it is not always realized that there is an even greater need for technicians to assist professional workers."

Gen. Schriever observed that there is an overall industry ratio of less than one technician for each professional. Many technicians are high school graduates with little or no college-level study. Effectiveness has been reached through job experience.

In the future "it appears that technicians will need to start with at least two years of college-level education."

## NUCLEAR PHYSICS AT "THE FAIR"



In GE Pavilion at 1964-65 New York World's Fair, controlled fusion reactions will occur in large quartz tubes. Temperatures in each tube reach millions of degrees. F. Dr. Henry Hurwitz, Jr., manager of nucleonics-radiation research, talks it over with Dr. Willem Westendorp (left) who designed the equipment.

## ENGINEERS IN R&D GROUPED IN FEW SCHOOLS

Scientists and engineers employed in research and development by U. S. engineering schools are concentrated in relatively few institutions, a new National Science Foundation report shows.

About one-third of 144 engineering schools studied employed almost 90% of all scientists and engineers engaged in research and development in these schools. Ten institutions employed almost one-half of those so engaged.

On an aggregate basis, scientists and engineers in the schools devoted almost two-thirds of their time to teaching and one-third to R&D. Schools in the

NSF study employed more than 22,000 scientists and engineers. About 60% were listed as faculty.

Study results are published in Reviews of Data on Research & Development, No. 43, "Scientists and Engineers in Engineering Schools, 1961." The bulletin is available from the Superintendent of Documents, Washington, D. C.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 120.

Many old line U. S. industrial firms wishing to diversify, and acquire an R&D aura, turn to the electronic industries as a new growth area. Taking on several small firms involves risks. Despite problems, the move has long-range advantages and financial rewards as Singer Company is finding out with Singer Metrics.

FOR MORE THAN A CENTURY The Singer Company has made profits on sewing machines and paid uninterrupted dividends to stockholders. Their success can be appreciated by the sales figures. Gross sales were more than \$600 million in 1962, of which some \$400 million came from sewing machines.

Singer's perennial goal is a minimum of 10% in net profits after taxes on invested capital. In reaching this goal over the years, profits have resulted in available cash that must be invested in other than government and private securities. That is, if the 10% profit rule is to be maintained. Singer's markets, here and abroad, were and are being challenged by the Japanese, the Italians and others. This competition, with increased automation and other factors, left Singer with surplus plant capacity.

Faced with this situation, Singer decided to make two major moves. The first was to transfer all sewing machine operations from the under-used Bridgeport, Conn., plant to the Elizabeth, N. J., plant, to reduce overhead. The other was to acquire and move other industry into Bridgeport. This would be part of an overall plan to diversify. It would be partly a hedge against an open flank in the world market for its primary line, sewing machines, and a means of putting surplus capital to work for higher returns.

One major decision was to keep the Bridgeport plant of 600,000 square feet rather than to sell it.

## BUILDING AN ELECTRONIC CAPABILITY BY 'ACQUISITIONS'

There were two compelling reasons. As a good "citizen," Singer didn't want to throw its 1,500-man labor force out of work, thus depressing the Bridgeport labor market. Also, the fairly modern plant could be adapted to light production.

### A Man to do the Job

Next, Singer hired Kenneth M. Miller, Vice President and General Manager of Daystrom's Pacific Division. His job was to look into the industry most compatible with Singer's business philosophy. Such an industry should be able to reach profits of at least 10% after taxes on invested capital. Its future should be fairly predictable and somewhat immune to depressions and whims of government spending. Above all, what was wanted was an industry based heavily on research and development. The idea was to bring to Singer an aura of technical competence as well as manufacturing capability.

All plans were based on maintaining jobs for 1,500 people in Bridgeport and achieving the required investment return. The need was a minimum of \$30 million in annual sales.

Mr. Miller's search pointed to the technical instrument field as most suitable for Singer's long-range goal.

Data from the Federal Trade Commission and the Securities and Exchange Commission show that



"It was at first feared that engineers from the three acquired firms would tend to stick together within their own groups. Thus far, there is good 'integration' among the 135 total engineers at Singer Metrics, some of whom use this research and test area."

By **ELMER T. EBERSOL**

Editor-at-Large  
ELECTRONIC INDUSTRIES

and **SIDNEY FELDMAN**

Associate Editor  
ELECTRONIC INDUSTRIES





Singer hired Kenneth M. Miller, formerly of Daystrom, to look into electronics potential and to launch Singer Metrics. "We thought of going into components but decided that this field might be adversely affected by microminiaturization. We decided to make black boxes."

"If we hadn't been under pressure to man the plants, we would have been wiser to let them temporarily stay where they were to increase our understanding of their operations, and then phase them into Bridgeport with less upset all around."



the total instrument market in general is about \$5 billion and yields 10.6% on invested capital. Singer accountants discerned that 10.6% return on capital in the instrument business is compounded of successful and unsuccessful firms, with profits above and below this average. Singer hopes to exceed the average.

### Had Electronics Background

With an electronics industry background, Mr. Miller knew how important it was to make the right decisions. He had to select the field of specialization and pick the right firms to acquire. Also, he would be held solely responsible for profits or losses in this newly formed division of Singer.

The electronic-electrical instrument market is about \$400 million annually. If Singer could get 10% of the market, it would have about \$40 million in annual sales; that would be more than needed to meet its minimum financial goal.

Thoughts turned now to "components vs black boxes" to determine which best met Singer's needs. After evaluating 200 companies Mr. Miller and his staff found:

- Black boxes generally involve less labor than components.

- Component making requires purchase and storage of more raw materials, and more labor time per unit sales dollar. Automation apparently won't change this situation.

- Return on equity is generally higher for black boxes.

- Components need a higher capital investment.

- More technical know-how is needed for black boxes.

- About twice the labor is devoted to test and quality control of black boxes than for their assembly.

- Component manufacture and test is the more automated.

- Black boxes require more worker knowledge and advanced skills, thus lifting a company out of the cut-throat unskilled and semi-skilled labor market areas common to components.

Microminiaturization also had been considered. Mr. Miller reasoned that the future of components, which go into original equipment and are supplied

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Salary Desired to Change Jobs in present area \_\_\_\_\_

Salary Desired to Change Jobs and relocate in another area \_\_\_\_\_

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Company	Div. or Dept.	Title	Dates

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## ACQUISITIONS (Continued)

as replacements, may be adversely affected by micro-miniaturization. It was agreed that microminiaturization is still a young, growing, uncertain, developing field. Also, black boxes can go the discrete component or the integrated circuit route depending on advantages and developments.

### Decided to Make Black Boxes

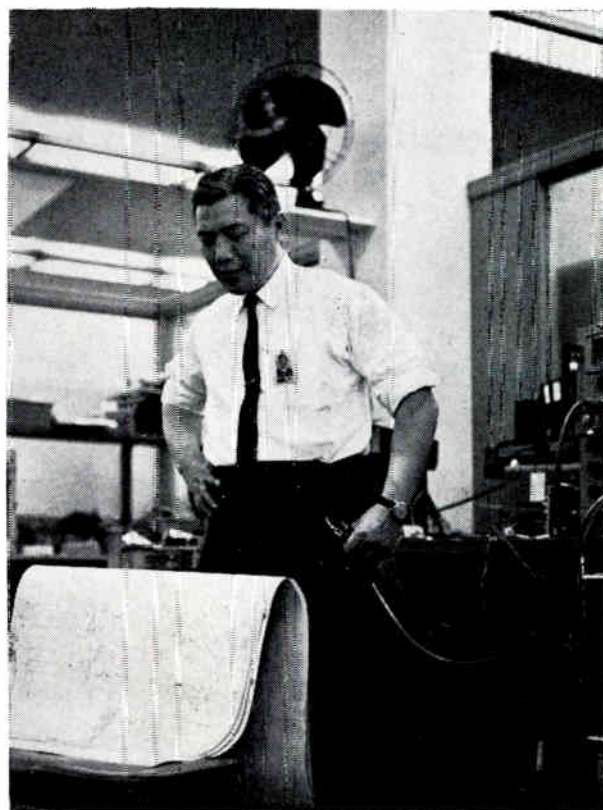
Singer decided to make black boxes.

Then Mr. Miller had to decide what area of electronic metrology looked best. Sophisticated electronic instruments were a likely prospect for concentration.

Development of such instruments "would bring to Singer an R & D complex with ability to generate new ideas for future growth." Instrumentation for specialized applications, or to severely tight standards, would give Singer "a niche all its own with little likelihood of cut-throat price cutting competition." There was little doubt that laboratory-type instruments would be needed in reasonable quantity regardless of production cycles and government contract whims.

And so, Singer Metrics came into being. Now, the "make or buy" decision came into play. Since Singer Metrics had Singer surplus capital behind it, there was no need to start with new and untried designs of instruments. The proper course was to buy going instrument firms with the following characteristics:

"Of about 575 total employees from all three acquired firms, nearly 25% of them moved to Bridgeport to join Singer Metrics. Setting up an equitable personnel policy was a major problem."



William I. Wu, native of Hong Kong, formerly vice president of Panoramic, now heads Singer Metric's R&D. He checked technical competence of prospective acquisitions with Mr. Miller. Here, he ponders physical layout of Metrics' research area.

- Each company should have a good reputation for quality products and leadership in its field.
- It should have had a profitable financial picture.
- A growth potential for its product line.
- Its key management and engineering people should be willing to relocate in Bridgeport.
- The products currently manufactured should be compatible with Singer Metrics goals.
- The acquisition price should be right.

Mr. Miller moved fast. This was part of the scheme to put Singer's low-return surplus capital to work as soon as possible, to consolidate sewing machine operations, to make better use of plant space and to replace vacated space, all at once. In 18 months, he investigated for possible acquisition more than 200 companies, acquired three of these and moved them "lock-stock-and-barrel" into Bridgeport. He is still looking. About five potential acquisitions get his attention each week.

### One Firm at a Time

He notes that usually he did not *strongly* negotiate with more than one firm in one field at a time. "One never really knows for sure what's under the carpet while he's seated on the carpet negotiating. Com-

# solder notes

An open forum on solder, solder preforms, fluxes, special alloys and ultra-high purity metals, with questions selected by the Alpha Research and Development Department from extensive correspondence, personal inquiries, and Alpha Seminars and Clinics. We invite you to submit your own solder and soldering problems to Alpha for review, without obligation.

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## Q. What causes "tin disease"? How can it be avoided?

A. At temperatures below 58°F., Tin may revert to the gray, beta phase. The condition is called "tin disease". This transformation can be inhibited by the controlled additions of small quantities of Antimony. Federal Specification QQS571C requires Antimony in the formulation.

## Q. Are there any reliable non-destructive test methods available for inspection of soldered joints?

A. While there are a number of tests in use, none are considered to be completely adequate for maximum reliability. Visual inspection of the contact angle of the solder with the base metal, and the amount of coverage, are two of the most common inspection methods in use today.

## Q. How can we eliminate skips or voids when joining with a core solder?

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## Q. How does the quantity of solder in a regular fillet affect the strength, the current carrying capacity and the inspectability of the solder connection?

A. Provided that the joint design takes into consideration the current carrying capacity and the strength requirements of the joint, shallow solder fillets amply fulfill the requirements of current carrying capacity, strength and inspectability. Excess solder will not increase the strength and/or the current carrying capacity and will mask inspectability. This has been proven both in industry and in experimental laboratory work. Contour soldering, therefore, can be highly recommended.

## Q. What is the new MAR type flux in the QQ-S-571d specification?

A. For years a group of materials that is more active than water white rosin but is still extremely mild and non-corrosive has been used throughout industry. A new government revision of QQ-S-571d specification has made allowance for this material under the specification with some extremely rigid controls. The Alpha 510 cored rosin which is supplied in both Cen-tri-core and single core meets this new specification. The material has a water extract resistivity of 135,000 ohms centimeter, and does not attack the copper mirror.

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## ACQUISITIONS (Continued)

panies tell us their sales and earnings. Then we say, 'We think you're worth X dollars—provided all you say can be substantiated by an audit of the books'."

By now, Mr. Miller knows that companies which *want* to sell always put their best foot forward. It's a kind of corporate courtship. But, like marriage, you don't know until the "morning after" what your partner is really like.

Singer Metrics acquired three firms:

- In September, 1962, Panoramic Electronics of Mt. Vernon, N. Y. This was the first electronics firm in this new division. It was bought for about \$10 million. Panoramic had sales of \$3.8 million, with more than \$500,000 in post-tax profits in the year before Singer took over.

- In January, 1963, Sensitive Research, a 30-year-old company in New Rochelle, N. Y. Singer paid \$2.5 million. It had sales of about \$3 million and also made money.

- Empire Devices of Amsterdam, N. Y., with \$4.7 million in annual sales and about \$660,000 post-tax earnings. It was acquired in September, 1963, after William I. Wu, formerly vice president of Panoramic and now Singer Metric's Director of R & D, checked Empire's technical competence and facilities with Mr. Miller.

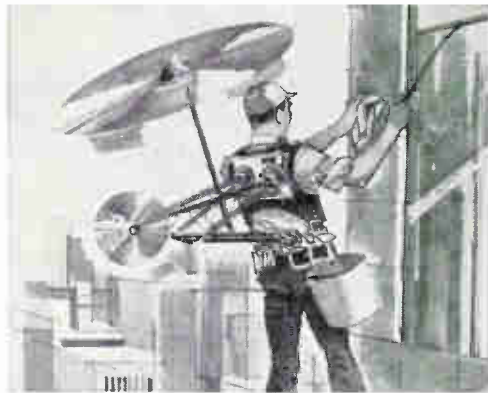
In February, 1963, Singer Metrics took over a complete product line of laboratory electronic test equipment from a company that was unprepared to market these products.

Panoramic's line was mostly broad band spectrum analyzers and accessories, frequency response plotters and telemetry test gear. Sensitive Research marketed electrostatic voltmeters, magnetic testing instruments, highly accurate wattmeters, voltmeters and ammeters, laboratory standards and special purpose test instruments such as potentiometers, galvanometers and ratio boxes. Empire Devices had a line of noise and field intensity meters, filters, ultra-sensitive receivers, calibration antennas, and other sophisticated communications test equipment extending into the microwave region, variable frequency power supplies and special products.

Singer Metrics is aware of the tendency to lose people, even key people, when an electronics plant is moved from one location to another. In these cases, however, the key men, mainly engineers, almost without exception, came to work for Singer Metrics. It is this nucleus management-engineer group around which Singer Metrics now is building its future.

It was at first feared that engineers from each com-

(Continued on page 124)



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You Think  
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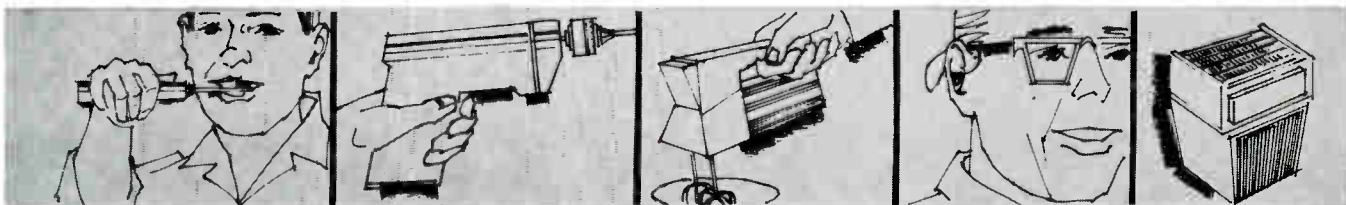
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Type No.	D.C. Primary	Secondary
TY-468	28	110-115-125v 400cps 60 watts
TY-462	12	110-115-125v 400cps 60 watts
TY-75A	12	110-115-125v 60cps 115 watts
TY-76A	12	110-115-125v 60cps 60 watts

**Engineering Bulletin TY-63** gives you the complete story on Triad transistor power supply transformers—general information, schematics, specifications and application notes. Write for copy: 305 North Briant Street, Huntington, Indiana.



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## ACQUISITIONS (Continued)

pany would tend to stick to their own group. Thus far, Mr. Miller says, there is good "integration" among the 135 total engineers at Singer Metrics. There is said to be mutual respect and cooperation among engineers, fostered by complementary interests and activities. Engineers of Empire and Panoramic, for example, are in effect piecing together the same jig saw puzzle. Hence, the compatibility.

Of about 575 total employees at all three firms, nearly a fourth of them moved to Bridgeport to join Singer Metrics.

Problems and matters to be resolved among top technical people included: vacation policies, fringe benefits, salary review and pay scales. Some engineers were receiving more pay than others for the same basic work, mainly because of seniority, or differing policies of the acquired companies. Also, Bridgeport is a union area—whereas Panoramic and Sensitive had no unions and Empire Devices had an in-house company union. Establishing an equitable personnel policy was a major problem.

Stock options were another problem, particularly with key personnel. Some options were higher than the market stock price. When some employees exercised their stock options (to get a high-price stock at a low price), they discovered that the market price of the stock had been reversed. Now, it was cheaper to buy the stock on the open market than it was to exercise a stock option and get the stock from the company. In effect, the option extra value evaporated.

### Advantages Offset Problems

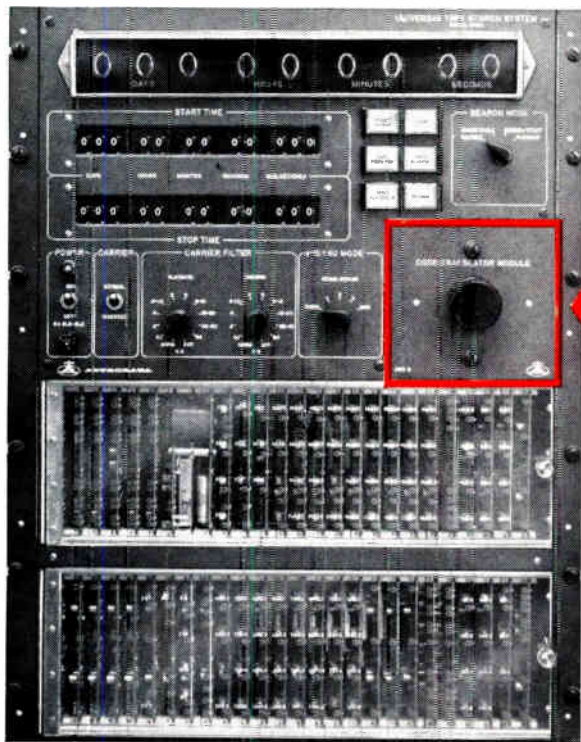
Some obvious problems or disadvantages in moving whole companies to a central location are often offset by these advantages, according to Kenneth Miller:

- Centralizing eliminates redundant overhead costs.
- Fewer purchasing people are needed.
- Buying in larger lots results in lower prices.
- Inventories, handling, invoicing are centralized.
- Common marketing should be more efficient, including common advertising, promotion, sales and distribution.
- Standardizing, to reduce redundant inventories, should effect economics.
- Pooled R & D talents should help create better products at less R & D costs.

### Inducements to Key People

Singer Metrics also offered inducements to hold  
(Continued on page 126)

# When a new time code is introduced...

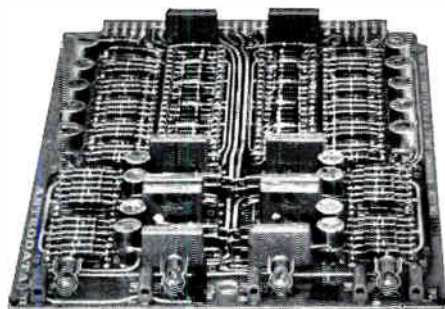


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Astrodata Model 6222 Universal Automatic Tape Search System accepts virtually any time code format, and provides completely automatic high-speed search, playback, re-record and stop operations. Extremely high input sensitivity (10 mv) assures highly reliable tape search.

## ...to forestall system obsolescence



Indicative of the MIL-type quality built into Astrodata timing equipment are the many extras carefully designed and incorporated into each system. The circuit cards, for example, are glass epoxy boards for maximum resistance to moisture and temperature; test points and indicator lights on the cards facilitate easy system checkout from the front without removing the cards. Included also are such construction refinements as strain-relief mounted components, tin immersion plated mounting eyelets, rhodium-plated connector contacts, taper pin connector contacts, "worst-case" operating tolerances for all components.

Astrodata Model 6222 Universal Automatic Tape Search System has been designed to prevent system obsolescence each time a new time code format is introduced. Circuitry common to all time code translating is built into the system — circuitry peculiar to each time code is built into individual plug-in modules.

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Considerable savings accrue to users because of Astrodata's years of experience in the design and manufacture of time code generation, translation, telemetry and tape search systems combined with a modular approach that permits many engineering and production economies.

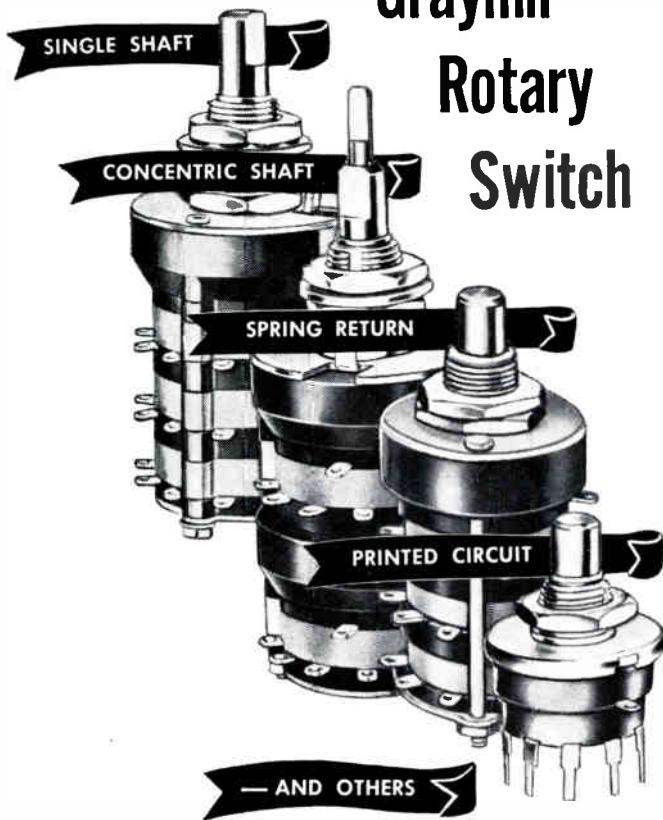
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## ACQUISITIONS (Continued)

key people in the acquired plants and attract others. Inducements, which generally could be afforded by a big company, included among others moving and relocation subsidies, and cash loans without collateral, to ease the moving burden. The company also offered a full-time technical library using Library of Congress numbering system, and an education support program. Complete costs of approved studies, undergraduate or graduate, would be paid by the company.

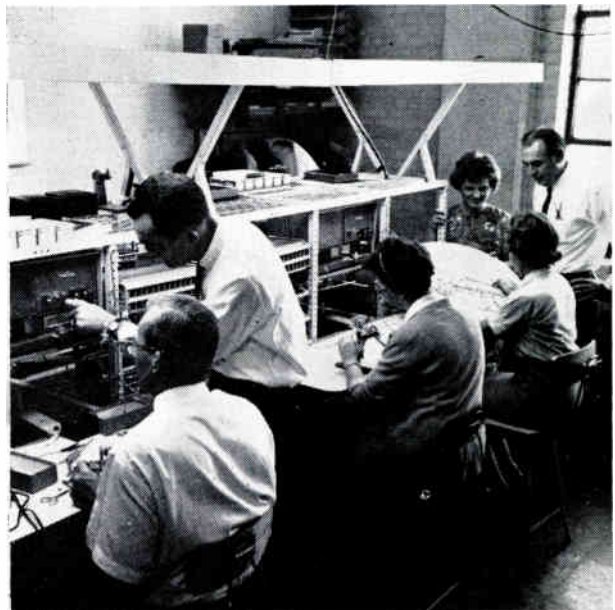
Cash awards were offered to engineers to write technical papers—over and above money received from publishers. Company drafting, typing, photographic and other facilities were at the author's disposal.

In short, Mr. Miller says Singer Metrics believes in “investing in people.”

By gradually phasing out industrial sewing machine manufacture while phasing in electronic operations, Singer has maintained its labor force and actually increased it by about 20%. It was somewhat of a surprise to find that a knowledgeable electronic production line foreman had worked previously on sewing machines! Singer Metrics has set up a school to retrain employees, including assemblers, sheet metal workers, foremen and others. Singer's sheet metal and machine shops have been adapted to fabricating electronic equipment.

Now that Singer Metrics has three acquired in-  
*(Continued on page 128)*

“Each acquisition had its own production methods. Singer Metrics is analyzing all methods and will choose the best.” One assembly method (below) uses video slide-sound instruction.

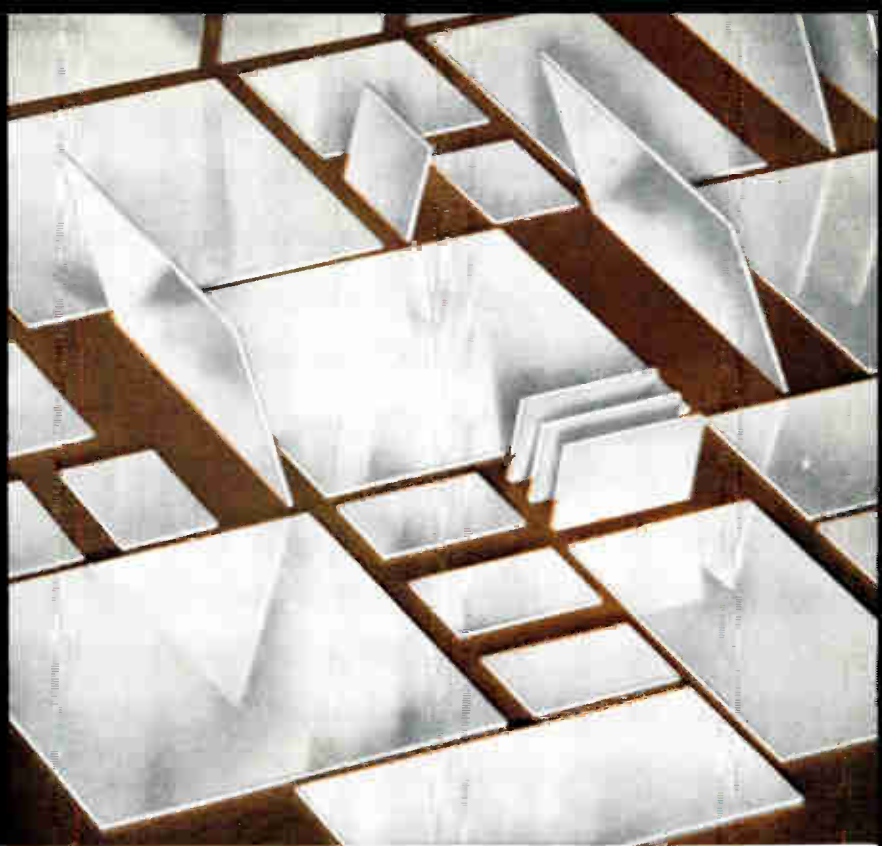




## PROGRESS REPORT



# ANOTHER NEW SERVICE ON **ALSiMag** TRADE MARK REG. U. S. PAT. OFF. ALUMINA SUBSTRATES



The use of thin ALSiMag substrates continues to accelerate because they have excellent insulation characteristics, great strength with good thermal conductivity and are stable mechanically and electrically over a wide range of temperatures.

The ALSiBase process, pioneered by and exclusive with American Lava Corporation, produces thin wafers with a degree of flatness well within acceptable limits for many applications. The natural finish of ALSiMag alumina ceramics has advantages in many applications. In general, it offers better electrical characteristics than a ground or lapped finish.

Grinding removes the original surface and causes minute voids, bubbles or scratches which can create problems on substrates for thin film deposition. These are eliminated with ALSiMag glaze 743 which so accurately matches ALSiMag 614 (96% aluminum oxide) that no defects are apparent after cycling test samples from room temperature (23°C.) to liquid nitrogen (-210°C.). This glaze has a softening temperature of approximately 725°C. The surface finish of the glaze is better than 1.0 micro-inch (CLA).

### PRACTICAL TESTS

About two years ago these ALSiMag substrates were announced in the technical press. Later, in response to the need for an exceptionally smooth surface, ALSiMag glaze 743 was developed. Prototypes were offered at attractive prices. At present many users have now satisfactorily completed their tests, including life tests, and are beginning to use production quantities.

### PREFERRED SIZES

The increasing acceptance of ALSiMag substrates has revealed certain preferred sizes. In the fall of 1963, preferred thicknesses were established as .025" for the unglazed and unground substrate with surface finish of 40 micro-inches or better and as .030" for the substrate glazed on one face with surface finish of better than 1.0 micro-inch CLA.

### NOW! STOCK SIZES

It now appears that we can render a needed service by stocking certain sizes. This permits prompt shipment (about one week) and lower prices on prototypes or other small quantity orders. Additional

sizes will be stocked as their need is established. At present these sizes of unglazed substrates are in stock, at a thickness of .025":

$\frac{1}{2}$ " x  $\frac{3}{4}$ "  
1" x 1"  
1" x 2"  
2" x 2"

Glazed substrates are available in these same sizes and at an over-all thickness of .030". Allow two weeks additional for shipment of glazed substrates.

### CUSTOM PRODUCTION

ALSiMag substrates may, as always, be had in materials other than alumina, for example, steatite and beryllia. A variety of sizes, shapes, serrations and patterns of holes is readily possible. Dimensional control is excellent. If you have an especially critical application that requires grinding, this may be obtained at commensurate cost.

Please outline your problem so that our technical men can make helpful suggestions based on the latest advances.

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Name \_\_\_\_\_ Title \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_  
All inquiries held in strict confidence.

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## ACQUISITIONS (Continued)

strument makers under one roof, Mr. Miller plans to make them into a cohesive force to establish a new Singer Metrics reputation. This will be reflected in advertising and sales promotion to portray the "corporate image," or the "division image" of Singer Metrics. The division will have its own quarterly publication, "Metrics," featuring upper level articles on product case histories.

### Product Evolution Plan

Mr. Miller admits that "We may continue to refer to these products by their original names for years, since engineers know of Panoramic, Empire and Sensitive, while Singer Metrics' name is not yet firmly established."

Product evolution is basically a three-step plan at Singer Metrics:

*Mark I* is to put a Singer Metrics name plate on the front panel of the original company product.

*Mark II* is to redesign the panels to have a distinct Singer Metrics style leaving chassis design and construction as is.

*Mark III* is to apply value analysis in redesigning the product on the basis of its function, to take advantages of modern technology, to improve production methods, and to create a distinctive design.

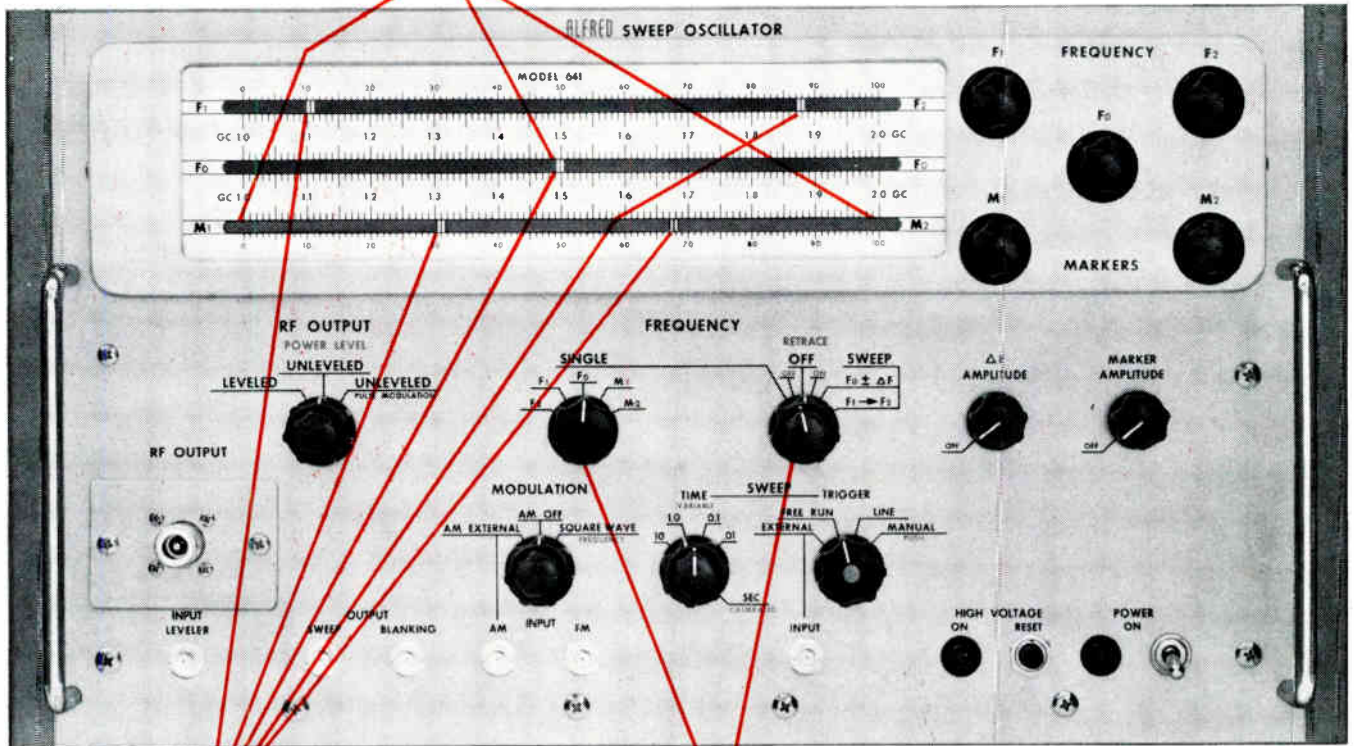
Singer Metrics is introducing the product manager concept to protect the \$27.5 millions that Singer Company has invested in Metrics as corporate insurance. The product manager has no line responsibility, but keeps after the line people. Engineers, sales, and marketing men will continue working in their own areas. However, the staff product managers (one for each line of products, paralleling what each individual company made formerly) will be under the general manager.

Ultimately, these staff product managers may go into line jobs or become product managers of other product lines. At this stage, they are "shadow managers," backing up the line people but reporting directly to the general manager.

A new products committee, composed of product managers and the general manager, will plan other products. Mr. Miller observes that the average life of electronic test equipment is about five years. So, every year the firm will have to regenerate one-fifth of its product line. Thus, every five years the entire product line either will be modified or somehow improved and updated. Singer Metrics strives to keep up the *state of the art* in instruments to hold its share of the market. The new product committee makes

(Continued on page 130)

**Multiple frequency markers** allow frequency calibration with 3 markers during broadband sweep and 2 during symmetrical sweep.



**Five single frequency settings** simplify and speed component evaluation. Choose stable, clean CW or modulated single frequencies at  $F_1$ ,  $F_2$ ,  $F_0$ ,  $M_1$ , and  $M_2$ . Sweep for qualitative analysis and measure precisely at end frequencies ( $F_1$ ,  $F_2$ ) and 3 intermediate frequencies ( $F_0$ ,  $M_1$ ,  $M_2$ ).

**Complete sweep flexibility.**  $F_1 \rightarrow F_2$  sweep for broadband evaluation.  $F_0 \pm \Delta F$  symmetrical sweep for expanded display.

**Separate  $F_0$  control** independent of  $F_1 \rightarrow F_2$  allows switching from broadband sweep to symmetrical sweep without "disadjusting controls."

## New Sweep Oscillator, 1 to 40 Gc

This is the face of the new Alfred 1 to 40 Gc sweep oscillator. Alfred 640 Series Sweepers offer the cost-conscious engineer the best price-performance ratio.

Features include: internal or external leveling with wide control range, retrace blanking at all sweep speeds for scope or recorder operation, accurate manual sweep, solid state design, 50 to 400 cps operation, ruggedized construction. Ask your Alfred representative for a demonstration.

Frequency Range	Power Output	Leveled Power Variation	Residual FM	Price	
641	1-2	100 mw	*	25 kc	\$3,050
641K	1-2	70 mw	$\pm 0.5$ db	50 kc	\$3,290
642	2-4	70 mw	*	25 kc	\$2,850
642K	2-4	50 mw	$\pm 0.5$ db	50 kc	\$3,090
643	4-8	20 mw	*	50 kc	\$2,850
643K	4-8	20 mw	$\pm 0.5$ db	75 kc	\$3,190
645	8-12.4	20 mw	*	75 kc	\$2,990
645K	8.2-14.4	10 mw	$\pm 0.75$ db	100 kc	\$3,390
647	12.4-18	10 mw	—	100 kc	\$3,350
648	18-26	5 mw	—	300 kc	on request
649	26-40	5 mw	—	350 kc	on request

\*Output may be leveled with external Alfred RF Samplers or directional coupler and crystal detector.

### Sweeps

Broadband, 2% to 100% of full range. Symmetrical, 0 to  $\pm 5\%$  about center frequency  $F_0$ . Manual, proportionate sweep voltage with  $F_0$ ,  $M_1$ , and  $M_2$  provided

### Sweep Time Sweep Trigger

10 msec to 100 sec  
External; free running; line; manual (single sweep)

### Amplitude Modulation

Internal 800 to 1200 cps square wave; external

### Single Frequency Control

$F_0$ ,  $F_1$ ,  $F_2$ ,  $M_1$ , and  $M_2$  continuously adjustable, panel switch selected

### Frequency Stability

Better than 0.01% per degree C

### Frequency Marker

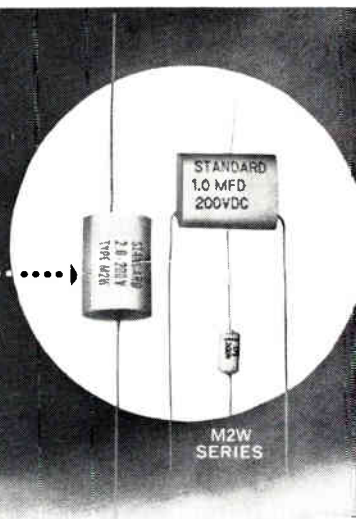
Three markers  $M_1$ ,  $M_2$ , and  $F_0$  adjustable over entire range.

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\*Du Pont Trademark for Polyester Film

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## ACQUISITIONS (Continued)

management-type decisions and allocates budget or sales dollars to the R & D program on a division or product-group basis.

### Gradual Product Phase-In

Singer Metrics gradually phases in its newly re-designed instruments. The first new product was introduced at the IEEE Show in March, 1963. The second was shown at Wescon in August. Others will be introduced this month at the IEEE 1964 Show.

Singer Metrics is trying to have its products reflect the market being served. For instance, Sensitive Research products have the traditional look of quality, accuracy, and reliability by use of molded black Bakelite panels and varnished wood cabinets. These instruments are used in laboratories to calibrate still other instruments.

Panoramic instruments reflect the market for on-the-line practical measuring instruments for use in communications or in design functions. Their panels and cabinets are metal for rugged service.

Singer Metrics aims to give a "new look" to all its products in about three years. In so doing, it hopes to make equipment easier to build, easier to test on-line or in user's labs, and easier to service in the field. The firm will make all equipment fully transistorized, if feasible, and employ plug-in boards and building block modules. It hopes to reduce assembly costs and standardize on parts common to all instruments, where possible, and assign common part numbers to the same part used in various instruments. Operation and maintenance manuals, including schematic format and symbols, will be standardized.

To avoid interrupting operations, Singer Metrics literally stripped down the three companies, crated them, and shipped them almost overnight to Bridgeport.

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The Editor  
ELECTRONIC INDUSTRIES  
Chestnut & 56th Sts., Phila., Pa. 19139

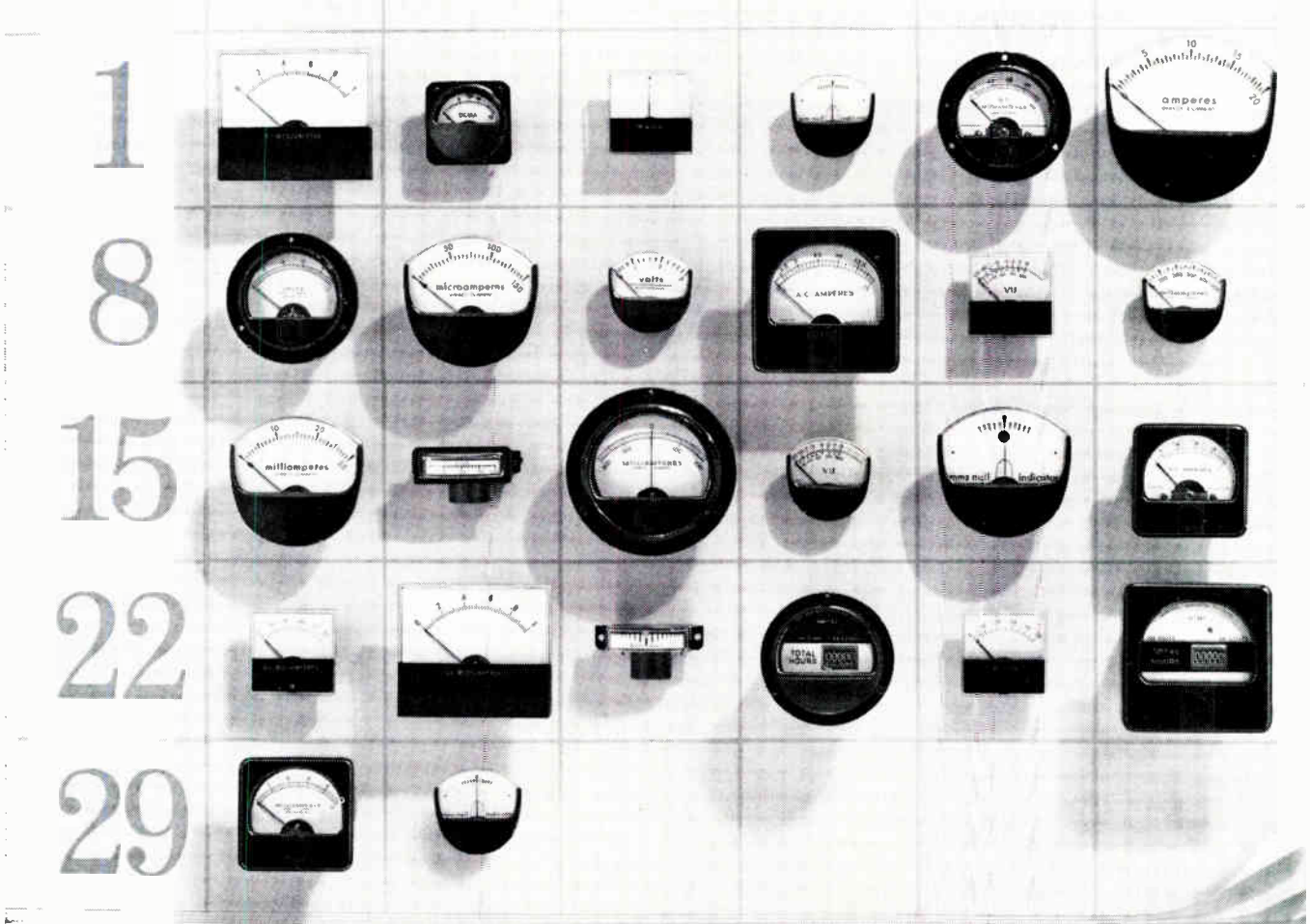
Each company had its own production methods. Singer Metrics is analyzing all these methods and will choose the best. The division plans to have common work areas, and use a sequential work and assembly technique, common to all manufacturers. There will be a central test area.

Eventually, separate specialty shops to modify standard off-the-shelf, out-of-the-catalog products, or to build custom products and equipment, will be set up.

(Continued on page 132)

# MARCH

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**ACQUISITIONS (Continued)**

Marketing now is in flux. Each firm had its own manufacturer's representative organizations and factory sales force. Panoramic had the fewest representatives, Sensitive Research had the most. Some reps had bigger territories than others. Many of the agreements between these firms and their reps were verbal. Some product commissions varied by rep, even in the same company.

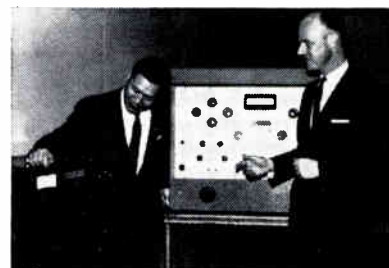
**Commissions Being Honored**

Existing commission arrangements are being honored, yet the most effective marketing techniques for a given product is being studied. Changes in rep relations are inevitable.

Singer Metrics will continue to monitor the rep operation to assure itself of the greatest marketing strength at the lowest cost. For instance, the division will eliminate multiple reps, and have one rep in a given sales area to handle all Singer Metrics lines, where feasible. Factory direct sales offices may be established in certain key industrial centers.

So far, foreign sales represent 10% of Singer Metrics volume, but it is a growing market. The company *now* uses reps abroad.

William Wu, research director and Kenneth Miller compare old (right) with new (left) laboratory standardizing test console now in production by Singer Metrics.



In the future, Singer Metrics plans to become the third largest factor in the electronic laboratory test instrument business, after Hewlett-Packard and Tektronix. The Singer division plans to achieve this goal, by the end of 1964, with other acquisitions.

Already, negotiations are in the final stage to acquire Gertsch Products, Inc., of Los Angeles. This firm has 70,000 square feet of plant space, \$4 million in sales in fiscal 1963, and post-tax profit of about \$270,000. Mr. Miller says Gertsch is the first of several acquisitions on the West Coast contemplated to give Singer Metrics a coast-to-coast potency. Current plans call for a West Coast complex with minimum potential sales of about \$25 million.

**Cost Many Times Earnings**

Panoramic, acquired as a Singer Metrics cornerstone, cost 20 times earnings. Empire devices cost about 16 times earnings. Gertsch may cost less than



*"The blood more stirs  
to rouse a lion  
than to start a hare!"*

William Shakespeare

There are challenges and then there are challenges.

Consider the one that confronts us at MITRE. We are responsible for the design, development and integration of the major command and control systems that protect the free world.

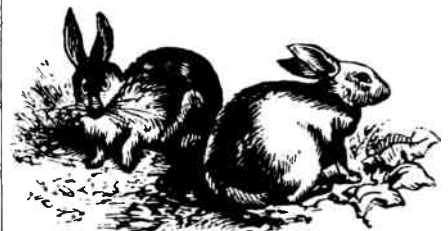
This involves systems for nuclear detection (NUDETS), long distance Air Force communications systems (SPACE-COM), ballistic early warning systems (BMEWS), National Military Command Systems (NMCS), and many more.

Working at MITRE, a man may think in terms of an overall system to provide instant warning in case of attack; of a sub-system that might be a flock of orbiting satellites; of a component that's one of the world's largest computers.

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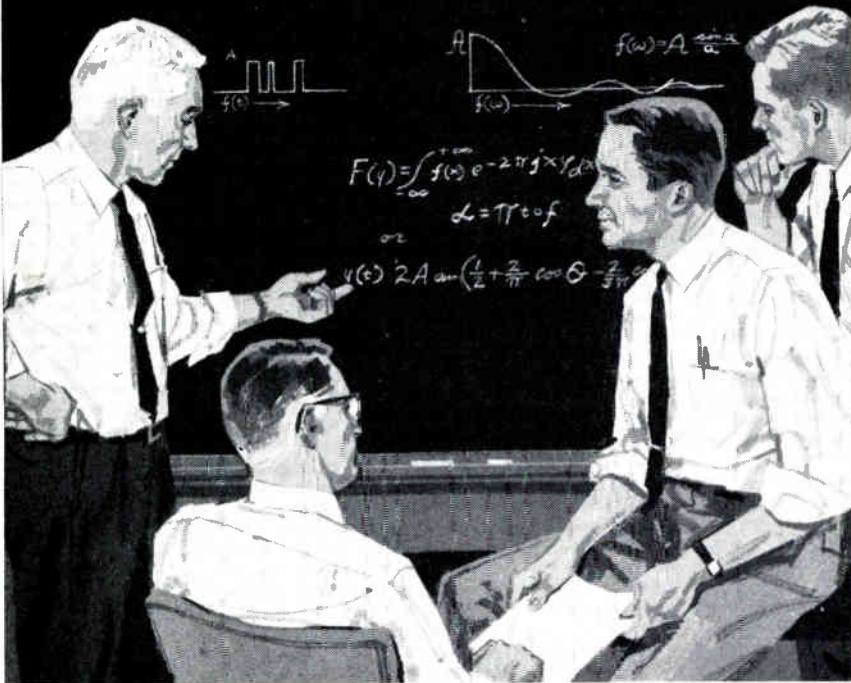
*MITRE is located in pleasant, suburban Boston. Openings are also available in Washington, D.C. and Colorado Springs. Rewards are competitive. Engineers and scientists — preferably with advanced degrees and at least five years' experience in electronics, mathematics or physics — write in confidence to Vice President — Technical Operations, The MITRE Corporation, P.O. Box 208AN, Bedford, Massachusetts.*

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From the very beginning, Motorola has been an "engineer's company"—an organization where every consideration was secondary to the newest technological development. As a result, Motorola has attracted the type of engineer and scientist who is noted, not for his ability to conform—but to create.

In this intellectually rarified atmosphere, the challenges to an engineer are great—but, of course, the rewards are commensurate.

Motorola does *not* need "engineers" per se, but there is always an urgent need for really *good* engineers and scientists—men who are inspired by this dynamic environment rather than afraid of it—men who shun monotony and search for diversified projects. If you are such a man, we would like very much to talk with you.

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## ACQUISITIONS (Concluded)

13 times earnings. Thus, based upon experience, and upon market conditions, Singer has been paying a lower price/earnings ratio for each successive acquisition. This may change, however.

Whenever Singer Metrics buys any company at more than 10 times earnings, it is not achieving Singer's overall objective of more than 10% return on invested capital. It now remains for Singer Metrics to achieve a growth that will allow it to "grow back" the profits. As an example, if Singer bought a company at 20 times earnings, it would need to double sales at the same percentage of profit, or maintain sales and double the profit, to achieve a 10% return.

Singer Metrics wants to steer a course somewhere between these two shores. It estimates total sales volume by the end of 1966 at about 5% of the 1962 total Singer sales of around \$600 million. The sales volume of Metrics in 1964 is expected to top \$20 million with acquisition of Gertsch Products. The Singer Company's investment of about \$27.5 millions in Metrics undoubtedly will increase by 1966 with continuing acquisitions.

Mr. Miller apparently made a minimum number of mistakes. He did admit, though: "Although we would have bought as we did—quickly but deliberately—we would have moved the plants to Bridgeport more slowly.

"If we hadn't been under pressure to man the plants, we would have been wiser to let the plants temporarily stay where they were to increase our understanding of their operations, and then phase them into Bridgeport with less upset all around."

He added: "The worst is behind us. We have no plan to move anything else to Bridgeport in the near future."



# Measure and calibrate current & voltage—DC to 1000 mc



**Model LTU** is illustrative of a unique Metrics Division capability in the fabrication of integrated calibration and measuring systems. The console consists mostly of Sensitive Research catalog items neatly packaged together to meet the specifications of a major computer manufacturer. Therefore, in spite of its special requirements, it is so standard that its cost is comparable to the total price of all items if purchased separately.

This efficient, reliable calibration system is ultra modern in appearance and function. It was designed and assembled by Sensitive Research instrument engineers who have been in the business of making respected standards since 1927. The only difference is that now they also call upon the considerable capabilities of the other product lines within the Metrics family. Therefore, since some Panoramic and Empire instrumentation was required in the console, it was easy to include. This is what makes the Metrics Division capability so unique!

The console consists essentially of the following self-sufficient modules and additional features:

**Model LTC-2**, a new  $\pm 0.035\%$  accurate, high speed calibration standard covering ranges of  $200 \mu\text{V}$ — $1110 \text{ v}$  and  $0.001 \mu\text{a}$ — $11.1 \text{ amps}$  over a frequency span of DC and  $7 \text{ cps}$ — $25 \text{ kc/s}$ . **Model LTPS-11**, a new variable frequency ( $10 \text{ cps}$ — $100 \text{ kc/s}$ ), low distortion ( $0.05\%$ ), stable ( $0.005\%$ ), ac power source that features a noteworthy  $200 \text{ va}$

output. **Model RFS**, a new high resolution RF readout system, for measuring AC/DC differences and frequency influence. When employed with micropotentiometers, coaxial thermal converters, and an A-T voltmeter, calibrations can be made from  $1 \mu\text{V}$ — $500 \text{ v}$  at frequencies up to  $1000 \text{ mc/s}$ . A special panel containing 12 precision thermoelements enables RF current measurements from  $1 \text{ ma}$ — $10 \text{ amps}$ . **Model FLH-1**, ac/dc transfer standard with ranges of  $1.5$ — $1125 \text{ v}$ . This unit has never been reported outside the NBS stated uncertainty of  $\pm 0.01\%$  up to  $30 \text{ kc/s}$  and  $\pm 0.02\%$  up to  $50 \text{ kc/s}$ .

Additional capabilities are incorporated, including a Lindeck microvolt source, a micropotentiometer calibrator, 3 signal generators, dc power supplies (remotely controlled, and programmed, and designed with interlocking circuits for overload protection), a high sensitivity galvanometer and a multirange  $\pm 0.5\%$  accurate millivoltmeter.

A Commander Type MR,  $\pm 0.005\%$  accurate dc potentiometer system complete with portable saturated standard cells as a reference, could readily have been included in the console. It would have occupied only  $19" \times 27"$  of additional panel space.

**More information**—Do you require a calibration and/or measuring console tailored to meet a big engineering need and a small budget? Contact Sensitive Research instruments... a product line of The Singer Company, Metrics Division.



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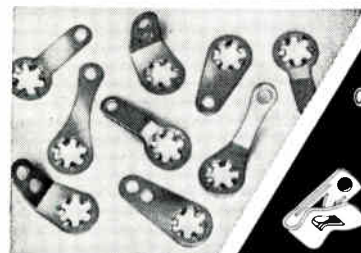
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## SMALL BUSINESS (Concluded)

. . . from page 36

"We also try to avoid the general manager who is a jack of all trades. He tries to do everything himself. We hear time and time again that anyone who tries to do everything himself and refuses to delegate, is a poor manager. As in every other business this is an important truism in electronics.

"Failure comes about by a man's inability to delegate responsibility. A good businessman's ability is one of strength and character, of relatively good experience, with a good sense of where profits can be made without cheating. If he's a conniver, a wheeler and dealer, if he's willing to pull fast deals, he will not normally attract a high quality person to work with him. He will invariably fail.

### Communicating

When ECC was founded, several of the underwriters of the original offering of \$16 million asked Mr. Salik, "How are you going to deal with the cocky engineer who started a business, had initial success and now needs follow-on capital?"

ECC's president answers, "We know it's true. Too many technical people who started businesses and enjoyed momentary success, are uncommunicative, overly cocky and unwilling to listen to ideas. With that kind of person, Electronics Capital Corporation can do no good. We cannot help them.

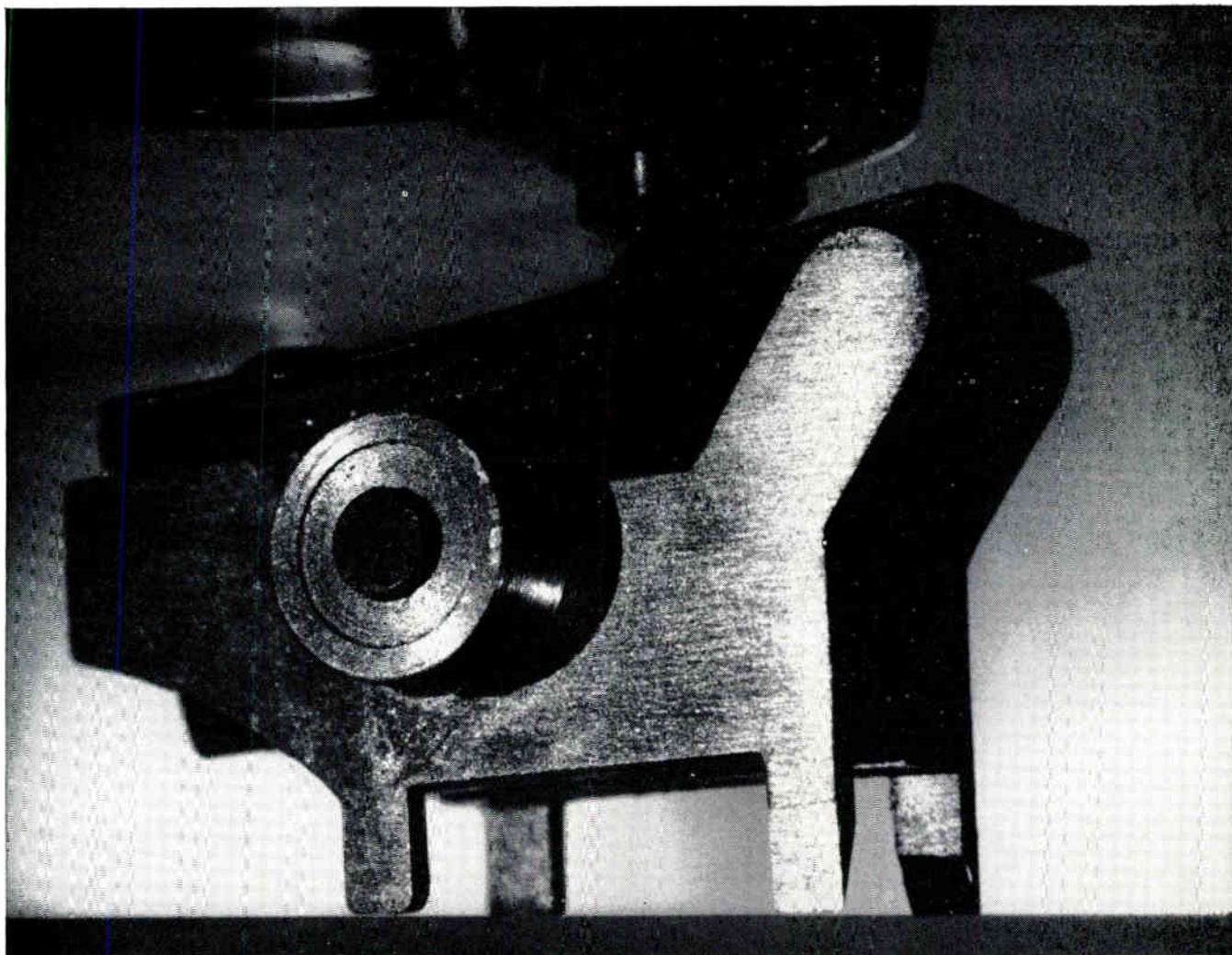
"We have specialists in every field of electronics. They all have had a lot of experience. They are not better than the applicant but they are able to communicate ideas and synthesize. They take information not only from the companies we have invested in, but also from companies we have turned down. Even so, many times they are ignored. If we find this out early enough we won't make a deal.

"We are delighted to make an investment and take a high degree of risk if the man is a composite of the things I have mentioned. He must be a communicative man, a receptive man, usually technically oriented. He must be a man who will accept the ideas of others not necessarily in his field but in areas that support his field."

In his concluding remarks Mr. Salik made this observation:

"We have learned from bitter experience that you cannot be too exact in your judgment of management and its potential.

"You have to have some broad outlines that you think apply in the areas that I have mentioned but there is a point at which you have to take a risk. And in our case we were, I believe, right seventeen times and wrong three times."



## CLOSE-UP

### of the modern way to make printed circuit masters

*(for a closer view yet, see K&E at the IEEE Show, Booth 4507)*

What you see above is the cutting head of a K&E circuit path cutting tool, shown 12 times life size. Used with STABILENE® Cut 'N' Strip film, it will cut a circuit path as fast as you can draw a pencil line. This is the fast, accurate, modern way to make masters for printed circuits, printed wiring, and micro circuit masking. Their precise spacing can be adjusted in fractions of an inch or decimal parts of an inch depending on the set used.



Cut 'N' Strip is a clear, dimensionally-stable film with a peelable, semi-transparent red coat on the front. Here's how easy it is to use: (1) Draw your circuit layout on the back of Cut 'N' Strip in pencil. (2) Turn over, cut your lands and runs in the peelable red coating on the front with K&E cutting tools. You just follow your pencil layout, which is visible through the film. (3) Peel off the red coating . . . inside your outlines for a negative master, outside for a positive master. Errors can be easily repaired with a special K&E opaquing fluid which can be cut and stripped like the original coating.

That's all there is to it . . . you now have a master far more clean and precise than one made by other methods. There's no ink to run. There's no tape to stretch, pile up, shrink, or

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K&E supplies everything needed: STABILENE Cut 'N' Strip Film with matte back (#44 5525) or non-matte (#44 5545), touch-up fluid #58 2190, and a complete layout tool kit (decimal: #56 1293; fractional: #56 1291). For more complete information on making printed circuit masters with Cut 'N' Strip, plus a free sample of STABILENE Cut 'N' Strip, clip and mail the coupon below . . . today. Keuffel & Esser Co., Hoboken, New Jersey. Offices in all principal cities.

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## Resistance Bridge

This data sheet describes Model DB-1 resistance deviation bridge, which provides a rapid, accurate and economical method of grouping resistors into percentage classifications. It can also be used for comparing resistors with a sample resistor and for general resistance measurements by the null method. Complete specs., application information, calibration and operation procedures are given. Industrial Instruments Inc., 89 Commerce Rd., Cedar Grove, N. J.

Circle 151 on Inquiry Card

## Wire Bonder

Data is available on a wire bonder, Model 403, which produces a somewhat larger bond than the ordinary wedge bonder. The bond is formed with a carbide or glass capillary. Higher speeds are possible because a single "chessman" positioner controls the motion of the wire feed and the bonding tool. Accuracies to within 20 mils are possible. The scissor cutoff leaves a very short tab. Kulicke and Soffa, 135 Commerce Dr., Industrial Park, Ft. Washington, Pa.

Circle 152 on Inquiry Card

## Switching System

Improved control-circuit performance from an SCR is possible when a silicon tunnel diode is connected between the gate and cathode of the SCR. It is now possible to buy these components in one package. The information contained in Bulletin 1-63 gives specs. on the SCR and the TD, plus typical characteristic curves for the system. These compare firing level vs. temp.; holding current vs. temp.; avg. load current vs. conduction angle; and temp. and pulse firing characteristics. Hoffman Electronics Corp., El Monte, Calif.

Circle 153 on Inquiry Card

## Computer

Bulletin 4110 describes the Model 420 System Computer. It gives a description of its uses, specs., command list, and theory of operation, including a block diagram showing computer organization. Model 420 is a special-purpose digital computer for real-time processing. It has a 32,000 word memory, up to 8 input/output channels, and a 3.2μsec. read/restore cycle time. Beckman Marketing Services Dept., 2500 Harbor Blvd., Fullerton, Calif.

Circle 154 on Inquiry Card

## Generators/Amplifiers

This short-form catalog contains descriptions, photos, and operating specs. for a line of pulse generators, swept signal generators, microwave amplifiers, electro-meters, and switching-time meters. Also offered is a manual with state-of-the-art data on pulse-measurement techniques. It treats the subject in depth, covers pulse-generator applications, measurement techniques, common pulse circuitry, and includes definitions. E-H Research Laboratories, Inc., 163 Addine St., Oakland, Calif.

Circle 155 on Inquiry Card

## Pushbutton Switch

The B5023, a non-snap keyboard-type pushbutton switch, is ideal for digital computers, program boards, control panels, adding machines and calculators. Removable plastic pushbutton, in variety of colors and sizes, may be engraved with a letter, number or symbol. It is 3a. resistive at 30vdc. Momentary contact, 2 circuit break-before-make action. Min. life 100,000 operations. Literature and specs. from Control Switch Div., 1420 Delmar Dr., Folcroft, Pa.

Circle 156 on Inquiry Card



**IEEE  
SHOW  
'64**



**march 23-26  
9:45 A.M. - 9 P.M.**

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### Welding Tools

Data is available on 4 accessory tools for small-parts welding. They are used for work that is difficult to reach and cannot be handled by a standard bench welder. The tools are tweezers, pliers, pencil and gun. All can be used to weld unusually small parts. Brochure is available from Federal Tool Engineering Co., 1384 Pompton Ave., Cedar Grove, N. J.

Circle 178 on Inquiry Card

### Measurement/Control

A brochure entitled, "Innovations in Instrumentation," describes a line measurement and control equipment. Instruments include bridges and accessories, transistor parameter adaptors, distance and vibration instruments, audio and video instruments, etc. Each description is accompanied with photos, and specs. Wayne Kerr Corp., 1633 Race St., Phila. 3, Pa.

Circle 179 on Inquiry Card

### Contact Theory Paper

"Reliable Electrical Contact Theory Applied to RFI Control" is the title of this paper. It will benefit design engineers and others concerned with the problems of RFI filtering and gasketing. Ask for bulletin RF-21 from Technical Wire Products, Inc., 129 Dermody St., Cranford, N. J.

Circle 180 on Inquiry Card

### Control Systems

Brochure GED-4930, 16 illustrated pages, presents major developments in missile control systems. Described are systems, subsystems and components for missile weapon control, gun-fire control and underwater ordnance uses. General Electric Co., Ordnance Dept., 100 Plastics Ave., Pittsfield, Mass.

Circle 157 on Inquiry Card

### Indium Arsenide

The Indium Arsenide described in this data sheet is available in polycrystalline form for use in infrared and Hall-effect devices. Cominco Products, Inc., 933 W. 3rd Ave., Spokane 4, Wash.

Circle 159 on Inquiry Card

### Photo-Conductive Cells

A 12-page illustrated brochure describes the cadmium sulpho-selenide photocell. Spectral response,  $\pm 50 \text{ \AA}$ ; resistance to  $200\Omega$  at 2 ft. candles. Response is 0.5-msec. The cells are available in  $\frac{1}{4}$ ,  $\frac{3}{8}$ , and  $\frac{1}{2}$  in. dia. Angstrom Electronics Corp., Box 712, Port Washington, N. Y.

Circle 161 on Inquiry Card

### Frequency Meters

This spec. sheet describes 400 cycle and 60 cycle freq. meters. Models PFM400HRM and PFM60HRM provide accuracy for most commercial and military specs. At  $25^\circ\text{C}$  and nominal input voltage of 115v., they have an accuracy of 0.1% at center scale and 0.25% at all other scale points. Temp. compensation insures accuracy within 0.75% over range of  $-55^\circ\text{C}$  to  $+55^\circ\text{C}$ . AMF Instrument Div., American Machine & Foundry Co., P. O. Box 929, Alexandria, Va.

Circle 158 on Inquiry Card

### Converter Applications

Complete specs., prices, and a technical description are now available on the DT-1401 voltage-to-freq. converter. This brochure contains several application notes. One describes how the converter is used with a counter to make an integrating digital voltmeter. Another shows how the converter can be used in a system to display interrelated inputs directly in engineering units. Data Technology Corp., P. O. Box 10935, Palo Alto, Calif.

Circle 160 on Inquiry Card

### Magnetostrictive Lines

This publication is a refresher or introduction to magnetostrictive delay-line fundamentals, theory, and applications. It has illustrations and drawings of various wave shapes under various operating modes. The booklet discusses RZ and NRZ recording methods, and includes a glossary of magnetostrictive delay-line terms and a summary of measurement practices. Ferranti Electric, Inc., Light Equipment Div., Industrial Park No. 1, Plainview, L. I., N. Y.

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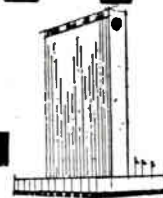
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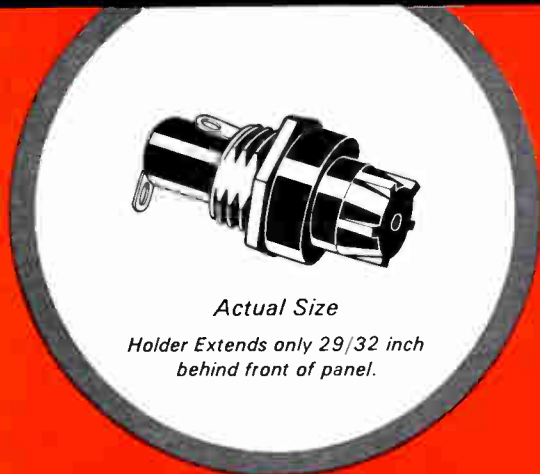


# IEEE SHOW '64



march 23-26  
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## New! BUSS SPACE SAVER PANEL MOUNTED FUSEHOLDER



*Actual Size*  
Holder Extends only 29/32 inch  
behind front of panel.

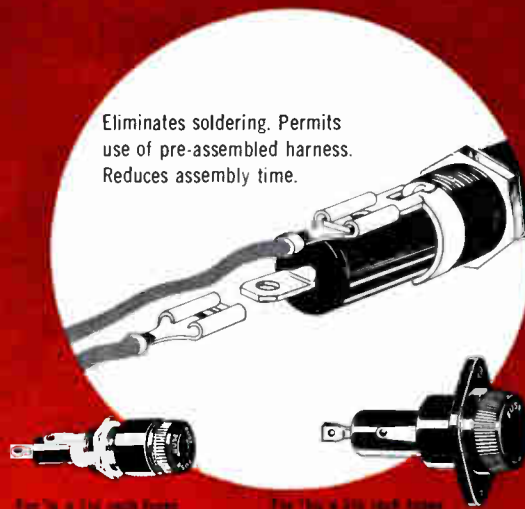
- Fuseholder takes 1/4 inch x 1 1/4 inch fuse. Converts to 9/32 x 1 1/4 inch fuse simply by changing screw type knob. Holder is rated at 30 ampere for any voltage up to 250.
- It is completely water proof.
- Holder meets the need for a highly reliable military fuseholder made to minimum dimensions for commercial and military applications.

**BUSS** Write for BUSS  
Bulletin SFH-10

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

Circle 75 on Inquiry Card

## Save Assembly Time with Quick-Connect Terminals on BUSS Fuseholders



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

For 1/4 x 1 1/4 inch fuse  
Series RL, RR, and RLD

For 1/4 x 2 1/4 inch fuse  
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# BUSS: 1914-1964, Fifty years of Pioneering....

### Edge Guides

These printed-circuit edge guides use photoelectric sensing. This allows broad applications guiding opaque, transparent, and open-mesh materials. Control is accomplished without touching the web. Solid-state, plug-in module design is used. Applied Engineering Corp., Walpole, Mass.

Circle 163 on Inquiry Card

### Pressure-Sensitive Film

Data is available on a metalized plastic, pressure-sensitive material used for name plates and labels. Selective processing allows drip and shallow embossing patterns, close-tolerance die-cut shapes, and selection of metallic, transparent, and opaque inks. Samples available from Pottersign, Inc., 169 Bridge St., Cambridge, Mass.

Circle 166 on Inquiry Card

### Counter Brochure

"Counters," an illustrated brochure, describes freq. counters using Numerik bright-light indicators. A solid-state data printer, a digital-to-analog converter with high-speed storage, and a photoelectric pickoff designed for direct connection to a counter are also described. General Radio Co., West Concord, Mass.

Circle 169 on Inquiry Card

### Selection Guide

Brochure 07-109 gives detailed properties on 21 separate electronic products. Titled, "Selection Guide to Electronic Materials" it summarizes physical, chemical, mechanical, and electrical properties on 3 silicone fluids; 8 potting, sealing and encapsulating materials; 4 varnishes and coatings; and 6 greases and grease-like compounds. Dow Corning, Midland, Mich.

Circle 164 on Inquiry Card

### Terminals Catalog

This fully illustrated, 39-page catalog covers a complete line of Press-Fit Teflon insulated terminals, and includes comprehensive selecting and installing guides. Terminal configurations include stand-offs, feed-thrus, bushings, test-point jacks, taper pin receptacles, probes and plugs, transistor holders and sockets. They are available in 10 EIA colors. Sealectro Corp., 225 Hoyt St., Mamaroneck, N. Y.

Circle 167 on Inquiry Card

### Plating Rectifiers

Data is available on a line of silicon plating rectifiers, completely sealed against corrosive fumes. Sealed-Current™, the dc power equipment features an intimate cooling system in which water flows within the basic components. No fans, vents or heat exchangers are needed. The Meaker Co., subs. of Sel-Rex Corp., Nutley 10, N. J.

Circle 170 on Inquiry Card

### Capability Brochure

This 20-page brochure, in color, describes Varian's capabilities in the field of microwave tube research and development. Copies available from Varian Associates, 611 Hansen Way, Palo Alto, Calif.

Circle 165 on Inquiry Card

### Conductivity Chart

This 20 x 11 1/2 in. reference chart provides data on the electrical conductivity of aqueous sulphuric acid at 25°C. The chart covers the range of specific conductance (mhos/cm) from 0 through 0.85, and % H<sub>2</sub>SO<sub>4</sub> by weight from 0 through 100. Industrial Instruments Inc., 89 Commerce Rd., Cedar Grove, N. J.

Circle 168 on Inquiry Card

### Plastic Design Ideas

A 20-page brochure entitled, "14 New Design Ideas in Shell Plastics and Resins" is available. This booklet features 14 original design ideas in polypropylene and EPON® resins. Shell Chemical Co., Plastics and Resins Div., 110 W. 51st St., New York 20, N. Y.

Circle 171 on Inquiry Card

# NEW TECH DATA

for Engineers

## Wire and Cable Catalog

Catalog Section No. 6204, "Underwriters' Laboratories Approved Wire and Cable," lists a large number of U.L. thermoplastic appliance wire approvals. The catalog describes standards of approval of Canadian Standards Assoc. and Mil-W-16878. The 28-page bound section covers appliance hook-up wire and cable, business machine and computer wire and cable, and appliance wiring. Brand-Rex Div., American Enka Corp., 31 Sudbury Rd., Concord, Mass.

Circle 172 on Inquiry Card

## Gases and Equipment

A broad line of specialty gases, gas mixtures, gas-handling equipment and accessories are described in this 72-page catalog. In addition to the common compressed gases and gas mixtures, the product line includes rare gases, high-purity research gases, fluorine compounds, calibration gas standards, carrier and zero gases, and sterilizing gas mixtures. Air Products and Chemicals' Specialty Gas Dept., Allentown, Pa.

Circle 173 on Inquiry Card

## Building-Block Monochromator

Bulletin 109, 12 pages, describes a building-block monochromator for construction of special-purpose analytical equipment. The Model 98 features a single-pass prism available in 10 different materials. It provides a choice of wavelength range from 0.2 microns to 45 microns. It meets the need of those who wish to study and use a set of spectral conditions, such as extreme resolution or optical range, which are not available from standard instruments. Accessories available, primarily for infrared use, include gas and liquid cells, cell mounts, cell slides, and a 3mm microcell and mount. The Perkin-Elmer Corp., Main Ave., Norwalk, Conn.

Circle 174 on Inquiry Card

## Microwave Catalog

Catalog 63-A, 40 pages, contains photo, specs., and descriptions for a line of microwave oscillators, harmonic generators, amplifiers, and special products. Characteristic curves are included. Trak Microwave Corp., Tampa, Fla.

Circle 175 on Inquiry Card

## Zener Diodes

PD6041-61 are a series of high-performance micro zener diodes. The line includes nominal zener voltages ( $\pm 5\%$ ) of 2.7 through 18v. Dynamic impedance characteristics have been improved from 30% on the low-voltage types to 80% on the high-voltage types. Tech. details are available from TRW Semiconductors Inc., 14520 Aviation Blvd., Lawn-dale, Calif.

Circle 176 on Inquiry Card

## Integrated Circuits

Data is available on a family of 7 high-speed clamped DTL integrated circuits. The A-series offers single power-supply operation, 18 nsec. propagation delay, binary counting rates up to 10Mc, and 7mw power drain/gate. A01A-A07A in the modified TO-5 and A01F-A07F in a solid alumina-glass FlatPac are designed around the basic NAND gate. Siliconix Inc., 1140 W. Evelyn Ave., Sunnyvale, Calif.

Circle 177 on Inquiry Card

## ...New Developments in Electrical Protection

### BUSS Sub-Miniature FUSE-HOLDER COMBINATION



A light weight, protective device for space-tight applications in multiple circuit apparatus. Fuse has transparent window for visual inspection of element. Fuse may be mounted alone or used in holder on printed circuit boards.

HWA holder can also be panel mounted with or without use of knob. Knob makes holder water proof for front of panel.

# BUSS

For full details write for BUSS bulletin SPB

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

Circle 75 on Inquiry Card

### THE NEWEST DEVELOPMENTS IN ELECTRICAL PROTECTION

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# I. E. E. E. SHOW

BOOTH 2740

If you can't make the show, but have a problem in electrical protection, our staff of fuse engineers is at your service to help you solve it. In any event, be sure to get latest information BEFORE final design is crystallized.

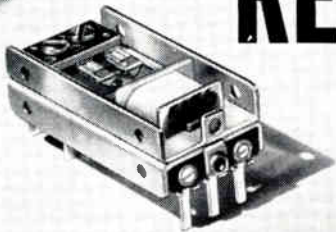
# BUSS

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Circle 75 on Inquiry Card

# RELAY



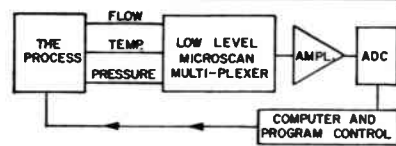
**HIGH SPEED—LESS THAN 1000  $\mu$  SEC.  
 LOW THERMAL—LESS THAN 1  $\mu$  VOLT  
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## JAMES

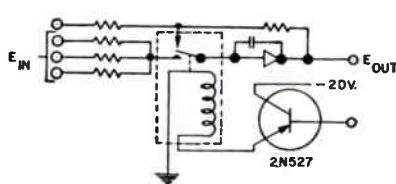
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 RELAYS ARE  
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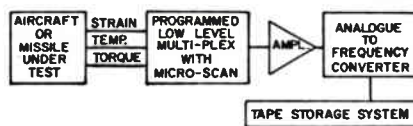
**A MODEL TO FIT  
 THE APPLICATION  
 AND THE  
 ASSEMBLY**



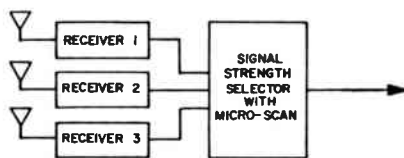
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**ANALOGUE INTEGRATOR CIRCUIT**



**DATA ACQUISITION SYSTEM**



**SIGNAL SELECTION SYSTEM**

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## NEW TECH DATA

### Reliability Brochure

A four-page brochure discussing reliability concepts and procedures in the manufacture of precision wirewound resistors is available. The brochure includes failure rate data and high-reliability specifications. Ultronix, Inc., 111 E. 20th Ave., San Mateo, Cal.

Circle 287 on Inquiry Card

### Paper Capacitors

Technical data on the Type P95ZN micro-miniature dipped metallized paper capacitors is now available in Bulletin 131B9. Specifications include a table of capacity ratings with case sizes and catalog numbers for 200 VDC, 400 VDC and 600 VDC units. Typical temperature characteristic curves cover insulation resistance, capacitance change, and dissipation factor. Aerovox, New Bedford, Mass.

Circle 288 on Inquiry Card

### Copper Powders

Data is available on beryllium copper powders that can be molded, sintered and heat treated to produce parts having unusually high tensile strengths, as well as the properties of wrought beryllium copper. Strengths of from 60,000 to 100,000 psi are possible and the resulting parts offer excellent electrical and thermal conductivity, good resistance to corrosion and non-magnetic characteristics. The Brush Beryllium Co., 17876 St. Clair Ave., Cleveland, Ohio.

Circle 289 on Inquiry Card

### Memory Drum

A descriptive brochure on SD-1000 memory drum is available. Copies of the brochure describing the drum, which has a large storage capacity and operates reliably in severe environments, may be obtained by writing to the marketing department, Guidance & Control Systems Div. Litton Industries, 5500 Canoga Ave., Woodland Hills, Cal.

Circle 290 on Inquiry Card

### Capacitor Assemblies

Data is available on an expanded line of Tantapak® capacitor assemblies using wet sintered-anode capacitor elements. The 'A' revision of Engineering Bulletin No. 3705 gives complete details on these capacitor assemblies. The new bulletin not only contains the original Type 200D designs, now identified as the A1 case code series similar to MIL Style CL55 units, but also capacitors in a large rectangular case. A total of 165 ratings at working voltages ranging from 6 to 500 volts d-c are listed in the new bulletin. Request on company letterhead Technical Literature Service, Sprague Electric Co., 233 Marshall St., North Adams, Mass.

Circle 291 on Inquiry Card

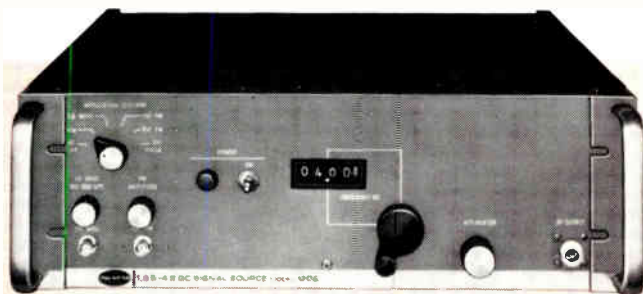


# MORE POWER TO YOU

## ...at L and S bands!

in Polarad's two newest modular microwave signal sources...

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Model 1205  
0.95 — 2.40 GC

Model 1206  
1.95 — 4.20 GC

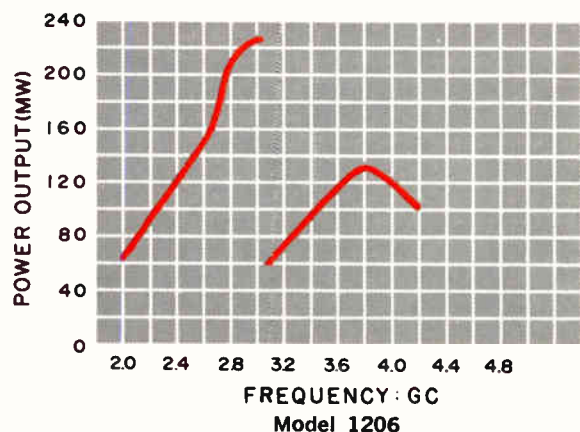
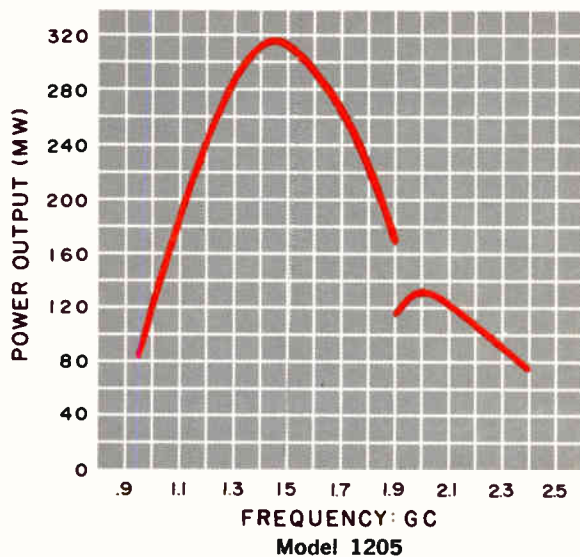
### Applications

- Investigation of antenna patterns and characteristics.
- Measurement of attenuation, gain, insertion loss; Q, selectivity, frequency, impedance, image rejection, and S/N ratio.
- Alignment of communication and radar systems and components.

- Accurate to  $\pm 0.5\%$  with digital frequency indication.
- Internal CW, square wave, and sawtooth FM; can be externally pulse, square wave or frequency modulated.
- High spectrum purity and stability.
- Phase-lock and remote tuning capability.
- Single-band UNIDIAL® tuning.
- New compact modular design can be racked or stacked with all other Polarad Modules . . .

**Now: L through X bands in only 21" of total rack height!**

TYPICAL POWER OUTPUT



These are the 9th and 10th major microwave instrumentation advances introduced by Polarad since last March — 10 months ago, at this writing.

Have you been keeping up to date on Polarad's "Microwave Masterpiece of the Month" program? If not, turn the page for a brief recap of the most remarkable engineering performance in the history of the instrument field . . .



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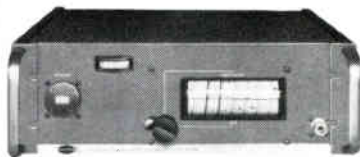
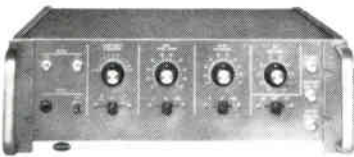
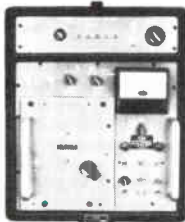
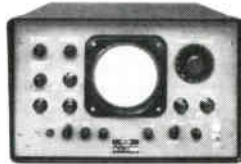




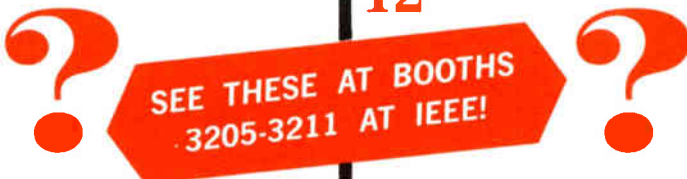
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# Now there are TEN

(and soon there'll be TWELVE)

**POLARAD**

engineering has designed, developed, and produced an amazing average of one major new microwave instrument per month since the March 1963 IEEE Show. Two more advanced families of instruments are in final field trial now . . . Don't miss their introduction at IEEE!

<p><b>1</b></p>  <p>Spectrum Analyzer Model SA-84 WA</p>	<p><b>2</b></p>  <p>Modular Signal Generator Model 1107/1108</p>	<p><b>3</b></p>  <p>Modular Doublers Model 1509/1510</p>
<p><b>4</b></p>  <p>Universal Modulator Model 1001</p>	<p><b>5</b></p>  <p>Extended-Range RI-FI Meters to 21 GC Model CFI &amp; FIM-2</p>	<p><b>6</b></p>  <p>Spectrum Signature Monitor Model DM1/2</p>
<p><b>7</b></p>  <p>C &amp; X Band Modular Signal Sources Model 1207/1208</p>	<p><b>8</b></p>  <p>Spectrum Analyzer with Phase-Lock Model SA-84 WAB</p>	<p><b>9</b></p>  <p>L &amp; S Band Sources Model 1205/1206</p>
<p><b>10</b></p>  <p>Communications Test Instrumentation Model 1307</p>	<p><b>11</b>      <b>12</b></p>  <p>SEE THESE AT BOOTHS 3205-3211 AT IEEE!</p>	

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My application is \_\_\_\_\_

My frequency range of interest is \_\_\_\_\_

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Your Polarad Field Engineer is a microwave expert. He is prepared to give you every form of technical assistance, including a live demonstration on every one of the instruments listed above, and 87 more . . . Call him today. He is listed in the Yellow Pages.

Here's how to keep up with the dynamic growth of microwave instrumentation. Fill in this card, and we'll make sure that you're the first to know as each innovation is announced!

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WE'D BETTER EXPLAIN WHY  
EQUIPMENT THAT USES  
FC-75 COOLANT  
GETS SO  
DARN . . .

small

Cooling electronic equipment used to be a big job . . . because of the sheer bulk of the cooling medium. 3M Brand Inert Liquid FC-75 (and its companion FC-43) changed all that. Why? Volatility.

Because of its lower boiling point—100°C, FC-75 removes heat many times faster than non-volatile organic liquid coolants. In fact, per gram of coolant, 30 or 40 times more heat can be removed with FC-75 than with those less volatile media. Same thing goes for FC-43. (Point is, conventional coolants are too "high boiling" to benefit from evaporative cooling, besides losing physical and electrical properties when they boil.)

Results in miniaturization are big! Using FC-75, elec-

tronic units have been reduced 4 to 1 in volume, 2 to 1 in weight. No small matter where designers must get more work out of the same space, or do the same job in much less space. Just one example: using FC-75, transformers have been reduced in size by 75%.

Other extras: Both FC-75 and FC-43 are excellent dielectrics—strength in excess of 35 KV, dielectric constant of 1.8, dissipation factor less than 0.0005. No electrical or chemical change in contact with various construction materials. Resist radiation. What big job can these exceptional fluids do for you? For technical details on FC-75 and FC-43, write Chemical Division, Dept. KCQ-34, 3M Company, St. Paul 19, Minnesota.

Chemical Division 

# NEW TECH DATA

## Shields

Data Sheet 166 pictures and gives technical details on the 2 basic types of Netic and Co-Netic magnetic/electrostatic shields. They protect devices from interior and exterior magnetic fields. Magnetic Shield Div., Perfection Mica Co., 1322 No. Elston Ave., Chicago, Ill.

Circle 181 on Inquiry Card

## Reversing Contactor

This data sheet gives photos and specs. for the FER reversing contactor. Ratings: 3 hp, 220v., 3 phase; 1½ hp, 110v., 1 phase; 15a., 250vac; and 10a., 100vdc. The contacts are double-break rated. The Roman Controller Co., Box 306, Bethel Rd., Westminster, Md.

Circle 182 on Inquiry Card

## Crystal Can Relay

Literature is available on a 6 PDT relay. Ideally suited to multi-channel sampling and relay matrix-type applications. The AR switches a full 2a. resistive load. A balanced armature makes the AR useful under high shock and vibration. Dry-circuit ratings can be provided with extensive run-in and pre-testing. Branson Corp., P. O. Drawer 160, Whippany, N. J.

Circle 183 on Inquiry Card



**These ALITE®  
POWER TUBE  
CERAMICS**

*Not only  
LOOK ALIKE*

**They are  
IDENTICAL**

- **Physically**
- **Electrically**

## Systems Analyzer

Model 1980 Servomatic® Analyzer is used for fast, accurate testing and analysis of dc control systems and components. It generates freqs. from 0.005 cps to 1kc. Outputs include sine wave, triangular wave, sq. wave, synchronized sweep, and sync. pulses. Other specs. available in a data sheet from Servo Corp. of America, Analog/Digital Products, 111 New South Rd., Hicksville, L. I., N. Y.

Circle 184 on Inquiry Card

## Phase Meters

Data sheets are available on Types 405, 405H and 405L phase meters. Features include: meter reading independent of the ratio of input-signal amplitudes; direct indication of phase angle from 500kc to 1 cps; no amplitude adjustment of either signal voltage; and provision for self-calibration and self-adjustment. Ad-Yu Electronics Lab., Inc., 249 Terhune Ave., Passaic, N. J.

Circle 185 on Inquiry Card

## Temperature Theory

Bulletin 7637, 28 pages, includes a general discussion of total temp. sensing, including performance, error analysis, and applications. Data is included on total temp. sensors for regular flight service, flight-test and high Mach operations (both regular and deiced). An appendix gives general theory of platinum resistance thermometry. Rosemount Engineering Co., 4900 W. 78th St., Minneapolis 24, Minn.

Circle 186 on Inquiry Card

## Phase-Shift Circulator

CXH-25 is a high-power, differential phase-shift circulator. It can be operated at 25kw CW with a 6:1 load mismatch. The circulator operates at 8.35 gc with isolation of at least 20db. Full specs. are available from Raytheon Co., Special Microwave Devices Operation, 130 Second Ave., Waltham, Mass.

Circle 187 on Inquiry Card

Envelopes . . . spacers . . . windows . . . insulators — whatever your requirements for high alumina ceramic power tube components, you can rely on Alite for exact duplication of properties, part after part, order after order.

This repeatability is assured by Alite's rigid Quality Control procedures. For example, accompanying each group of parts through production is a card on which is kept a record of material lot code numbers, process times and temperatures, etc. In-process and final inspections are detailed and thorough.

As a result, Alite high alumina ceramics are perfectly homogeneous. Dimensional tolerances are strictly held. Several Alite formulations, with differing Al<sub>2</sub>O<sub>3</sub> content, are available which meet or exceed the specifications of our most demanding customers.

Alite parts can be supplied unmetallized, metallized, or as vacuum-tight ceramic-to-metal sub-assemblies.

\* \* \* \*

Let us review your specific requirements — without obligation: send us prints and other pertinent data. Or, write for free bulletins giving complete information about Alite.

ALITE

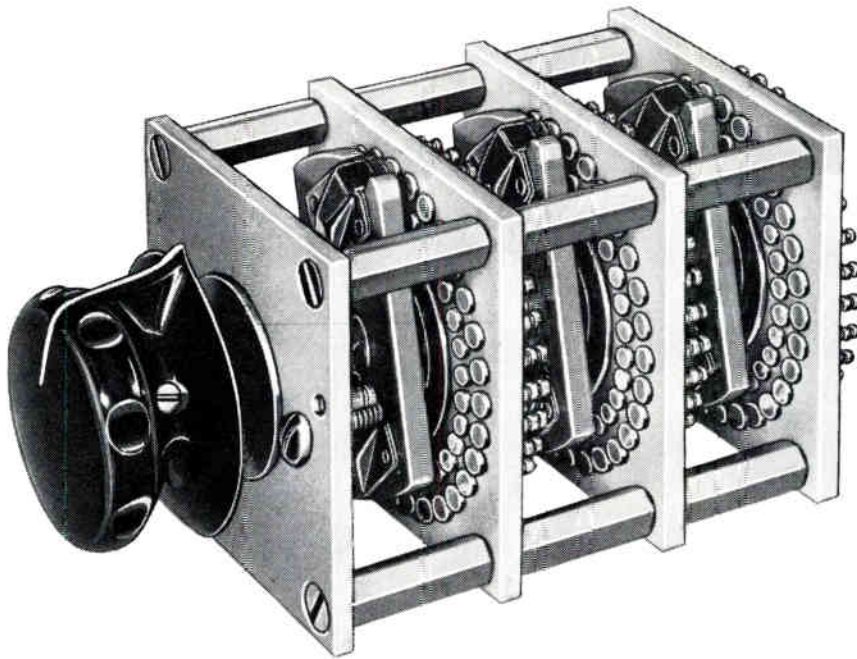
DIVISION

**U. S. STONWARE**

BOX 119

ORRVILLE, O. 44667

# Quality switches—available from stock!



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### **87 adjustable stop switches that replace 2,001 standard types!**

Daven revolutionizes switch availability by putting the equivalent of 2,001 standard types as close as your telephone. That's 97% of all your switch needs brought right to your door—direct from Daven within 48 hours! Daven does it by designing the characteristics of 2,001 switches into 87 easy-to-stock, easy-to-use adjustable stop switches. The result: instant availability and **maximum flexibility** (you can change the number of switch positions at any time). The cost is the same, or less, than its standard counterpart.

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square configuration, in 1¾" and 2¼" sizes. Like all Daven switches, their metal parts are fabricated from corrosion-resistant materials . . . plastics are heavily filled with non-organic fibres and are capable of withstanding high temperatures . . . switch contacts and rotor arms are solid silver alloy. Daven's patented knee action, tamper-proof rotor is standard. Designed to meet the requirements of MIL-S-3786.

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# Need ultra pure fused quartz components?

*General Electric offers most complete line... plus prompt delivery!*



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**Midwestern:** Euclid Ave. & Campbell Rd.  
Willoughby, Ohio  
Phone: 942-9300

**Western:** 2747 South Malt Avenue  
Los Angeles 22, California  
Phone: 723-2541

## NEW TECH DATA

### Planar Epitaxial NPN

An engineering data sheet describes the 2N2270 Leaf transistor used for HF and VHF amplifiers. The Leaf configuration offers a typical  $f_t$  of 180mc, high gain, low saturation, and improved Beta linearity at collector currents to 1a. Bendix Corp., Semiconductor Div., Holmdel, N. J.

Circle 188 on Inquiry Card

### High-Frequency Heating

A copy of "Review," a 12-page publication that deals with induction heating, is available. The publication includes an article entitled, "Inductive Heating for High Temperature Fatigue Testing," and four other technical articles. It also contains a section on new products and shop hints. Lepel High Frequency Labs., Inc., Woodside, N. Y.

Circle 189 on Inquiry Card

### Core Memory

The Ministore 111 memory has an access time below  $4\mu\text{sec}$ . and a clear/write cycle of  $10\mu\text{sec}$ . It contains 1024 discrete address locations in which up to 8 bits may be stored. Specs., design features, timing diagrams, photos, block diagrams, and application data are contained in a bulletin from Rese Engineering, Inc., A & Courtland Sts., Phila., Pa.

Circle 190 on Inquiry Card

### Silicon in Ribbon Form

Data is available on hyper-pure silicon in ribbon form. It is for use in planar and epitaxial transistors and diodes, microelectronic circuits, radiation detectors, and other devices. This new form—described as silicon web—is produced in widths of 3 to 8mm, thicknesses of 50 to 250 microns and lengths to 50 cm. Dow Corning, Midland, Mich.

Circle 191 on Inquiry Card

### Core Memories

Design economies resulting in improved noise rejection for a series of magnetic-core memories are described in this brochure. The brochure, "EECO Magnetic Core Memories" presents technical features of 3 new memories. Descriptions, applications, characteristics and specs. are included. Electronic Engineering Co. of Calif., Box 58, Santa Ana, Calif.

Circle 192 on Inquiry Card

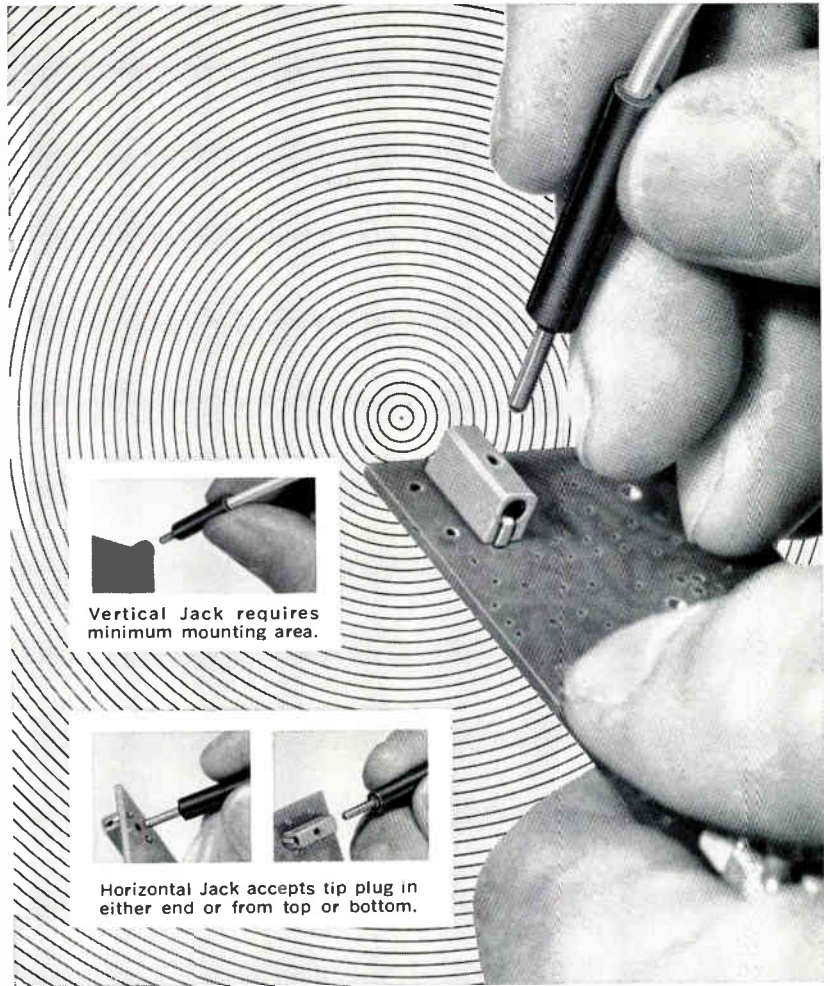
### Fabricating Machine

Catalog FM describes the Fabramatic<sup>TM</sup>, a tape-controlled unit used for punching and matching  $\frac{1}{4}$  in. material. Resolution and electrical accuracy is  $\pm 0.0005$  in. Wales Strippit Co., Akron, N. Y.

Circle 193 on Inquiry Card

Designed for  
printed circuit use!

# MINIATURE PLUGS AND JACKS



Vertical Jack requires minimum mounting area.

Horizontal Jack accepts tip plug in either end or from top or bottom.

**Operating voltages to 1500 V RMS . . . up to 5 amps current carrying capacity!**

Extremely compact—highly resistant to extremes of shock, vibration, temperature and moisture, these tiny Johnson Tip Plugs and Jacks are ideal for limited space applications! Bodies molded of tough, low-loss plastic per MIL-P-17091. Available in 10 colors, including basic colors for MS16108C coding applications. Contact resistance: less than 2 milliohms. Capacitance between two adjacent jacks: less than 1 mmf. at 1 Mc.

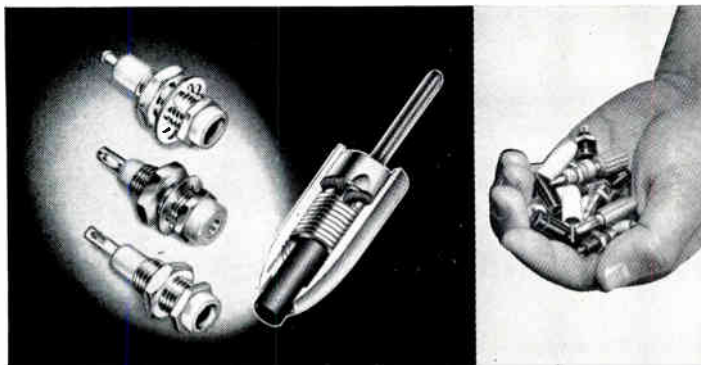
**Series 105-751 Horizontal Jack**—Unique design accepts .080" diameter tip plug in either end, or from top or bottom. Formed silver-plated beryllium copper contact. Two terminals.

**Series 105-851 Vertical Jack**—Mounts through single .052" hole, requires minimum mounting area. Silver-plated, machined beryllium copper contact.

**Series 105-771 Sub-Miniature Tip Plug**—For use with miniature jack. .080" diameter tip. Nickel-plated, machined brass body. Solder type lead connection.

**Series 105-881 Long Handle Tip Plug**—Identical to tip plug above, but with 4" molded plastic body for ready access to "hard to reach" test points.

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

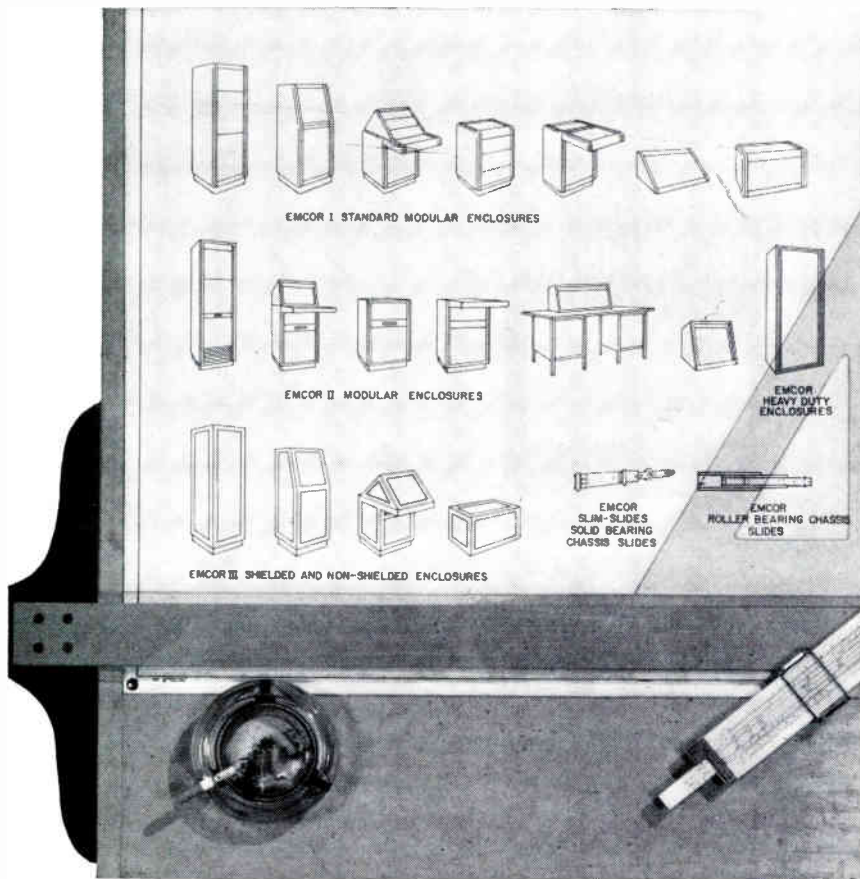


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← **OTHER CONNECTORS** — Johnson also manufactures a complete line of standard connectors including Tip Plugs and Jacks; Metal-Clad and Rapid-Mount Jacks; Banana Plugs and Jacks; Binding Post. Voltage breakdowns to 12,500 volts DC. Jacks designed for fast, easy mounting — plugs for solderless connection — available in 13 colors for coded applications. Current components catalog provides full specifications on complete line — write today for your free copy.



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That's why we have EMCOR I, a complete line of standard modular enclosures; EMCOR II Enclosures designed to give each customer an "individualized custom look"; EMCOR III Shielded and Non-Shielded Enclosures for radio frequency interference, air, dust and oil shielding protection or for non-shielded high strength duty and EMCOR Heavy Duty for rugged enclosure applications. We reduce your costly custom enclosure design time, expensive tooling, production and intermittent plant operations. Specifying is as easy as catalog ordering. For full details, phone your nearest EMCOR Sales Engineering Representative, listed below, or clip this ad to your letterhead along with your name and mail to us—no obligation.

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Circle 85 on Inquiry Card

## NEW TECH DATA

### Capacitors

Bulletin 525 describes the UHF communication capacitors designed for screen-grid, bypassing, and coupling of tubes. Miniaturization offers a volumetric improvement. Capacitance up to 10,000pf. Erie Technological Products, Inc., 644 W. 12th St., Erie, Pa.

Circle 194 on Inquiry Card

### Control Switching

Two new 6-page bulletins outline operating principles of resonant reed encoders and decoders for remote-control switching with audio-tone signals. Complete specs., functional block diagrams, detailed wiring diagrams and dimensions of components and modular assemblies are included. Bramco Controls Div., Ledex Inc., College and South Sts., Piqua, Ohio.

Circle 195 on Inquiry Card

### Accelerometer

A data sheet describing a miniature piezoelectric accelerometer is now available. The accelerometer, Model AC-107, measures shock and vibration over wide freq. and acceleration ranges, and is particularly applicable in space-restricted area. Specs. are included. Massa Div., Cohn Electronics, Inc., 280 Lincoln St., Hingham, Mass.

Circle 196 on Inquiry Card

### Transducer-Amplifier Unit

Bulletin P-63187/290-1 provides photos, descriptions and specs. of a recently developed Teleflight® transducer-amplifier package. It weighs less than 10 oz. and is designed for pressure ranges from 0-15 through 0-200 psia with an operating temp. range from -65°F to +225°F. Withstands pressure overloads to 500psia. Taber Instrument Corp., 107 Goundry St., No. Tonawanda, N. Y.

Circle 197 on Inquiry Card

### Amplifiers/Power Supplies

A line of amplifiers, power supplies, and miscellaneous equipment are contained in this catalog. The data includes photos, specs., features, and applications. Listed under miscellaneous products are bi-stable trips, which include silicon and germanium transistors. California Electronic Mfg. Co., P. O. Box 355, Alamo, Calif.

Circle 198 on Inquiry Card

### Mil. Specs. Defined

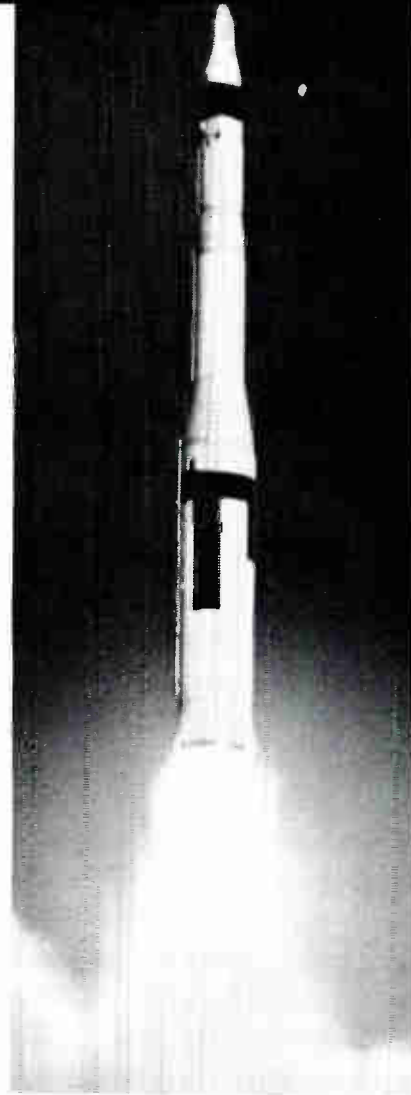
Bulletin No. 5 outlines each Mil. Spec. that applies to magnetic tape. It explains the history of the Spec. and the latest revision. It also explains how some Federal Specs. have replaced Mil. Specs. Ampex Corp., 401 Broadway, Redwood City, Calif.

Circle 199 on Inquiry Card





**BeO,**  
the core of reliability  
that saves space,  
improves  
performance



Designers for Minuteman elected to keep wirewound resistors same-size and use Thermalox 998\* (beryllium oxide) cores, made by Brush, to get a no-sweat extra margin of performance.

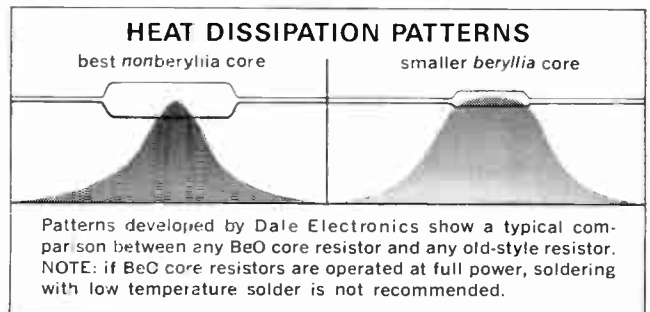
You may want equal or better reliability from smaller resistors.

Whichever advantage you seek, resistor cores made of Thermalox 998 will deliver better performance than any other known material. Because: beryllium oxide combines the paradoxical properties of electrical insulation and thermal conductivity better than any other known material.

If you want to reduce size, cut total cost, or improve reliability, consider the unique properties of Thermalox.

We fabricate ceramics in virtually unlimited sizes and configurations, and a wide selection of standard off-the-shelf parts are available. Beryllia can be metalized and precision ground.

For technical service and information about beryllium oxide ceramics, write: The Brush Beryllium Company, Ceramics and Nonmetallic Products Department, Elmore, Ohio 43416.



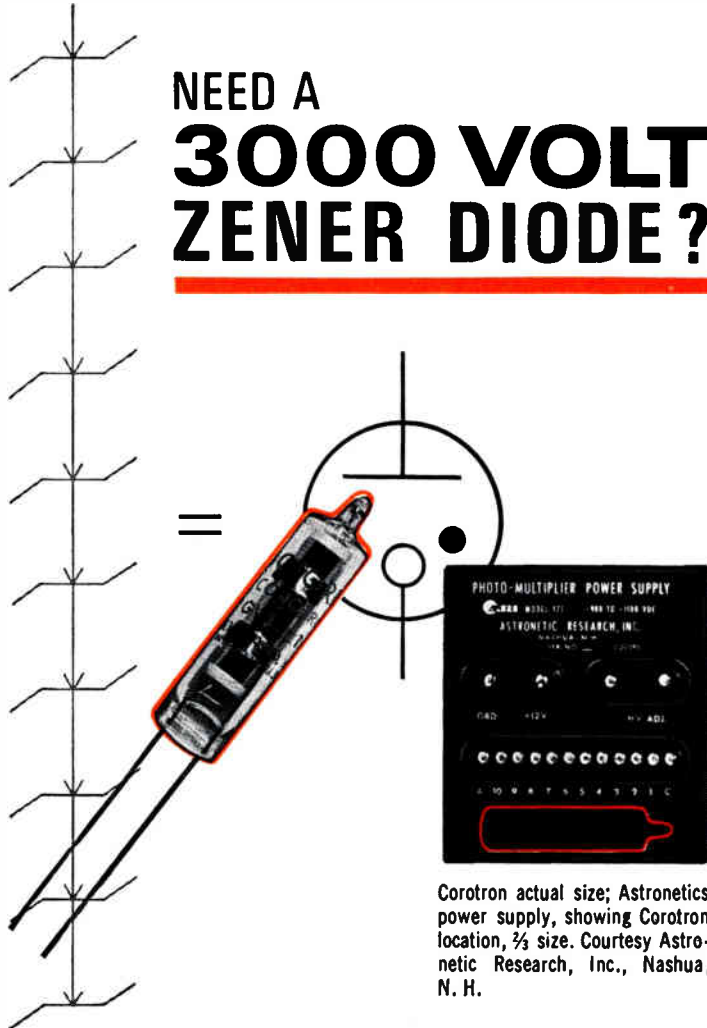
\*Trademark of the Brush Beryllium Company



**THE BRUSH BERYLLIUM COMPANY**

Manufacturers of Beryllium Oxide, Chemicals, Alloys and Metal  
Ceramics and Nonmetallic Products Department,  
Elmore, Ohio 43416

## NEED A 3000 VOLT ZENER DIODE?



Corotron actual size; Astronetics power supply, showing Corotron location, 1/3 size. Courtesy Astronetic Research, Inc., Nashua, N. H.

You could string together several hundred zeners. Or you could specify one Victoreen Corotron. It is the gaseous equivalent of the zener with all the advantages of an ideal HV zener diode.

For space research and other rugged applications requiring absolute power supply stability, GV3S Series, shown, provide the ideal reference voltage anywhere in the range of 400 to 3000 volts. They enable circuitry to maintain constant high voltage regardless of battery source voltage or load current variations. Cubage and weight (GV3S Corotron weighs only 4 gm.) are important considerations. So is temperature variation (Corotrons operate from 200°C down to -65°C). Ruggedized versions withstand shock to 2000 G, vibration 10 to 2000 cps.

If you're trying to simplify circuits . . . to cut cost, size and weight . . . to upgrade performance—you need Corotron high voltage regulators. Models are available now from 400 to 30,000 volts. A consultation with our Applications Engineering Dept. will speed up the countdown.

748-A



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5806 Hough Avenue • Cleveland 3, Ohio, U.S.A.

Victoreen European Office: P. O. Box 654, The Hague

### Power Units

Catalog Bulletin RPU-11464 illustrates and describes a standard line of silicon and selenium rectifier power units. They are available in capacities to 1000kw. However, 5000kw can be supplied. The catalog is profusely illustrated, contains considerable data on the construction and components used, and includes detailed specs. Syntron Co., 263 Lexington Ave., Homer City, Pa.

Circle 200 on Inquiry Card

### Lacing Tapes

The 4th edition of the Product Data Book, 28 pages, includes revised technical data for each Gudebrod product. Data also includes temp. range, finish, dimensions, and packaging. One product described is a lacing tool for wire harness tying. The tool virtually eliminates harness lacing hazards and increases production. Gudebrod Bros. Silk Co., Inc., 12 S. 12th St., Philadelphia 7, Pa.

Circle 201 on Inquiry Card

### Photo-Etch Guide

"Preliminary Cost Estimating Guide and Factors Affecting Photo-Etching Pricing," is a 2-color brochure. It contains an easy-to-follow guide for estimating the cost of parts when photo-etching is used. The brochure also contains many factors to reduce parts cost. Photo/Etch Co., div. of Industrial Electronic Engineers Inc., 5358 Cartwright St., N. Hollywood, Calif.

Circle 202 on Inquiry Card

### Standards Report

Reliability statistics for tuning forks and freq. standards are now available in a report. The report study was conducted using Mil-HDBK-217. It shows the mean-time-before-failure for the tuning fork to be 2,604,166 hrs. at room temp., for a typical oscillator circuit and fork it was 906,618 hrs. Copies available from the Special Products Div., Melpar, Inc., Falls Church, Va.

Circle 203 on Inquiry Card

### Tantalum Capacitors

Bulletin B 401-1 contains data on performance characteristics and applicable test specs. for Type TES solid-electrolyte tantalum capacitors. Data includes curves showing typical performance, and a reference on Mil-C-26655 type numbers for ready identification. The capacitors operate at -80°C to +125°C and offer a high capacity-to-volume ratio, low leakage, high stability, and reliability. Astron Corp., 255 Grant Ave., E. Newark, N. J.

Circle 204 on Inquiry Card

Armco Thin Electrical Steels					
Grade	Thickness mils	Core Loss Limit (400 cps)			Description
		Induction kilogausses	Grain of Sample	Core Loss watts/lb	
ORIENTED T	1	10	Parallel	6.5	An oriented type with best permeability in the direction of rolling. Recommended for wound cores or stacked laminations with flux mostly in direction of strip length.
	2	15	Parallel	8.5	
	4	15	Parallel	6.5	
	5	15	Parallel	7.0	
	6	15	Parallel	7.5	
ORIENTED TS	4	—	Parallel	—	A super-oriented steel with very high permeability in rolling direction. (1800 min. at 10 oersteds) Designed for 400 cps service above 16 kilogausses.
TRAN-COR® T	5	10	50-50	6.5	Has good permeability in all directions. Designed for punched laminations in rotating equipment or sheared laminations with random flux.
	7	10	50-50	7.5	

## Make cores of 400 and higher cps units lighter and smaller with Armco Thin Electrical Steels

Armco Thin Electrical Steels enable you to produce 400 cps and higher frequency equipment with these advantages: lower core loss—smaller and lighter cores—savings in copper.

Available in three different grades and a wide range of thicknesses, they not only provide those basic advantages but enable you to design more precisely and meet your specific needs at least cost. In addition, Armco Thin Electrical Steels offer this unusual combination of properties:

**Exceptionally high permeability**  
**Low hysteresis loss**

**Minimum interlaminar loss**  
**High lamination factor**  
**Properties fully developed at the mill**  
**Unexcelled uniformly high quality**

Use the multiple advantages of these special Armco Electrical Steels for radio and television transformers, magnetic amplifiers, reactors, pulse generators and other components operating at frequencies of 400 cps and higher. Write us for specific information and ask for a copy of the new edition of our design manual, "Armco Thin Electrical Steels." Armco Division, Armco Steel Corporation, Dept. A-984, P. O. Box 600, Middletown, Ohio, 45042.



**Armco Division**

**TWENTY BILLION  
(20,000,000,000)  
SOLDERLESS CONNECTIONS  
HAVE BEEN MADE  
WITH GARDNER-DENVER  
"WIRE-WRAP"<sup>®</sup> EQUIPMENT  
WITHOUT A REPORTED  
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Because "Wire-Wrap" tools make permanent solderless terminal connections. Because operators with little or no experience can learn to use "Wire-Wrap" tools easily and make perfect connections right away. Result: Highest possible reliability—lowest possible cost per connection. Send for Bulletin 14-1.



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Gardner-Denver Company, Quincy, Illinois

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**RADAR BOATS SCOUT 'GITMO'**



Radar-capped U.S. Navy patrol boats scout the waters off Guantanamo Bay, Cuba. A Raytheon radar on each boat gives its crew a 12-mile electronic view day and night. Like the boats carrying them, the Model 1900 radars are "off-the-shelf" commercial models fishermen use.

**NEMA PUBLISHES FIRST  
SILICON DIODE STANDARDS**

To clear away some mounting confusion in specifying silicon diodes, the National Electrical Manufacturers Association (NEMA) has published a set of standards.

Because of wide variations in testing and rating methods, NEMA's Power Semiconductor Component Section offers its new 65-page booklet as a comprehensive standard.

Called *NEMA-EIA Standards for Silicon Rectifier Diodes and Stacks*, the book contains many useful sections. Some of them are definitions, terminology and letter symbols.

The book, at five dollars a copy, contains standards on physical shapes and markings. It also asks makers to show the class of service for which their devices are intended.

A "User's Guide" lists use and engineering data to aid evaluation of design needs.

**COMPUTING LANGUAGE LAB  
SET UP IN VIENNA BY IBM**

A laboratory for computing languages has been set up in Vienna, Austria, disclosed IBM World Trade Corp., subsidiary of IBM Corp. Major mission of the lab is advanced work in computing languages.

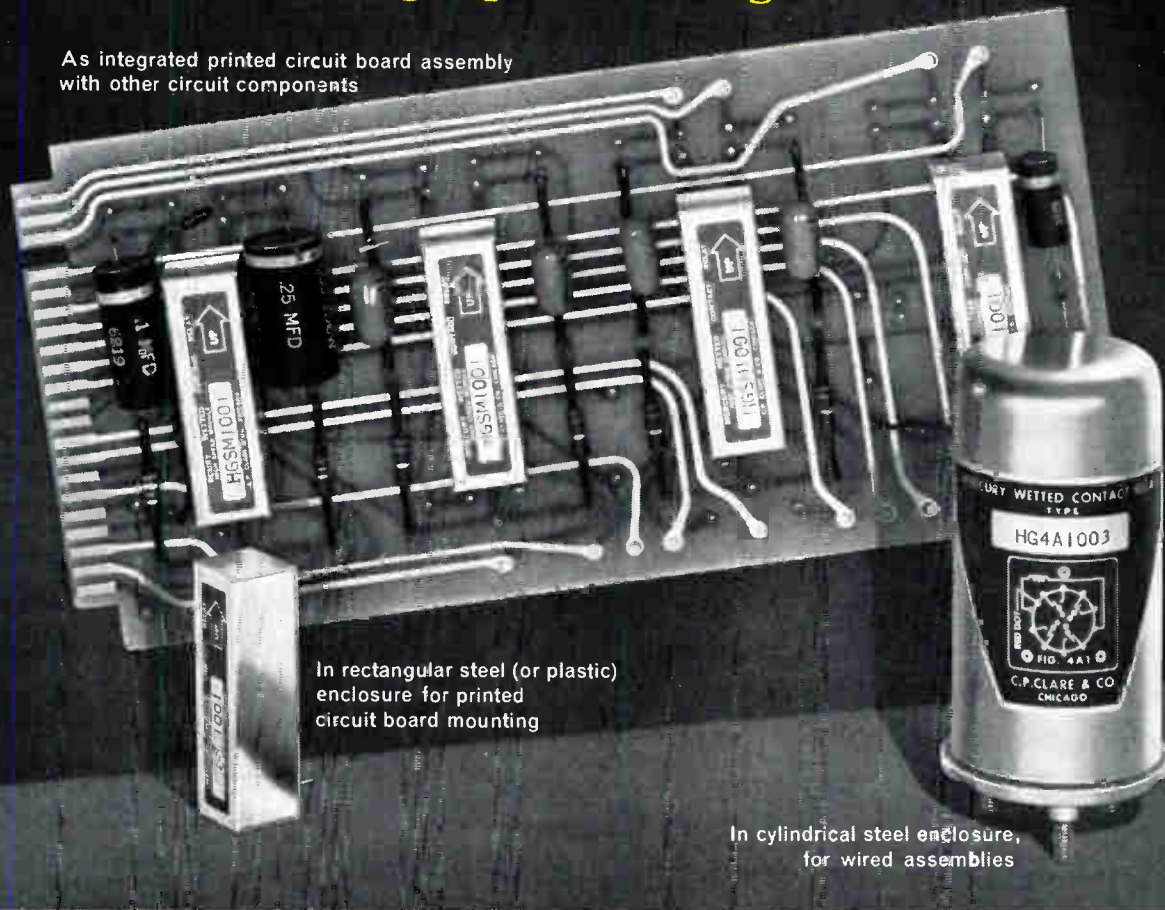
Information theory and automata theory will be studied. Techniques will be applied to better understanding of computing languages.

Laboratory Manager is Dr. Heinz Zemanek, known world wide for his work in the field.

# specify **CLARE** Mercury-Wetted Contact Relays

**for billions of operations with  
Low and Consistent Contact Resistance • No Contact Bounce  
Versatile Load Switching Capabilities • High Power Gain**

As integrated printed circuit board assembly  
with other circuit components



In rectangular steel (or plastic)  
enclosure for printed  
circuit board mounting

In cylindrical steel enclosure,  
for wired assemblies

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

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

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

For wired assemblies: plug-in, solder terminal, or AN connectors in one to four-pole multiples. For printed circuit board mounting: modules of molded plastic or steel enclosures. As integrated

printed circuit board assemblies: custom-built from your circuits or "black box" requirements.

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

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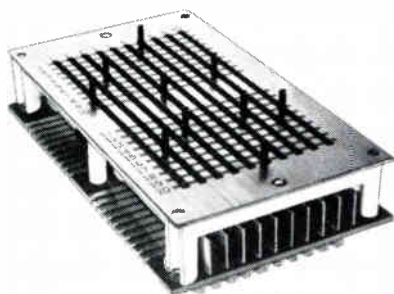


*Relays and related  
control components*

"... advancing the STATE-OF-THE-ART in Components & Equipment.

## PROGRAMMER-SELECTOR

Ten select stations provide 200 switching combinations.



The CIO-01A is a manual switch measuring  $2 \times 3\frac{1}{2} \times 6$  in. Each module has 20 PC contact strips and 10 dual-purpose transverse rails. The unit is well suited for programming, circuit design, and sequencing of automatic equipment. Wiring connections are made with Q. C. terminals. Current-carrying capacity is 1a, 15vdc; 150ma, 125vac make and break; or 3a, 125vac/dc current-carrying only. Cherry Electrical Products Corp., P. O. Box 438, Highland Park, Ill.

Circle 212 on Inquiry Card

## DC AMPLIFIER

Transducer excitation supply is 10v.; less than  $0.3\Omega$  output impedance.

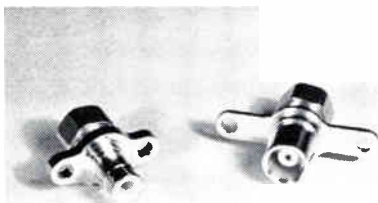


The Type 1-360 amplifier has a fixed gain of 100-175. Output impedance below  $50\Omega$ . Temp. effects are within  $0.002\%$  /°F over range of  $0^\circ$  to  $200^\circ$ F. Can be mated with almost any transducer. Consolidated Electro-dynamics, a sub. of Bell & Howell, 360 Sierra Madre Villa, Pasadena, Calif.

Circle 213 on Inquiry Card

## CONNECTORS

The  $50\Omega$  coaxial connectors features  $10\mu$  VSWR. For four cable sizes.

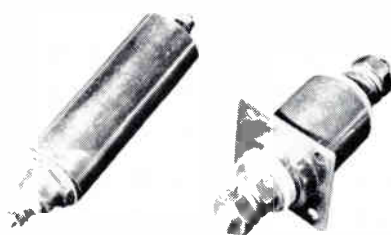


These connectors have an integral hermetic seal. Existing designs are for cables with dia. of 0.092, 0.216, 0.500, and 0.140 in. This series are push-on and slip-on types for bulkhead mounting, using high-temp. metal O-ring flange seals. Metals, dielectric materials, plating, and mechanical configuration are selected to meet physical and environmental needs of space applications. Stoddard Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif.

Circle 214 on Inquiry Card

## SUPPRESSION CAPACITORS

Ratings from 1.0-4.0 $\mu$ f in 25, 50 and 100a groups. Exceed Mil-C-11693-B.



These r-f components work at high amperages on voltages of 100vdc and below. This rating provides ample safety factors for transients and other over-voltage conditions on 28 and 50vdc lines. Rugged design makes them ideally suited for use in extreme environmental conditions. Genistron, Inc., 6320 W. Arizona Circle, Los Angeles 45, Calif.

Circle 215 on Inquiry Card

## AC LINE REGULATOR

Features 500 to 1 transient rejection and 250 to 1 harmonic attenuation.

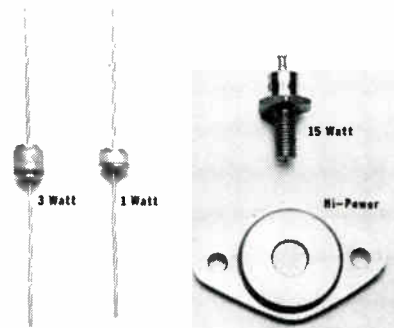


Model LC-1000 (Dynamic Line Corrector) uses solid-state circuitry. Power output is 1 kva, and derating or power factor corrections are not required. Load regulation is 0.02%. Recovery time is less than  $50\mu$ sec. The LC-1000 is designed for precision test and measurement operations where even minor variations or distortions in the ac line cannot be tolerated. Elin Div., International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif.

Circle 216 on Inquiry Card

## ZENER DIODES

Shock-proof construction eliminates glass-to-metal seal.



These diodes are available in power ratings of 1, 3, 10 and 50w, and are guaranteed to surpass any existing Mil specs. It uses a solid-mass construction technique that guarantees immunity to any amount of shock, vibration and stress. American Semiconductor Corp., 3940 N. Kilpatrick, Chicago 41, Ill.

Circle 217 on Inquiry Card

# three hundred million diodes later

Twelve years have passed since Hughes Semiconductor Division introduced the first hermetically sealed sub-miniature glass diode. This remarkable development led to the reliable volume production of the glass diode. To date, 300 million diodes have been produced and shipped by Hughes, each a quality product, each with a built-in reliability unsurpassed in the industry.

In the germanium diode field alone, Hughes currently is shipping well over a million diodes a week. Of the millions of germanium diodes shipped during 1963 only 0.6% were returned by customers because they did not meet final tests. And the silicon diode story is even better.

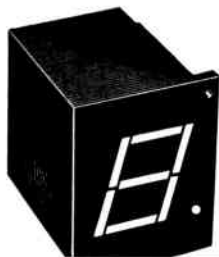
As any production engineer will tell you, that's an excellent record. And it is very important to you. It means that you can depend upon Hughes for diodes that will stand up under your most exacting requirements. It means that you won't have to spend extra time and money because of production delays caused by defective diodes. It means that no matter how large or small your order, you can be assured that you will meet your production schedules.

*Three hundred million diodes and twelve years after pioneering with the subminiature glass diode, Hughes is again ready to launch what may become the ultimate diode.*

*Creating a new world with electronics*

**HUGHES**

HUGHES AIRCRAFT COMPANY  
SEMICONDUCTOR DIVISION  
NEWPORT BEACH, CALIFORNIA



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NUMERIC READOUT\***  
FOR 12 TO 160 VOLT SUPPLY



Exceptionally bright, crisp, easy to read digits are produced by an exclusive DIALCO light cell system. Numerals lie in a single plane—can be seen at extremely wide angles.

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A choice of long-life incandescent lamps for operation on low voltages, or seasoned and selected neon lamps for use at 100 to 160 volts, is available. **DIALCO readouts are adaptable to all power supply voltages.**

Transistorized translators can be provided on application.

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\*PATENT APPLIED FOR

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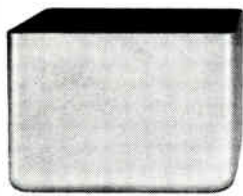
Booths 2729-31 of the IEEE Show

Circle 95 on Inquiry Card

**ARE YOU PAYING TOO MUCH FOR FABRICATED BOXES?**

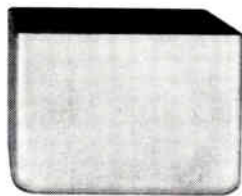
THIS PART COST

**87¢**



THIS PART COST

**\$1.90**



(Both made from .064" aluminum in lots of 1,000)

**THIS PART** is made by the Zero deep draw process. It costs less than the fabricated part and offers these additional advantages: Uniformity; close tolerances; straight side walls; excellent surface finish; work-hardened side walls. Because it was made from stock tooling, there was no tooling or set-up charge.

**THIS PART** was fabricated by the conventional notch-fold-weld method. In addition to a higher cost it has these disadvantages: Measurements vary; welds are subject to porosity and failure; warpage caused by weld heat must be straightened. Fixtures and tools must be charged for with a set-up charge for every order.

**NEW 38 PAGE CATALOG LISTS 20,000 STOCK SIZES**

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**LETTERS**

to the Editor

**"Technical Translations  
By Computer"**

Editor, *ELECTRONIC INDUSTRIES*:

The cover article "Technical Translations by Computer" which appeared in the December issue of "Electronic Industries" was read with considerable interest and satisfaction by our staff engaged in language processing research. The description of a rather involved procedure was presented in a clear and informative manner.

The comment — "while machine translation is rough—much rougher than the human translation—it is still understandable,"—is an accurate assessment of the status of the operational MT program at IBM Research and also testifies to its usefulness. However, the concluding statement in the article, "It appears that our problems in making technical translations have been solved. Further refinement should only add icing to the cake," is much too general. While it is true that further improvements to a particular, operational MT system may contribute little to its translations, researchers in this field still face the considerable task of conceiving and perfecting an acceptable grammar which will support smooth translations, free of ambiguities. Intuitively, the prospect of realizing such a grammar appears favorable, but we must finish the cake before adding the icing.

The prominent and timely reporting of this MT program in *Electronic Industries* is considerably appreciated by our staff. We share your interest in portraying a completely accurate status of this important aspect of data processing.

W. B. Strohm

International Business Machines Corp.

Thomas J. Watson Research Center  
Yorktown Heights, New York

**What is a Writer?—Pt. III**

Editor, *ELECTRONIC INDUSTRIES*:

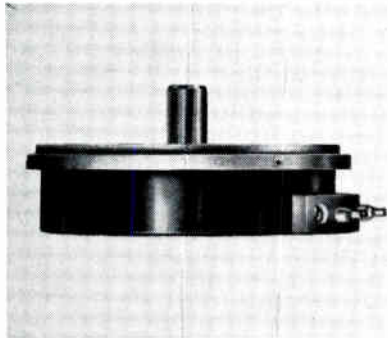
I have read with interest Roger M. D'Aprix's article on technical writing (*ELECTRONIC INDUSTRIES*, October 1963) as well as Stephen E. McCallum's letter regarding his "What is - my - occupation?" quandary (*EI*, January 1964). (Continued)



# NEW PRODUCTS

## POTENTIOMETER

Power rating: 2w. @ 40°C derated to 0w.  
@ 125°C. Temp. range -55° to 125°C.

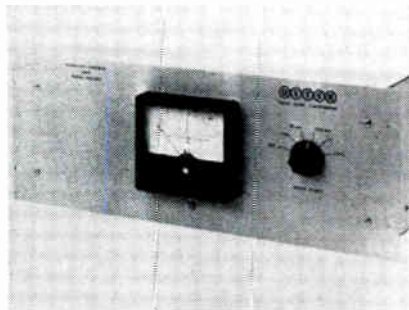


Model MDU is a wirewound unit with a total resistance of 250Ω to 150KΩ. Up to 200KΩ available. The potentiometer is 1/2 in. long from mounting flange. A new wiper assembly eliminates backlash. Resistance tolerance is ±5% and ±0.1%. Noise at 10 RPM is 100Ω max. std. but 25Ω is available. Insulation resistance is 500 meg min. at 500vdc. Potentiometer Div., Litton Precision Products, Mt. Vernon, N. Y.

Circle 210 on Inquiry Card

## CONTROL DEVICE

Provides automatic On-Off operation for vacuum pumps, pump heater, etc.



This auxiliary control device is sensitive to pressure changes in high-vacuum systems used for thin-film deposition, tube processing, space research, etc. The device functions on the principle that current in an ion-pumped vacuum system bears a linear relationship to the pressure (or vacuum) within the system. Thus in a high vacuum bakeout operation the auxiliary control is set to turn on the heaters when suitable pressures are reached. When outgassing is completed, a lowering of the pressure and a consequent increase in ion pump current turns off the heaters. Ultek Corp., Box 10920, Palo Alto, Calif.

Circle 211 on Inquiry Card

**THE VERNIER IS**

**OVER-AUTOMATED**

(... we may have Gone Too Far)

Are we being fair to the Man in the Lab? Will he feel Left Out? Unwanted? Will his Life be Empty without the Vernier? With **AUTOBALANCE**®, you see, the vernier on our B221A Universal Bridge becomes a useless ornament.

The principle is simple.\* Any bridge unbalance is fed to an operational amplifier, which furnishes a proportional "re-balance" voltage. Two phase-sensitive detectors give readings of the in-phase and quadrature components of the rebalance signal, (directly, on meters). Add these to the decade settings and you have the resistive and reactive answers—without touching the vernier... electronic, automatic, and terribly modern.

Think of batch-lot-checking to four digits, without touching a knob (once the decades are set at the start). Think of automatically recording component drift! The question is, is the Game worth the Candle?

Help us! Tell us you care more for efficiency than for tradition! Buy the AA221 and write us admiring and forgiving letters. (If you're not all that impulsive, at least ask for the literature.\*\*)

One last word—if you ever feel sickeningly "over-automated" with the AA221, you can always pull out the adapter cable and "go native" with the raw B221A.

### B221AQ SPECIFICATIONS

Capacitance: 0.0002 μF to 100,000 μF	Frequency Range: 1000 or 1592 cps Internal;
Resistance: 25μohms to 50,000 megohms	20 cps to 20KC External
Inductance: 5mμH to 10 <sup>6</sup> H	Accuracy: ±0.1%

® **AUTOBALANCE** is a registered trademark of Wayne-Kerr

\* And patented

\*\* While you're at it, go all the way, and ask about the B541, a ±0.25% Capacitance Bridge with built-in **AUTOBALANCE**!



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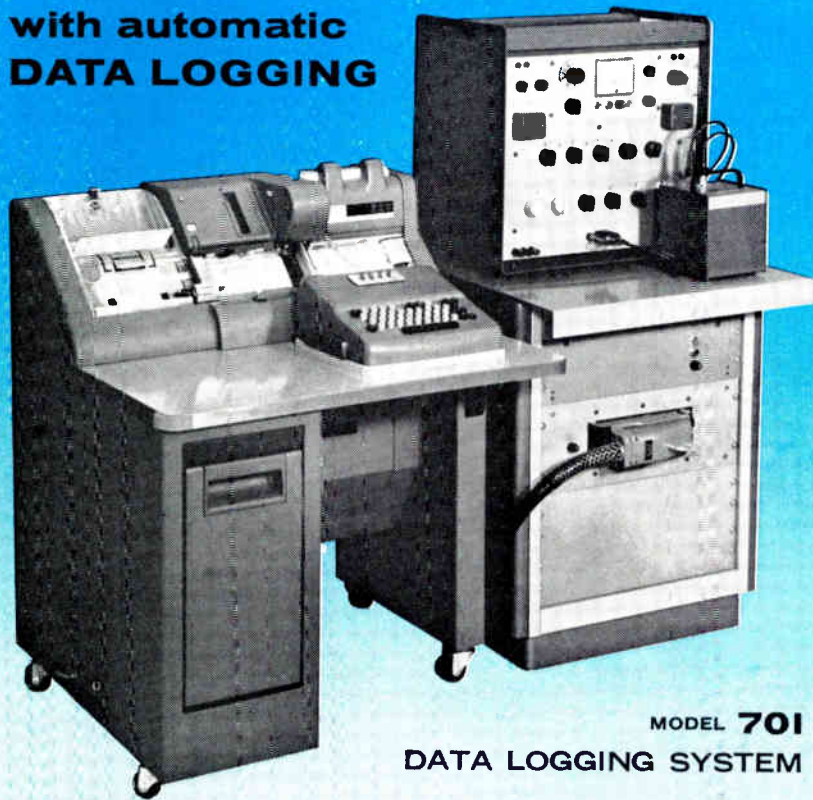
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# CAPACITANCE MEASUREMENTS

**with automatic DATA LOGGING**



**MODEL 701  
DATA LOGGING SYSTEM**

ESI's state-of-the-art Model 701 Capacitance Measuring System with data logging capabilities to record automatically the nominal value of a capacitor being measured; deviation from nominal; and the dissipation factor. All values recorded to the nearest dial division. Dates, control numbers, serial numbers, temperature and similar information may also be programmed and recorded simultaneously.

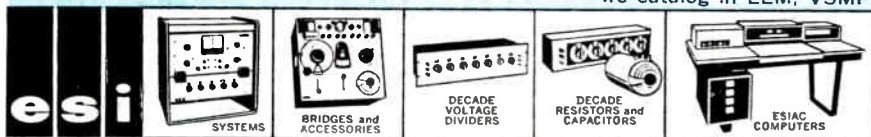
Ideal for use in capacitor-oriented studies, repeated operational testing, studying environmental effects on stability and reliability and for recording data for historical entry or historical files. Direct-reading accuracy of the basic 701 system  $\pm(0.01\% + \text{one dial division})$  except on the highest range where it is accurate to  $\pm(0.02\% + \text{one dial division})$ .

Output device may be any of a variety of standard machines, including card punches, tape punches or electric typewriters. Illustrated with IBM 526 Summary Punch.

For additional information, send for Catalog Sheet C-53, "Model 701 Data Logging System;" Catalog Sheet C-51, "Model 701 Capacitance Measuring System."

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## NEW PRODUCTS

### CRYSTAL SOCKET

*All-molded unit facilitates assembly by eliminating breakage.*

Socket No. 9748-16 is suited for use where mechanical shock and vibration are problems. It is available in mica-filled phenolic with phosphor/bronze contacts, or in general-purpose phenolic with brass/cadmium contacts. Overall dimensions: 0.859 x 0.312 x 0.375 in. Dielectric withstands 1200v. rms; individual contact resistance, not greater than 0.03 $\Omega$ ; current-carrying capacity, 1a. Hugh H. Eby Co., 4701 Germantown Ave., Phila., Pa.

Circle 292 on Inquiry Card

### OSCILLOSCOPE

*Trace range: 0.1 $\mu$ sec. to 0.1 sec. Accuracy, 3%. Vertical bandwidth, dc-6Mc.*

Model K-106 is an all transistor oscilloscope which meets environmental tests of Mil-E-16400. The 18 lb. unit draws 25w. and can be readily adapted for battery use. DC and ac coupling are provided. Horizontal bandwidth is dc to 500kc-3db. General Atronics Corp., 1200 E. Mermaid Lane, Phila. 18, Pa.

Circle 205 on Inquiry Card

### THERMOPILES

*Shows r-f dissipated by converting differences into voltage.*

The 389A and 189A differential thermopiles have output voltages of 3.7mv/ $^{\circ}$ C and 1mv/ $^{\circ}$ C respectively. For lower power levels, several thermopiles can be connected in series. Pressure drop/side for the 389A is 10 psi for 2.0 gpm; for the 189A, 10 psi for 1.4 gpm. Max. pressure and temp. is 75 psig and 95 $^{\circ}$ C. Sierra Electronic Operation, Philco Corp., 3885 Bohannon Dr., Menlo Park, Calif.

Circle 206 on Inquiry Card

### SERVO ACCELEROMETER

*Withstands shock and measures acceleration to 500G.*

The Model 5310 flexure accelerometer measures acceleration to an accuracy of 0.1% over the range of  $\pm 10G$  to  $\pm 100G$ . Extended range are available to a high range of 500G and a low range of 1.0G. Standard modification are offered to adapt the unit to special requirements. The new flexure design is almost entirely solid state—free of pivots and jewels. Systron-Donner Corp., 888 Galindo St., Concord, Calif.

Circle 207 on Inquiry Card



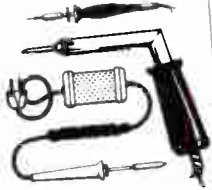
**american beauty**  
 A-mer'i-can Beau'ty (a-mēr'i-kān bū'tī),  
 n. Brand of electric soldering irons used



in most U.S. industrial soldering departments. Manufactured since 1894 by American Electrical Heater Company. a-vail'a-ble (ā-vāl'ā-b'l), adj. Ready; handy. Example: A. B. Soldering Irons —available from qualified distributors throughout civilized world. (You can always get genuine A. B. replacement parts.)

one (wūn), adj. Single in kind. As in American Beauty's motto, "Made in one quality only—the best".

va-ri'e-ty (vā-rī'ē-tī) n. A varied assortment. As in American Beauty Irons, available in dozens of different models, sizes and types.



in'de-strūct'i-ble (in'de-strūk'tī-b'l), adj. Not destructible. For example, it is common for A. B. Irons to give 100% service after decades of daily use.

min'i-a-ture (mīn'ī-ā-tūr), n. On small scale; as in B-Series electric soldering irons developed by American Beauty for electronics and missiles industries. (Illustrated on facing page.)

par'a-gon (pār'ā-gōn), n. A type of perfection; as in American Beauty's "Paragon" Quality Soldering Tips; outlast previous tips up to 10 to 1; retain themselves; no scal-



"Paragon" Quality Tips

Modern soldering iron is a precision instrument. Shown: American Beauty B-2000; 7" long; weighs 3 oz.; produces 750°F. heat at 22½ watts. (Resistance wire in heating element is finer than human hair.)

319 **electric soldering irons**

ing; drip-proof; freeze-free. spec'i-fi-ca'tion (spēs'i-fi-kā'shūn), n. Designation of particulars; such as "contract specifications" in electronics industry. Soldering "specs" are often so high that equipment of American Beauty quality is used to keep rejects at minimum.

feel (fēl), n. Feeling; perception by sensations. An important factor in choosing soldering irons, some of which are used delicately as a writing pen, often under magnification.



com'fort (kūm'fōrt), n. Freedom from pain or trouble. For example, among soldering workers, those using A. B. Irons, which are scientifically balanced, heat insulated, comfort contoured.

au-thor'i-ty (ō-thōr'ī-tī), n. One appealed to in support of opinions, actions. Authority for authentic, technical information on soldering equipment is your American Beauty Distributor.

dem'on-strā'tion (dēm'ūn-strā'shūn), n. Showing of product's merits. As, demonstration of any American Beauty product; available immediately by contacting your A. B. distributor.

cat'a-log (kāt'ā-lōg), n. Articles arranged in order; as in American Beauty's new 24-page catalog. (For yours, write American Electrical Heater Company, 6110 Cass Avenue, Detroit 2, Michigan.)

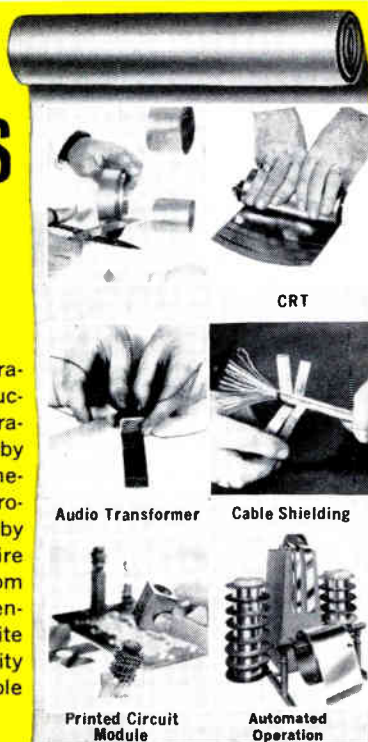


# WRAP-AROUND MAGNETIC SHIELDS

**APPLIED IN SECONDS**

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

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



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Circle 102 on Inquiry Card

# LETTERS

to the Editor

(Continued from page 165)

but price. A general distribution of prices leads to price cutting wars.

2. Mr. Jenkins indicates another reason for not publishing price. Our most technically advanced products typically have higher price tags. If the competition is bidding on less sophisticated items and price is the deciding factor, we are bidding at a disadvantage. Unless the systems engineer specifies what he can afford or indicates all the systems parameters including price factors, he will not receive two quotes alike—even from the same component manufacturer.

3. Most reader service card inquiries are of a general nature and most manufacturers consider these inquiries as an indication of interest in the product line. Pricing information for this type of inquiry is usually not warranted.

4. Most manufacturers or sales representatives are as close as the nearest phone. Our items sell for several hundred dollars each and if a customer does not feel justified in calling long-distance for this information, most component manufacturers will accept a reversal of charges.

Although the above reasons do not solve Mr. Jenkins problems, perhaps they will help him in sympathizing with our position and will indicate methods for overcoming his problem.

Irving Hirsch  
Business Manager

E & M Laboratories  
15145 Califa St.  
Van Nuys, Calif.

Editor, ELECTRONIC INDUSTRIES:

Permit me to strongly second the plea of Mr. Richard Jenkins (EI, Jan. '64, page 135) for price information. Even when price and delivery are requested by letter, the request is often (usually?) ignored. Are manufacturers ashamed to put the price (of typical quantities) in their magazine ads, or is it an unwritten rule?

Scott Nevin  
ITT Industrial Laboratories  
Div. of International Tel. & Tel. Corp.  
3700 East Pontiac St.  
Ft. Wayne, Ind.

# KLEIN PLIERS *Speed up electronic wiring*

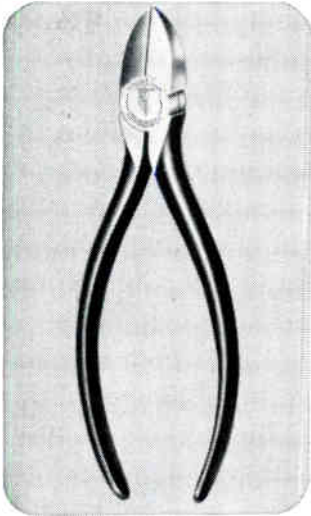
When the crystal set was a seven-day wonder, Klein long nose pliers were used to adjust the cat's whisker. Through the era of B and C battery sets, Klein kept pace by providing pliers specially adapted for electronic wiring.

Today, more than 100 different styles and sizes of Klein pliers are available to provide the exact tools needed for any job. Klein engineers have developed a special plier for wiring printed circuits; a high hardness

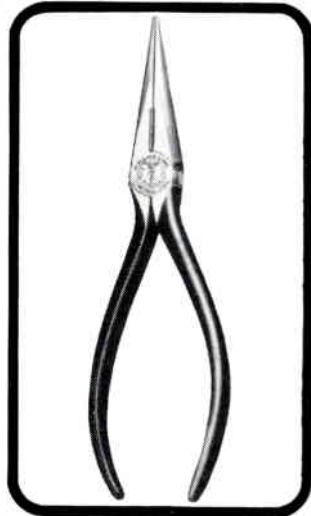
plier for cutting nickel ribbon wire; a transverse end cutting plier for cutting closely in confined spaces; extremely small pliers for wiring midget assemblies—and many others.

Klein has also developed special pliers to do special jobs requested by electronic manufacturers.

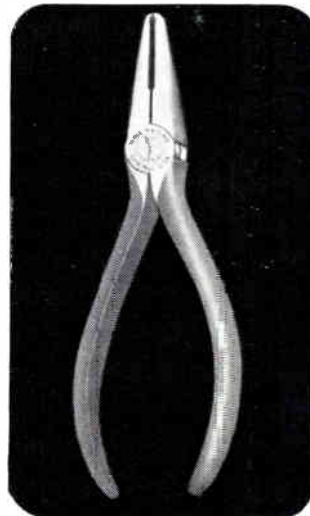
For better work done more quickly and at lower cost, be sure the pliers you use are exactly suited to the job . . . made by Klein, of course, "Since 1857."



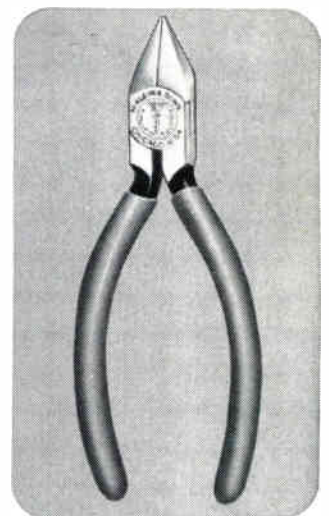
202-5C Oblique Cutting Plier with narrow nose. Available with coil spring. 5½-, and 6-in. sizes.



203-5C Long Nose Side Cutting Plier. Available in 5½-, 6½-, and 7-in. sizes. Supplied with coil spring.



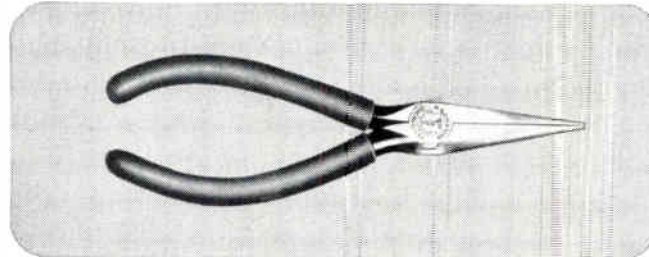
204-6C Transverse End Cutting Plier, 6-in. long. Supplied with coil spring to hold jaws open.



D209-5C Lightweight, Pointed Nose, Flush Cutting Plier. Supplied with coil spring to hold jaws open.



301-5C Long Nose Plier. Available in 5½-, 6½- and 7-in. lengths. Coil spring.



D307-5½C Slim Long Nose Plier for reaching into confined spaces. Yellow plastisol handles. Supplied with coil spring to hold jaws open.



D310-6C Slim Long Nose Plier. Handles are yellow plastisol covered. Supplied with coil spring to keep jaws open.



314-8 8-in. Long Nose Plier. Jaws have knurl.



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## Low Cost / High Quality Ratio



Model TR040M

**New ERA highly regulated DC power source provides continuously variable output, 0-40 VDC @ 0-500 ma for only \$99**

Compare the *price* of the new ERA all-solid state Model TR040 with other make power supplies providing the *features* and *specs* shown below. You'll agree that here is a truly unique power supply whose cost/quality ratio makes it ideal for the broadest possible range of applications, from laboratory to equipment-component use.

### FEATURES

- Compact, Lightweight
- Highly Stable
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- Low Ripple Content
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- Short Circuit Proof—Automatic Recovery
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- Remote Sensing Provision
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- For Laboratory or System Use

### SPECIFICATIONS

Input: 105-125 VAC, 50-1000 cps  
 Output: 0-40 VDC at 0-500 ma  
 Line Regulation: Within  $\pm 0.015\%$  or 5 mv, whichever is greater  
 Load Regulation: Within 0.03% or 5 mv, whichever is greater for 0-100% load change  
 Ripple: Less than 800  $\mu$ v RMS  
 Operating Temp. Range:  $-20^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$  free air, full rating  
 Constant Current Operation: 0-500 ma  
 Remote Programming Constant: 500 ohms per volt  
 Remote Sensing: Connections provided  
 Short Circuit Protection: Automatic current limiting  
 Thermal Protection: Automatic thermostat operation  
 Series or Parallel Operation: Connections provided  
 Output Terminals: Ungrounded, either positive or negative terminals may be grounded  
 Cooling: Internal convection-cooled  
 Panel Size:  $3\frac{1}{2}'' \times 7\frac{1}{2}''$  (designed for bench or half relay rack mounting. Two units may be mounted side-by-side in a 19" standard rack dimension for dual outputs.)  
 Price: \$99.00 (for current/voltage metering, add \$15.00 and suffix M. Relay Rack Mounting Kit—single or dual mounting, add \$5.00.)

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**SCHOOL TELEVISION** can also teach teachers. Student teachers can watch from training college while pupils are taught in their own classrooms. Closed-circuit TV, by EMI Electronics Ltd., has been put in a Kidbrooke School in London. Systems are connected by leased co-axial land-line to TV sets in Avery Hill Training College in Eltham. Cameras can also be used for teaching parallel classes in five classrooms at Kidbrooke, a 2000-girl comprehensive school. Pupils ignore TV cameras and student teachers are able to see special techniques.

**DOOR AJAR JARS JETS.** Radio interference between Air Force jets was reported to FCC Dallas. Control tower reported the stray signals were not heard there. The outlaws were detected near Big Springs, Tex. When search on foot proved fruitless, FCC sleuths hired two helicopters to direct a mobile search posse. The trail led across prairie, through draw and canyon to a driveway and a faulty electronic garage door opener. Though radiating  $2\frac{1}{2}$  miles into the sky, the culprit transmitter was barely detectable 200 feet from the door.

**ATOM-POWERED FOGHORN AND BEACON** to run continuously for ten years are in test at Baltimore for the U.S. Coast Guard. If successful, unit will displace a four-man crew and a diesel-powered lighthouse. Built by Martin Company, the size of a trash can, the 60-watt nuclear-powered generator converts heat from strontium titanate (safe strontium-90) into electricity by thermocouples. The SNAP (Systems for Nuclear Auxiliary Powers) generator weighs 4600 lbs. About 20 lbs. of the chemically-tamed strontium titanate are used.

**SCIENCE OF TELECHIRICS** will take care of design and making of remote-controlled gear needed in anything from collecting ocean floor samples to building a space station. Telechirics—from the Greek meaning distant and hands—was coined by Dr. John W. Clark of Batelle Memorial Institute. Telechiric systems are not the same as automatic systems, Dr. Clark said. Automatic systems displace man and do predetermined operations. Telechiric systems allow man to operate tools remotely, as if by hand.

(Continued on page 170)

# "Quick Heat" for "Push-to-Talk" Equipment



Hollow, cylindrical design of the RCA-8462 mesh filament offers greater emitting surface as well as built-in mechanical strength.



## New RCA-8462 with Mesh Filament Achieves 70% of Rated Power Output Within 1 Second

A warm-up time of less than 1 second *without external circuitry* provides the new RCA-8462 conduction-cooled Beam Power Tube with a heating capability so quick that standby power can be eliminated in "push-to-talk" emergency equipment. In a suitably-designed filament over-voltage pulse ("hot-shot") circuit, this ceramic-metal tube achieves warm-up in less than 100 milliseconds.

The thermal capabilities of the mechanically-rugged mesh filament were proved in a 100,000-cycle "hot-shot" test. The only commercially available "Quick-Heat" tube in its frequency-power range, the RCA-8462 is designed for use in inexpensive, 11-pin

sockets answering many communications needs.

In CW operation with a plate voltage of only 700 volts, the RCA-8462 provides 110 watts power output at 50 Mc, 105 watts at 175 Mc, and 85 watts at 470 Mc. It can be used as an RF amplifier, oscillator, regulator, distributed amplifier, or linear RF amplifier in both mobile and stationary equipment.

For more information on the RCA-8462 and other RCA tubes with ceramic-metal construction, see your RCA Representative. For technical data, write: Commercial Engineering, Section C-50-DE, RCA Electronic Components and Devices, Harrison, N. J.

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## EDITOR'S NOTEBOOK

(Continued from page 168)

**AIR-RENEWAL SYSTEMS** for space flight are being studied at Battelle Memorial Institute based on unusual electrolytic cells. They will operate in any position in weightless conditions. One cell contains phosphoric acid. The other uses palladium-silver foil. Cabin air may be passed through cells. Water vapor, product of breathing and perspiring, is absorbed. Air is replenished by released oxygen. The phosphoric acid cell may also serve as a dehumidifier.

**SALESMEN AND TOURISTS** may fly through space and sub-orbital areas by the early 1970s, according to Dr. Ernest H. Planck, industrial physician for The B. F. Goodrich Company. Aircraft that will take civilians through space on commercial business are feasible today, he said. But, space salesmen, Dr. Planck cautions, may find that a 2,000-mile-per-hour or more trip upsets the physiological day-night cycle. In effect, a traveler might taste his spinach in Los Angeles and swallow it in Rome, but it may take a week to readjust to eating habits after such a trip—both ways.

**EDUCATIONAL TELEVISION** is being introduced in Colombia through the American Peace Corps. The U.S. General Services Administration authorized purchase of 1,500 23-inch table model TV sets from Admiral International. The first 400 of the special high-performance TV sets has already been shipped by air to Bogota. The others will follow. A television relay network covering Bogota and remote mountain areas will be used by Corps volunteers to help reduce illiteracy.

**ARE BRAIN WAVE RESPONSES** from specific stimuli good indicators of the human brain's overall state or condition at any given time? Honeywell research men are now looking around in the brain's billions of electrical impulses for a group of responses which are reliable monitors of mental state or responsiveness. If Honeywell can achieve this goal, it will mean a big step toward a means of predicting and controlling human behavior. We might one day be able to monitor the mental state of astronauts millions of miles out in space.

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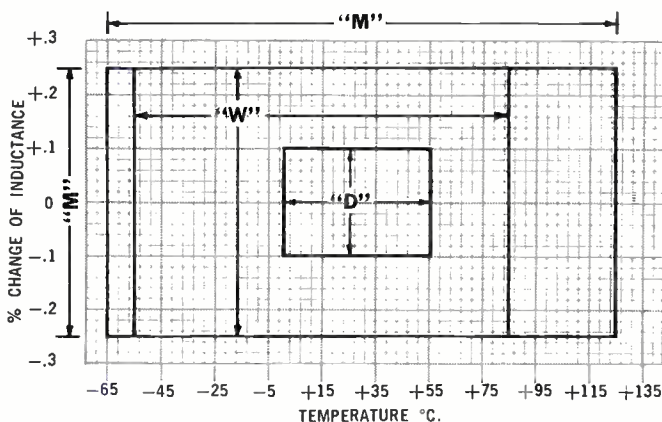
# Bulletin

**MAGNETICS inc.**

## New, M-Stabilized Powder Core First to Meet Higher Temperature Requirements of Military Specs

Now you can *guarantee* temperature stabilization ranges on filters, chokes, and inductors used in military communication and control equipment. The new M-Stabilized core limits inductance change to  $\pm 0.25\%$  from  $-65$  to  $+125^\circ\text{C}$ . Available in inside diameters from .110 to 1.400"; in standard permeability levels from 60 through 200. Check the Inductance vs. Temperature graph, then write for the full story.

New "M" Stabilized Temperature/Inductance Characteristic (Compared to "D" and "W" Stabilized)

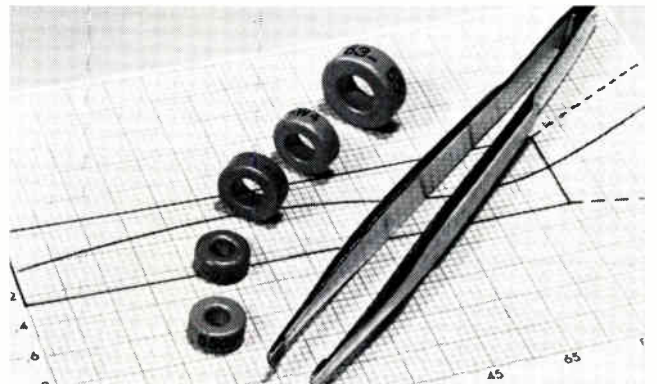


NOTE: "M" Stabilization extends the guaranteed range of  $\pm 0.25\%$  change of inductance to cover MIL Specs. specifying  $-65^\circ\text{C}$ . It also exceeds the temperature range of Class A insulation ( $105^\circ\text{C}$ ) allowing stable inductors to be designed to the limit of Formvar type film insulated magnet wire.

## New, Miniature Permalloy Powder Cores Offer Guaranteed Temperature Stabilization Properties

Need miniature cores for ultra-stable inductors? Now available, for the first time in the industry, temperature stabilized powder cores down to 0.110" I.D. Three miniature sizes in "D", "W", and the new "M" stabilized toroids have been added to the line. The "D" limits the change in inductance to  $\pm 0.1\%$  from  $0^\circ$  to  $+55^\circ\text{C}$ . The "W" limits the change to  $\pm 0.25\%$  from  $-55$  to  $+85^\circ\text{C}$ . The "M" limits the change to  $\pm 0.25\%$  from  $-65$  to  $+125^\circ\text{C}$ . The new miniature stabilized sizes have I.D.'s of 0.20, 0.156, and 0.110". Add these size features to guaranteed temperature stabilization properties, and

you've got a winner in miniaturized circuitry demanding extremely stable inductance properties. And all these sizes were designed so they could be wound on present miniature torodial winding equipment.



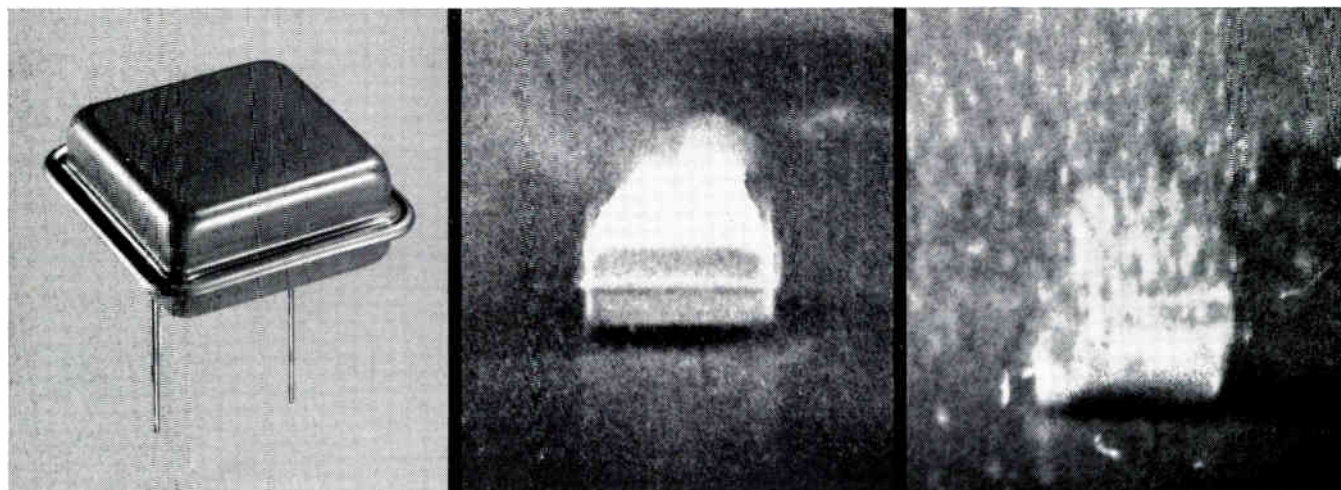
## New, too . . . Four Large Size Permalloy Powder Cores

Magnetics Inc. is now producing four additional larger size Permalloy Powder Cores. Their inside diameters measure 0.95, 1.13, 1.25, and 1.40". All available in permeability levels of 60 through 200. . . and can be supplied either unstabilized or in "D", "W", or the new "M" temperature stabilization ranges. Your choice of 68 different combinations of stabilizations and permeabilities for such applications as capacitance compensation in telephone circuitry; frequency selection or control filters; chokes in certain high frequency power supplies; and inductors to provide phase shift. A proper match for every job.

For complete new technical data, write Dept. EI-20, Magnetics Inc., Butler, Pennsylvania.



# HIGH RELIABILITY in Frequency Control Devices from Reeves-Hoffman's **COLD WELD TECHNIQUE**



## EXPLOSION TESTS RUPTURE THE HOLDER, NOT THE SEAL

Explosion tests, designed to determine the reliability of the cold weld, consistently result in rupture of the holder, not the seal. Tests were photographed (as shown in center and right photos above) with a high speed movie camera at 3000 frames per second.



## HIGH RELIABILITY, MINIATURE FILTER

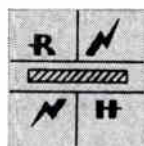
is actually two units in one. Each can be used independently and is controlled by two crystals in cold-welded holders. Each has a center frequency in the 500 kc region. This filter, designed to customer requirements, has the following approximate characteristics: bandwidth at 3 db is 0.1% of center frequency—at 20 db, 0.3%—at 30 db, 0.5%.

Reeves-Hoffman's new cold welding process provides crystal holder seals with a leak rate reliability of more than 100,000 times better than the requirement of MIL Spec 3098. Elimination of solder, and attendant flux and heat, removes undesirable damping and corrosion . . . solve problems of thermal isolation. The result: substantial increases in the reliability and stability of crystal units, oscillators and filters . . . further opportunity for miniaturization . . . faster delivery . . . lower cost.

Cold-welded holders have enabled Reeves-Hoffman to produce precision crystals no larger than power transistors. These units are much more rugged, many times lighter, and much smaller than their glass-enclosed equivalents. As proof of their ability to withstand severe environmental conditions, Reeves-Hoffman crystal units in cold-welded holders are being used in the Mariner space probe that will soon be on its way to Mars.

Reeves-Hoffman production crystals, from 1 kc to 100 mc, are available in cold-welded holders for use in networks of your own manufacture, or as components of Reeves-Hoffman filters, oscillators or standards.

SEE COLD WELDING AT IEEE BOOTH 1202



# REEVES- HOFFMAN

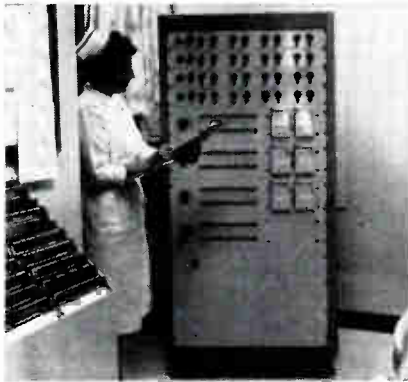
CARLISLE, PENNSYLVANIA

DIVISION OF DYNAMICS CORPORATION OF AMERICA

A Rixon Sebit 36 data system will provide a data-communication link for the Canadian Pacific Railway. The data link will initially operate at 2400 bps to handle accounting data. The system is capable of 3600 bps. It has modular construction and operates SSB.

### NURSES AID

The Executone-Gulton Physiological Monitoring aids in maintaining close vigil over post-operative and intensive-care patients. The system includes 3 portable monitoring units. Each bedside unit measures pulse, respiration, systolic and diastolic blood pressure.



A tropospheric-scatter system that achieves fourth-order diversity by using a single transmitter, receiver, and antenna/terminal is practical and economical, according to Martin, Orlando. A combination which uses time-delayed digital modulation with 4 frequencies spaced 1MC apart on an 8MC band—which requires no external multiplexing—seems ideal. The system would be capable of simultaneous voice-data transmissions. Twenty-four voice channels and one supervisory channel could be provided.

A system, which simulates the effects of low-freq. noise created by large rockets, is being built for the Air Force by MB Electronics. At the freq involved, 1-30 CPS, the test subject will feel, rather than hear, much of the noise in the form of pressure changes. With the system, scientists will be able to determine how long a man can tolerate these sound pressures.

MIT and three Boston hospitals are using remote electronic medical diagnostic and data-processing systems. A GE 225 is linked by telephone lines with the three hospitals. The computer, in the MIT neurological laboratory, processes data from electrocardiograms as well as from eye movement and hand motor coordination studies. Data is analyzed and returned to the hospitals, where it is presented in graphs and other forms.

An in-flight electronic system will help astronauts trouble shoot malfunctions. It is being developed for Apollo by ITT Chicago. The 36 lb. system monitors 150 key parameters. It allows the astronaut to decide if the systems are with operating margins. Some spare parts will be carried and can be installed by crew members.

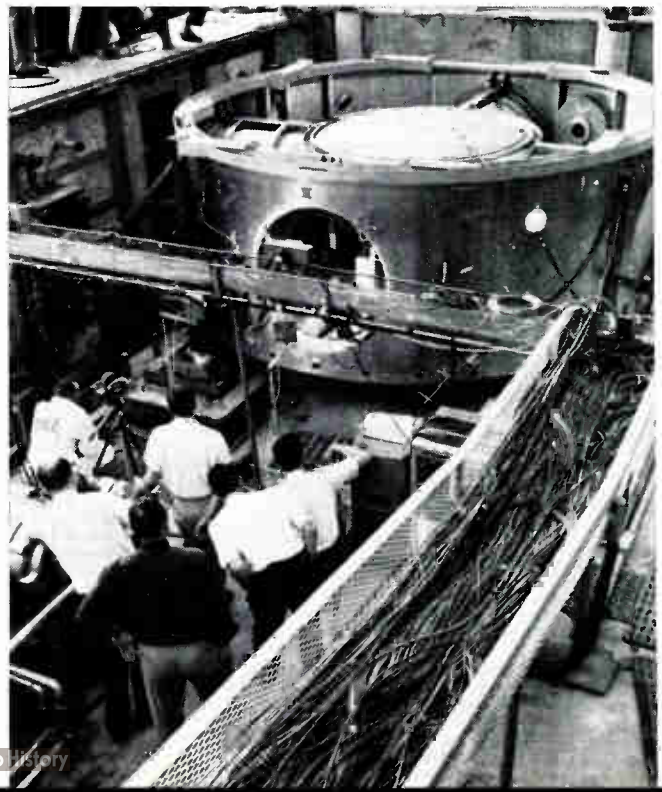
The general condition of the electronic systems aboard Relay II will be determined by Thompson Ramo Wooldridge Space Technology Laboratories. The STL designed equipment is pre-programmed to perform a series of 5 to 7 communications experiments on the system's black boxes. The results of these tests determine to what extent TV and telephone communications may be made.

Data-Line Terminal, Type 2 (DLT-2) allows data to be exchanged rapidly between magnetic-tape terminals and Univac 1004 Card-Processor Systems. It enables the Univac 1004 to communicate over conventional telephone lines with magnetic-tape terminals located around the corner or thousands of miles away. Through the medium of magnetic tape, the Univac 1004 and the DLT-2 can be a remote originating or terminating point for data processed by other computers.

General Tire & Rubber has added an RCA Speed-Pak enhancement package to an RCA 501 system and increased the work time 20%. The Speed-Pak offers four advantages: increase the memory cycle from 15 to 12 $\mu$ sec.; a 3-character adder enables common operation for a number of related records on a single command; left-to-right comparison increases speed; it can read, write, and compute at the same time.

### SHAKE DOWN

A vibration testing system, which produces 200,000 force-pounds horizontally or vertically, has been built by Wyle Laboratories. Hydraulically-powered exciters are used. A state-of-the-art advancement is represented in the capability for random and sinusoidal vibration.



The increasing use of high speed digital computers has created a demand for high speed readout. This demand has stimulated the development of methods for generating alpha-numeric and symbolic information from coded digital inputs. An economical, high speed generator with good legibility is described here.

For Computers . . . .

# A HIGH SPEED CHARACTER GENERATOR

THE CHARACTER GENERATOR described here is intended to be an economical, high speed device. It can generate alpha-numeric and symbolic information with good legibility. Character information obtained from the described "Aperture Plate Character Generator (APCG)" may be displayed on a cathode-ray tube (CRT) and viewed directly or photographed. It could also be printed on paper by electrographic printing methods.

\* \* \*

tially positioning the CRT writing beam to various x-y coordinates and unblanking the beam. The x-y coordinate and unblanking information for individual characters is stored in the character generator.

*Beam Shaping*—Characters are formed by passing the CRT writing beam through a stencil mask. The mask contains all characters to be generated. The desired character is selected by x-y beam deflection.

Typical characters generated by the above methods are shown in Fig. 1. The number of dots or

Fig. 1: Typical characters by various techniques are shown below.



To evaluate the capabilities of the proposed generator, we must be familiar with methods now available for generating alpha-numeric and symbolic information capable of being displayed on a CRT. Although there are many generators of this type available, most of them use one of the following character generating methods:

*Scanning*—Character information stored in the generator is sequentially sampled in a predetermined order to obtain intensity signals for modulating the display generator output. The appropriate area of the display must be scanned in sync with the character generator.

*Waveforms or Strokes*—Characters are stored in the generator as x and y deflection and intensity information. This information is simultaneously sampled to form 3 parametric analog waveforms. These are used by the display generator to draw out characters much as a pencil is used.

*Dot Pattern*—Characters are formed by sequen-

scanning lines contained in the individual characters of Fig. 1a and 1b can be increased to improve resolution. But, such an increase will increase cost and size and decrease reliability and writing speed.

## Proposed Generator

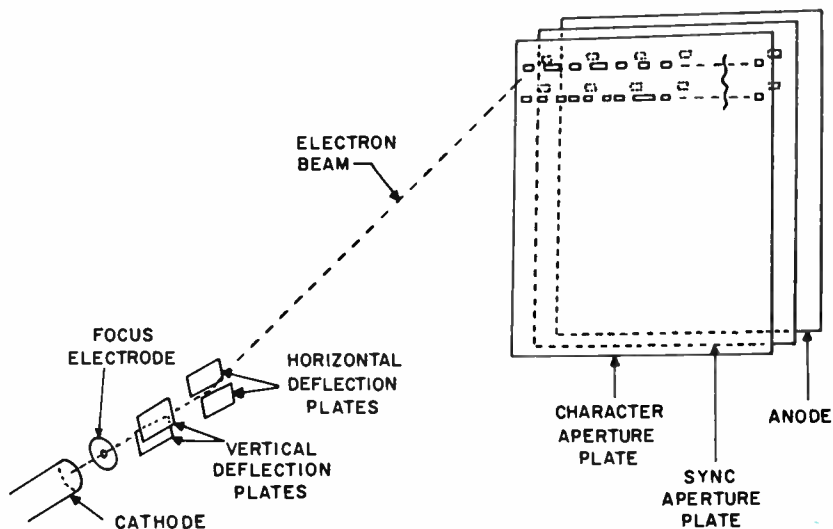
The "APCG" uses the *scanning* method described above. However, a unique method of storing the alpha-numeric and symbolic information in the character generator is used. This information is stored in aperture plates of a special purpose CRT as shown in Fig. 2. Two plates are used, one behind the other, to provide separate video and sync output information.

### By WILLIAM R. SLOAN

Senior Engineering Specialist  
Department 83450  
ITT Federal Laboratories  
3301 Wayne Trace  
Ft. Wayne 1, Indiana



Fig. 2: A special purpose CRT is used to store information in the Aperture Plate Character Generator. Two plates are used to provide separate video and sync output information.



All information needed to generate a character is contained in a single row of apertures across the width of the plates. A row of apertures is provided for each alpha-numeric or symbolic character to be generated. Fig. 3 is a view of the character aperture plate (showing a row of apertures for the character "I") as seen from the cathode end of the tube. Sync apertures are also provided in the character aperture plate to allow the electron beam to reach the sync collector.

Fig. 4 is a simplified diagram of the character generator. It shows the input and output signals and the various sub-units needed for the generation of the character video and sync information.

### Operation

The generator can be operated either at a fixed clock rate or asynchronously. Maximum character generation rate will depend on the display device (s) used and the bandpass of the video and horizontal deflection amplifiers in the system.

A digital code to identify the desired character (or symbol) to be generated is applied to the digital/analog (D/A) converter. The converter generates an analog voltage in response to the input code. It then applies it to the vertical deflection plates of the character generating tube to position the electron beam to the desired row of apertures.

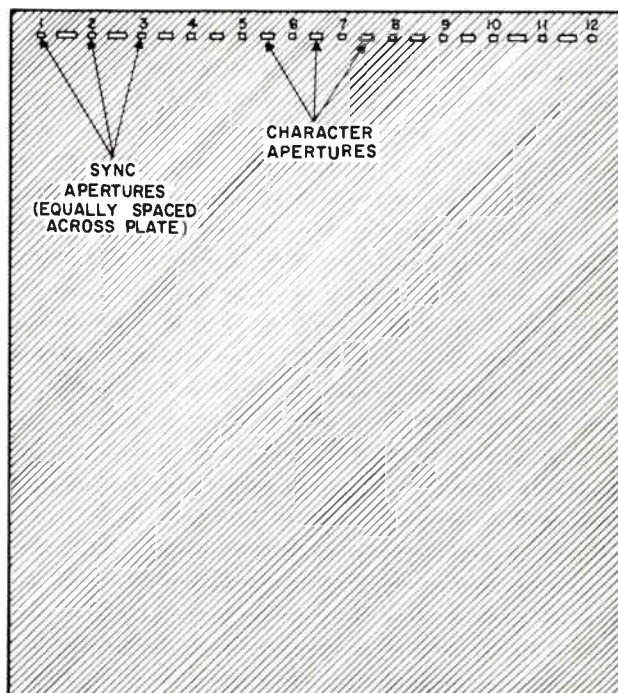
When the character selection analog voltage has stabilized, a character read signal is applied to the character generating tube to unblank the character video output. At the same time, a signal is applied to the character read sweep generator, from the D/A converter, to start a linear horizontal deflection voltage. This voltage is applied to the horizontal deflection plates of the generator tube and causes the electron beam to scan across the apertures of the selected character.

The character read sweep generator also provides a vertical sync (or trigger) pulse to the display generator to start a vertical character scan voltage at the display.

As the electron beam of the character generator tube scans across the apertures, horizontal sync and video pulses are generated and applied to the horizontal deflection generator and video amplifier of the display generator, respectively.

Time relationship of the vertical drive, horizontal drive and video signals from the character generator is as shown in Fig. 5. The display generator uses

Fig. 3: Character aperture plate as seen from the cathode end of the tube. Apertures shown are for the character "I". Sync apertures are also provided in the aperture plate to allow the electron beam to reach the sync collector.



## CHARACTER GENERATOR (Continued)

these signals to scan out the selected character, Fig. 6a. Size of the displayed character is found by the amplitude of the horizontal and vertical deflection signals generated by the display unit.

Spot wobble may be used in the display unit to fill in the area between the horizontal character scan lines, Fig. 6b. This is done by adding an h-f sine wave deflection component to the vertical deflection generator output of the display. Required amplitude of the spot wobble voltage is a function of the character height of the display, and the spot size of the display generating tube electron beam.

Raster lines (Fig. 6), that are outside the character area are normally not visible at the display. But, they can be made visible on an individual character basis to call attention to specific information.

Positioning of the individual characters on the display device is normally determined from a digital position code. If the display device is a direct view CRT, both x and y position information must be given. But, if the information is to be printed on paper (or other material) by photography or electrographic printing methods, it is sometimes better to move the material in the y direction and only provide digital position code for the x direction. This, of course, is not practical when the information is to be randomly positioned in the y direction.

X and y position information to the display device is not needed when the character information to be shown is received in a character sequential, line sequential manner. Certain instruction signals, such as "begin page," "line reset," "end page," etc., must be provided, however to sync the display device with the input information. The display device must also contain the necessary counter(s) and logic circuits to correctly reposition the CRT electron beam after each character has been printed.

It is sometimes necessary for the character generator to be separated from the display device by 1,000 ft. or more. If so, it may be desirable to mix the horizontal sync and video information at the generator, transmit the composite information over a single coax cable, and separate it at the display device. This can easily be done by making the sync amplitude of the composite signal greater than the character video amplitude, Fig. 7.

### Advantages

The "APCG" has several basic characteristics that make its use attractive in display generating systems needing characters with good legibility accurately positioned on the display device. Some of these characteristics are:

- a. High signal-to-noise (S/N) ratio.
- b. Positioning of the character generating tube electron beam to select the desired character is not critical.
- c. Repeatability of the individual characters is good.
- d. Position of the characters at the display is not affected by the generator character selection voltage.
- e. Separate or composite sync and video can be provided.
- f. Only one character selection D/A converter is needed.
- g. Locations along the character scan line at which the video output is switched on or off is not limited to discrete points.

All character generators possess some of the above characteristics; but it is believed that no other generator now available possesses all of them.

Since only black and white (no intermediate shades of gray) information is needed from a generator, S/N ratio of the generated signal is normally not a problem. With this type of signal, clamping, etc., can be used to improve the S/N ratio if needed.

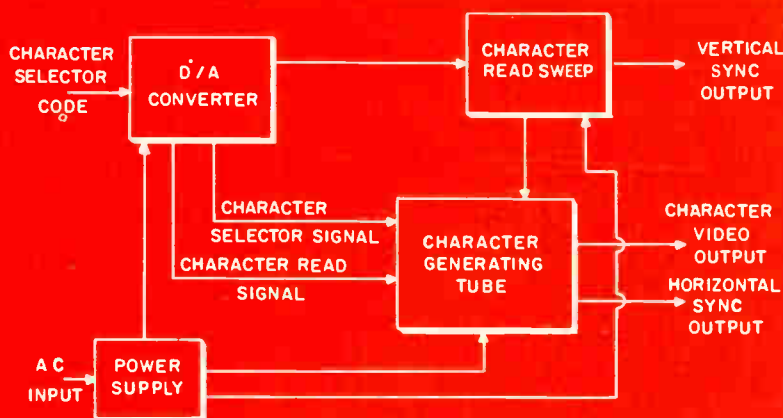


Fig. 4: Character generator block diagram.

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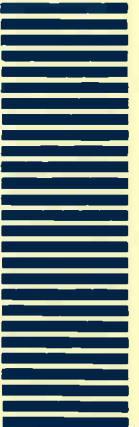
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281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
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321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
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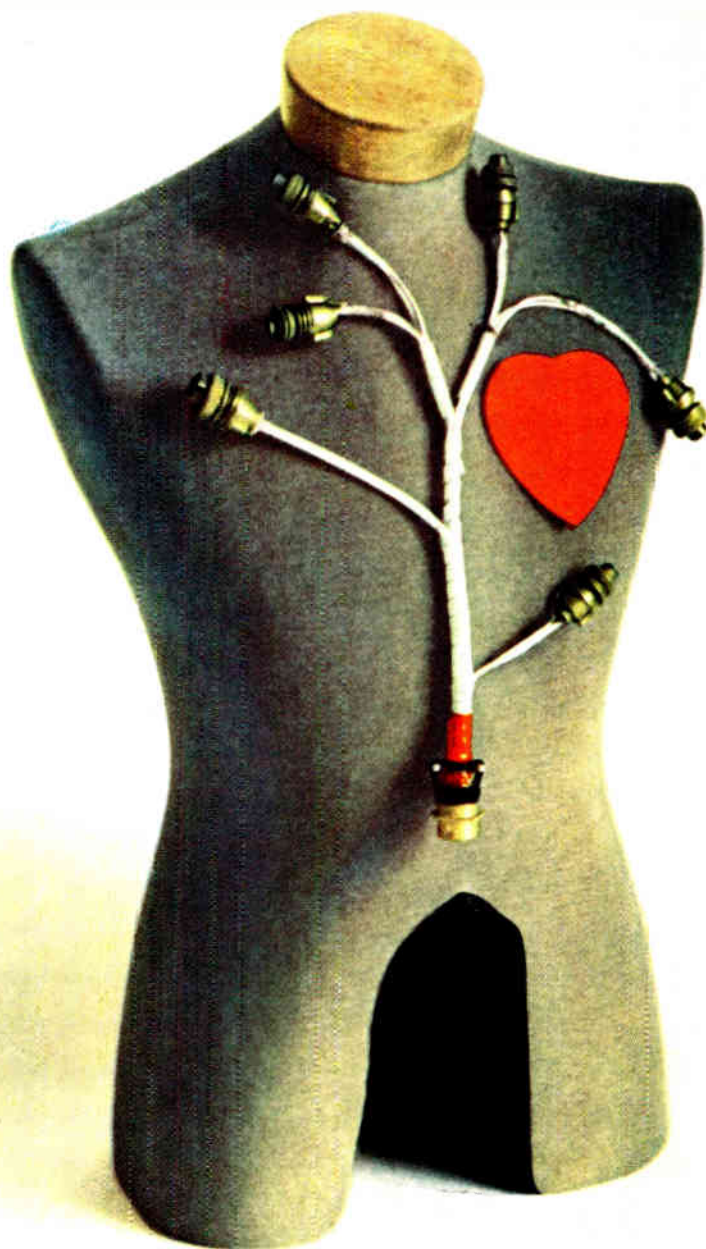
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But, the "APCG" has an inherently high s/N ratio because the output current varies from zero between apertures to full cathode current at the apertures.

In most generators that scan the selected character with an electron or light beam to obtain character video information (such as the monoscope tube) it is necessary for the character selection voltage(s) to be very accurate. This problem is eliminated in the "APCG" by making the height of the apertures (Fig. 2) only slightly less than the spacing between rows of apertures.

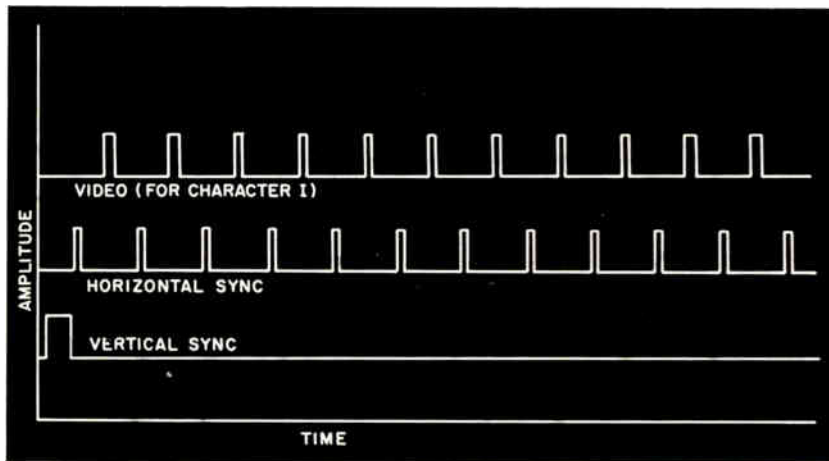


Fig. 5: Time relationship of sync and video information from the character generator.



Fig. 6: Characters as generated at the display—without (1) and with spot wobble.



Lateral displacement of the scanning beam, by as little as one line width, will cause a variation in the video output of generators using a TV like raster scan. With the "APCG" the video output is not affected by lateral displacement of the scanning beam by several scan line widths. This is due to the character aperture height being large in relation to the diameter of the electron scanning beam.

Since the video output is not affected by up to  $\pm 4$  or 5% lateral displacement of the generator scanning beam, and the horizontal sync for the display device is generated by this beam, the position of the character at the display is not affected by generator character selection voltage. This is an important advantage over character generators, such as the monoscope.

Many generators can provide separate or composite sync and video. Thus, the capability is thought to be relatively unimportant in connection with the "APCG" advantages.

The need for only one D/A converter is also rather unimportant; since the same number of binary bits must be handled whether one or two converters are used.

Scanning type generators using core storage as the method of storing the character (or symbol)

data can't produce many of the diagonal lines needed, without irregularities, Fig. 1b (1). Theoretically, such a generator could provide all diagonal lines without irregularities; but an infinite number of cores would be needed. Thus, it is impractical.

Since the characters are stored as apertures in a metal plate in the generator discussed here, the start and end of a character segment can occur on any point. Thus, irregularities inherent in the core storage type of generator are non-existent in the "APCG."

### Disadvantages

Although the advantages of the "APCG" are believed to outweigh the disadvantages, for many uses, it does have some disadvantages that must be considered. Some of these that are overcome by some other types of generators are:

- Method of changing symbols.

- Need for a CRT.

- Physical size.

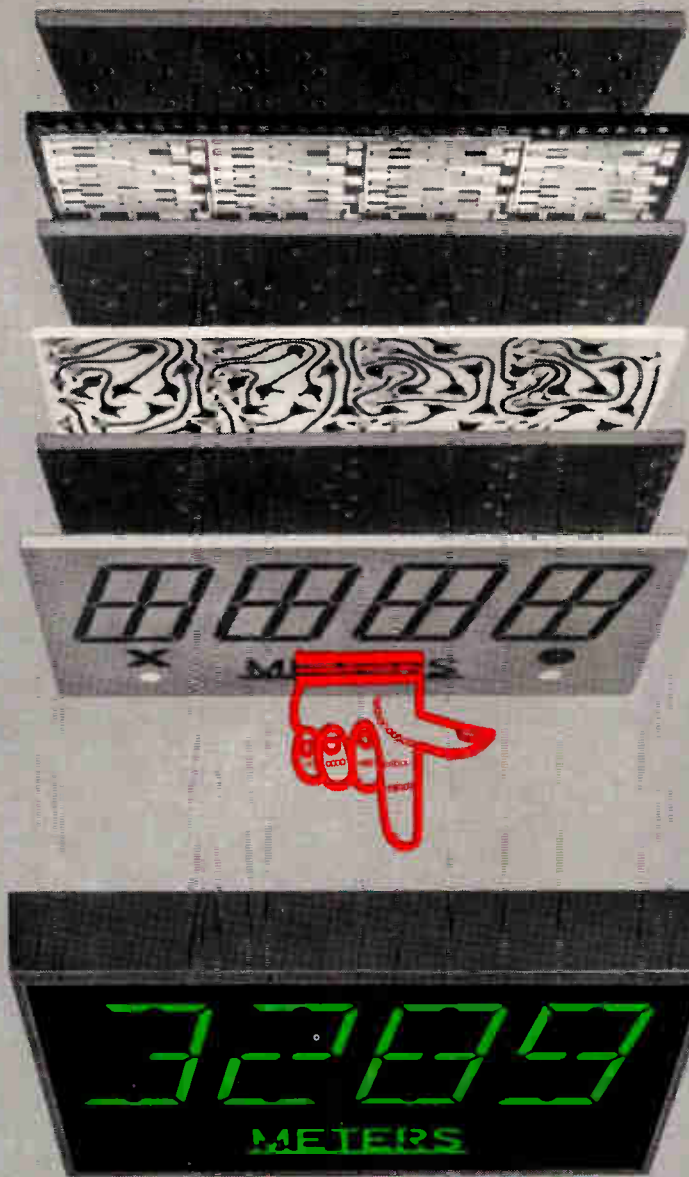
- Only one character can be generated at a time.

- Ratio of active to inactive time during a character generation period.

In many generators it is possible to change symbols by rewiring a memory, replacing a mask, replacing core planes, replacing resistor cards, etc. In the "APCG," as in a monoscope type, the character generating tube must be replaced. This somewhat limits the use of special symbols, due to economics, unless several identical generators are needed.

The use of CRT as the character storage device in the "APCG" limits its reliability, in general, to less than that obtainable with solid state type generators. This also limits minimum physical space needs for the generator.

Some generators, such as those using core storage, are able to generate all characters simultane-



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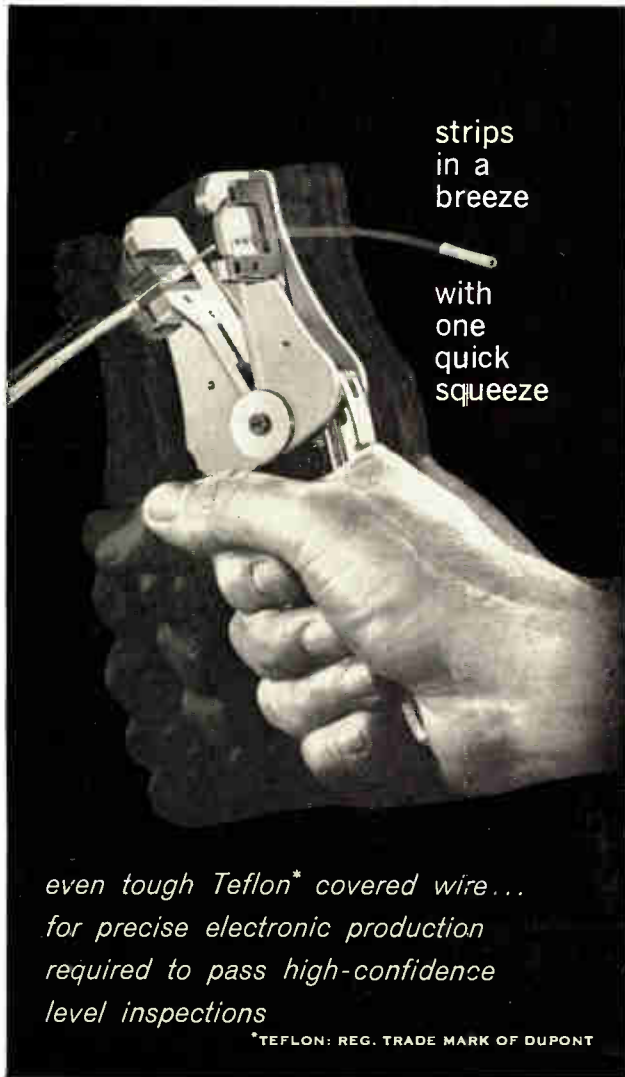
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## CHARACTER GENERATOR (Continued)

... from page 182

ously. In such cases the desired character is obtained by selecting the appropriate character generator output line. This is sometimes advantageous when two or more display devices can be driven by a common character generator. The "APCG" cannot generate more than one character at a time.

In generators that draw out the characters and symbols, using the electron beam of the display device much as a pencil is used, the active character writing time approaches 80 or 90% of the character generation period. In the "APCG" the active character writing time, in relation to the generation period, is much less. This is due to the fact that the entire rectangular area within which the displayed character is contained must be scanned. Thus, the relative energy that can be used for actual character generation is much less for the "APCG."

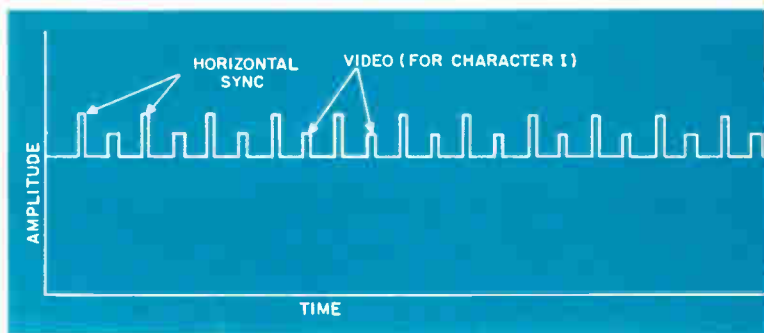
### Remarks

The generator described here can generate 20,000 characters/sec. It can be operated synchronously or asynchronously at any rate up to its maximum.

No cost figures are available on this generator at present. But, its cost should be about the same as the monoscope generator. (Between \$5,000 and \$7,000.)

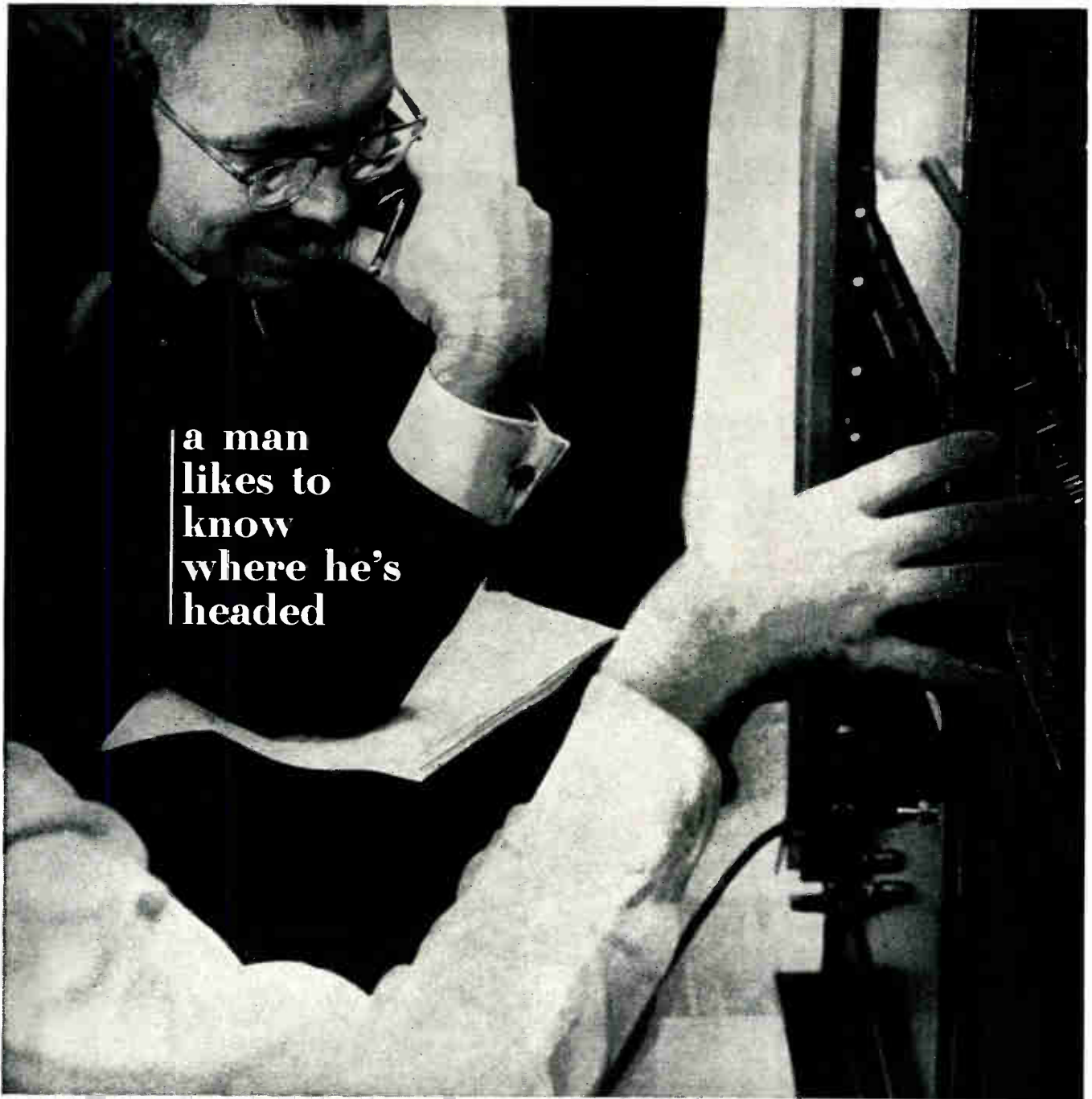
The video bandwidth of display generators to be used with the "APCG" should be about 10 mc.

Fig. 7: Composite character video and sync information.



### References

- Statlnad, N. "A Comprehensive Look at High Speed Printout," *Management and Business Automation*, pp. 34-37; Jan., 1960.
- "Reading the High Speed Printers," *Data-ation*, pp. 18-20; Aug., 1958.
- Moore, J. K. and Kronenberg, M. "Generating High Quality Characters and Symbols," *Electronics*, Vol. 33, pp. 55; June 10, 1960.
- "New High Resolution Symbol Generator," *Automatic Control*, pp. 28-29; June, 1960.
- Perry, K. E. and Aho, E. J. "Generating Characters for Cathode-Ray Readout," *Electronics*, Vol. 31, pp. 72; Jan. 3, 1958.
- West, R. E. "High Speed Readout for Data Processing," *Electronics*, Vol. 32, pp. 83-85; May 29, 1959.
- "New Character Generator," *Jour. Franklin Inst.*, Vol. 268, pp. 135-136; Aug., 1959.
- Loewe, Sisson and Horowitz, "Computer Generated Displays" *IRE*, pp. 185-195; Jan., 1961.



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## IEEE (Continued)

stable states is oscillatory and conductive while the other is cutoff. The circuit can be triggered alternately on and off by a stream of unipolarity pulse applied to a common input. This paper will be given at Session 18.

"Simple Submicrosecond Transient Sampling Technique," also given at Session 18, will describe a technique which allows samples to be taken every 10 nsec., with sample apertures on the order of 2 to 5 nsec. This allows reconstruction of a pulse about 1 μsec. long. Samples may be accurate to 1% or more in amplitude. The technique uses no gating or timing circuits.

The design of a spacecraft for an unmanned scientific fly-by mission to the vicinity of near planets places severe requirements on system design. Inter-agation of spacecraft scientific instruments places additional constraints on design because of the nature of the instruments themselves. This paper, "Incorporation of Scientific Instruments in Deep Space Probes," given at Session 19, discusses a method for resolving the conflicts between spacecraft and instruments without sacrificing reliability or weight.

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scribed in "Projection Photolithographic Technique for Use in the Fabrication of Microcircuits," will be given at Session 31. The projection technique uses conventional photographic emulsions, registration by ground-glass screen or binocular viewer, and very high ultraviolet light concentrations. The technique has produced photo-mask patterns similar to those used in current microcircuit fabrication.

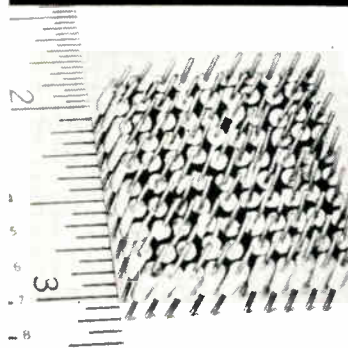
A single-function wafer, capable of many diverse logic functions, will be discussed in "A Universal Logic Function Wafer." The paper, presented at Session 31, will describe a production process that uses titanium thin-film circuits and a layered interconnection matrix. This matrix permits a connection between any pair of appropriate component terminals after the initial wafer fabrication.

The advantages of the non-reciprocal parametric amplifier over conventional types are many. Perturbations in signal source characteristics no longer degrade stability and power gain. For this reason conventional preamps require circulators, which tend to be noisy and temperature sensitive. In "Non-Reciprocal Parametric Amplifiers: Theory and Instrumentation," Session 34, the theory of non-reciprocity and applications are discussed.

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(Continued on page 188)

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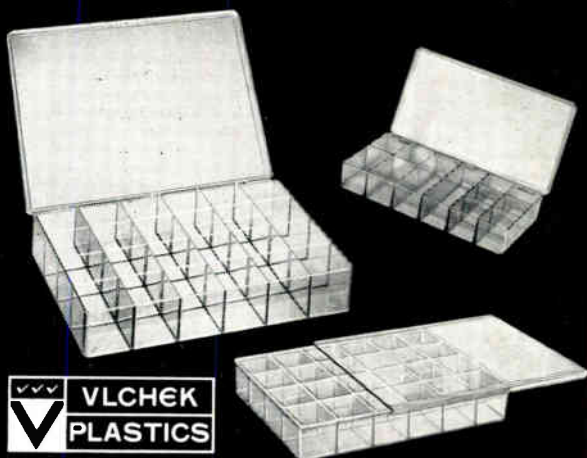
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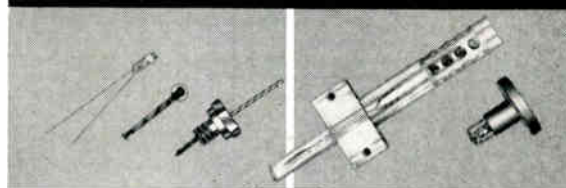
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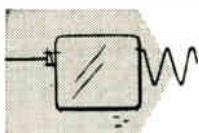
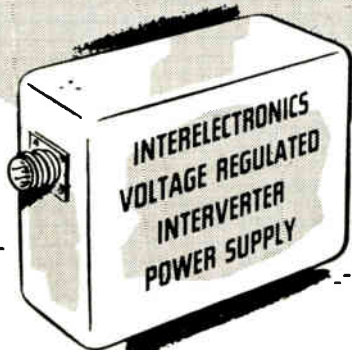
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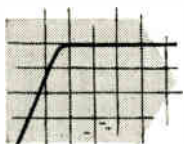
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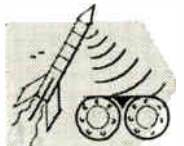
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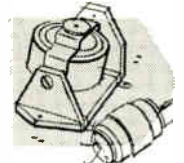
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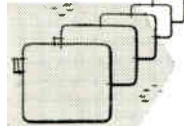
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## IEEE (Concluded)

ac power control. Its ability to perform bidirectional switching in response to small gate signals makes it a contender for present SCR uses. The paper, "The Triac-Gate-Controlled Silicon AC Switch," in Session 36, tells how the unit combines the function of a pair of SCR's in a single silicon wafer package.

Long range radio communications using orbiting dipoles as microwave scattering medium will be discussed in the "West Ford System Concept" at Session 41. Continuous global communications can be achieved with two rings of dipoles—one polar and one equatorial.

A new technique which allows interconnecting of integrated circuits with printed wiring will be presented at Session 46. The technique allows the use of conventional resistance welding equipment and does not require bending the module leads in flat or wafer packages.

If you aspire to go into management, you'll be very interested in "Engineers as Managers: Good or No Good?" According to some industrialists, engineers do not make good managers because they are 'thing-minded' rather than 'people-minded'. They say the engineers are too rigid in their thinking and too dependent on details for high-level decision making. For more on this subject, attend Session 59.

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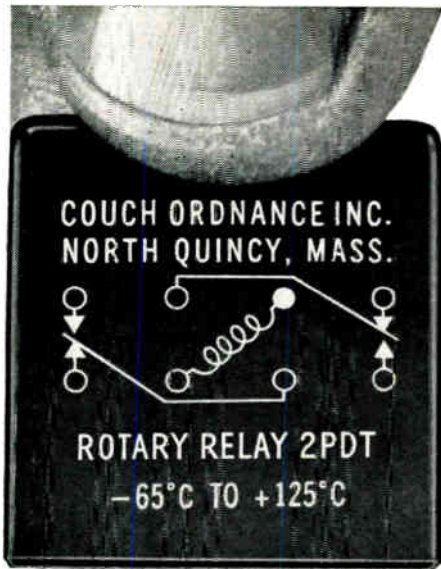
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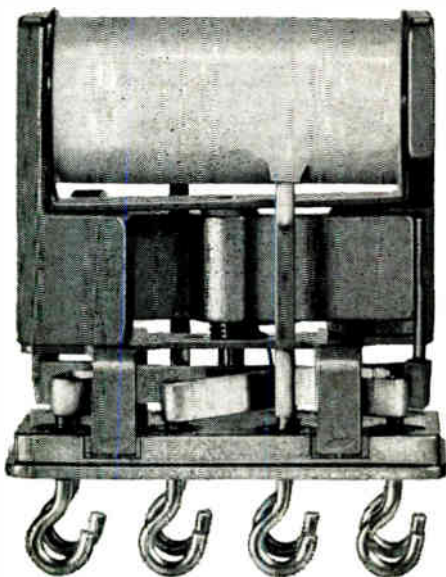
Lawrence, Mass. Dept. C-46

Circle 111 on Inquiry Card

ELECTRONIC INDUSTRIES • March 1964



**design simplicity**



**25<sub>mw</sub>  
sensitivity**

COIL RESISTANCE (@ 25°C).....6250 ohms ± 10%  
 MAXIMUM PULL-IN CURRENT.....2.0 ma DC  
 MINIMUM DROP-OUT CURRENT.....0.2 ma DC  
 NOMINAL OPERATING VOLTAGE.....26.5 VDC  
 CONTACTS 2 PDT (2 FORM C).....1.0 amp @ 30 VDC

Write for Data Sheet No. 8

RUGGED ROTARY RELAYS  Dynamically and Statically Balanced

**COUCH ORDNANCE INC.**

3 Arlington Street, North Quincy 71, Mass., Area Code 617,  
 CYPRESS 8-4147 • A subsidiary of S. H. COUCH COMPANY, INC.

Circle 125 on Inquiry Card  
 ELECTRONIC INDUSTRIES • March 1964

**'TYPEWRITER WITH A MEMORY'**



Honeywell's "versatile electronic console" developed to speed preparation, editing and updating of standard - format reports. The unit—"Report Composer"—is said to be suited for many uses in military and commercial fields. Shown is the input - output keyboard. The Composer also has paper tape reader and punch units, a page - printed display, all around a digital control system.

**FAA URGES TAPE RECORDERS FOR ALL COMMERCIAL CRAFT**

Proposed FAA rule would require cockpit voice recorders on all commercial airplanes by July 1, 1966. George S. Moore, Director of FAA's Flight Standards Service, said voice recorders would be a valuable tool in probing air mishaps.

Recorders would provide firsthand knowledge on flight crew talk during emergencies. This knowledge could lead to better flight safety through corrective action.

Recorders would run continuously. Talk would be picked up by open mikes or by headset boom-mounted mikes, depending on the plane and the noise level. The recording would have to stand an impact force of 100 G 1100°C, plus immersion in sea water for 48 hours.

The FAA now requires flight data recorders on all turbine-powered and other large commercial airplanes flying above 25,000 feet.

**TWA PIONEERS MAINTENANCE MONITORING**

A new and highly advanced system of airline maintenance, one which will monitor the vital systems of a jet airliner as often as ten times a minute, is being used by Trans World Airlines. Called the "Lockheed Maintenance Recording System," it furnishes, on magnetic tape, up to 315 "status reports" on the condition of the engines, instruments or complex systems of a jet aircraft every 6 sec.

**MIL specs place a**



**shields!**

The JAN-S-28A cancellation notice and revisions to general equipment specifications now require heat-dissipating electron tube shields.

Meet these specs with shields from IERC's complete line of MIL types.

**IERC** 

DIVISION

INTERNATIONAL ELECTRONIC RESEARCH CORPORATION

WRITE IERC Division, 135 West Magnolia Blvd., Burbank, Calif. for helpful digest of MIL spec references to tube shields — TODAY

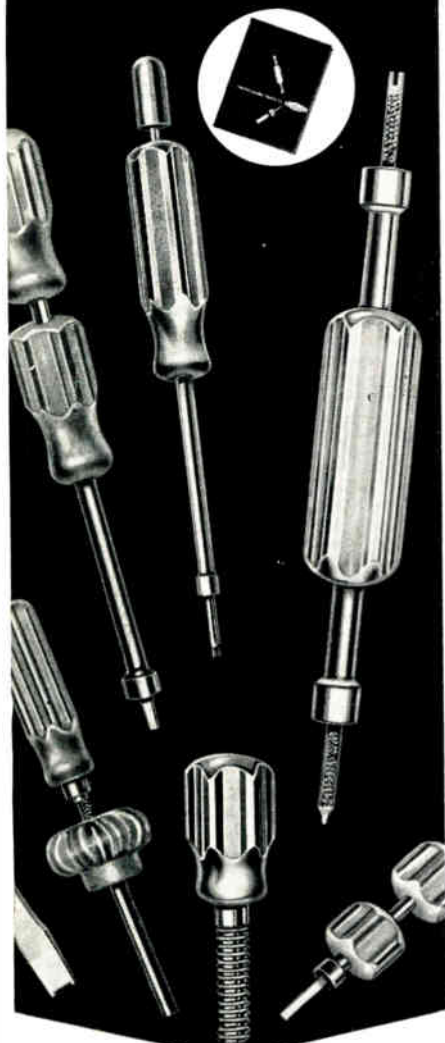
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# SPECIAL TOOLS FOR SPECIAL PROBLEMS

Odd as they look, these are actual production tools. They were manufactured by Xcelite to increase efficiency on special assembly work where conventional hand tools proved inadequate.

Chances are that "special function" tools can speed your production. Supply prints (model if available) of part on which tool will be used. Prototype designed and tooled for your approval. Any quantity . . . to meet your production schedule. Contact factory direct.

Complete information in new "Custom-made Tool" Brochure No. 660. Request on your letterhead.



## XCELITE

### INDUSTRIAL HAND TOOLS

XCELITE, INC. • 28 BANK ST., ORCHARD PARK, N. Y.

Circle 127 on Inquiry Card

190

## AUTO TEST SIMULATOR



Automotive engineers were introduced to systems and methods designed for testing vehicles using magnetic tape as the program source, at a meeting sponsored by Perfect Circle Corp. Electronics Division. Dr. Vern C. Vanderbilt (left), Division General Manager, explains HyTReSS (Hyway Test Recorder and Simulator System) a magnetic-tape program laboratory that simulates varied field tests.

## FLEA-POWER RADIO BUOYS SEND OCEAN DATA 600-MILES

ITT engineers announced success of some 280 tests in sending signals from flea-powered transmitters in radio equipped buoys anchored off Bermuda.

Operating at less than one watt, the buoyed radios transmitted oceanographic data over a 600-mile path to Southampton, New York. The buoys were turned on by a command signal from a station at the Oceanographic Institute at Woods Hole, Mass. They transmitted very-narrow band telemetry data on 6970 kc, under hf propagation conditions.

Working with the Institute, ITT engineers made tests in winter and summer. They found only small season variations in signal strength over the Bermuda-Long Island path.

Ronald H. Taplin, senior scientist at ITT, said that the buoys were designed by the Woods Hole Oceanographic Institute. The program is sponsored by the Office of Naval Research. They are equipped with very-low-power transmitters and batteries. They also contain special oceanographic data-sensing gear. The buoys may soon feed data directly into computers.

Data received covered size, course and depth of ocean currents. State of the sea, temperature, water salinity and weather are also data that can be collected from a network of ocean buoy data stations. They would serve weather research devices and mid-ocean radio beacons.



LDR-25

## AVAILABLE AT THESE DISTRIBUTORS

### EAST

Binghamton, N. Y.—Federal Electronics  
P. O. Box 208/PI 8-8211

Philadelphia 23, Penn.

Almo Industrial Electronics, Inc.  
412 North 6th Street/WA 2-5918

Pittsburgh 6, Penn.—Radio Parts Company, Inc.  
6401 Penn Avenue/EM 1-4600

Newton 58, Mass.—Greene-Shaw Co.  
341 Watertown Street/WO 9-8900

New York 36, N. Y.—Harvey Radio Company, Inc.  
103 West 43rd Street/JU 2-1500

Baltimore 1, Md.—Radio Electric Service Company  
5 North Howard Street/LE 9-3835

### SOUTH

Birmingham 5, Ala.—Forbes Distributing Company, Inc.  
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West Palm Beach, Fla.—Goddard, Inc.  
1309 North Dixie/TE 3-5701

Richmond 20, Va.—Meridian Electronics, Inc.  
1001 West Broad Street/353-6648

### MIDWEST

Detroit 3, Mich.—Glendale Electronic Supply Company  
12530 Hamilton Avenue/TU 3-1500

Minneapolis 16, Minn.—Admiral Distributors, Inc.  
5305 Cedar Lake Road, St. Louis Park/LI 5-8811

Indianapolis 25, Ind.—Graham Electronics Supply, Inc.  
122 South Senate Avenue/ME 4-8486

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Main Line Electronics Division  
777 Rockwell Avenue/EX 1-4944

Chicago 30, Ill.—Merquip Electronics, Inc.  
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Cincinnati 10, Ohio—United Radio, Inc.  
1308 Vine Street/CH 1-6530

Kansas City 11, Mo.—Walters Radio Supply, Inc.  
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St. Louis 44, Mo.—Electric Components for Industry Co., Inc.  
2605 Henley Road/MI 7-5505

### WEST

Dallas 1, Texas—Adleta Company  
1907 McKinney Ave./RI 1-3151

Houston 1, Texas—Harrison Equipment Company, Inc.  
1422 San Jacinto Street/CA 4-9131

San Diego 1, Calif.—Radio Parts Company  
Division of E.C.I., 2060 India Street/232-8951

Los Angeles 15, Cal.—Radio Products Sales, Inc.  
1501 South Hill Street/RI 8-1271

Los Angeles, Cal. 90022—Kierulff Electronics  
2585 Commerce Way/OV 5-5511

Mountain View, Cal.—Kierulff Electronics  
2484 Middlefield Road/968-6292

Denver, Colo.—L. B. Walker Radio Company  
300 Bryant Street/WE 5-2401

Seattle 1, Wash.—C & G Electronics Company  
2221-3rd Avenue/Main 4-4355

Albuquerque, N.M.—Midland Specialty Co., Inc.  
1712 Loma Blvd., N.E./247-2486

Phoenix, Ariz.—Midland Specialty Co., Inc.  
1930 North 22nd Ave./258-4531

Tucson, Ariz.—Midland Specialty Co., Inc.  
951 South Park Ave./MA 4-2315

Ask for a complete catalog

**DELCO**  
DEPENDABILITY  
**RADIO**  
RELIABILITY

Division of General Motors, Kokomo, Indiana

# new power photocell from Delco

## 25 watts

Here's a cadmium sulphide photocell with muscle. It's Delco Radio's new LDR-25—a light dependent resistor equipped to dissipate 25 watts at  $\frac{1}{2}$  ampere and with a 200 DC or peak AC voltage capability.\* Dark resistance

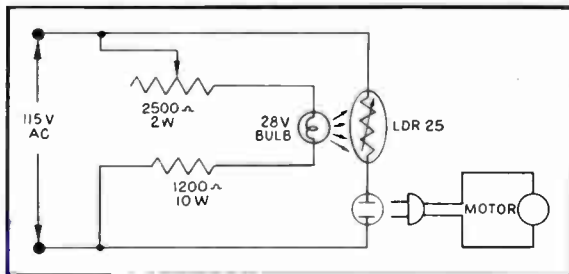


Actual Size

LDR-25

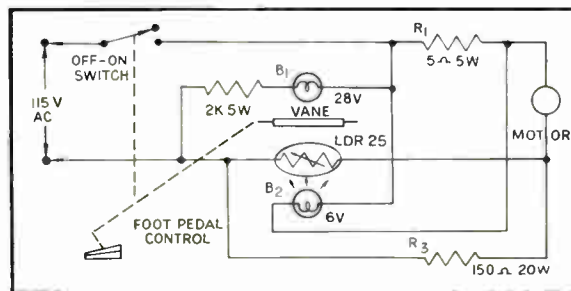
value of the device exceeds .5 megohm while 1,000 foot candles of illumination will reduce its resistance to 15 ohms.

Characteristics of the LDR-25 make it ideally suited for direct-to-line control of 115 VAC powered appliances. It can be used as a "variable relay" in series with an inductive load operating



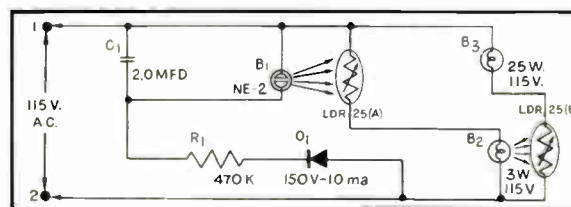
LDR-25 in series motor control using potentiometer controlled light source.

\*When properly mounted on heat sink.



LDR-25 in series control circuit using foot operated mechanical vane to regulate light—eliminates need for moving contacts. Dual light source provides feedback for constant motor speed under varying loads.

at power levels up to 100 watts. Its medium and high power switching abilities are ideal for inductive loads where voltage surge from breaker points or junction devices is a problem.



Flasher circuit in which chain of lamps and LDR-25s provide power amplification with a gain of 100.

The amazingly low-priced LDR-25 is available now.

Contact any of our sales offices listed below for more information.

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324 Chestnut Street  
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LPTon 0-8807  
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General Sales Office\*: 700 E. Firmin, Kokomo, Ind., Gladstone 2-8211—Ext. 500 • Area Code 317

\*Office includes field lab and resident engineer for applications assistance.

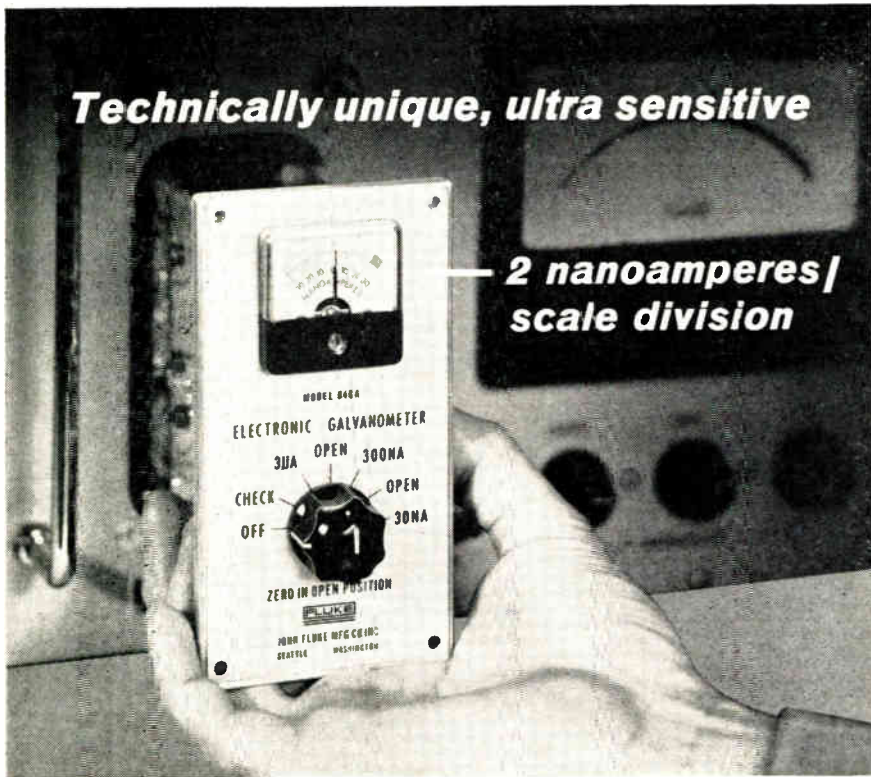
**DELCO**  
RADIO  
RELIABILITY

Division of General Motors, Kokomo, Indiana

SEE OUR EXHIBIT AT I.E.E.E. SHOW—BOOTHS 1522-1524

**Technically unique, ultra sensitive**

**— 2 nanoamperes / scale division**



## New FLUKE Model 840A ELECTRONIC GALVANOMETER

Model 840A is a solid state electronic galvanometer of unique design, with 2 nanoamperes per scale division sensitivity.

Operable in any position, the Model 840A has better than 50 times the power sensitivity of the most sensitive light-beam galvanometer it is designed to replace in OEM applications. Current overloads of more than 110 db on the most sensitive range cause no damage.

Separate mounting case, mercury battery kit, or AC power pack are optional accessories. The instrument has passed rugged environmental tests; mechanical design includes flow-soldered glass-epoxy PCB's. Convenient recorder output provides 100 mv DC full scale on all ranges.



### BRIEF SPECIFICATIONS

#### DC CURRENT SENSITIVITY:

- 30-0-30 nanoamperes, full scale (2 na/scale div.)
- 300-0-300 nanoamperes, full scale (20 na/scale div.)
- 3-0-3 microamperes, full scale (200 na/scale div.)

#### INPUT IMPEDANCE:

Approximately 150 ohms, all ranges

#### INPUT ISOLATION FROM CHASSIS:

Greater than  $10^9$  ohms (100V maximum potential between chassis and input)

#### TEMPERATURE RANGE:

Operating: 0° C to 50° C  
Storage: -40° C to 85° C

#### HUMIDITY:

0 to 90%

#### SIZE:

5 1/2" high x 3" wide x 4 3/4" behind panel

#### PRICE:

A84-1 metal instrument case	\$ 175.00
A84-2 mercury battery kit	\$ 20.00
A84-3 AC power pack	\$ 5.00
	\$ 25.00

*Prices and specifications subject to change without notice.*

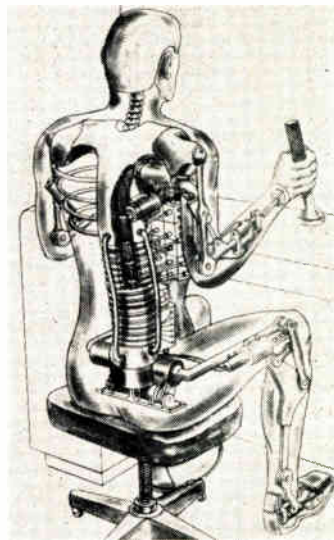
John Fluke Mfg. Co., Inc., Box 7428  
Seattle, Wash. 98133. Tel. 206-776-1171



• Send for complete specification data on Model 840A and new Catalog Digest 64A. Describes over 40 models of differential voltmeters, power supplies, voltage calibrators, micro-volt potentiometers and other Fluke precision test and measurement instruments. Lists nearest Fluke sales representative.



### MECHANICAL SPACEMEN



Robot astronauts being built by ITT Research Institute for NASA Manned Spacecraft Center to use in designing of space suits. Remote-controlled, robots will have actuators for muscles, servo valves as nervous systems, and mechanical joints, as shown in drawing. They will also grow or shrink to match the stature of the average man in U.S. military service.

### NEW AERIAL SCANNER SIGHTS GROUND TARGETS IN 3-D

A research mathematician at HRB-Singer, Inc., and two former officers of the firm, have developed an improved aerial reconnaissance stereo scanning unit.

Most current systems produce only a single image of an area or installation, limiting their value. The new system allows interpreters to view a scanned area in 3-D and recognize objects moving on the ground.

Part of the system is a pair of scanning faces which operate at oblique angles from the aircraft. As the recon plane flies over target, a rear scanning face scans the target previously covered by the forward face. The target is viewed from two different angles at different times.

Any movement of ground objects is easily detected.

### JOHN SODOLSKI HEADS EIA SYSTEMS REQUIREMENT UNIT

John Sodolski has been named staff manager of the Electronic Industries Association Systems Requirements Committee, EIA disclosed. Mr. Sodolski, 32, joined EIA in 1962 as military economist for the Committee.

The Committee is made up of marketing and planning officers of EIA-member firms. Committee provides defense-space industry with special marketing and planning data.

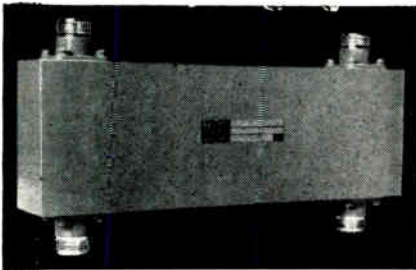
See it at the  
IEEE Show



Booth No. 1105

# A SINGLE 3db HYBRID COUPLER

COVERS A 5:1 BAND



NOW . . . FOR THE FIRST TIME . . . a single AEL model HCN, 100 Series, 3db HYBRID COUPLER can be used to cover an extremely wide band, and completely eliminates the need for additional intermediate couplers.

## SPECIFICATIONS

Model	Frequency band (Gc)	Coupling (db)	Directivity (db, min.)	VSWR (max.)
HCN101A	0.1—0.5	3±0.5	30	1.15
HCN102A	0.2—1.0	3±0.5	30	1.15
HCN103A	0.4—2.0	3±0.5	25	1.15
HCN104A	1.0—5.0	3±0.5	20	1.25

Maximum insertion loss—0.1 db. Phase difference at output—90° at all frequencies.

Let us consult with you on producing HYBRID COUPLERS for use in other bands than are listed above. Contact your AEL Product Sales Representative . . . or write directly to AEL, stating your requirements. Your inquiry will receive prompt attention!

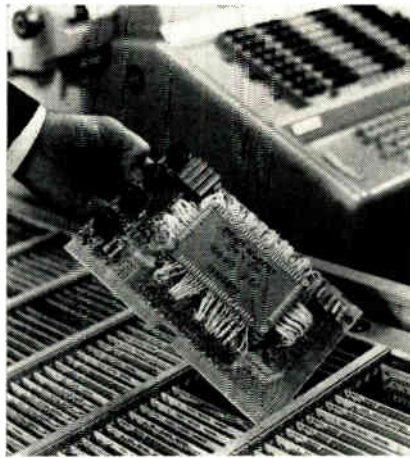


**American Electronic  
Laboratories, Inc.**

P. O. BOX 552C, LANSDALE, PENNA. 19446  
(215) 822-2929 Suburban Philadelphia

Circle 131 on Inquiry Card  
ELECTRONIC INDUSTRIES • March 1964

## COMPACT MEMORY



Electronic memory of the new Burroughs E2100 is in compact circuit unit. Tiny ferrite cores woven by intricate wiring provide capacity to store 100 words in low-cost computer's magnetic core memory. No internal memory is needed for programming storage.

## NEW BURROUGHS UNIT AIMED AT OFFICE MACHINE MARKET

A new EDP unit aimed at the broad middle range of the \$2½ billion-a-year business machine market was announced by Burroughs Corp.

The new unit is called E2100 Direct Accounting Computer. Priced under \$20,000, it is a general purpose unit designed for both "low end" data processing and for accounting machine uses, according to Ken T. Bement, vice president of marketing.

Features of five models presented include ability to read and write alphanumeric data on magnetic striped ledgers. There is a choice of punched card or punched paper tape output.

The E2100 comes with either 40 or 100 words of magnetic core internal memory, none of which is needed for program storage. All memory addresses may be chosen automatically or at random from keyboard.

## SOUTHERN RESEARCH GROUP FORMED IN MISSISSIPPI

Engineers and scientists from the University of Southern Mississippi have formed the South Mississippi Association for Research and Technology, it was disclosed by Dr. Charles Brent, executive secretary.

The Association, formed at Hattiesburg, Miss., in January, will make new product and process studies for firms in the Gulf Coast area. The group lists Ph.D's in mathematics, chemistry, physics, biology and geology. EDP programming and operations research are some capabilities.

## MUST SEE AT IEEE

Booths 3233-3235

**FLUKE** NEW MODEL  
831A

**MICROVOLT POTENTIOMETER**

Brings high accuracy, infinite input impedance to voltage measurement from 0.2 uv to 50 mv.



MEASURES MINUTE POTENTIALS

**FLUKE** SOLID STATE  
382A, 383A

**VOLTAGE CALIBRATORS**



Voltage calibration ± 0.01%  
Current calibration ± 0.02%

5 ppm LINE & LOAD REGULATION!

**FLUKE** NEW MODEL  
840A

**ELECTRONIC GALVANOMETER**



Unique solid state design.  
Sensitive to 2 na.  
Panel mount, or in  
5½" x 3" x 4¾" metal case.

TECHNICALLY UNIQUE, LOW COST

**FLUKE** NEW 50A, 60A  
MIL-SPEC

**DECADE POTENTIOMETERS**

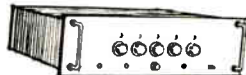
Now, linearity of ± 0.0025% available in Fluke precision decade pots, commercial and military!



PROVED IN PERFORMANCE

**FLUKE** MONTRONICS  
New 302-303

**FREQUENCY SYNTHESIZERS**



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Simplified design, improved performance.  
COST DOWN, PERFORMANCE UP

**FLUKE** Full line  
showing

**DIFFERENTIAL VOLTMETERS  
THERMAL CONVERTERS  
IMPEDANCE BRIDGE  
POWER SUPPLIES**

and other precision  
test and measurement instruments.

**FLUKE**

John Fluke Mfg. Co., Inc.  
Box 7428, Seattle, Wash. 98133

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# Adlake

**makes  
more kinds of  
mercury relays  
than anybody**



**Send  
for a  
free  
catalog.**

A recent addition to the Adlake line: the polarized bi-stable mercury wetted contact relay, pictured above, which delivers speeds up to 100 operations per second. Others include: time delay; load (contacts open or closed); wetted contact (including epoxy encapsulated and sensitive non-bridging).



**THE ADAMS &  
WESTLAKE COMPANY**

Elkhart, Indiana

Dept. P-8803 Relay Division  
Dial Area 219 COngress 4-1141  
Circle 133 on Inquiry Card

## BRITISH AIR CRASH MONITOR STANDS 1000 G IMPACTS

An aircraft accident data recorder has been developed in Britain. The recorder gives a monitored account of the last 15 minutes of flight on continuous loop. It can withstand impact shocks of 1000 G.

Designed to British Ministry of Aviation specs, the recorder will be installed on supersonic military aircraft. The recorder will be installed in all TSR 2, Britain's low-flying tactical strike reconnaissance plane.

Data is recorded on tape. Six channels are available for data fed through a signal multiplexer, one for speech and one for reference frequency.

## NEW UNIVAC PROGRAM MAKES TAPES TO RUN MACHINE TOOLS

A new program to prepare perforated tapes to machine metal parts was announced by UNIVAC.

The tapes used to direct numerically controlled machine tools may be prepared on the UNIVAC III System, the firm disclosed. The new program is expected to broaden the use for EDP-assisted machine tools throughout the U. S. and Europe.

Specifically Engineered for  
RF COMPONENTS

# Q-max

A-27 Superfine  
EXTREMELY LOW-LOSS  
RF LACQUER



Q-MAX impregnating and coating composition penetrates deeply, seals out moisture, provides a surface finish. Q-MAX imparts rigidity and promotes stability of the electrical constants of high frequency circuits. Effect on the "Q" of RF windings is negligible.

Write for catalog today.

## Q-max Corporation

MARLBORO, NEW JERSEY

Telephone: 462-3636 (Area Code 201)

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# Small... but, oh my!


## CEC's mighty miniature d-c amplifiers

These "famous four" from CEC are the most advanced, reliable miniature differential d-c amplifiers ever designed.


They easily withstand extreme acceleration, vibration and shock—yet provide outstanding stability, low output impedance, high input impedance and wideband frequency response. Plus... superior linearity and hysteresis effects, excellent isolation and common mode rejection.

As miniature, direct-coupled, true differential amplifiers, they are ideal for amplification of low-level signals in general radio telemetry equipment and airborne tape systems.


### 1-350 d-c Amplifier

 Input Impedance—1 megohm min. • Full Scale Output—±5 volts into 50,000-ohm load • Output Impedance—250 ohms max. • Output Isolation—100 megohms min. at 50v. d-c


### 3-351 Power Supply

 Full Scale Output—40-48 volts d-c, 10 ma max. • Excitation Voltage—Fixed 6.2v ±5% at 8 ma nom. • Regulation—±0.2% max. for ±2 volts, d-c to 400 cps • Isolation—100 meg min. at 50 volts d-c

### 1-360 d-c Amplifier

 Input Impedance—100,000 ohms ±10% • Full Scale Output—±5 volts into 50,000-ohm load • Output Impedance—50 ohms max. • Output Isolation—100 megohms min. at 50 v. d-c

### 1-363 d-c Amplifier

 Input Impedance—1 megohm min. • Full Scale Output—±5 volts into 50,000-ohm load • Output Impedance—250 ohms max. • Output Isolation—100 megohms min. at 50 v. d-c

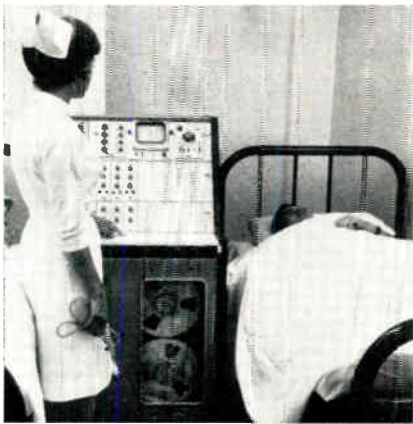
For all the facts, which we believe you'll find most impressive, call or write for Bulletins in CEC Kit 5034-X4.

**CEC**  
Transducer Division  
**CONSOLIDATED ELECTRODYNAMICS**  
A SUBSIDIARY OF BELL & HOWELL/PASADENA, CALIF. 91109  
INTERNATIONAL SUBSIDIARIES: WOKING, SURREY, ENGLAND  
AND FRANKFURT/MAIN, GERMANY

Circle 135 on Inquiry Card



## MOBILE MEDICAL RECORDER



A new 22-inch wide hospital version of AMPEX DAS-100 data acquisition system moves easily into hospital rooms and between beds. System has complete facilities for recording a wide range of physiological data for analysis by conventional or advanced methods. DAS-100 has magnetic tape transport, record/reproduce amplifiers, low-level pre-amps and input couplers plus an oscilloscope monitor. Simple master control panel controls calibration, record and reproduce, event marking, voice annotation functions.

## SUPERSONIC AIRLINER TO BE OWN 'NOTCH' RADIO ANTENNA

The new 1,500 mph Anglo-French supersonic airliner—the Concorde—set for service in 1967, will be its own antenna.

ITT disclosed the fact with Sud Aviation of Paris naming ITT's affiliate, Standard Telephones and Cables Ltd., of London, to do a study on a "notch" antenna system. The system would use the wings, tail, and 180-foot fuselage of the Mach 2 plane as a long-range antenna system.

STC's "notch" system has been used with success in the British Trident and Vanguard airliners and in military aircraft. "Notch" antennas are fitted below the skin of the craft and covered with glass fiber to restore skin contour and eliminate friction heat at supersonic speeds.

The design is expected to cover the whole high frequency band with a broad radiation pattern.

## ASTM FORMS NEW COMMITTEE TO SEEK DIELECTRIC TESTS

A sub-committee to aid in finding a standard test for dielectrics in new environments has been formed by the American Society for Testing and Materials (ASTM).

The Committee, designated D-9 Sub-Committee IV, will deal with problems in making electrical tests and measurements under space-like and cryogenic conditions.



# CHICAGO



# STANCOR

# Industrial Transformers



Booth 1216 - IEEE Show

Immediate availability from over 150 Authorized Stancor Industrial Distributors\*

\*With back-up stock in depth at Chicago, Dallas, Los Angeles, New York

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**ELECTRONIC MARKETING DIVISION  
ESSEX WIRE CORPORATION  
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### LOW COST PROPORTIONAL CONTROL OVEN



**JKO-44 Proportional Oven:**  
A compact, plug-in oven designed for use with both crystals and components requiring precise temperature control. Advanced circuit design, excellent performance at modest cost. Utilizes a thermistor sensing unit followed by a high gain DC amplifier. Ideal where switching action of a thermostat cannot be tolerated and where high stability is a must. For specification and performance data, write today.





**THE JAMES KNIGHTS COMPANY  
SANDWICH, ILLINOIS**

KEITHLEY

## MILLIOHMMETER

The Model 503 provides fast, accurate direct-readings from 10 micro-ohms to 1000 ohms. The measurement technique involves a four terminal ammeter-voltmeter method. By using an ac test current maximum power dissipation through the sample is 10 microwatts. Thus, the 503 is useful in dry-circuit testing of contact resistance and safe measurement of fuses and squibs.

- Range: 0.001 to 1000 ohms fs on linear scales with 13 overlapping ranges
- Accuracy: 1% of fs on all ranges
- Output: 100 millivolts
- Line Operated
- Max. Sample Dissipation: 10 microwatts
- Price: \$675

also available

MODEL 502 Milliohmmeter:  
Battery operated . . . \$390

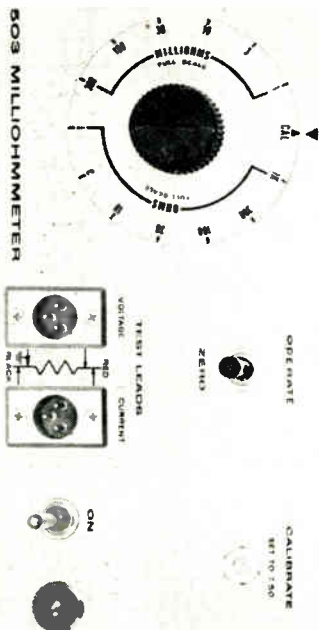
Send for catalog giving full details



KEITHLEY  
INSTRUMENTS

12415 Euclid Avenue • Cleveland 6, Ohio

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## XENON TUBE FLASH OUTPUT 650 TIMES BRIGHT AS SUN

A xenon flash tube producing light 650 times brighter than the sun for 1 msec. is operating at Marshall Space Flight Center in Huntsville, Ala.

The tube has an 11-turn helix of optically clear quartz 12 inches long with an inside diameter of three inches. It is believed to be the most powerful xenon flash tube in the world. It uses 240,000,000 watts for its 1/1000th sec. flash, the power needed to run a 60-watt bulb for one hour.

Robert J. Schwinghamer, research team leader, said that the tube will be used to supply needed light to "pump" a ruby rod in a powerful laser being built by the team. The laser rod is about a foot long and 3/4" wide.

The tube has been flashed a number of times, power increased for each "shot." When the entire 240,000-joule load from a bank of capacitors was dumped into the tube, the flash instantly bleached black paper white, a sharp report shook the building and the flash tube's wooden base was left charred and smoking.

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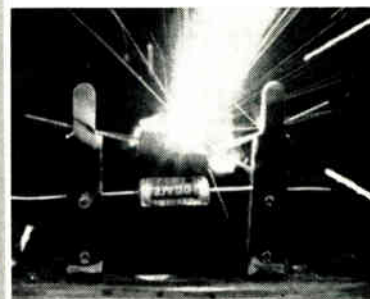
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# REVIEW AND FORECAST FOR THE ELECTRONIC INDUSTRY

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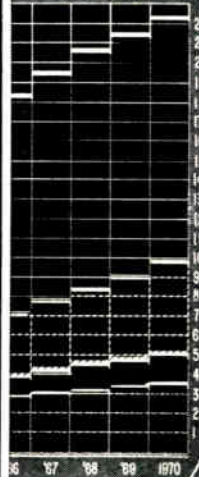
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## REVIEW AND FORECAST FOR THE ELECTRONIC INDUSTRY

Article appeared January 1964



From an estimated total output of \$15.3 billion in 1963, the electronic industry may rise to a total of \$22 billion or more by 1970. The industry's growth rate may begin to recede slightly as we near the end of the sixties, but there should be record sales years up to and beyond 1970.

**HARDLY MORE THAN A STRIPLING**, the electronic industry already ranks fifth among the nation's leading industries. Still another leading industry—aerospace—is also largely electronic.

Other front-rank industries are also supplied to a large extent by the electronic industry, including auto and chemical industries. There is, in fact, hardly an area of our industrial and national economy that has not been influenced in some way by the growth of electronics.

To be sure, the electronic industry is growing. But, there may be just a few less Federal dollars to go around as we go on toward the next decade. We may actually find a completely different market facing us by 1970.

### GENERAL MARKET ROUND-UP

Total electronic factory sales for 1963 have been charted at about \$15.3 billion. This figure includes everything in electronics from a Tiros antenna to a personal transistor radio.

We will see another record year in 1964, though perhaps a bit lower in growth rate. We can look for a record 16-billion-dollar-plus market in electronics by next Christmas. With some imagination, we can even look ahead and see a string of record years to and beyond 1970.

Still the biggest plunger of the electronic market is Uncle Sam. The Federal Government paid out about \$9.2 billion to industry for its electronic products in 1963. It

also spent nearly \$2 billion for electronic research and development (R&D).

Aside from anticipated cutbacks in defense spending, military and space contracts will continue as the major spending for electronic hardware in 1964. The figure for aerospace and defense, plus NASA and FAA, is expected to exceed \$10 billion this year. Of this figure, DOD may spend \$8.3 billion, and NASA \$1.6 billion.

U. S. industry itself took up about \$2.7 billion of our electronic market in 1963 to help lift the nation's gross national product (GNP) to nearly 600 billion. The industry market was mostly computers, industrial controls, and communications equipment throughout all industry.

Sales of industrial electronic products have by-passed consumer sales. The industry market should bring about \$3 billion for 1964, up about \$300 million over 1963. By far the largest share—70% to 80%—will continue to go into the pockets of computer makers.

While industry was buying its electronic systems, U. S. families from some 60,000,000 homes went out and bought about \$2.5 billion in TV sets, radios, phonographs,

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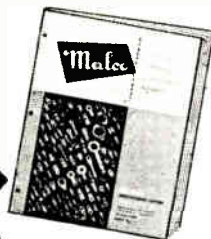


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**IEEE ELECTS 1964 OFFICERS**

Clarence H. Linder, a retired Vice President of General Electric Co., has been elected President of the Institute of Electric and Electronic Engineers (IEEE), reports the Institute's Board of Directors. Mr. Linder is former President of the American Institute of Electrical Engineers (AIEE) merged last year with Institute of Radio Engineers (IRE) to form IEEE.

Among 26 other officers elected for IEEE office in 1964 was Walter E. Peterson, President of Automation Development Corp., who was elected Vice President.




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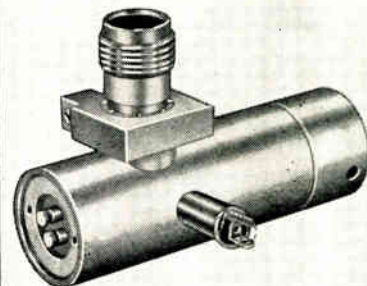
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RISE TIME: 16 nanoseconds.  
DUTY CYCLE: .005.  
**PLATE PULSE SERVICE**  
PART NO: 9170-1018.  
POWER OUTPUT: 25 watts minimum from 8.5-9.4 Gc; 10 watts minimum from 9.4 to 9.6 Gc.  
POWER INPUT REQUIREMENT: Modulator 1200 V @ .6a peak nominal; fil. 6.3 V @ .3a nominal.  
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RISE TIME: 25 nanoseconds.  
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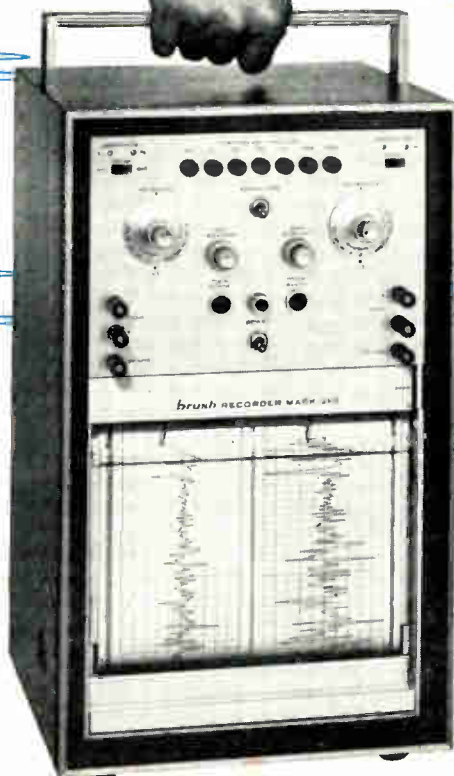
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40mm

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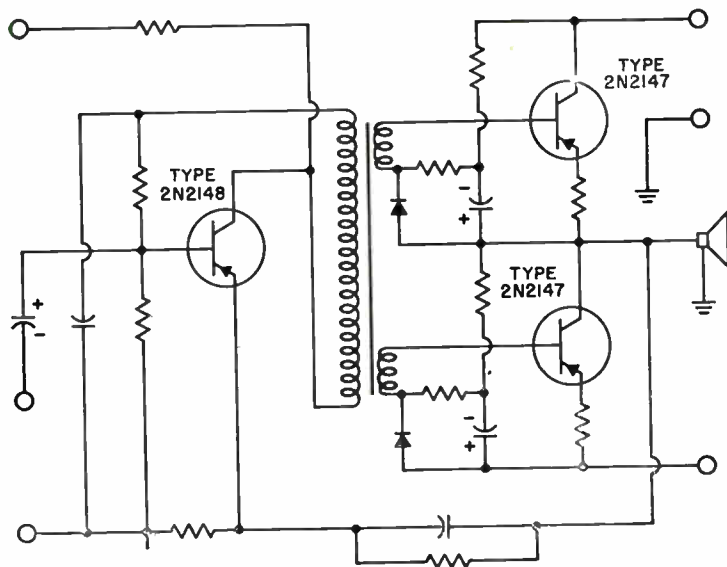
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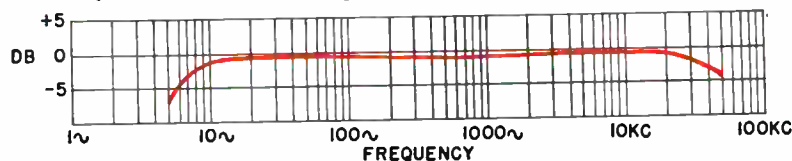


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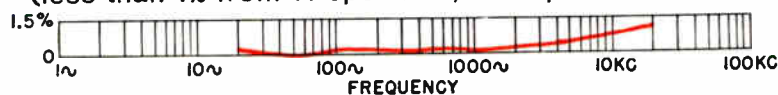
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