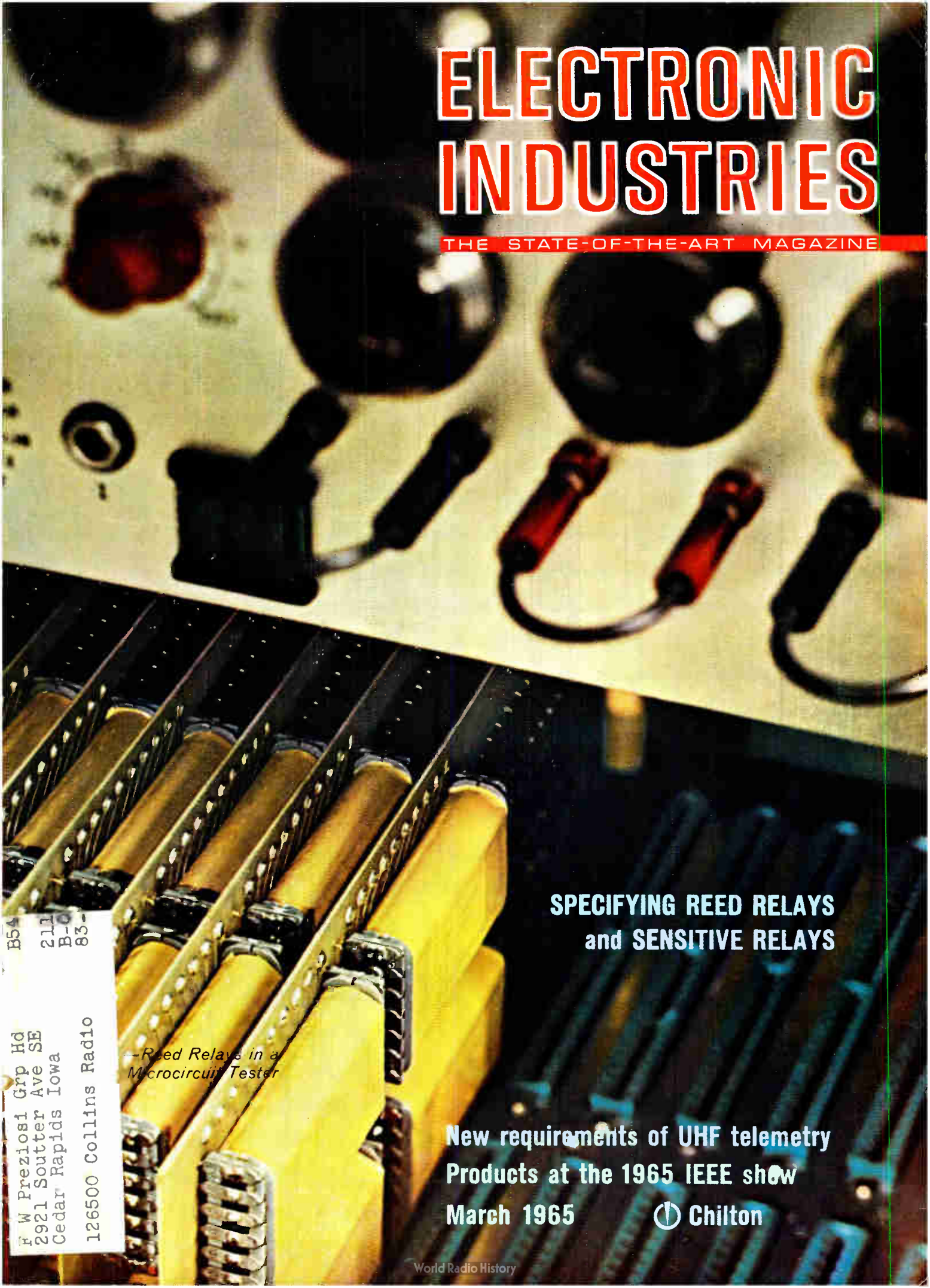
ELECTRONIC INDUSTRIES

THE STATE-OF-THE-ART MAGAZINE



SPECIFYING REED RELAYS and SENSITIVE RELAYS

—Reed Relays in a Microcircuit Tester

New requirements of UHF telemetry

Products at the 1965 IEEE show

March 1965

Chilton

AUDIO TRANSFORMERS

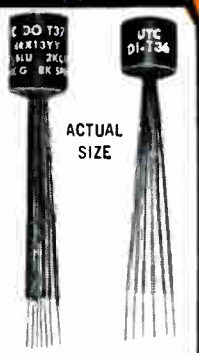
DO-T No.	Pri. Imp.	D.C. Ma.‡ in Pri.	Sec. Imp.	Pri. Res. DO-T	Pri. Res. DI-T	Mw Level	DI-T No.
DO-T44	80 CT 100 CT	12 10	32 split 40 split	9.8	11.5	500	DI-T44*
DO-T29	120 CT 150 CT	10 10	3.2 4	10		500	
DO-T12	150 CT 200 CT	10 10	12 15	11		500	
DO-T13	300 CT 400 CT	7 7	12 16	20		500	
DO-T19	300 CT	7	600	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	DT-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 useage (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. → *Units newly added to series

§Series connected; §§Parallel connected

UTC

PIONEERS IN MINIATURIZATION



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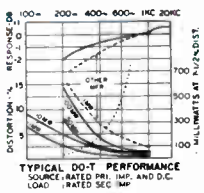

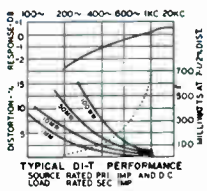

High Power Rating	up to 10 times greater
Excellent Response	twice as good at low end
Low Distortion	reduced 80%
High Efficiency	up to 30% better . . . compare DCR
Moisture Proof	hermetically sealed to MIL-T-27B
Rugged	Grade 4, completely metal cased
Anchored Leads	will withstand 10 pound pull test
Printed Circuit Use	(solder melting) nylon insulated leads
Suited to Clip Mounting	use Augat #6009-8A clip

INDUCTORS

DO-T No.	Inductance Hys @ ma	DO-T DCRΩ	DI-T DCRΩ	DI-T No.
*DO-T50 (2 wdgs.)	§.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	25		
	.1 Hy/4 ma, .08 Hy/10 ma		25	DI-T28
DO-T27	1.25 Hys/2 ma, .5 Hy/11 ma	100		
	.9 Hy/2 ma, .5 Hy/6 ma		105	DI-T27
DO-T8	3.5 Hys/2 ma, 1 Hy/5 ma	560		
	2.5 Hys/2 ma, .9 Hy/4 ma		630	DI-T8
DO-T26	6 Hys/2 ma, 1.5 Hys/5 ma	2100		
	4.5 Hys/2 ma, 1.2 Hys/4 ma		2300	DI-T26
*DO-T49 (2 wdgs.)	§20 Hys, 1 ma, 8 Hys/3 ma §§5 Hys/2 ma, 2 Hys/6 ma	5100 1275		

POWER TRANSFORMERS

*DO-T400	Pri 28V 380-1000 cycles, Sec 6.3V @ 60 ma
*DO-T410	Pri 28V 380-1000 cycles, 2-Sec 6.3 @ 30 ma each
*DO-T420	Pri 28V 380-1000 cycles, Sec 28V @ 20 ma (Isol. Electrostatic Shld.)

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ELECTRONIC INDUSTRIES
The STATE-OF-THE-ART Magazine

Electronic Engineering Profile-1965

In our March 1959 issue we published our first "Profile of Today's Electronic Engineer." This information was extremely valuable to the industry at large because it was the first time that any magazine had developed such data. This report included engineering income by age groups, experience, education and geographical location. Other data covered family status, car ownership, insurance and net worth.

As editors, the data was especially important to us because it gave us guidelines on which to develop the most significant and interesting editorial material for our readers.

Three years later, in our March 1962 issue, we updated and supplemented this information. Another three years have passed, and we are now preparing a new electronic engineering profile. We earnestly solicit your cooperation.

We all know that during the past two years our industry has undergone considerable change. There has been a shift in government procurement objectives. As a result, there have been notable cutbacks in electronic hardware production. Research and development activities are expanding. New programs emphasize higher reliability as well as cost reduction.

With the rapid onrush of integrated solid-state circuitry, the role of the circuit design engineer will be altered considerably.

There is now a noticeable effort on the part of many manufacturers to diversify their activities. Some are developing new products for commercial-industrial markets. Others are entering into merger or acquisition agreements. Component suppliers may turn to systems development work. For the electronic engineer this can bring reassignment or relocation.

Rapid technological changes are forcing the engineer to continue his education in order to avoid obsolescence.

As editors, and being aware of these changes, we are naturally concerned with the effects that you, our reader, have personally experienced. Our questionnaire for the Electronic Engineering Profile-1965 has been especially designed to take these changing times into consideration. It is included in this issue on page 145. We ask that you review it, fill it out, and send it back to us. Your return will be completely anonymous except for the geographical location information requested in question 36. This we need in order to develop a true national statistical sample.

You will note in some cases the questions are number coded. These are only to facilitate future computer processing. There are no "right" or "wrong" answers. Other questions give you an opportunity to express your own opinion. Perhaps question 37 is the most important part of this questionnaire. Your comments here will enable us to know more about your problems and assist us to be effective as your spokesman to the industry. If you need more space please attach additional sheets.

For those who plan to attend the IEEE International Convention in New York City this month, our booth number is 4201-4203. ALL ELECTRONIC INDUSTRIES' editors will be there. We would like to discuss any or all of these industry conditions with you personally.

For our "pass-along" readers we will have additional questionnaires available at our booth. For those who cannot attend and who wish to participate, simply send us a postcard with your name and address along with the words Electronic Engineering Profile-1965. A questionnaire will be forwarded you by return mail.

Through your cooperation we can develop interesting and meaningful data of mutual benefit. We can determine the effect of these new developments on our industry. We plan to review and analyze your questionnaire as it is received and to publish compiled results in our "State-of-the-Art Reference Issue" next June. Many thanks for your help!

Bernard F. Osbahr

New from Sprague!

For extreme size reduction and unusual capacitance stability . . .

FILMITE® 'K' POLYCARBONATE FILM CAPACITORS

- New Filmite 'K' Polycarbonate Film Capacitors are *more than 13 times smaller than paper capacitors of equivalent capacitance value and voltage rating!*
- Polycarbonate film dielectric provides exceptionally high capacitance stability over the entire temperature range, due to inherently low coefficient of expansion of polycarbonate film and a dielectric constant which is nearly independent of temperature.
- Filmite 'K' Capacitors exhibit almost no capacitance change with temperature—dramatically better than polyester-film types, they even surpass polystyrene capacitors.
- Low dissipation factor (high *Q*) makes these capacitors extremely desirable where high current capabilities are required, as in SCR commutating capacitor applications.
- Low dielectric absorption (considerably lower than that of many other commonly-used film dielectrics) over a broad frequency/temperature spectrum makes Filmite 'K' Capacitors ideal for timing and integrating.
- Extremely high insulation resistance, especially at higher temperatures. Superior to many other commonly-used film dielectrics.
- Close capacitance tolerances—available to ±0.25%!
- Filmite 'K' Capacitors are excellent for critical applications including tuned circuits, analog and digital computers, precision timing and integrating circuits because of the unusual properties of the polycarbonate film dielectric.

Type 260P *Filmite 'K' Capacitors are metallized, utilizing non-inductive construction. They feature special self-healing characteristics, in the rare event of capacitor dielectric breakdown. Designed for operation at full rated voltage over the temperature range of −55 C to +105 C, these metal-clad capacitors are hermetically-sealed and are available with both standard and weldable wire leads or solder tabs in a variety of mounting styles.*

Types 237P and 238P *Filmite 'K' Capacitors are of high-purity foil construction, and are hermetically sealed in metal cases. Operating temp. range, −55 C to +125 C.*

For complete technical data on Type 260P and on Type 237P and 238P Capacitors, write for Engineering Bulletins 2705 and 2700, respectively, to Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

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March 1965, Vol. 24, No. 3

ELECTRONIC INDUSTRIES

The STATE-OF-THE-ART* Magazine

COVER

A typical application of reed relays is in automatic test equipment. Here we show Clare Reed Relays being used in the Philco Automatic Circuit Tester (PACT) which checks out integrated circuit wafers at Philco's Lansdale, Pennsylvania microelectronic manufacturing plant. For more on PACT, see page 107. For more on reed relays, see "1965 Survey of Reed Relays & Sensitive Relays" on page 40.

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

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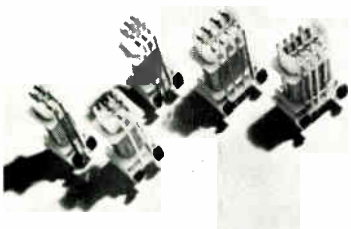
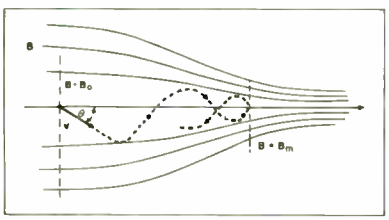
ELECTRONIC INDUSTRIES

HIGHLIGHTS

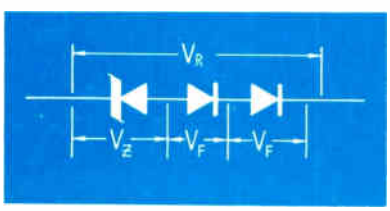


Relay Specifications

I.E.E.E. Show and Convention

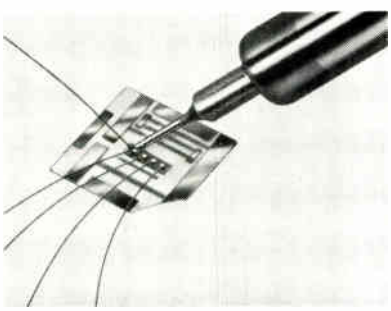


Understanding Plasma



Silicon Reference Elements

Solder Alloys



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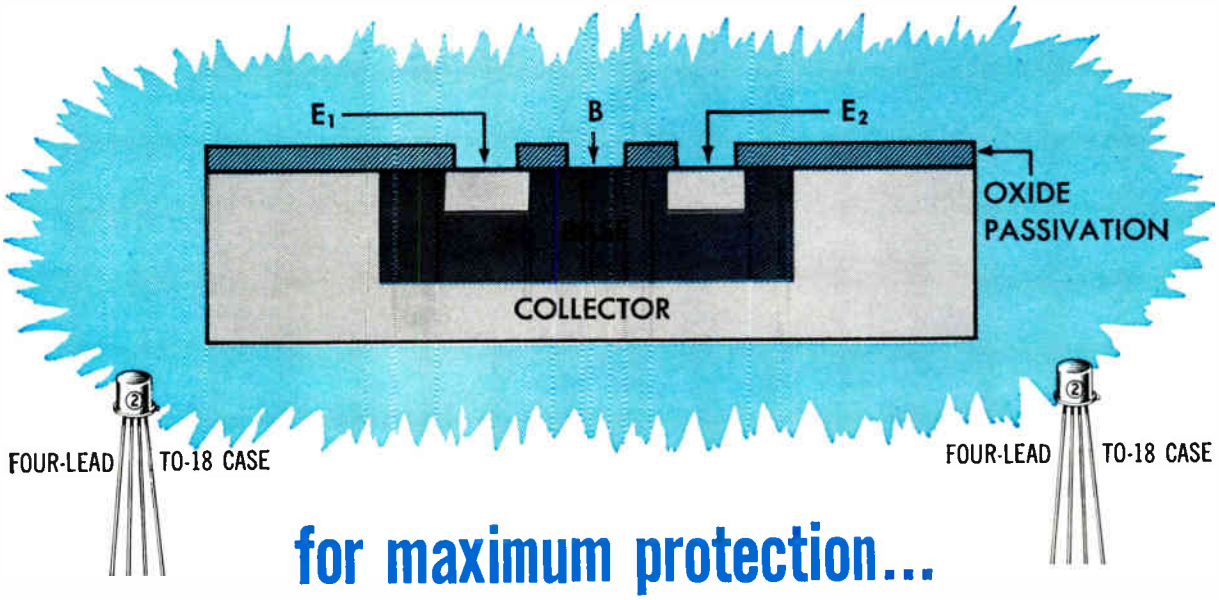
New from Sprague!

DUET* 50-VOLT DUAL-EMITTER CHOPPER TRANSISTORS



for maximum protection...
3 times the emitter voltage previously available!

COMPARE THESE PARAMETERS WITH THOSE OF ANY OTHER DUAL-EMITTER!

Type No.	BV_{EEO}	I_{EEO}	V_O
3N93	50V	1nA	50μV
3N94	50V	1nA	100μV
3N95	50V	1nA	200μV
3N90	30V	1nA	50μV
3N91	30V	1nA	100μV
3N92	30V	1nA	200μV

*Trademark

Sprague DUET* low level dual-emitter choppers are fully passivated PNP silicon planar epitaxial transistors. They feature guaranteed emitter voltage of up to 50 volts, three times the emitter voltage previously available.

The Sprague DUET* is ideally suited for applications such as low-level chopping, multiplexing, commutating, etc., where low leakage current, low saturation resistance, and close matching are required. The DUET* is a product of Sprague's extensive research effort in silicon planar epitaxial and silicon based microcircuit technology.

The high emitter voltage ratings mean circuit design simplification, improved circuit reliability, and reduction in the number of components required. When designing chopping circuits where maximum voltage is required, do it with DUET*.

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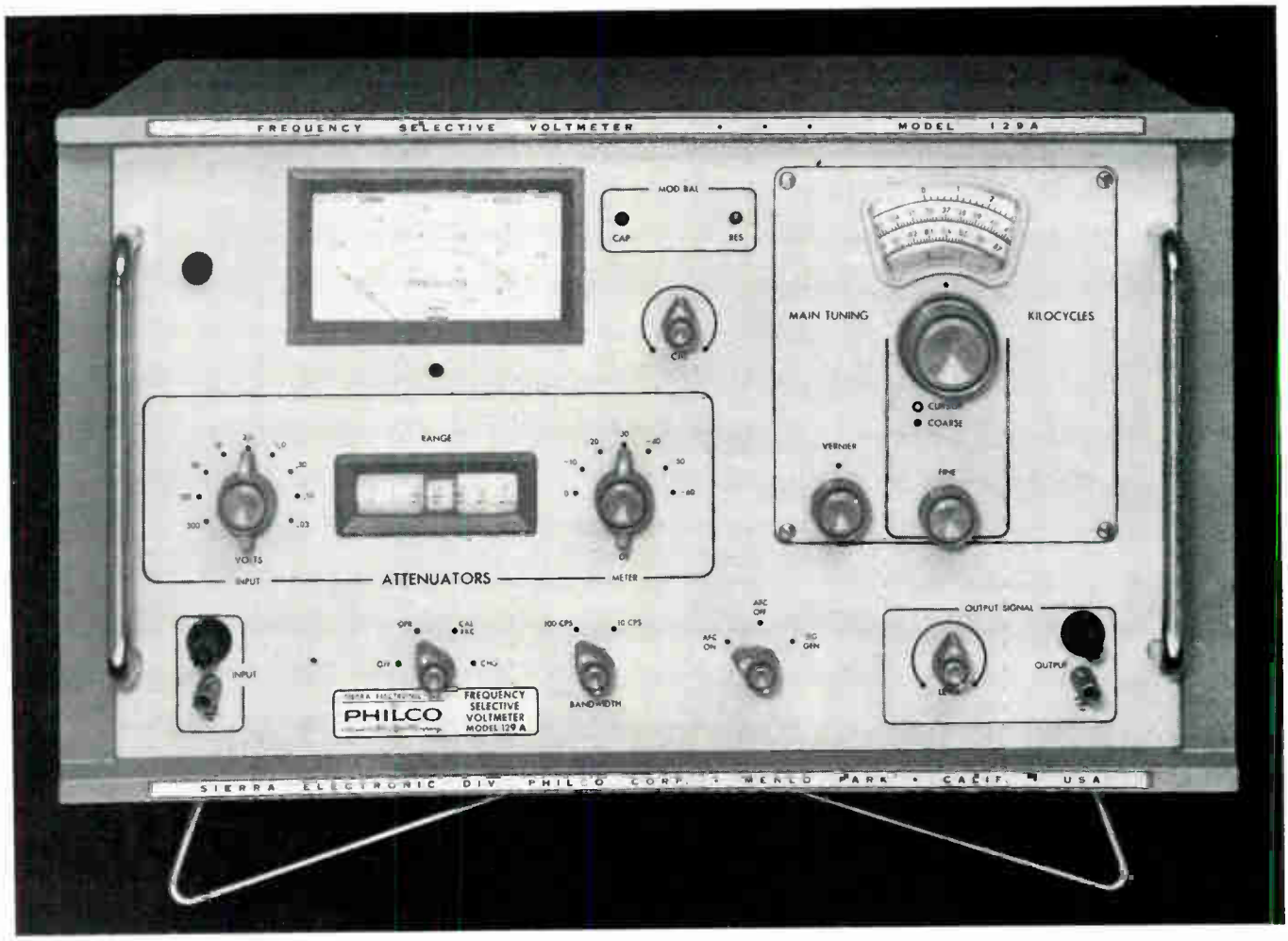
Sierra's 129A



10 cps to 100 kc Wave Analyzer

The Sierra 129A low frequency wave analyzer provides excellent stability at all frequencies from 10 cps to 100 kc. In addition, it can be used as a signal generator or tunable voltmeter.

This wide range low frequency wave analyzer features: Wide AFC (±300 cps) . . . restored signal output at identical frequency to input signal . . . extremely close tracking . . . excellent IF rejection characteristics. Input sensitivity is from —110 to +32 dbm referred to a 600Ω system. A unique benefit of the 129A is that it operates on either 110V or up to six hours on its rechargeable built-in power source.

Whether you figure on total cost or cost per band, the Sierra Model 129A Wave Analyzer is your best buy. Price: $1,675.00.

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Voltmeters/Wave Analyzers/Signal Generators/ Transistor Testers/Fault Locators/Power Monitors/Power Sources/Calorimeters/Loads/ Couplers/Power Amplifiers

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ELECTRONIC INDUSTRIES RADARSCOPE

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

AIR TRAFFIC CONTROL

Eight of these new Alpha Numeric Simulation Display Systems will be used by the FAA to study methods of controlling dense air traffic. As many as 60 aircraft can be superimposed on this 400 sq. mi. airway map. Specific map sections can be enlarged and unwanted information erased in this Radiation, Inc., system.

FUEL CELLS operating directly from powdered coal are being developed by Westinghouse researchers. An experimental 100 watt unit was demonstrated. It consists of a fuel cell battery having 400 thimble-sized cells, plus a chemical reactor for producing volatile gases from the coal. Reactor and battery operate at 1800°F. Ceramic electrolyte in the cells does away with liquids and paste-type chemicals normally used. Output was 100 volts at 1 ampere.

SENSING THE MASS of an object at a distance is the basis of a contract awarded to Hughes Aircraft Co. by NASA. The sensor will consist of an aluminum cruciform about 5 inches in diameter that rotates within a vacuum chamber. When the sensor is rotated within the gravitational field of an object, the pull on the ends of the cruciform varies with the change in position caused by rotation. This sets up vibrational modes that can be read by sensitive piezoelectric strain transducers, and measured in terms of the object's mass.

BETTER LASER MATERIALS are the subject of a research project at General Precision's Aerospace Research Center. The work is concerned with the influence of chemical environment on the fluorescence or light emitting of the atoms of rare earth compounds. Large increases in the light intensity emitted from europium, terbium, and samarium have been noted as a result of varying the molecules and chemical groups immediately surrounding the rare earth atom.

MICROCIRCUIT containing 576 light-emitting diodes on a single chip of silicon has been developed by Fairchild Semiconductor's scientists. The silicon rectangle is 5/8 inch on its longest size. There are 32 rows of 18 diodes. The diodes can be flashed on one at a time or in various combinations. While the light emitted can be seen by the unaided eye in a dimly lighted room, the main purpose is to expose film. The first application will be in a photographic reconnaissance camera system. Many other applications are possible.

FAILURE MECHANISMS at metal-dielectric interfaces have been studied by Motorola's Semiconductor Products Div. Research shows thermal or electrical stress may induce diffusion of electrode metal into the dielectric material of a thin-film capacitor. This can alter resistivity and other electrical and physical properties, hence leading to high leakage or complete failure. Details are contained in AD 609 066N, price $3.00, available from Clearinghouse for Federal Scientific and Technical Information (formerly OTS).

HIGH TEMPERATURE BATTERIES can operate at 250°F. without affecting their operation. Developed by Astropower Labs., Douglas Aircraft Co., they can operate for months in high temperatures. Batteries have special inorganic separators between silver and zinc electrodes. Separators resist swelling and other deformation from high heat. Batteries can be recharged many times more than current silver-zinc models. They can be recharged by solar energy.

SYSTEMS ELECTROMAGNETIC COMPATIBILITY is a critical problem coming under sharp focus. The basic approach to a solution lies in the adoption of an adequate systems point of view, recognition of the differences between intra-system and inter-system compatibility problems, and an understanding of the basic scientific principles involved. A two-week seminar covering this will be given in June by the Moore School of E. E., University of Pennsylvania.

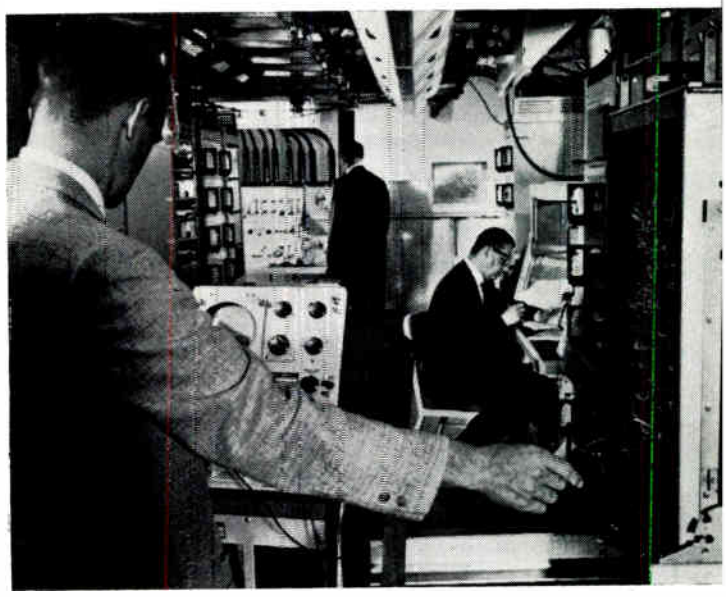
MICROWAVE POWER TUBES have been improved by Litton Industries Research Dept. Noise figure has been cut to one-third by using a low diocotron gain factor within the electron beam and a special "noise transformer" electrode in the electron gun. The results are most significant in crossed-field amplifiers. But, gains will occur in other types also.

SAFER JET takeoffs and landings has been the subject of a computer simulation program conducted by Battelle Memorial Institute. The findings lead to an advanced control system providing predictive information to the pilot. The system can be built from existing instruments.

MAGNETIC TAPE can now withstand up to 600°F for prolonged periods of time. The tape has a magnetic coating over a non-magnetic stainless steel substrate. Also, because of its packing density, twice as much information can be stored in a given area as on current tapes. The tape was developed by Whittaker's Narmco R & D Div. in San Diego.

TEST PACKAGE

Ion engine ballistic flight test package is adjusted by Jack Davis, Propulsion Systems Mgr. at Electro-Optical Systems, Inc., Pasadena. The Air Force recently flew such an engine successfully for the second time. The candidate for the job of propelling future space vehicles is about 5½ in. in dia. and 8 in. long.



MISSILE CONTROL

Targeting and firing of the Air Force's Minuteman ICBM is being simulated by Sylvania Electric Products Inc., Waltham, Mass. Here, engineers check elements of the company's advanced ground electronics system which assures that the missiles are poised at the ready and, when necessary, fires them.

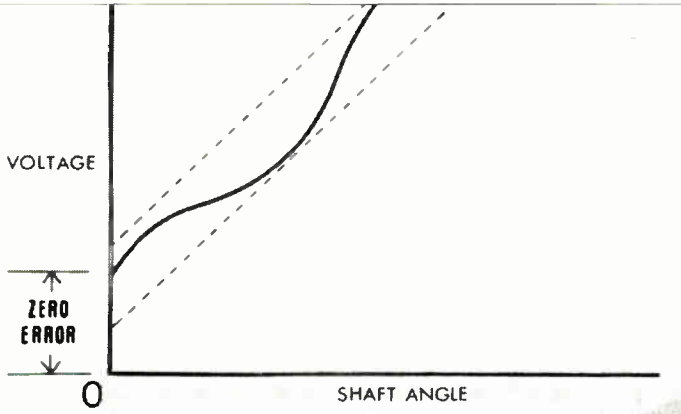
FREQUENCY MULTIPLIER CIRCUIT that multiplies three, four, five, seven or more times is the basis of a patent received by TRW Space Technology Labs. The Kaufman "idler circuit," along with semiconductor frequency multiplier systems, replaces methods using klystrons and TWTs for generating signals up to 30KMC. It has applications in uhf and microwave regions. Complete information is available to prospective licensees.

TITANIUM CARBIDE wears better than tungsten carbide in the manufacture of parts for receiving and color TV tubes. The new material, developed by Adamas Carbide Corp., lasts at least six times longer in its use as a wear part.

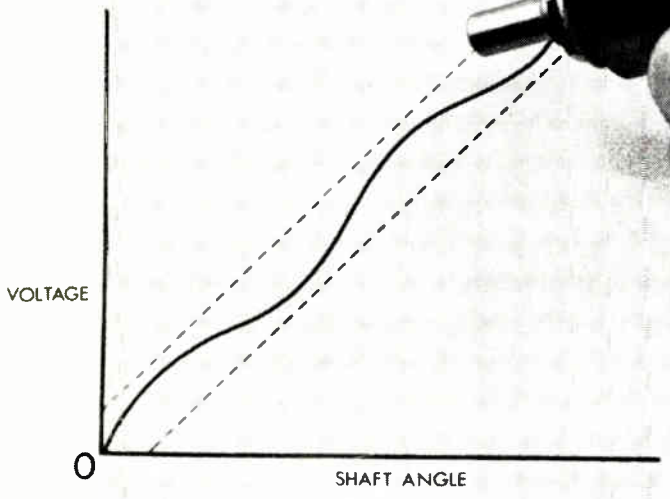
DEVELOPMENT WORK is under way at Melpar to make a package to reveal if there is any life on Mars. The system will be used on the Voyager flight in 1971. By passing a beam of polarized ultraviolet light through a solution in which a sample of Mars soil has been dissolved, it is hope to learn if "life" does exist. Life could mean just the lowest form of plant life.

COLOR PICTURE TUBE sizes are starting to become as varied as black and white tubes. Starting out with a round 21 inch tube, we now have a 25 inch rectangular tube, with work being done on 19 and 16 inch sizes. Foreign competition is working on a 12 inch tube, with a 9 inch tube to follow. U. S. companies are rapidly expanding facilities to meet the demand for color tubes.

(MORE RADARSCOPE on Page 11)



INDEPENDENT LINEARITY



ZERO-BASED LINEARITY

A new pot with .15% zero-based linearity for only $7

This new Amphenol 7/8″ pot costs less than other brands with only ±0.25% independent linearity. (As little as $7 in production quantities.) Yet our new 2170 potentiometer comes to you precalibrated from the factory with ±0.15% zero-based linearity.

ZERO-BASED POTS CUT PRODUCTION COSTS. As you can see in the chart, a pot with just independent linearity actually gives an output signal even when it is in the zero-stop position. This condition is called zero-error. It means your production people may be spending needless time and money to phase in electrical zero or buck out residual voltage—extra expense in calibration time, trimmers, and resistors that adds up to more than the *price* of the Amphenol 2170!

AMPHENOL EXCLUSIVE EXTRAS. The 2170 also gives you other hidden advantages you won't find anywhere else. For example: ZERO BACKLASH. The wiper drive mechanism is especially designed to hold precise, repeat settings. WELDED TERMINATIONS. Strap terminations to the resistance element and lugs are all solidly welded. Absolutely no delicate, heat-sensitive wire connections. LONG LIFE. Guaranteed for 2,000,000 revolutions rotational life—up to 100% more than many competitive models.

CHOOSE FROM 33 POTS. The 2170 is just one example of the better buys you can get from Amphenol in military, industrial or commercial pots. We make pots by the hundreds-of-thousands. All shapes, all styles. That's why our prices are lower. So call your Amphenol Sales Engineer or distributor today for the best potentiometer values. Or write us in Janesville, Wisconsin.

Circle 5 on Inquiry Card

Amphenol® CONTROLS DIVISION

AMPHENOL-BORG ELECTRONICS CORPORATION

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

RADARSCOPE

A LASER SYSTEM that produces smooth, rectangular-wave signals, variable in duration from 2 to 50 μsecs., has been announced by Westinghouse Electric Corp. The new high-power system has a minimum power of 20 joules which can be raised to 44 joules. At 44 joules, however, there is a slight degradation of the output pulse. A new type of electro-optical oscillator and an improvement in laser amplification made possible the new system. The oscillator produces a pulse that has no "spike" but rather a smooth, rectangular waveform.

COMPRESSIVELY - STRESSED RHODIUM that stays that way has been made for printed circuits and other uses where thick deposits are needed for high corrosion resistance. Rhodium X-Less has been developed by Technic, Inc., Providence, R. I.

CRYSTAL STANDARDS have been adopted for NATO use. All equipment using frequency control crystals must contain only those listed in STANAG No. 4032. The U. S. Armed Forces will observe this standard as much as possible.

THYRISTORS for power control is a feature of 20 silicon rectifier locomotives recently ordered by the Swedish State Railways. Purchased from ASEA (Vasteras, Sweden), the locomotives will follow a new ASEA principle—the electrical equipment will be installed as fully assembled units. Total value of the contract, which includes an option to purchase 40 more locomotives, exceeds $20,000,000. ASEA subsidiaries in the U.S. are ASEA Electric, Inc., Armonk, N.Y., and STAL-LAVAL, Inc., New York, N.Y.

Wear this glorious medal

Everybody craves recognition . . . you do, and so do we. So let's help each other. We're asking you to display a certain kind of engineering courage that is the mark of a Crusading Engineer. In return we'll award you this glorious medal with our deepest and sincerest appreciation.

Here's our problem. We've got a line of electronic counters that, by spec and performance, are better buys than anything Beckman or Hewlett-Packard make. We just figured that would automatically get us the big share of the business. We were wrong. Oh, we're doing all right (an easy third in sales) but we haven't exactly pushed those other two big companies into complete bankruptcy.

We don't want your sympathy . . . just a bit of recognition. Sure, we know it takes a little extra courage to consider CMC when there are those two other "big name" brands around. So all we ask is that you have the guts to compare our specs and performance against those other guys'. If you do, there's a good chance you'll see why we honestly believe we make the world's best counters . . . and maybe next time you need a counter you'll buy a CMC counter.

CMC

To honor your courage we'll decorate you with this Crusading Engineers' medal to bolster your morale during battle. If more men follow your lead, soon it won't take courage to recommend CMC . . . it'll take courage **not** to.

Now that you know we exist, keep your eyes and ears open. As one of the "hottest" young electronics outfits in the business we're making big plans. We are going to compete with high-powered H-P and big, bad Beckman right up and down their full line. But that's news for later.

Right now, act! Join the crusade. Write for our stimulating technical catalog and earn your medal. Just think how proud your kids will be.

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COMPUTER MEASUREMENTS COMPANY IS A LEADING DESIGNER AND MANUFACTURER OF ELECTRONIC INSTRUMENTATION TO COUNT, MEASURE, AND CONTROL.

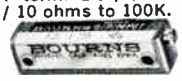
BOURNS TRIMPOT® POTENTIOMETERS

World's largest selection — longest record of reliability

Units shown approximately 3/5 actual size.

TRIMPOT® POTENTIOMETERS—UNSEALED

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

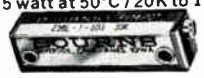


General-Purpose RESISTON® Carbon Element Model 215. Max. temp. 125°C / L, S, P terminals / 0.25 watt at 50°C / 20K to 1 Meg.

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

TRIMPOT POTENTIOMETERS—HUMIDITY PROOF

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



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

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

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

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

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

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

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

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

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

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

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

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

¾"-Square Wirewound Model 3280. Max. temp. 175°C / L, P, W terminals / 1.0 watt at 70°C / 10 ohms to 50K.

¾"-Square RESISTON Carbon Element Model 3281. Max. temp. 150°C / L, P, W terminals / 0.5 watt at 50°C / 20K to 1 Meg.

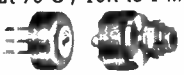
½"-Square, High-Temperature Wirewound Model 3250. Max. temp. 175°C / L, P, W terminals / 1.0 watt at 70°C / 10 ohms to 50K / Mil-Spec style RT22 and meets MIL-27208A.

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

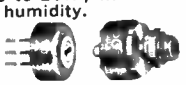
BOURNS® SINGLE-TURN POTENTIOMETERS

⅜"-Diameter Micro-Miniature High-Temperature Humidity-Proof Wirewound Model 3300. Max. temp. 175°C / W, P, S terminals / 0.5 watt at 70°C / 10 ohms to 20K.

⅜"-Diameter Micro-Miniature High-Temperature Humidity-Proof RESISTON Carbon Element Model 3301. Max. temp. 150°C / W, P, S terminals / 0.25 watt at 70°C / 10K to 1 Meg.



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



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

LOW-COST COMMERCIAL POTENTIOMETERS

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

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

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

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

SPECIAL-PURPOSE POTENTIOMETERS

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

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

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

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

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

PANEL-MOUNTED POTENTIOMETERS

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

KEY TO TERMINAL TYPES

L = Insulated stranded leads

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

P = Printed-circuit pins

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

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

TRIMPOT® means BOURNS, BOURNS means QUALITY, so remember . . .

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PROTECTS AGAINST • Bent Pointers • Burned-Out Resistors • Damaged Pivots • Overheated Springs • Burned-Out Meter • Changes in Accuracy Due to Overheating

TRIPLETT

Model 630-PLK

BURNOUT PROOF V-O-M

$79.50
Suggested U.S.A. User Net

USES UNLIMITED

School Classrooms • Field Engineers • Application Engineers • Electrical, Radio, TV, and Appliance Servicemen • Electrical Contractors • Factory Maintenance Men • Industrial Electronic Maintenance Technicians • Home Owners, Hobbyists

FACTS MAKE FEATURES:

1. Comprehensive overload protection.
2. One selector switch minimizes chance of incorrect settings
3. Polarity reversing switch

Additional protection is provided by Model 630-PLK's new transistorized relay circuit. Transistorized overload sensing device does not load circuit under test, eliminating the possibility of damaging circuit components. A special meter shorting feature on "off" position offers high damping when moving tester. The exclusive patented Bar Ring Movement provides self-shielding and is not affected by stray magnetic fields. Wider spread scales, and unbreakable clear plastic window assure maximum readability. Diode network across meter protects against instantaneous transient voltage.

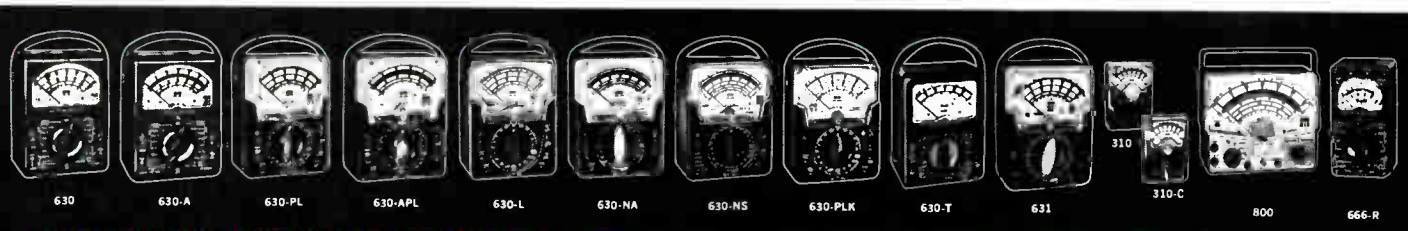
TRIPLETT ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO

RANGES	
DC Volts:	0-2.5-10-50-250-1,000-5,000 at 20,000 ohms/volt. 0-0.25 at 100 microamperes.
AC Volts:	0-3-10-50-250-1,000-5,000 at 5,000 ohms/volt.
Decibels:	−20 to +11, +21, +35, +49, +61, +75; "0" DB at 1 MW on 600 ohm line.
DC Microamperes:	0-100 at 250 Mv.
DC Milliamperes:	0-10-100-1,000 at 250 Mv.
DC Amperes:	0-10 at 250 Mv.
Ohms:	0-1,000-10,000 (4.4-44 at center scale).
Megohms:	0-1-100 (4,400-440,000 at center scale).

Output Volts (AC): 0-3-10-50-250-1,000 at 5,000 ohms/volt jack with condenser in series with AC ranges.

CARRYING CASE

Model 639-OS black leather carrying case, built-in stand, Flaps open to permit use of tester in the case. Suggested U.S.A. User Net.....$12.10



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COMING EVENTS

March

Mar. 10-12: Particle Acceleration Conf., APS, IEEE, NBS, AEC; Shoreham Hotel, Washington, D. C.

Mar. 18-20: 2nd Southeastern Symp. on Gov. Contracts, NAPCA; Ramada Inn, Cocoa Beach, Fla.

Mar. 21-24: 19th Annual Broadcast Eng. Conf., NAB; Sheraton-Park & Shoreham Hotels, Washington, D. C.

Mar. 22-25: Int'l Conv. IEEE; Coliseum, New York Hilton, New York, N. Y.

Mar. 29-Apr. 1: 1st Nat'l Conv., Assoc. of Electronic Mfrs, AEM; New York Hilton Hotel, New York, N. Y.

Mar. 31-Apr. 2: 7th Annual Electron Beam Symp., Alloyd Corp.; Penn State Univ., University Park, Pa.

April

Apr. 6-8: Railroad Conf., IEEE, ASME; Penn-Sheraton Hotel, Pittsburgh, Pa.

Apr. 13-15: Nat'l Telemetering Conf., IEEE, AIAA—ISA; Shamrock Hilton, Houston, Tex.

Apr. 14-15: Electronics & Instrumentation Conf. & Exhib., IEEE & ISA; Cincinnati Garden, Cincinnati, Ohio.

Apr. 19-21: 3rd Nat'l ISA Biomedical Sciences Inst. Symp., ISA; Statler-Hilton Hotel, Dallas, Tex.

Apr. 20-22: Symp. on System Theory, IEEE, USDRA, SIAM; Polytechnic Inst. of Brooklyn, N. Y.

'65 Highlights

IEEE Int'l Conv., Mar. 22-25; Coliseum, New York Hilton, New York, N. Y.

WESCON, Western Electronic Show & Conv., Aug. 24-27, IEEE, WEMA; Cow Palace, San Francisco, Calif.

Nat'l Electronics Conf., Oct. 25-27; McCormick Place, Chicago, Ill.

NEREM, Northeast Research & Eng. Mtg., Nov. 3-5, IEEE; Boston, Mass.

Apr. 20-22: 19th Annual Freq. Control Symp., Army Electronics Labs.; Atlantic City, N. J.

Apr. 21-23: Inst. of Environmental Sciences Mtg. & Expos., IES; Sherman House, Chicago, Ill.

Apr. 21-23: Southwestern IEEE Conf. & Elect. Show, IEEE; Dallas Memorial Audit., Dallas, Tex.

Apr. 21-23: Int'l Nonlinear Magnetics Conf., IEEE; Sheraton Park Hotel, Washington, D. C.

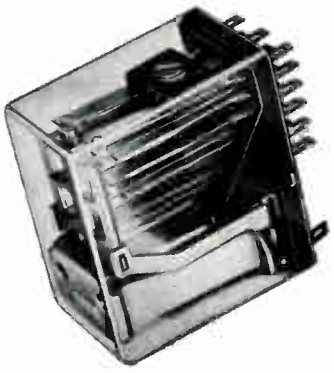
Apr. 27-29: American Power Conf., IEEE; Sherman Hotel, Chicago, Ill.

Apr. 27-30: Spring Conv. Audio Eng'g Soc., AES; Los Angeles, Calif.

May

May 4-6: 5th Annual Packaging Ind. Conf., IEEE; Milwaukee Inn, Milwaukee, Wisc.

May 5-7: Microwave Theory & Tech. Symp., IEEE; Americana Motor Hotel, Atlanta, Ga.



cost life

- **LOW COST**—Unusually modest prices for features offered
- **VERSATILE**—Up to 6PDT, standard contacts are gold plated for low level up to 2 amps.
- **FLEXIBLE**—Most of these relays plug into the same style socket
- **DUST COVER**—At no extra cost
- **SMALL SIZE**—The smallest 6PDT telephone type relay made in the U. S.
- **DURABLE**—Life expectancy—100 million or more operations
- **ADAPTABLE**—Standard plug-in terminals are pierced—can be soldered to directly
- **CONTACT OPTIONS**—Five amp. or bifurcated (for extreme low level)

AL256

SOME OUTSTANDING FEATURES OF THIS POPULAR SERIES

T-154—One of the most widely used commercial relay styles in the world.
Sensitivity—As low as 50 mw. (SPDT)
Made in up to 6PDT

T-163—Similar to the T-154 but with bifurcated contacts designed for maximal reliability under low-lever conditions.
Sensitivity—As low as 180 mw. (DPDT)
Made in up to 6PDT

T-255—The AC version of type T-154. Plugs into the same socket, although a bit greater in height.
Sensitivity—As low as 1.2 va.
Made in up to 4PDT

T-351—A magnetic latch relay in the same format as the T-154. Made with single and double wound coils for set and reset. Beyond initial pulse, requires no holding power.
Sensitivity—As low as 300 mw.
Made in up to 4PDT

TAP—The T-154 mechanism with splayed terminals for use in printed circuit boards. This type can also be furnished with bifurcated contacts.
Sensitivity—As low as 50 mw. (SPDT)
Made in up to 4PDT

TFMDO—Similar to the T-154, but motor is encased in larger dust cover. Base is standard, popular octal plug-in connector.
Sensitivity—As low as 50 mw. (SPDT)
Made in up to DPDT

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SAMPLE ORDERS HANDLED PROMPTLY

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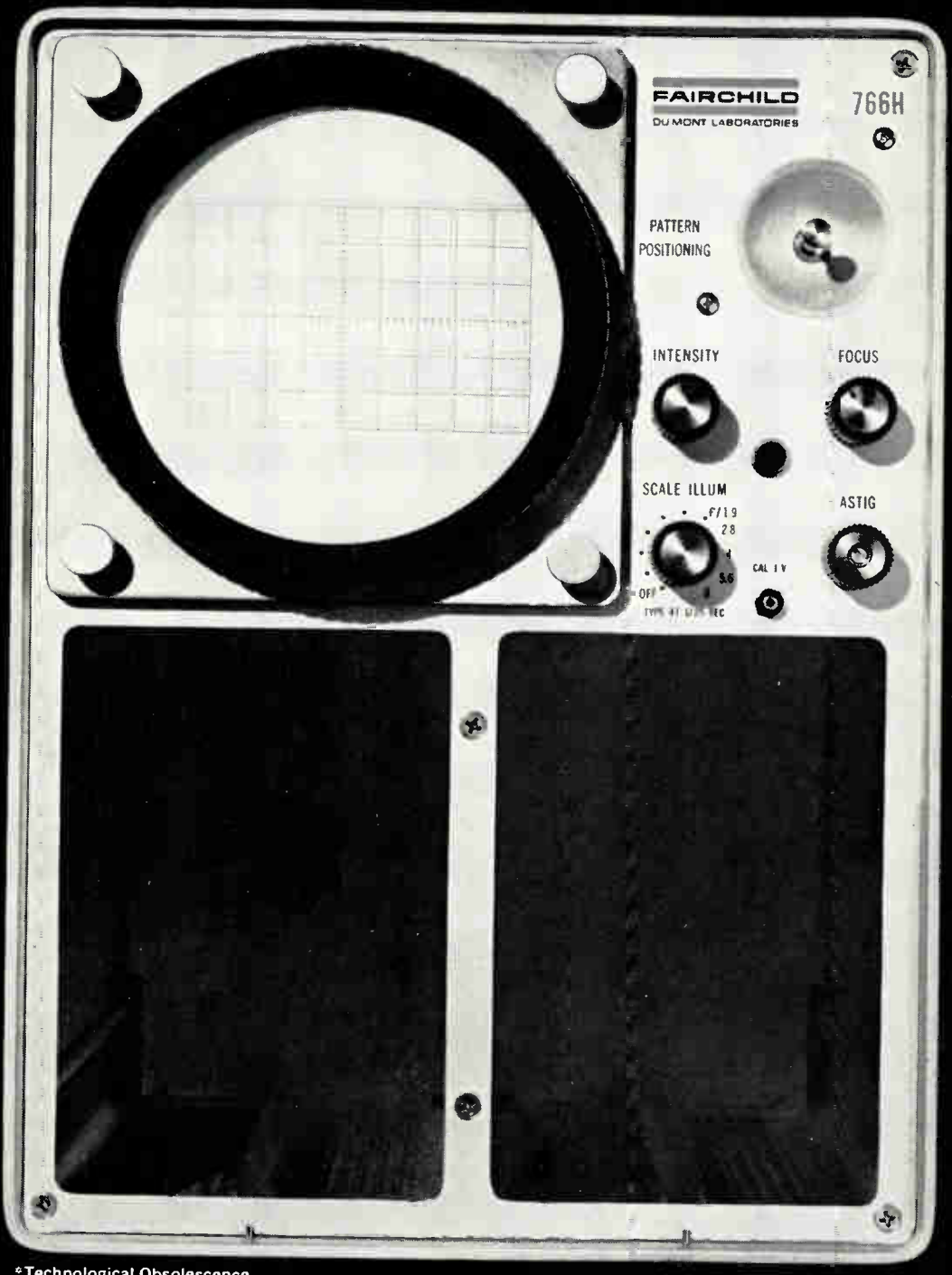
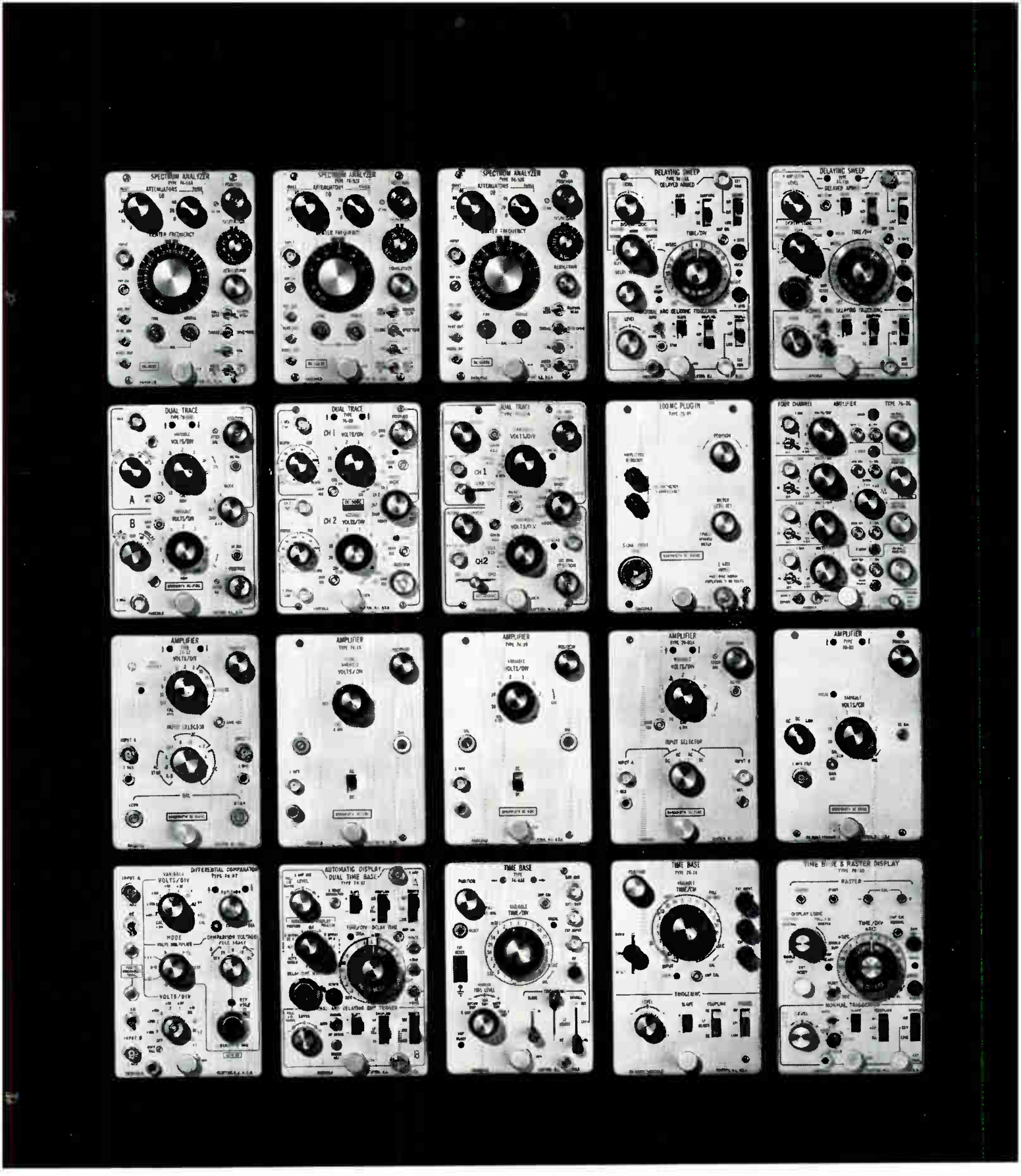


BEAT T.O.* WITH FAIRCHILD

*Technological Obsolescence

WITH THIS SCOPE AND THOSE PLUG-INS...

Your oscilloscope applications change with the work you're doing and the state-of-the-art. Over the years, you could buy a lot of special purpose scopes for that reason. But you don't have to. There are now 20 plug-ins available for the Fairchild Series 765H main frame (and more are on the way). The versatility not only helps you beat the high cost of T.O.—Technological Obsolescence; it lets you add new capabilities at low cost if and when you need them. Other factors that contribute to Fairchild value are . . . all solid-state circuitry for long term reliability . . . all deflection circuitry in the plug-in . . . four main frame configurations (bench, rack, portable, and dual gun).



...WHO NEEDS COSTLY SPECIAL PURPOSE SCOPES?

Ask your Fairchild Field Engineer for a demonstration of the Series 765H. Judge it on performance and by your own standards of value analysis. For a new catalog describing the Series 765H and other Fairchild scopes write Fairchild Scientific Instrument Dept., 750 Bloomfield Ave., Clifton, N. J. Visit Fairchild at the IEEE Show — Booth Nos. 2701 thru 2717.

FAIRCHILD

DU MONT LABORATORIES

SCIENTIFIC INSTRUMENT DEPARTMENT

Circle 12 on Inquiry Card

LBJ PUSHES DISARMAMENT—Pres. Johnson is asking Congress for $55 million to run the Arms Control and Disarmament Agency (ACDA) for the next four years. ACDA is now spending about $9 million a year. It's prime reason and aim: search for ways to disarm and study probable effects resulting from disarmament. Studies range from effects of disarmament on U.S. economy to ways of inspecting military establishments of nations that promise to disarm.

FCC VS NETWORKS—Commercial TV networks will be barred from owning more than half of the programs on evening "prime time" if a proposal now before the FCC is approved. The Commission wants to break up the solid mass-appeal programs that fill such time. While not commenting on the low calibre of many programs, the nets reply that they need an uninterrupted flow of mass-appeal to hold viewers. FCC contends that prime-time programs will never improve unless the networks are barred from owning most or all of prime-time shows.

CHECKING COST-CUTTING—Defense Department has issued rules for verifying cost reductions claimed by contractors and sub. Purpose of the cost-cutting program, in effect since May 1964, is to encourage firms handling defense contracts to achieve meaningful cost reductions. Firms with defense business valued at $5 million or more, and who have accepted the invitation to report cost-cutting accomplishments are covered by the new rules. Text of the rules (Instruction No. 7720.12) is available from the Secretary of Defense.

RCA PRESIDENT HEADS BOND DRIVE

Pres. Johnson praises aims of Industrial Payroll Savings Bond drive; 1965 chairman is RCA's Elmer W. Engstrom (right) succeeding Frank R. Milliken (center) Kennecott Copper President. In rear, Treasury Secretary Dillon (right), and A. J. W. LeBien (left), Eli Lilly & Co.

COMSAT CONTRACT—Communications Satellite Corp. (COMSAT) has filed notice of a plan to award a contract for $14 million to Hughes Aircraft Co. for 24 satellites capable of handling military communications. The contract is to be executed after DOD decides whether it will use the system offered by COMSAT. The Hughes contract contemplates a 100% leasing of new satellite network by the military.

CONGRESS IS CRACKING BOOKS — National legislators are boning up more on science and technology than at any time in history. More congressmen are now aware that it is almost impossible to debate and legislate effectively on bills related to electronics, space and the advanced sciences without some understanding of technical fundamentals in each proposal. Congress, therefore, is taking on and sending more staff experts to the Library of Congress.

BRIEFINGS FOR INDUSTRY—The Pentagon is sending some of its top procurement brains to a series of briefings for industry, sponsored by the National Security Industrial Association. The briefings are intended to provide management and labor with a long-range view of Pentagon development and procurement needs. Briefings are set for: Los Angeles, March 3, 4; New York, March 16, 17; Chicago, March 31, April 1; Dallas, April 14, 15; Washington, D.C., April 28, 29. To register, write NSIA, 1030 15th St., N.W., Washington, D.C., 20006.

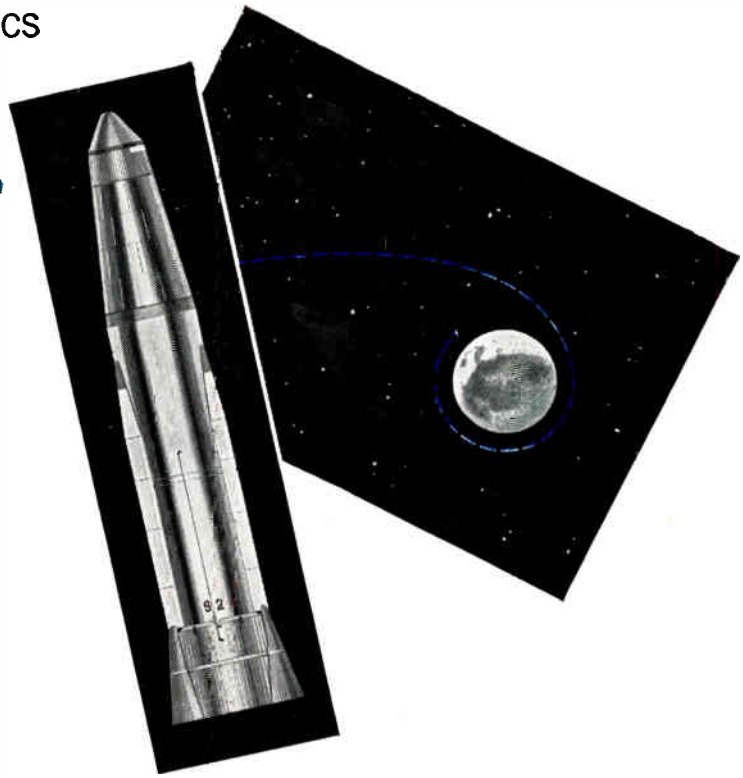
COMPUTER STANDARDIZATION—The Pentagon is pressing for standardization of computer systems. The Air Force is studying its airborne systems toward this goal. Advantages: speedier results, less error, lower cost. Space systems division of the Air Force Systems Command wants standardization of space guidance computers. The trend toward a single, common-language EDP system seems inevitable.

FASTER TECHNICAL DATA—Technical information is now moving faster from government repositories to firms that need it. A new Department of Commerce program now employs state manufacturers' associations and state universities as distributors in making the government's vast fund of scientific and engineering data available to firms that can use it to expand and improve business. More information is available from Institute for Applied Technology, National Bureau of Standards, Washington 25, D. C.

IN ELECTRONICS...AVIONICS...ASTRIONICS

STEMCO THERMOSTATS

RANK FIRST IN PRECISION TEMPERATURE CONTROL



In today's military and commercial projects, you can't afford to overlook any one of these important areas: Reliability, Size, Availability, Economy.

And because Stevens is in production now on the largest number of different types and styles of bimetal thermostats, all these advantages are yours automatically when you specify Stemco thermostats.

1st in Reliability. Proven designs, latest production techniques, most stringent inspection procedures.

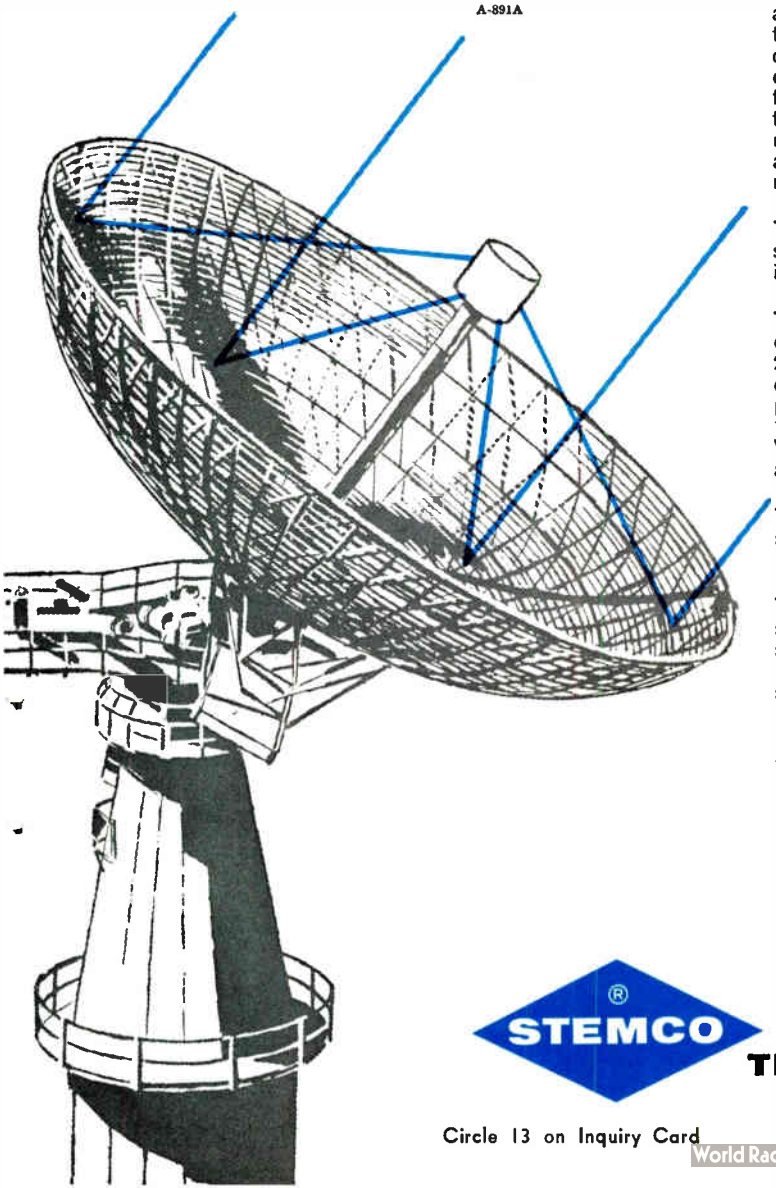
1st in Size. Stemco thermostats score in compactness and lightness without sacrificing performance.

1st in Availability. Tooling for most types is in existence. Flexibility of design cuts lead time on other types.

1st in Economy. Mass production of many standard Stemco types with hundreds of terminal arrangements and mounting brackets cuts your costs.

***Refer to Guide 400EO for U.L. and C.S.A. approved ratings.**

A-891A



TYPE A* semi-enclosed. Bimetal disc type snap action thermostats; give fast response to temperature changes. Can be made to open on rise or close on rise. Single-throw with double make and break contacts. Operation from -20 to 300°F. Lower or higher temperatures on special order. Average non-inductive rating 13.3 amps, 120 VAC; 4 amps, 230 VAC and 28 VDC. Various mountings and terminals available. Bulletin 3000.

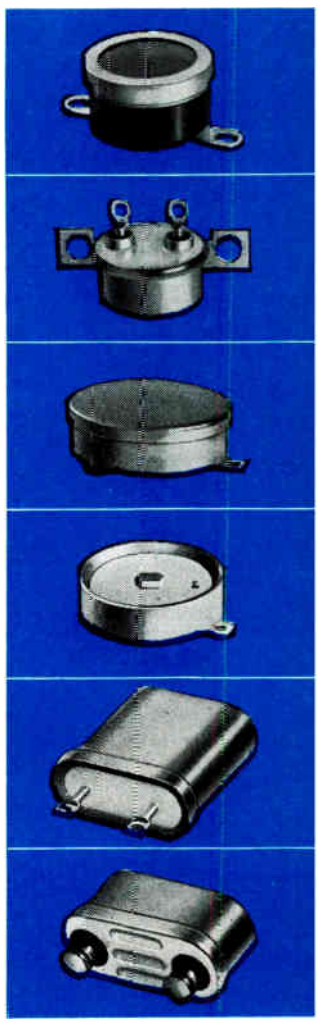
TYPE A hermetically sealed. Electrically similar to semi-enclosed Type A. Various mountings, including brackets, available. Bulletin 3000.

TYPE MX hermetically sealed. Snap acting bimetal disc type units to open on temperature rise. 2 to 6°F differentials as standard. 1 to 4°F differentials available on special order. Depending on duty cycle, normal rating 3 amps, 115 VAC and 28 VDC for 250,000 cycles. Various terminals, mountings and brackets available. Bulletin 6100.

TYPE MX semi-enclosed. Construction and rating similar to MX hermetically sealed type. Bulletin 6100.

TYPE M hermetically sealed. Bimetal disc type, snap acting thermostats. Also available in semi-enclosed. Operation from -20 to 300°F. Lower and higher temperatures available on special order. Depending on application, rated non-inductive 10 amps, 120 VAC; 3 amps, 28 VDC. Various terminals, wire leads and brackets available. Bulletin 6000.

TYPE C hermetically sealed. Also semi-enclosed styles. Small, positive acting with electrically independent bimetal strip for operation from -10 to 300°F. Rated at approximately 3 amps, depending on application. Hermetically sealed type can be furnished as double thermostat "alarm" type. Various terminals and mountings. Bulletin 5000.



STEMCO® **THERMOSTATS**

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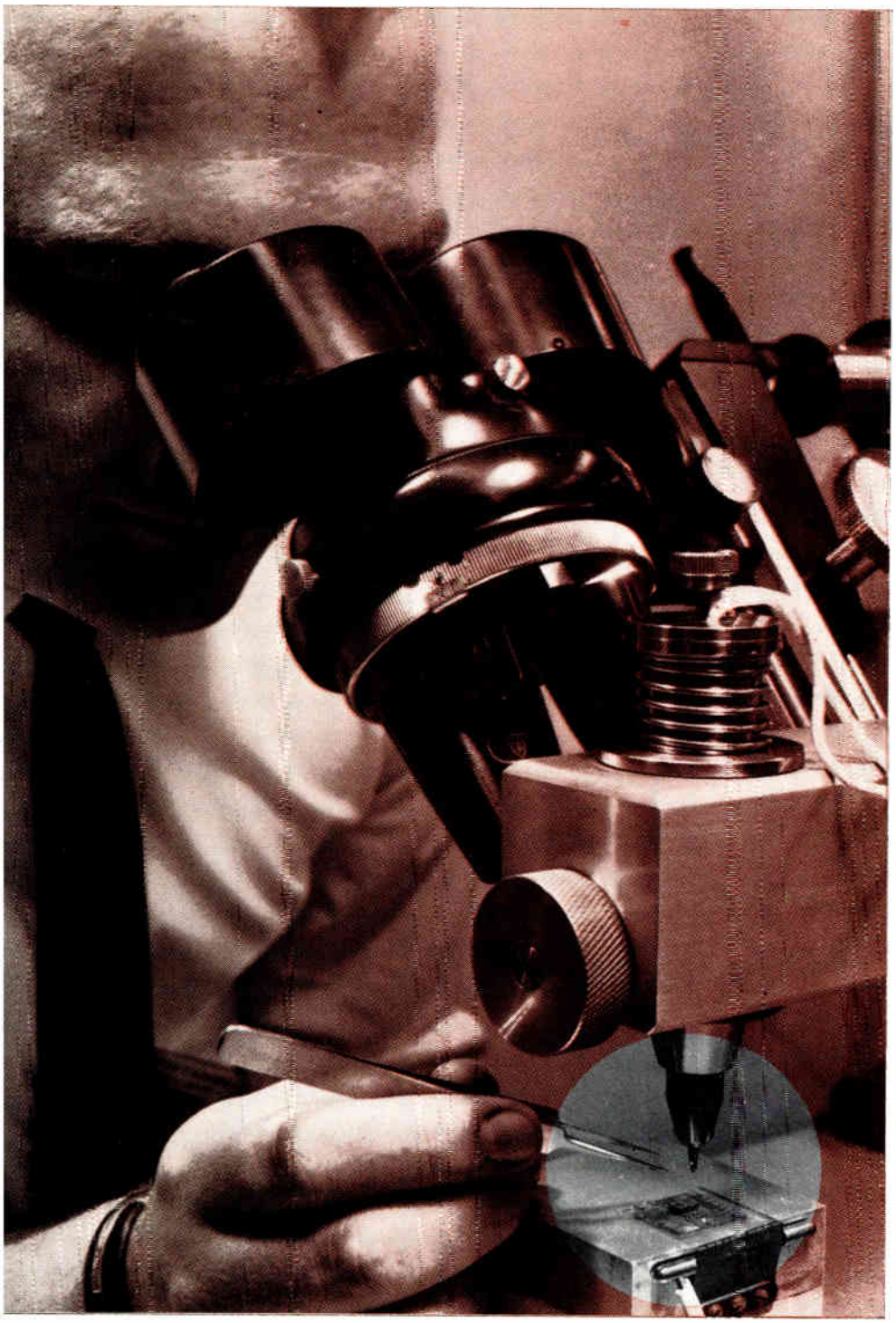
STEVENS *manufacturing company, inc.*
P.O. Box 1007, Mansfield, Ohio

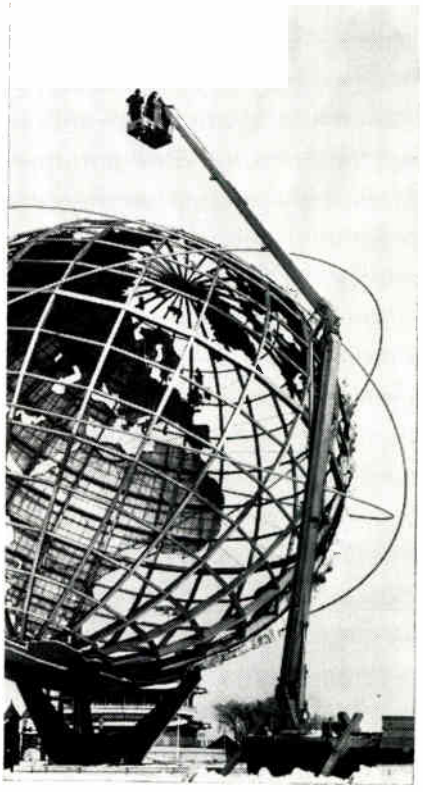
ELECTRONIC SNAPSHOTS

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



▲ **NEW BONDING DEVICE**

Method for assembling intricate microelectronic equipment has been developed at Honeywell's Minneapolis aeronautical division. The new device, a thermocompression bonder, combines heat and weight for a diffusion bond. Operating the device is metallurgist Dr. Ken Solie.



HIGH POINT ▶

Heavy duty Pitman aerial platform rented from New York World's Fair by NBC was used at the inauguration of Pres. Johnson to simulate aerial television. Located at the East Plaza of the Capitol, the platform, able to support 700 lbs, was the highest vantage point.

▲ WORLD'S SHORTEST TV CAMERA

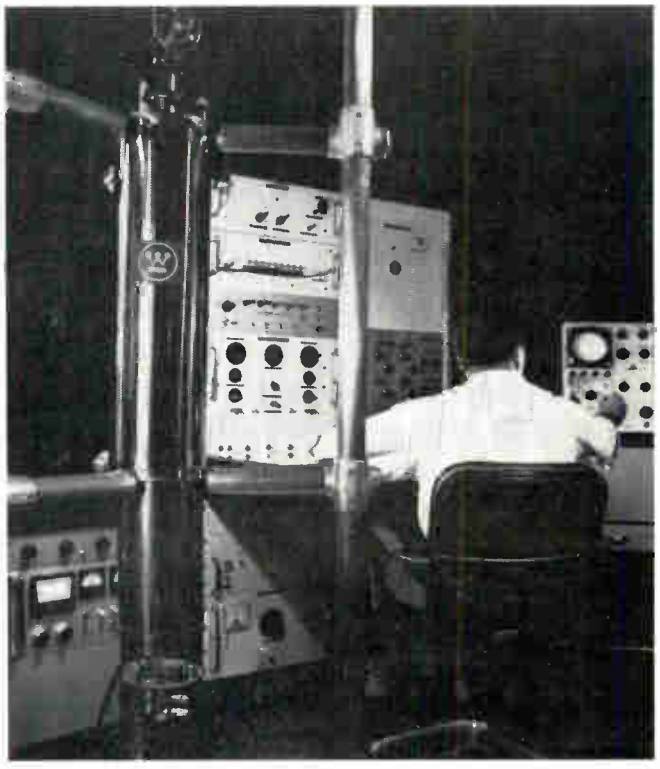
A seven-inch miniature television camera made by Cohu Electronics, Inc., is teamed up with one of the world's longest telephoto lenses (500 mm) at San Diego. Pat LeRoy aims mighty little system designed to cover sports, troop movements and satellite tracking.

◀ FAULT LOCATOR

New underground fault locator can determine course of buried cable and pinpoint defects from surface. Introduced by Delcon Division of Hewlett-Packard Co., entire portable system weighs 15 lbs., including signal transmitter and power supply, receiver, inductive probe (photo) and conductive probe to pinpoint defect within fraction of an inch.

WAFER SORTER ▶

Germanium wafers for transistors are sorted at rate of 3,000 per hour into 10 grades of thickness by this machine at British subsidiary of ITT Corp. The machine, used at ITT's Standard Telephones and Cables Ltd., detects thickness difference of 0.0001 inch.



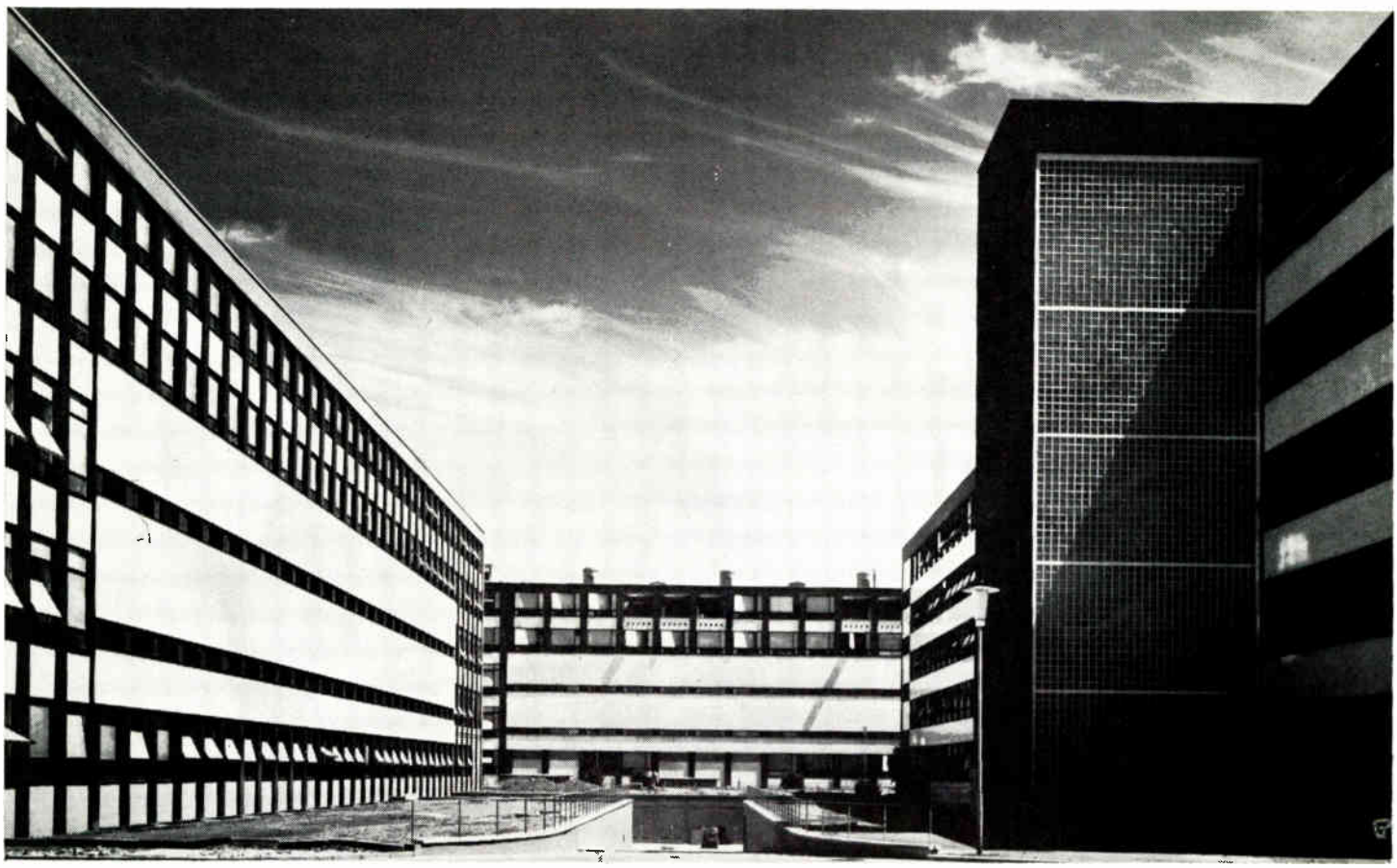
◀ SUPER MAGNET

First superconducting magnet for use in a commercial nuclear magnetic resonance (NMR) spectrometer is shown being used at the Rice Institute Chemical Engineering Department. The Westinghouse magnet is rated 25 Kg and has a field uniformity of better than 1 part in 10^6. The magnet weighs 200 lbs.

This is Siemens

Serving the entire field of electronics and nucleonics, the Siemens Group is one of the world's most diversified electrical engineering organizations.

The particular strength of the Siemens Group is in its all-round capabilities—both in the overall handling of large-scale technical projects, from planning to final delivery, and also in the quantity production of electrical components and electronics devices. Distribution companies and agencies in 80 countries, backed by Siemens factories and hundreds of depots maintained in all parts of the world, guarantee customers a maximum of service. In cooperation with their central offices, they provide or arrange for every conceivable form of service that may be required in connection with electrical installations.



Siemens & Halske AG
Components Division

SIEMENS

Siemens ferrite pot cores

Precision-engineered for adjustable, high-stability, high-Q coils

These pot cores meet the most critical requirements for filters used in multiplex and other carrier-frequency applications. They're unique in performance because of these built-in advantages—easy adjustment to precise inductance, high stability, high Q, low distortion, plus self-shielding that allows compact component density without regeneration or coupling.

Unique manufacturing controls Siemens pot cores offer uniform electrical characteristics month after month—complete dependability to close standards.

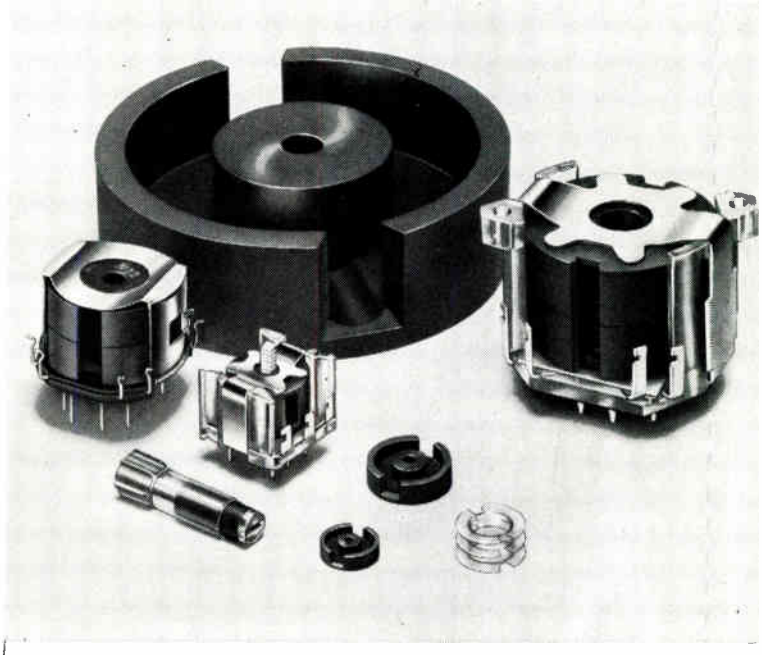
Wide range of materials 7 different types provide optimum properties for frequency ranges up to 40 mc/s for oscillating and filter coils—up to 400 mc/s for transformers.

Wide range of sizes Diameters range from 0.22" to 2.75" including all International Standard Sizes. Most of the listed pot core sizes, materials, and A_L values are stocked for immediate shipment from White Plains, N.Y.

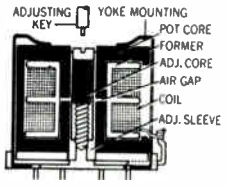
Stability Less than 0.2% change in permeability in 10 years at temperatures up to 70° for typically gapped cores used in filter coils.

Temperature coefficients are closely controlled.

High Q value with high stability is typical. For example, a 26 x 16 core of N22 or N28 material A_L 315 at 100 kc/s shows a Q value of approximately 950.



Complete line of "hardware" includes coil formers with one to four sections, mounting assemblies for chassis or printed circuits, adjustment devices and keys.



WRITE NOW for complete information on Siemens pot core application

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A Corporation of THE SIEMENS GROUP IN GERMANY
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In Canada:
SIEMENS HALSKE SIEMENS SCHUCKERT (CANADA) LTD.
407 McGill Street, Montreal 1, P.Q.

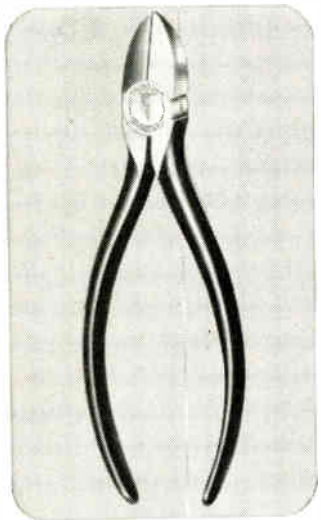
KLEIN PLIERS *Speed up electronic wiring*

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.

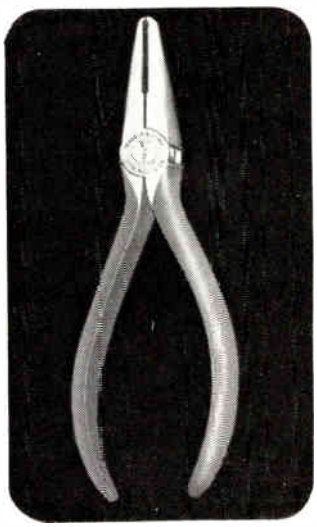
Klein has also developed special pliers to do special jobs requested by electronic manufacturers.

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."

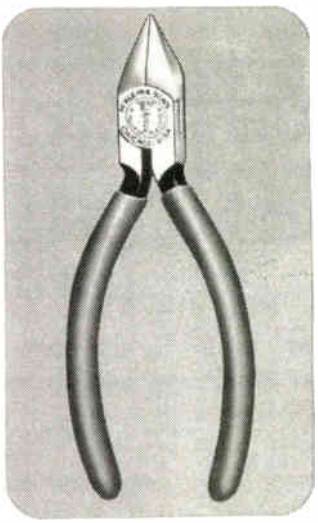


202-5C Oblique Cutting Plier with narrow nose. Available with coil spring. 5½-, and 6-in. sizes.

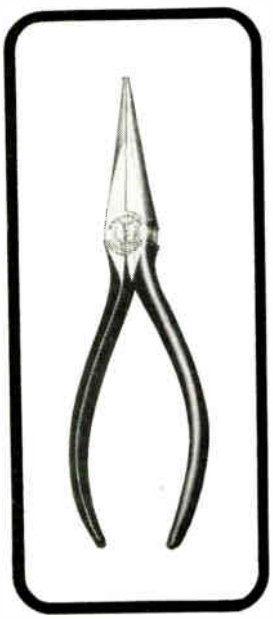
203-5C Long Nose Side Cutting Plier. Available in 5½-, 6½- and 7-in. sizes. Supplied with coil spring.



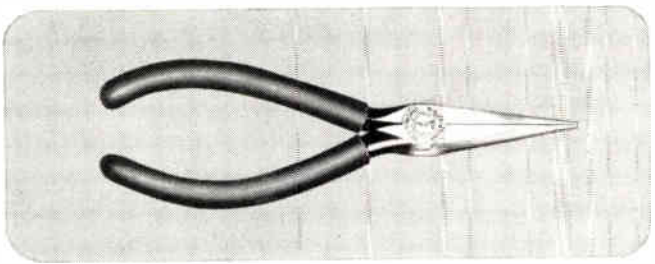
204-6C Transverse End Cutting Plier, 6-in. long. Supplied with coil spring to hold jaws open.



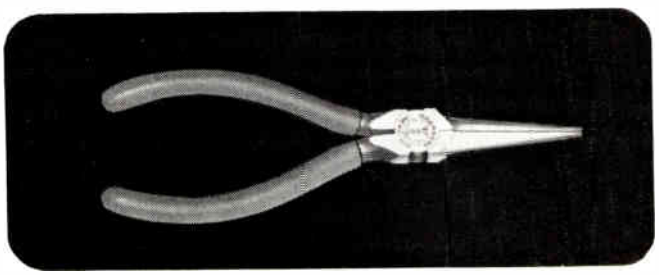
D209-5C Lightweight, Pointed Nose, Flush Cutting Plier. Supplied with coil spring to hold jaws open.



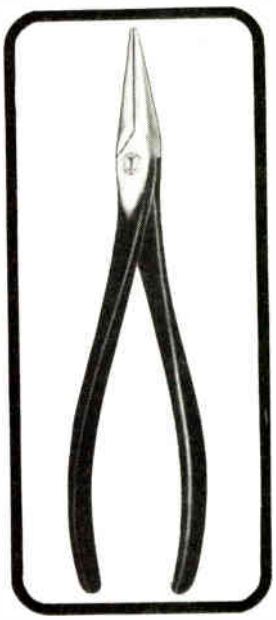
301-5C Long Nose Plier. Available in 5½-, 6½- and 7-in. lengths. Coil spring.



D307-5½C Slim Long Nose Plier for reaching into confined spaces. Yellow plastisol handles. Supplied with coil spring tc hold jaws open.



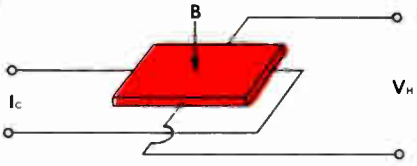
D310-6C Slim Long Nose Plier. Handles are yellow plastisol covered. Supplied with coil spring to keep jaws open.



314-8 8-in. Long Nose Plier. Jaws have knurl.

THE HALL EFFECT and its applications*

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



The Hall phenomenon may be expressed by the equation:

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

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

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

***Send for complete booklet.**

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

Now an Invaluable Laboratory Instrument

F. W. Bell's Model 240
INCREMENTAL GAUSSMETER

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

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

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

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

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

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

SEE IT ALL AT THE IEEE SHOW — BOOTH 3948

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Circle 33 on Inquiry Card

STRONG MARKET GAINS SEEN, BUT THEY ARE CONDITIONAL

George S. Dively, chairman of the Harris-Intertype Corp., observed recently that current business activity, well into the fourth consecutive year of strong growth, continues remarkably well balanced.

He said that still further gains are likely—if industry maintains effective planning and avoids excessive inventories and unsound credit extensions, if labor assumes its share of economic responsibility, and if the government pursues sound monetary policies with timely action when required.

In new business strengths, Mr. Dively remarked that the continuing acceleration of technological developments, for consumers and for industry, could create stronger market demands. This in turn could give our national economy impetus well beyond present levels.

EDP NETWORKS MAY SPEED RETAIL SALES DATA

The gathering of retail sales information will one day be speeded by computer networks linking all phases of distribution, predicted Bryce S. Durant, President of RCA Sales Corporation.

He observed that the improvement of communications in all consumer product industries between the point of sale and the manufacturer will certainly lead to more efficient production and distribution and lower consumer prices.

"A consumer who buys a TV receiver will in the not too distant future start a computerized flow of data that will directly benefit the dealer, distributor, manufacturer and even local banking sources."

TV SALES, PRODUCTION RISE IN NOVEMBER

Distributor sales of monochrome TV sets for the first 11 months of 1964 were 13.3% ahead of 1963, reports the Electronic Industries Association. Black and White production in November was up 22.3% from November 1963, and production for January through November was up 13.7%.

Radio distributor sales (excluding auto) were up 8.1% for the first 11 months of 1964. Radio production for the first 11 months of 1964 was up 4.3% from 1963.

Monochrome distributor sales totaled 711,243 units in November, and 6,873,514 units for the first 11 months of 1964. Total TV production for the 11 months was 8,638,812 units. Of these, 7,321,508 were monochrome. The 11-month 1964 total for color was 1,317,304 units.

STEREOPHONIC ASTROVISION

Stewardess instructs American Airlines passenger in use of Astrovision, airline's four-part entertainment system. Astrovision, using Sony equipment, allows passengers to see motion pictures, live TV, local terrain, takeoffs, landings, and also has stereo music.

JAPAN NIBBLES AT MARKETS STILL DOMINATED BY U.S.

Increased international electronic competition is shaping-up between U.S. and Japan. Leveling and shrinking defense markets have encouraged U.S. companies to explore industrial markets at home and abroad.

The Japanese, with virtually no defense market, have based their electronic industry on consumer products. But, since most domestic markets are satisfied, except for color TV, the Japanese are turning to industrial items. In 1963 sales of Japanese computers, starting from a low base, have nearly doubled. But sales of industrial test and measuring instruments dropped by 5%.

While trying to export industrial products, the Japanese are aware that their industrial lines still compete poorly against many U.S. products. Moreover, of electronic products Japan imports, better than 90% comprise industrial computers, measuring instruments and other equipment.

Japan's bright hope continues to be exports of tiny, smart, unique transistor radios and TV sets. Still later, they plan to export special color TV sets.

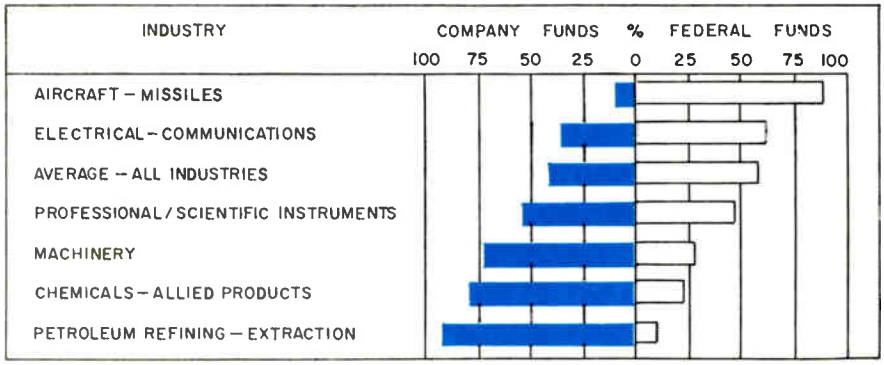
NEMA SEES $30 BILLION FOR TOTAL MARKET IN 1965

A record high of $30 billion was forecast by the National Electrical Manufacturers Association as value of shipments of all electrical and electronic manufactured products in 1965. (Previously forecast electronic component of the total is about $17 billion.)

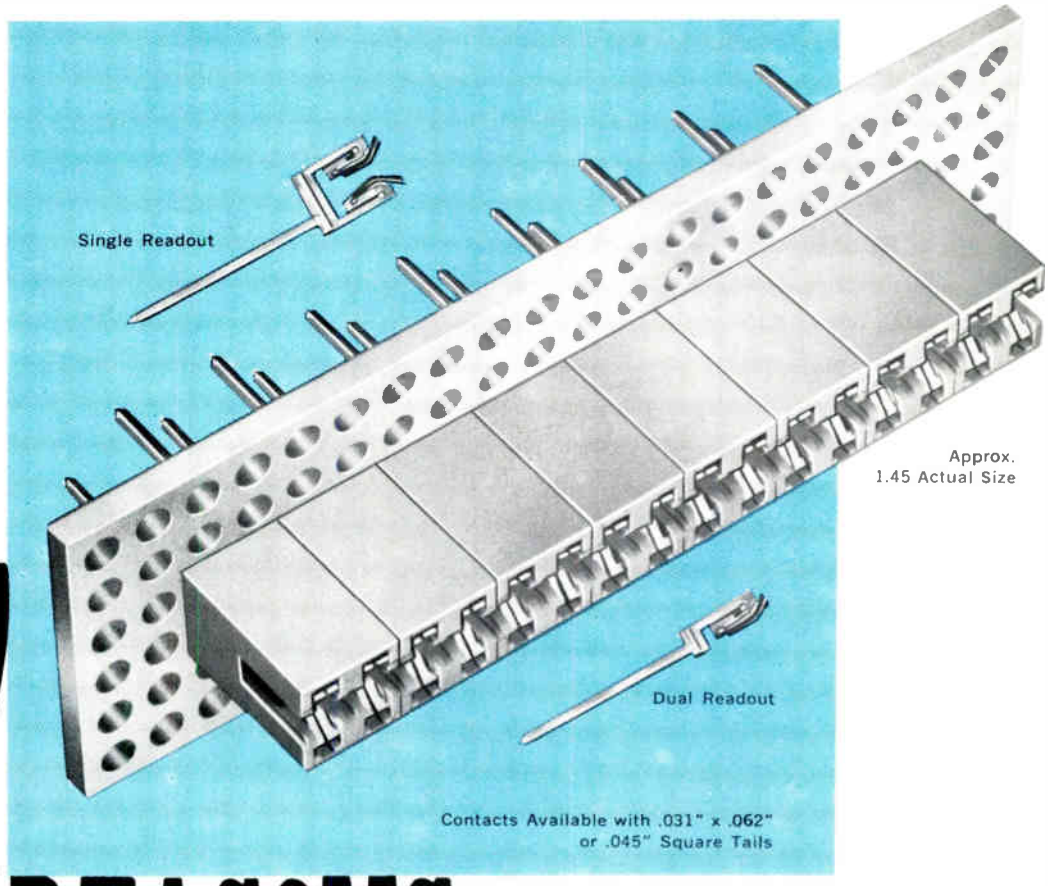
The predicted total for all electrical/electronic products is 4.8% above the 1964 record of $28.7 billion.

DISTRIBUTION of R&D FUNDS by SELECTED INDUSTRY and SOURCE FOR 1963

(Based on National Science Foundation Figures)



SEE US AT IEEE
BOOTHS 1420-1422



14,407 REASONS

TO SPECIFY NEW ELCO SERIES 5430 CARD-EDGE VARIPLATE*/BIFURCON* MINIATURE CONNECTORS!

Reason No. 1: Is the only connector of its type offering the choice of .031" x .062" or .045" square contact tails for programmed back-panel wiring at .200" spacing ■ Reason No. 2: Provides the option of single or dual readout contacts for single or double-sided circuitry ■ Reason No. 3: Contact noses are Elco Bifurcon* double-cantilever, bifurcated design, each having 2 contact points; permit maximum deflection without taking a set ■ Reason No. 4: Modular polycarbonate insulators hold up to 4 contacts each ■ Reason No. 5: Connectors mate directly with 1/16" cards, eliminate necessity for mating connector half ■ Reason No. 6 to 14,406: As many as 14,000 contacts may be installed in our 24" x 36" metal plates (maximum recommended practical size) ■ Reason No. 14,407: Offers the proven reliability, versatility and production efficiencies associated with every Elco product—reason enough in itself to write, wire, phone or TWX at once for Bulletin 5400.

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

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

*TRADE-MARK

TWO GREAT NEW CHAMPS

See them at IEEE
March 22-25
Booth 3038

NEW COAX

Recording 1.5 mc on as many as fourteen tracks, Mincom's new Portable Coaxial Recorder offers the industry's highest performance per cubic foot. Stands under two feet high. 14-inch NAB precision reels. 1⅞ to 120 ips. Two playback channels. RFI-shielded, this new system is unequalled for van, shipboard and similar installations.

NEW PCM

Digital data in an improved parallel format at 120,000 bits per second per track—that's the story of Mincom's newest solid-state system. Sixteen channels for NRZ digital input, clock, timing and voice. Seven push-button speeds from 1⅞ to 120 ips. Controls and adjustments front-accessible for CRT display and digital electronics.

Mincom Division 3M COMPANY
300 South Lewis Road, Camarillo, California

A COOL 400 V

Delco Radio's new DTS 413 and DTS 423 power transistors, are conservatively rated at 75 and 100 watts. Our standard TO-3 package assures low thermal resistance (junction to heat sink 1.0°C per watt) for cool power. The silicon element gives you high voltage protection, high frequency response and low saturation voltage.

The price is low (less than 3¢ a volt for sample quantities) for two reasons: special inter-digitated geometry of the devices and our unique 3D* process for high yields.

Now you can reduce current, the size of other components, and increase efficiency in high energy circuits. Vertical and horizontal TV outputs, for example.

Your Delco Radio Semiconductor distributor has these two new power transistors on his shelf. Call him today for data sheets, prices and delivery.

*Triple sequential diffusion

RATINGS	DTS 413	DTS 423
VOLTAGE		
V_{CEO}	400 V (Max)	400 V (Max)
V_{CEO} (Sus)	325 V (Min)	325 V (Min)
V_{CE} (Sat)	0.8 (Max)	0.8 (Max)
	0.3 (Typ)	0.3 (Typ)
CURRENT		
I_C (Cont)	2.0A (Max)	3.5A (Max)
I_C (Peak)	5.0A (Max)	10.0A (Max)
I_B (Cont)	1.0A (Max)	2.0A (Max)
POWER		
	75 W (Max)	100 W (Max)
FREQUENCY RESPONSE		
f_t	6 MC (Typ)	5 MC (Typ)

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DELCO RADIO
Division of General Motors

LETTERS

to the Editor

A Suggestion . . .

Editor, ELECTRONIC INDUSTRIES:

We have enjoyed and found useful your Marketing and Applications type articles printed under "Professional Guidelines."

May we request more of these and request some market and application studies in depth.

Saul Padwo
Manager Marketing & Sales

Yardney Electric Corp.
Yardney Building
40-52 Leonard St.
New York 13, N. Y.

Ed. Note: Thanks for the suggestion, we'll certainly take it under consideration.

Toy Inventors

Editor, ELECTRONIC INDUSTRIES:

I read with great interest your article, "New Market Looms in Electronic Toys," published in the January issue of ELECTRONIC INDUSTRIES.

Having built several toys of various types for my own children I would be very interested in procuring the name of companies or individuals who would evaluate the feasibility of producing and marketing what I consider the "best of the lot."

The family has dubbed the unit "Hand-hula"—it combines simple dexterity exercise with the wonder of motion and color. The addition of a simple battery circuit provides illumination of the colors for fascinating patterns in the dark.

Centrifugal force provides the operating motion and the unit can be sized to meet the difficulty index of the various age groups.

The marketing potential would seem limitless as the unit would not be seasonally or environmentally orientated. It's interesting indoors or out; in the dark or in the light; in the heat or in the cold. Additionally, in states such as ours which prohibit fireworks, the lighted models would provide the color and excitement of the celebration without the hazards.

Simplified working models are available and will be submitted on notification of interest.

Robert L. Schwantz
11601 Norway St.
Coon Rapids, Minn.

Editor, ELECTRONIC INDUSTRIES:

I am quite interested in toy inventions but have been frustrated by not knowing how to pursue the ideas I have. Your article on toy inventions, "New Market Looms in Electronic Toys" in the January issue of ELECTRONIC INDUSTRIES was therefore well received until I read it, and found the one thing I was interested in finding out, was missing. How does a person who feels he has a toy invention proceed toward getting his idea to the right people? Perhaps you can tell me whom I can contact for guidance along these lines.

Ronald A. Orland
56 Hamlet Road
Levittown, N. J.

Ed. Note: We suggest that you contact Mr. Ned Strongin, Ned Strongin Associates, 128 32nd St., Brooklyn, N. Y. He should be able to help you. If he can't use your idea himself, he can suggest avenues for you to explore.

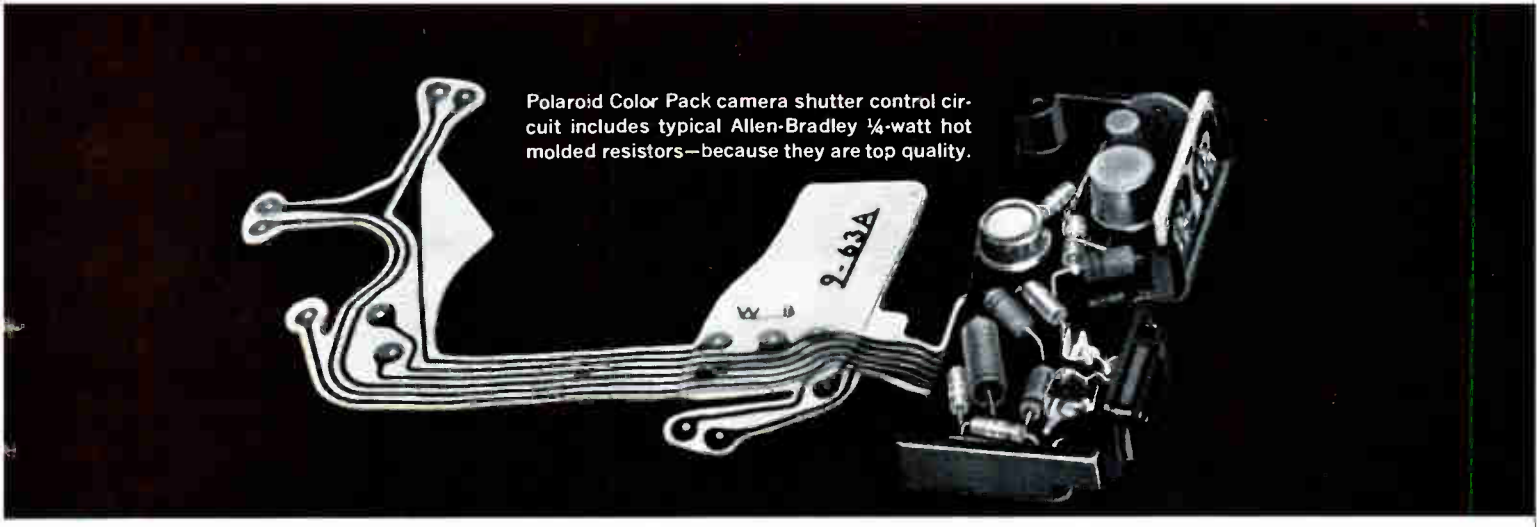
A Service . . .

Editor, ELECTRONIC INDUSTRIES:

It might interest you that Prototype Electronic Engineering Company provides exactly the service you mention in your December 1964 editorial. We are engaged in commercial electronic research, design and manufacturing. The idea is, that an enormous number of companies are not electronically oriented at all, but nevertheless can use, once in a while, advice on how to improve their production with electronic aids.

The big problem is how to reach this enormous diversified market. Advertising in electronic magazines only attracts people already working in the electronic field. We will design and build commercial electronic equipment by the customer's specifications and submit drawings, schematics, parts and price lists to the customer who wants to mass produce the particular product, or we build small quantity equipment for customers with a limited need of a particular special item. This way a company does not need to maintain a full time electronic engineering staff. Even though a prototype of any product costs a considerable amount of money compared to the final product price, a company can *save* engineering, overhead, time, and thus money by using such a service.

R. van Kreuningen
President PEECO
Prototype Electronic Engineering Co.
2005 Magnolia Ave.
Manhattan Beach, Calif.



Polaroid Color Pack camera shutter control circuit includes typical Allen-Bradley ¼-watt hot molded resistors—because they are top quality.

Polaroid uses reliable Allen-Bradley hot molded resistors in

the automatic electronic shutter of their new Color Pack Camera

■ The new shutter system for the Polaroid Color Pack Camera has a remarkably small transistorized electronic circuit that measures the light—from the split second burst of a flash to the glow of a candle—and automatically closes the shutter when the film has been properly exposed. Response to this wide range of light levels demands dependable performance . . . summer or winter . . . rain or shine. For this reason, Allen-Bradley Type CB ¼-watt fixed resistors are used in the timing circuit.

The uniformity of Allen-Bradley resistors which results from the exclusive hot molding process—perfected and used only by A-B—is so consistent that long term resistor performance can be accurately predicted. In addition, their stable characteristics and conservative ratings assure superior performance in the most critical circuits.

Join the rapidly growing list of leading electronic and instrument manufacturers who guard the reputation of their products by standardizing on Allen-Bradley hot molded resistors. By the way, Allen-Bradley offers you only one quality of resistor—your customers will recognize this mark of quality in your products. For complete specifications, please send for Technical Bulletin 5050: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

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

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ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

39-10-4E

RODGERS 36-E
CUSTOM THEATRE ORGAN

"Allen-Bradley ferrite cores have made an important contribution to our electronic organ"

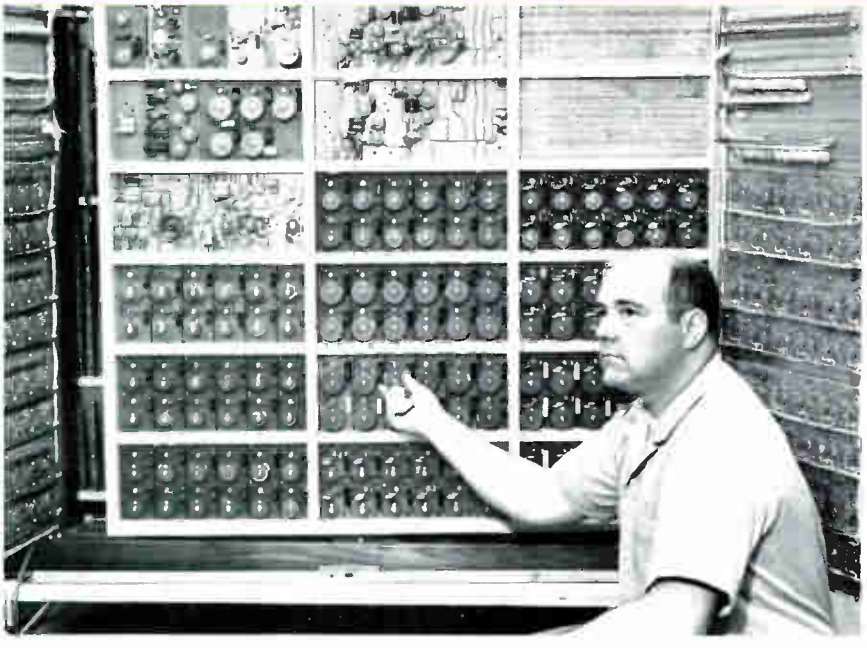
—Rodgers Organ Company

Since the permeability of Allen-Bradley Type W-03 ferrite material remains constant over a practical working range of flux values, this enabled the Rodgers Organ Company engineers to design stable inductors for use in a simplified tone generator that "stays on frequency"—one of the basic requirements of an electronic organ. In addition, proper grinding of the center air gap surfaces of the cup core and matching cover assembly permits the inductance and the resulting frequency to be adjusted by simply rotating the cover.

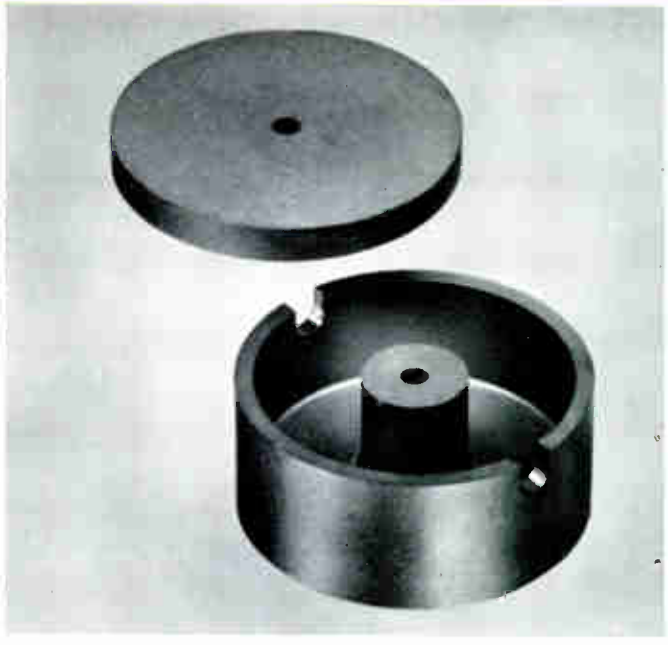
Allen-Bradley ferrite materials offer a wide choice of characteristics to meet the design requirements of such applications as:

1. TV flyback transformers
2. Broad band transformers
3. TV deflection yokes
4. Transistorized inverter power supplies
5. Pulse transformers
6. Ultrasonic frequency transformers

Allen-Bradley engineers will be pleased to work with you in the selection and application of an Allen-Bradley ferrite with the exact properties to fit your design requirements. Please let us hear from you. Write: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.



Rear view of Rodgers organ with panel doors open showing extensive use of Allen-Bradley Type W-03 ferrite material in the form of cup cores and covers for tone generators.



Typical Allen-Bradley ferrite cup core and cover. These are available in sizes from 0.368" to 2.400" in diameter.

42-11-4E

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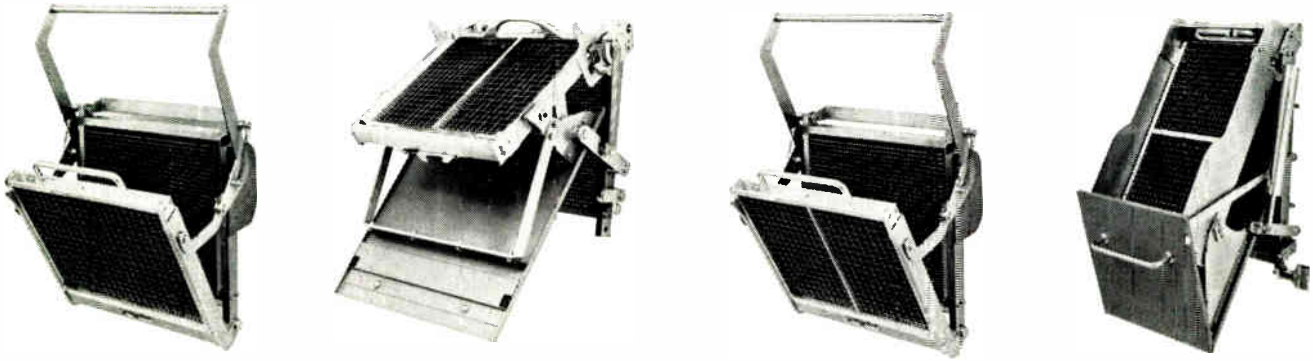
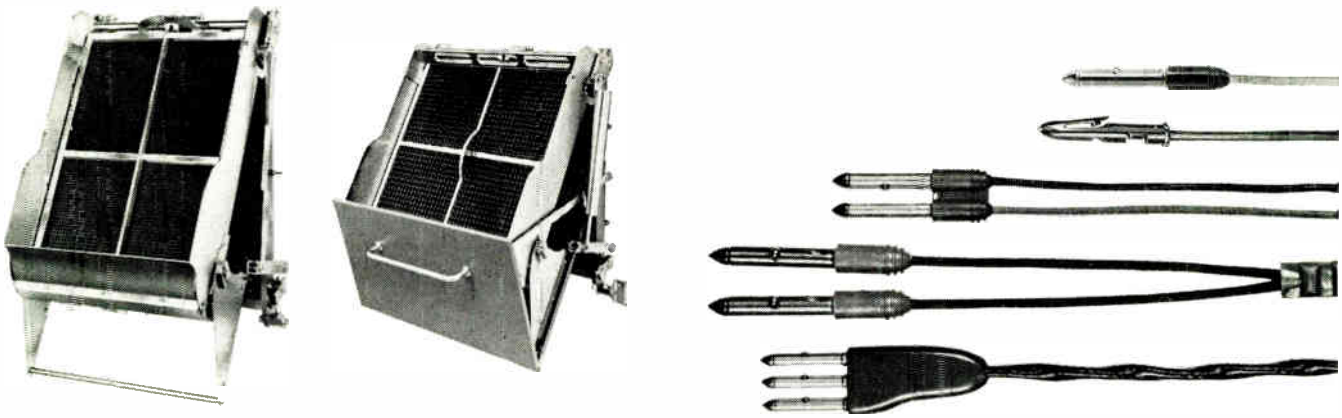
←——Circle 20 on Inquiry Card

ELEVEN SIZES OF PRECISION MAC PANEL PLUGBOARD PROGRAMMING



SYSTEMS PLUS A COMPLETE LINE OF PLUGWIRES AND HARDWARE



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MAC Panel's Plugboard Programming Systems range in size from 200 to 5120 positions, and are designed and engineered to assure rugged construction, flush mounting capabilities and ease of plugboard insertion. Each system consists of a precision engineered receiver, lightweight molded phenolic or diallyl phthalate plugboard and a complete line of plugwires. Whether your requirements call for special design applications or for a system to fit standard racks, MAC Panel assures you of quality and guaranteed satisfaction. See your MAC Panel representative or write for specifications.

MAC PANEL COMPANY, MAC PANEL High Point, North Carolina

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SHOW
3801-3812

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portable, solid state, SSB analyzer

Panoramic SSB-50 (2—40 mc) OPTIONAL TO 10 CPS

IDEAL FOR MOBILE AND ON-BOARD SIGNAL TESTS

PANORAMIC* Model SSB-50, rugged, fully modular, provides the stable, high-resolution spectrum analysis and two-tone generators needed for monitoring and checkout of modern SSB transmitters and receivers. Uses of the comprehensive SSB-50 include:

- Distortion, interference, unwanted sidebands, carrier levels, and noise measured to —60 db at a glance.
- 10 cps resolution and skirt selectivity for hum sidebands 60 db down.
- Audio, I-F, and Multiplex analysis to 10 cps with REC-2 Extender.

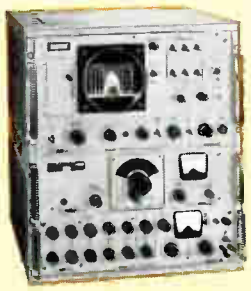
SSB-50 solid state construction has telescoped size and weight into a compact, easily mobile equipment with no compromise in performance. Operation is simple and self-checking at all steps. Battery operated portable or rack mount main frames are available. SSB-50 system elements are:

- TA-2 (portable) or rack mount RTA-50 Main Frame with bright, calibrated readouts.
- CA-5 *Panalyzor* Module. Preset and variable sweep widths to 100 kc. 60 db dynamic range, and self-checking markers.
- RF-8 Tuning Head Module, with jitter-free single knob tuning from 2 mc - 40 mc. Search and fine tuning modes provided.
- REC-2 Range Extender. 10 cps - 2 mc — without image response problems.
- Two-Tone AF and RF Generators — TTG-2 (100 cps - 10 kc) and TTG-5 (2 - 30 mc).

Performance and design of the SSB-50 reflect the leadership in the communications analysis field established by the well known *Panoramic* Model SSB-3b (AN/URM-134A) now used in hundreds of military and commercial applications — the standard of the industry!

Frequency Range: 2 - 40 mc, (10 cps opt. with REC-2), useable to 160 mc. ■ **Sweep Width:** Adjustable, 0 - 100 kc, plus five preset scans with automatic optimum resolution. ■ **Resolution:** 10 cps - 3 kc adjustable. ■ **Skirt Selectivity:** to 50 cps at —60 db points. ■ **Readout Scales:** Frequency, linear, ten divisions. Amplitude linear and 40 db (extendable to 60 db). ■ **Dynamic Range:** Residual distortion is at least 60 db down. ■ **Sensitivity:** Less than 20 μv f.s. **Flatness:** ±0.5 db over scan range; ±3 db overall. ■ **Self Checking:** Xtal cont. 2-tone IM test to —70 db; dispersion markers, 5 kc. ■ **Tuning Head Accuracy:** ±1%, sets to 0.01% with int. markers. Stability enables 10 cps resolution all freq. bands. QC per MIL-Q-9858A.

STANDARD OF THE INDUSTRY



2 - 40 mc

Panoramic SSB-3b Analyzer

(Equivalent to AN/URM-134A)

SSB-3b is continuously specified in systems not requiring solid state compactness. It is standard in several Air Force and Navy programs. Delivery is off-the-shelf. Optional capabilities available as modules. Major performance specifications are similar to above SSB-50. Conformance to specifications and reliability are well established. Write for complete information.

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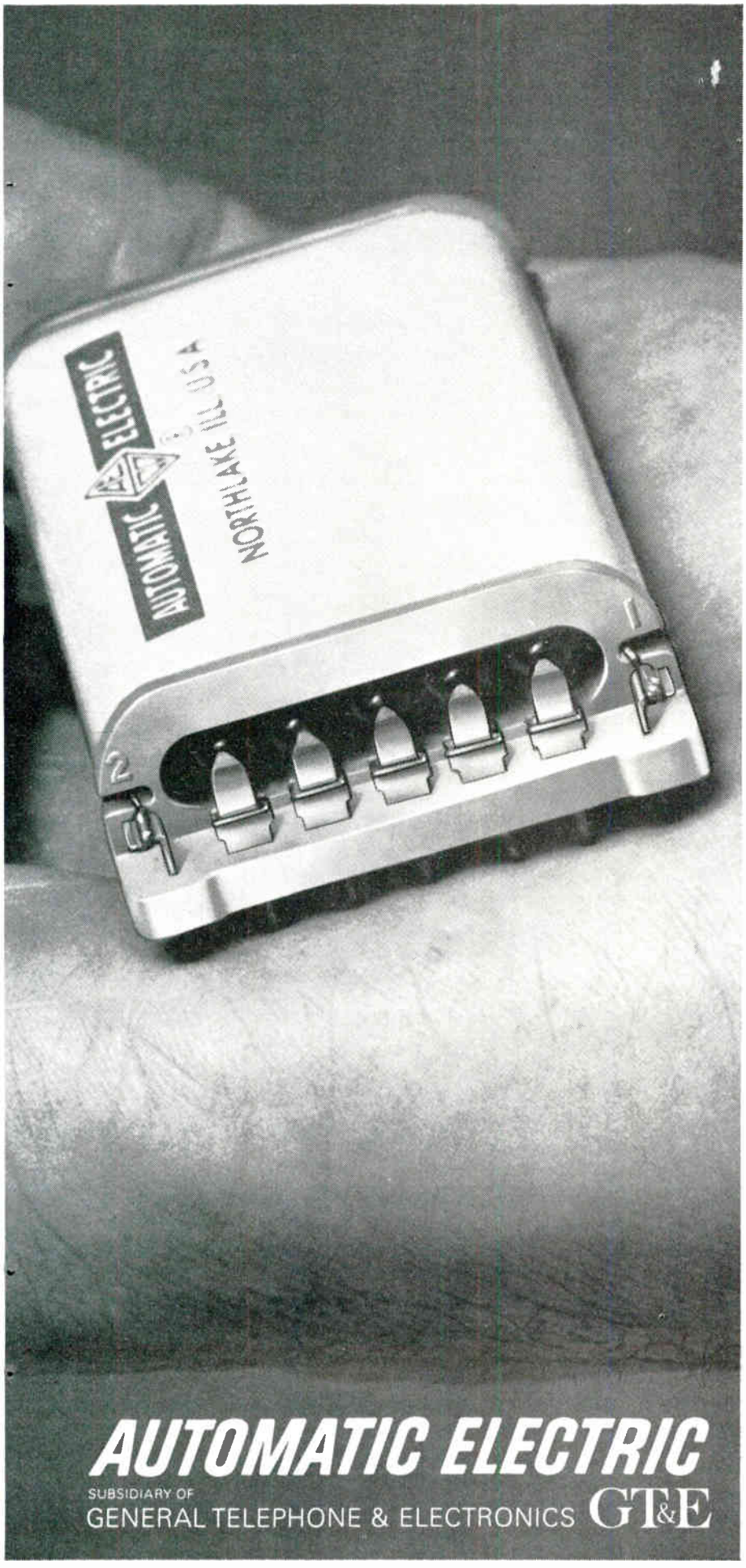

AE has developed a new Correed that overcomes the principal mechanical and electrical shortcomings of conventional dry-reed switches designed for mounting on printed circuit boards. The result: new 1-, 2-, 3- and 5-capsule PC Correeds* and a single-capsule magnetic latching type, all incorporating the five advanced features...

1 Separate Terminals—The capsule leads are not used as terminals. Separate terminals provide superior electrical contact and eliminate strain on the glass capsules.

2 "I-Beam" Strength — The terminals are longitudinally "ribbed" for added strength and rigidity. This facilitates insertion into printed circuit boards.

3 Welded Connections — The contact terminals are welded—not soldered — to the capsule leads, assuring serviceable connections. Capsules can be removed without having to remove the entire package.

4 Moisture Resistance — AE uses glass-filled plastic bobbins for greater strength and to eliminate electrical failure due to moisture absorption.

5 "Standard" Measurements — Measurements between terminal centers are multiples of 0.200 inches, in accordance with industry standards for circuit boards. Standardized terminal size and spacing also allow for greater package density.

These new PC Correeds have magnetic shields surrounding the coils, to avoid interaction between adjacent Correeds; also provisions for soldering diodes directly to the upper side of the terminals.

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

[*U. S. Patent applied for.]

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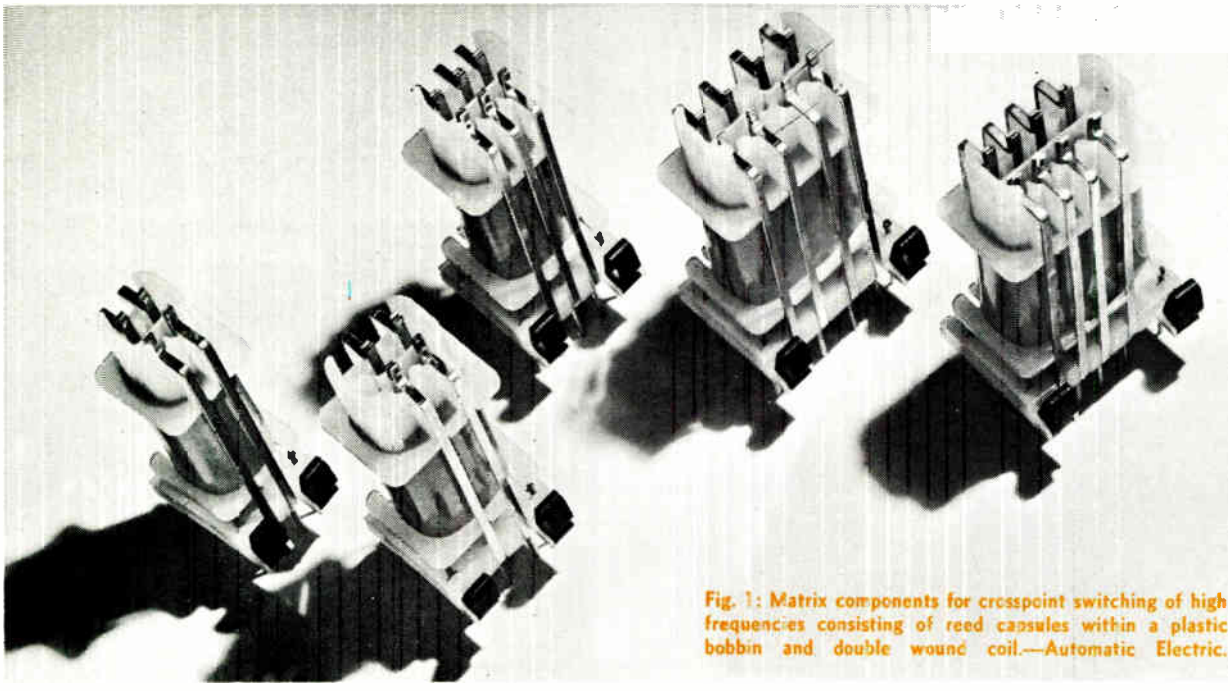


Fig. 1: Matrix components for crosspoint switching of high frequencies consisting of reed capsules within a plastic bobbin and double wound coil.—Automatic Electric.

1965 Survey of Relay Specifications

First of a series of special reports giving key commercial and military type relay specifications as compiled by EI editors from information supplied by 230 relay manufacturers.

ELECTRONIC INDUSTRIES
STATE-OF-THE-ART
FEATURE

AN ELECTROMECHANICAL RELAY is basically simple, consisting of an electromagnet and a moveable armature to actuate one or more sets of contacts.

Indeed, its very simplicity can lead the engineer into grossly misapplying the device. Proper selection requires a general understanding of the important relay parameters and the variations that can take place with changes in conditions such as temperature and voltage. This information is usually contained in the manufacturers' product literature. With it, the designer will find it possible to optimize a given characteristic important to his design. MIL-R-5757, Mil-R-6106, Mil-R-9221 and other published military specifications outline important parameters of military relays, and provide the basis for specifying most general purpose military relay requirements.

For those interested in thorough technical discussions of relay design and application characteristics, a wealth of material is available from the National Association of Relay Manufacturers (NARM), P. O. Box 7765, Phoenix, Ariz. 85011. Also, a document, "American Standard Definitions and Terminology for Relays," may be purchased from the American Standards Association, Inc., 10 E. 40th St., New York 16.

Watch future issues for more in this
RELAY SURVEY
Part 2: STEPPERS & COUNTERS
H. V. RELAYS
Part 3: POWER RELAYS
Part 4: SPECIAL & G. P. RELAYS
(Incl. Telephone & Subminiature Types)

Relay Classifications

Part I of this survey presents reed relays and sensitive relays, two unrelated classes which make up a large segment of the more than 2,000 different relay types that are available.

Relays may be classified in a number of ways, by size, contact rating, input power, by application, such as high speed, military, printed-circuit, or by design, i.e., mercury wetted, hermetically sealed, latching, d-c operated, etc. Depending upon the classifications used, many relays could conceivably fit into several or perhaps all the categories, with great duplication for so comprehensive a listing as this.

Relay classifications selected for the EI survey (see note on future relay issues) are based on those used most by relay suppliers in describing their products. For example, types listed as "sensitive" relays are those referred to as such in the manufacturers' literature. The range of power sensitivities of those listed

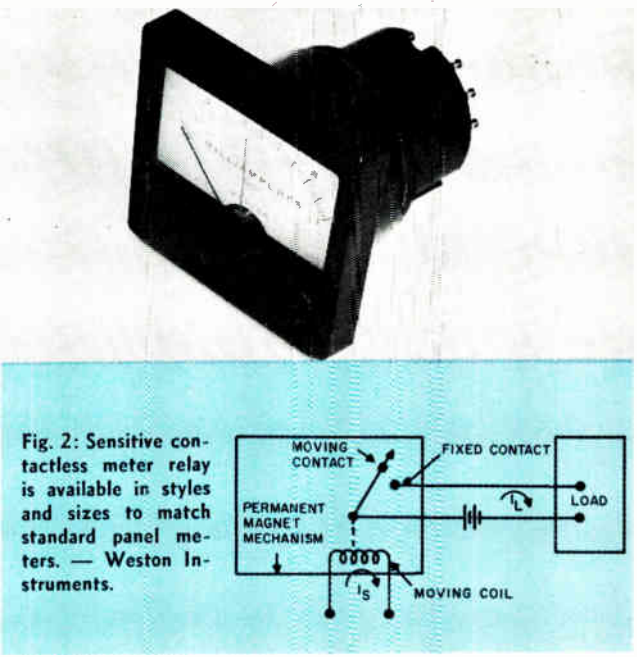


Fig. 2: Sensitive contactless meter relay is available in styles and sizes to match standard panel meters. — Weston Instruments.

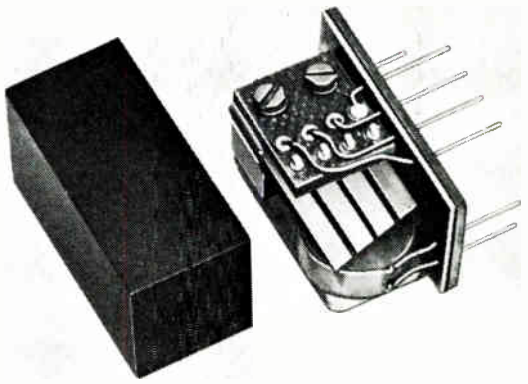


Fig. 3: Four-channel resonant reed relay designed for printed circuit mounting. Tone sensitive decoder is used in selective calling, the telemetry and industrial control.—Bramco, Inc.

Fig. 4 (below): Miniature mercury wetted reed relay.—Grigsby-Barton, Inc.

Part 1. Reed Relays and Sensitive Relays

in this class is quite wide, so the coil power column should be consulted to see if the relay listed answers your requirements as a sensitive relay.

Reed Relays

The reed relay is one that by design at least is in a class by itself. The switch capsule consists of two identical nickel-iron reeds sealed in either a vacuum or inert gas atmosphere within a glass tube. A coil surrounding the tube generates a magnetic flux which magnetizes the reeds, causing them to flex (as little as .006 inch) and make contact. Gold, silver, tungsten, rhodium and molybdenum, as well as mercury-wetted contacts are available for various applications. By using a permanent magnet bias with the capsule and coil, a normally closed, or Form B contact is formed. When the Form B switch is actuated, current through the coil creates a magnetic field that opposes the bias magnet, allowing the switch to open. Form B contacts are also made by using a Form C and clipping off the normally-open terminal. Form A and Form B contacts can be combined to provide one or more Form C (make before break) contacts in a single tube. Up to six or more contacts are common in a single relay package.

With operating speeds in the tenths of a millisecond, the dry reed relay is faster than any electromechanical

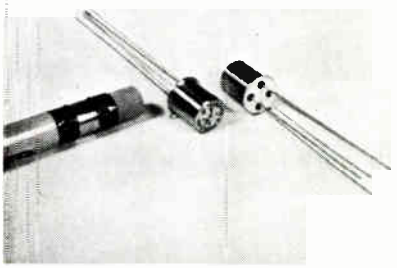
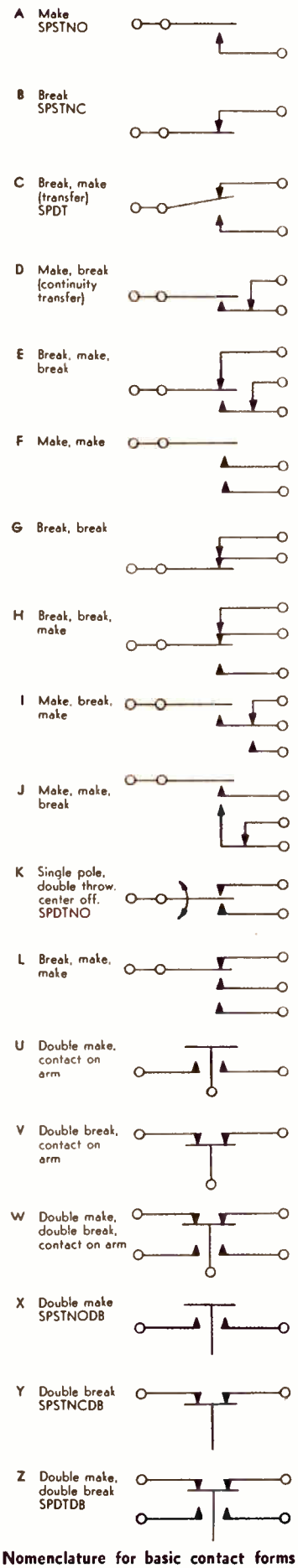


Fig. 5: Sensitive SPDT relay for .5 amp switching hermetically sealed and all welded in TO-5 case. — Teledyne Precision, Inc.

Fig. 6: (below) Sensitive relays to cover wide resistance and voltage ranges. — Terado Corp.



Nomenclature for basic contact forms — American Standards Association.

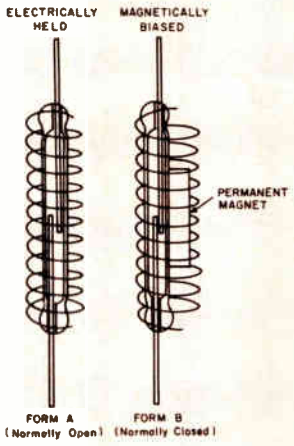


Fig. 7: (left): Simple Form A reed becomes Form B by use of bias magnet to hold contacts closed. Current creates opposing magnetic field to open contacts.

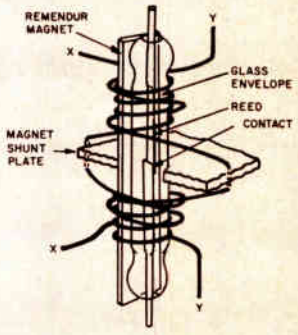


Fig. 8 (right): Key switch in Bell Systems new central office is bi-stable "Ferreed" which remains closed in either position with short current pulse.

REED RELAYS (Continued)

relay. Like other relays reed switch life is a function of contact load and actuation frequency, being billions of operations for dry circuit levels and in excess of 100 million for the mercury capsule at rated resistive load. Special reed contacts must be used for high inrush currents; otherwise reed contacts may be damaged. Electrical noise levels are somewhat higher in reed relays.

Reed relays together with crystal can and solid state relays perform the great majority of all low level switching operations today. The comparative advantages of each of these switching devices is detailed in the chart.

Resonant Reeds

A resonant reed relay, commonly called a decoder, is an electromechanical device that acts as an audio frequency filter, detector and amplifier switch. It has one or more steel reeds suspended in a magnetic circuit produced by a permanent magnet for bias and a field coil that receives the exciting AC signal. Each reed has contacts which close intermittently when the reed vibrates at its resonant frequency. The intermittent contact closure supplies low levels of pulsating DC which can be integrated with a capacitor to switch light loads or sensitive relays.

An audio tone to excite the resonant reed can be generated by an electronic oscillator or another resonant reed *encoder*.

Compared to other types of tone filters, resonant reeds are small and inexpensive. Bandwiths are in the order of 1%, corresponding to an LC filter with a Q of several hundred. Also, power gain is high. A typical resonant reed relay operating at 20 milliwatts input is capable of switching one watt—a power gain of 50 to 1.

Sensitive Relays

Many plate circuit and instrument, or meter relays, are considered sensitive relays. The most sensitive type of electro-magnetic relay is the meter relay. Operated by microwatt energy levels, it can be used to sense either current or voltage and has found wide-spread applications for control and alarm requirements. There are meter relays with power gain factors in excess of 500,000.

The first meter relay designs, known as the sensitive contact type, depended solely upon the current flowing through the moving coil to maintain contact pressure. To im-

NOW... P&B QUALITY IN A FULL LINE OF

SOLID STATE time delay relays

FAST
ACCURATE
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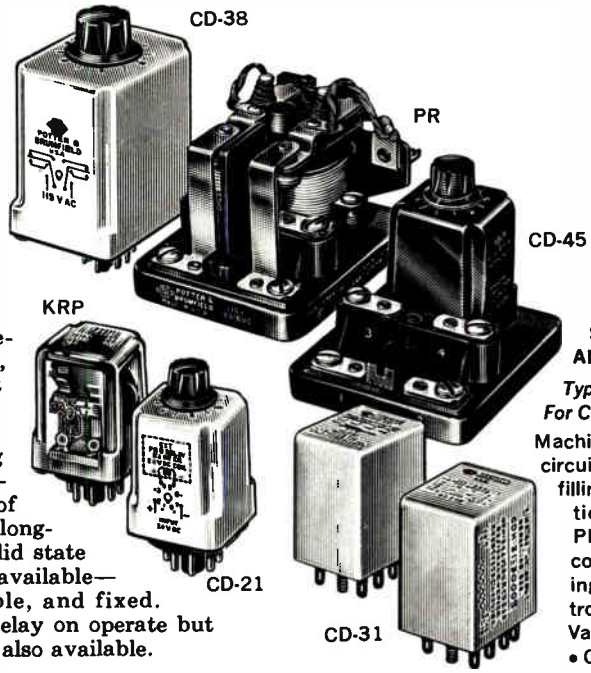

A wide range of time delay requirements can be met with these accurate, easy-to-use solid state relays. All built to P&B's exacting standards of reliability, this new series offers a multitude of advantages, including timing repeatability of ± 2%; nearly instantaneous (milliseconds) reset; a choice of sizes, mountings and terminations; long-life inherent with non-mechanical solid state switching. Three modes of timing are available—knob-adjustable, resistor-adjustable, and fixed. Most standard relays provide time delay on operate but relays with time delay on release are also available.

CD-38 HAS RELIABLE P&B DPDT RELAY MOUNTED INSIDE CASE
An internally mounted DPDT relay has contacts rated to 10 amps, 115V AC, resistive. Fixed time delay can be specified or relay can be adjusted with knob or external resistor.

CD-21 TIME DELAY PAIRS WITH POPULAR P&B KRP SERIES RELAYS
Compact AC or DC units available to time in increments from 0.1 to 180 seconds. For use with popular P&B KRP relay which provides up to 3PDT switching. Delay time may be fixed or adjusted with knob or external resistor.

USE CD-45 WITH PR RELAY FOR HEAVY DUTY APPLICATIONS
Designed for use with PR power relay in elevator controls, machine tools and other industrial applications. Contacts will switch up to 25 amps at 115V AC non-inductive, or 1 HP at 115/230V AC single phase. Heavy-duty screw terminals. Time delay: fixed or knob-adjustable.

CD-31 USED WITH KH RELAY PROVIDES 4PDT SWITCHING
Only slightly larger than one cubic inch. Available with fixed or resistor-adjustable time delay. Match with KHP relay for up to 4-pole switching capacity. Plug-in convenience when used with socket having solder or printed circuit terminals.

SOLID STATE TIME DELAY RELAYS ARE EASY TO APPLY IN ANY CIRCUIT

Typical Applications
For CD Series Time Delay Relays

Machine tool sequencing • Motor starting circuits • Vending machines • Container-filling control • Data processing operations • Warm-up or turn-on delay • Photographic process control • Recorded message repeater • Heat sealing • Induction heating • Elevator controls • Die casting • Alarm circuits • Vacuum processing • Injection molding • Conveyor control

THESE STANDARD TIME DELAY RELAYS ARE AVAILABLE FROM ELECTRONIC PARTS DISTRIBUTORS

Type	Time Delay in Seconds	Input Voltage	Notes	Sugg. Resale Price
CDB-38-70003	0.1 to 10	115V AC	1	43.80
CDB-38-70004	0.6 to 60	115V AC	1	43.80
CDB-38-70005	1.8 to 180	115V AC	1	43.80
CDD-38-30003	0.1 to 10	24V DC	1	41.55
CDD-38-30005	1.8 to 180	24V DC	1	41.55
CDB-21-70003	0.1 to 10	115V AC	2	38.70
CDB-21-70001	1.8 to 180	115V AC	2	38.70
CDD-21-30003	0.1 to 10	24V DC	3	38.35
CDD-21-30001	1.8 to 180	24V DC	3	38.35
CDH-31-30005	180 (note 5)	24V DC	4 & 5	38.90
CDB-45-70002	0.6 to 60	115V AC	6	37.05
CDB-38-70012	0.6 to 60	115V AC	1 & 7	52.45
CDD-38-30012	0.6 to 60	24V DC	1 & 7	49.50

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

Now available at leading electronic parts distributors

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In Canada: Potter & Brumfield, Division of AMF Canada Ltd., Guelph, Ont.
Export: AMF International, 261 Madison Avenue, New York, N.Y.

CRYSTAL CAN & REED RELAY COMPARISONS

	CRYSTAL CAN	MINIATURE REED	STANDARD REED	MERCURY-WETTED REED	TRANSISTOR SWITCH
OPERATE TIME (INCL. BOUNCE)	5 ms	0.7 ms	2.0 ms	2.2 ms	< 10 μs
RATED RESISTIVE LOADS	2 A., 52 W.	0.12 A., 4 W.	1 A., 15 W.	2 A., 50 W.	< 0.5 W.
SUITABILITY FOR INDUCTIVE LOADS	Best	Good	Good	Poor	Poor
CONTACT ISOLATION	High	High	High	High	Low
INITIAL C-C CONTACT RESIST. (OHMS)	.05	0.1	.05	.03	1.0
O-C RESISTANCE (OHMS)	10^8	10^{12}	10^{13}	10^8	10^6
POWER CONSUMPTION	1 W.	0.125 W.	0.15 W.	0.15 W.	.05 mw
TEMPERATURE STABILITY	High	High	High	High	Low
SPACE & WEIGHT SAVINGS	Good	Excellent	Fair	Fair	Excellent
RELATIVE CIRCUIT COSTS	Low	Low	Low	Higher	Highest
AUX. CIRCUITRY	Simple	Simple	Simple	Simple	Complex

Fig. 9: Information compiled by Wheelock compares the characteristics of reed and crystal can relays.

prove reliability and increase scope of applications, additional contact force was obtained by design of the magnetic contact relay which used magnetic contacts or magnets. Then came the use of an additional winding on the moving coil called an aiding coil, to provide a design known as a "load current contacting aiding" (LCCA) relay. Because DC is required by the aiding coil, this type relay is necessarily a DC relay.

A new concept in the field of meter relays is the contactless type. This relay operates when a vane attached to the pointer interrupts light being directed from an internal lamp onto a photocell. The change in photocell resistance in turn operates a power relay or SCR circuit. Microampere sensitivity is obtainable. Of course, the load current to be switched can be quite high.

Dry Circuit Switching

Dry circuits, or low level circuits, are generally in the millivolt and microampere region and have been defined as circuits carrying values of voltage or current that are too low to cause any physical change in a relay contact.

Physical change in the contact surface is important to continued low contact resistance. In a relay switching under normal rated load conditions at current values of, say, an ampere, current density in the contact area is sufficient to provide constant cleaning or burnishing action, keeping the contacts free of insulating contaminants caused by dirt particles or corrosive gases. At current values less than a half ampere ("minimum" current values are considered to be between 25 and 500 ma), the action is reduced and contact resistance can rise. However, in low level circuits (for which the NARM has established 50 millivolts and one milliampere as maximum values for testing purposes) there is insufficient voltage to break through the barrier film and insufficient current to produce arcing and heating to cleanse the contact area, causing the contact resistance to become very high. For this reason the contacts of the relay are of noble metal to resist corrosion and are manufactured to maintain optimum cleanliness.

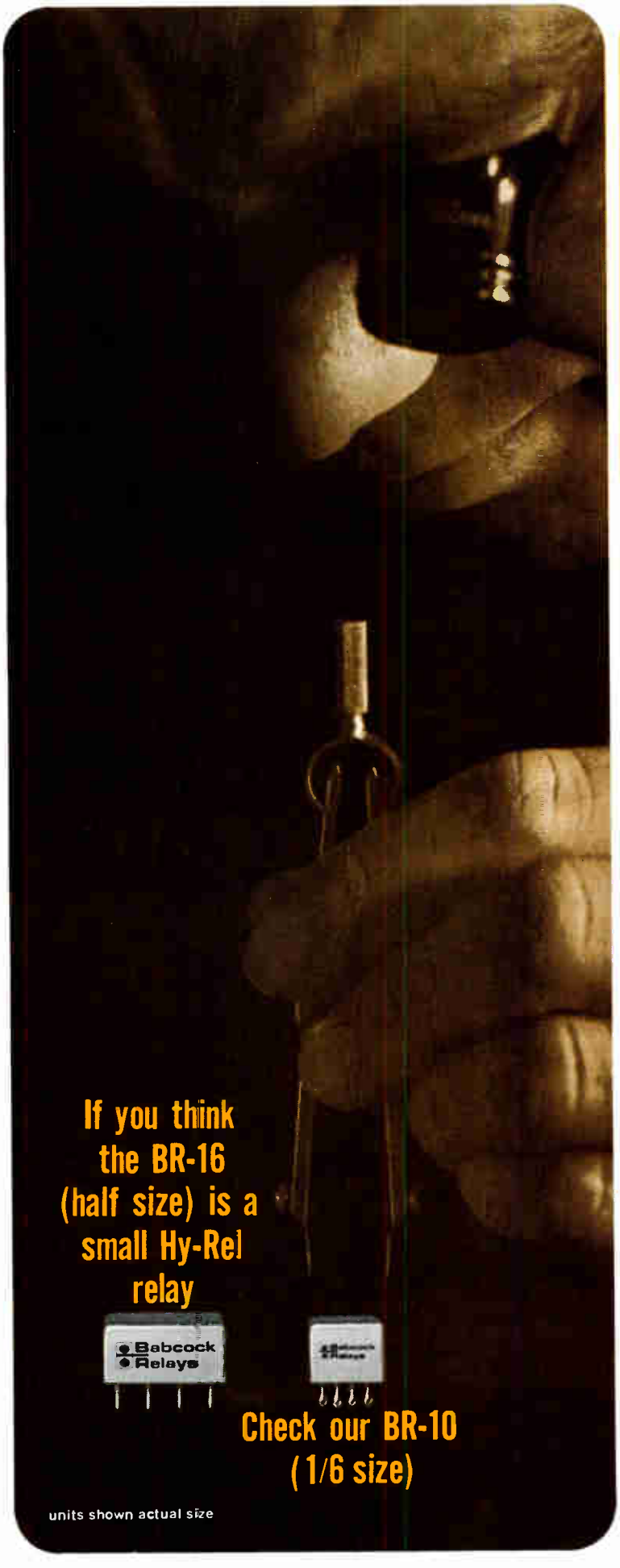
Higher contact resistance, to as high as 500 ohms, is usually permissible for low level switching. It is common practice in certain applications, however, for the relay manufacturer to provide a run-in miss test of a few thousand operations to determine the ability of the relay to perform its low level switching function. Detailed information on dry circuit contacts and testing methods was the subject of a paper presented at the NARM symposium in April, 1964.*

"Survey of Relay Specifications" starts on page 48

*"Recommended Techniques and Specifications for Low Level Switching" by J. A. Garratt, available from Hi-G, Inc. Windsor Locks, Conn.

REED SWITCH MANUFACTURERS

Automatic Electric Company, Northlake, Ill.
C. P. Clare, 3101 Pratt Blvd., Chicago, Ill.
Coto-Coil, 65 Revillion Ave., Providence, R. I.
Electronic Specialty Co., 4561 Colorado Blvd., Los Angeles, Calif.
General Reed, 174 Main St., Metuchen, N. J.
General Electric, Specialty Control Dept., P.O. Box 812, Waynesboro, Va.
Gordos Corp., 250 Glenwood Ave., Bloomfield, N. J.
Hamlin, Inc., Lake and Grove Sts., Lake Mills, Wisc.
Hathaway Instruments, 5800 E. Jewell Ave., Denver, Colo.
IBM, White Plains, N. Y.
ITT, Distributor Prods., 20 Broadway, N. Y., N. Y.
Line Electric Co., 229 River St., Orange, N. J.
New Products Engineering, Wabash, Ind.
RBM Controls, 131 Godfrey St., Logansport, Ind.



Babcock's new BR-10 1/6-size crystal can relay will switch dry circuit to 1-amp loads with the same sensitivity as DPDT types many times its size. Designed for low profile mounting, it exceeds MIL-R-5757D requirements and withstands severe environmental conditions encountered in airborne applications. Available both single pole and double pole.

For 2-amp contact requirements, the Babcock BR-17 (latching) and BR-16 (non-latching) half-size crystal can relays provide the same reliability and, like the BR-10, incorporate the exclusive Babcock Vycor getter to adsorb outgassed organic contaminants after production degassing. Various mounting arrangements and either plug-in or solder hook terminals can be supplied as standard. Write for complete details in our new 24-page catalog.

	BR-16	BR-17	BR-10T	BR-10W
Operation	Non-Latching	Latching	Non-Latching	Non-Latching
Contact Arrangement	DPDT	DPDT	DPDT	DPDT
Construction	All Welded	All Welded	Solder Seal	All Welded
Sensitivity	175mw	175mw	100mw	100mw
Contact Rating	2A @ 26VDC	2A @ 26VDC	1A @ 26VDC	1A @ 26VDC
Size	.131 cu. in.	.131 cu. in.	.046 cu. in.	.046 cu. in.
Weight	.25 oz.	.25 oz.	.15 oz.	.15 oz.
Vibration	30g 30-2000 cps	30g 30-2000 cps	30g 40-3000 cps	30g 40-3000 cps
Shock	50g 11 msec.	50g 11 msec.	150g 11 msec.	150g 11 msec.

See us at Booth 2927 IEEE

BABCOCK RELAYS

A DIVISION OF BABCOCK ELECTRONICS CORPORATION
3501 HARBOR BLVD., COSTA MESA, CALIF. · (714) 546-2711

THESE are reed relays...

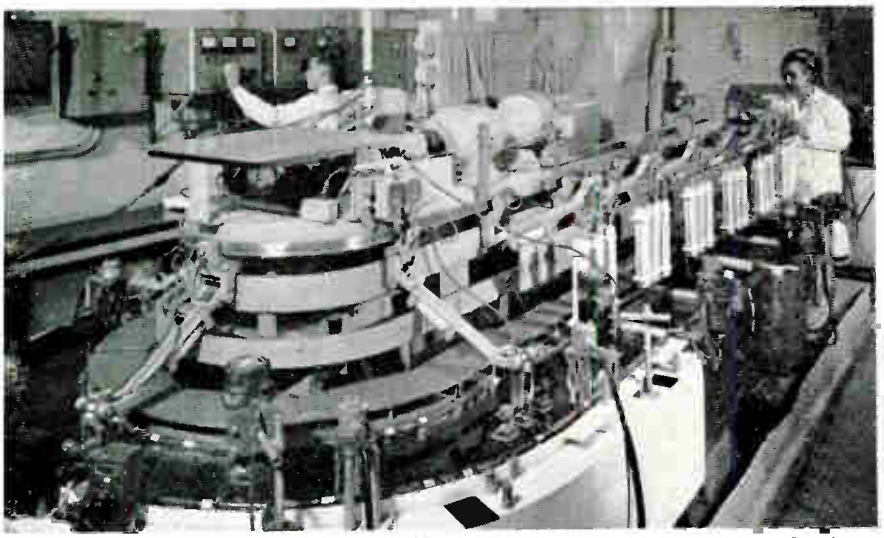
But make no mistake. Don't confuse them with ordinary reed type relays. These are

CLAREED® relays...built by Clare from start to finish. Every step in the manufacture of every part—nickel iron reeds, contact plating, encapsulation in glass, coil winding, final packaging, testing—is performed by Clare in Clare plants, under Clare supervision to one high quality standard.

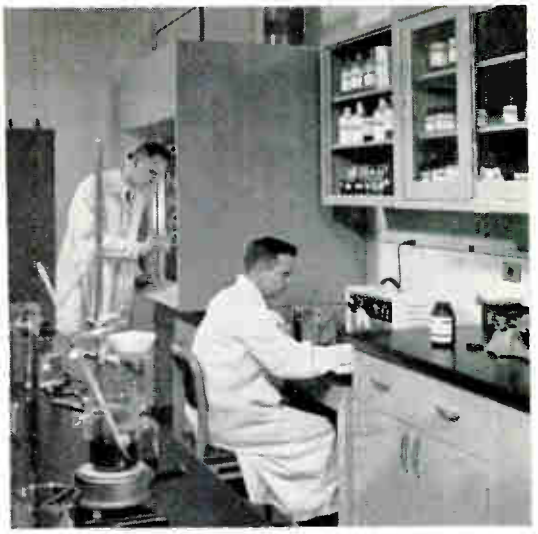
Every CLAREED switch is tested so that *every switch* always operates consistently with proper characteristics *every time*. Relay assemblies are *tested 100%* for coil breakdown, operating characteristics, contact resistance and CLAREED switch seal integrity.

Try CLAREED relays. That's the real way to know how this careful control Clare exercises over every single CLAREED relay pays off in longer life, consistent performance and greater reliability for you and your products.

CLAREED relays provide the switching capability needed for practically every type of control function. For wired assemblies, for printed circuit application, or as complete switching units in functional printed circuit board assemblies, look to CLAREED relays. Want to know more? Call or write C. P. Clare & Co., Group 3D9, 3101 Pratt Boulevard, Chicago, Illinois 60645.



EXACTING, controlled mass production begins with nickel-iron reeds of carefully-determined metallurgical characteristics. Blades are pre-straightened. Contact areas are flattened to assure precise mating in the "closed" position, then gold-plated (above) for consistent contact resistance.



CONTINUOUS in-process quality control procedures assure careful adherence to standards... resulting in long switch life.

CLEAN parts assure CLAREED cleanliness. Ultra-sonic cleaning removes all contaminants from contact surface.

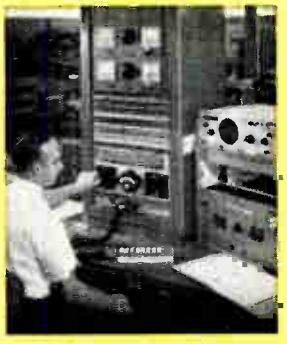
PRECISION, automatic, clean-room assembly provides consistent, same-characteristic CLAREED switches... every time.

STANDARD quality control subjects switches to statistical physical tests and 100% electrical checks... including hermetic seal checkout, micro-visual inspection and ten automatic electric tests.

AND *this means you get* *built-in reliability* *when you specify* *CLAREED relays or control modules.*

ASSEMBLIES are 100% tested for coil breakdown, operating characteristics, contact resistance, and seal integrity.

CLARE production controls ...from switch parts to printed circuit board assembly...are to one high quality standard.



FINAL tests of printed circuit board assembly, relay operation, and circuit function assure CLAREED quality...everytime.

CLARE®

relays and related control components

SPECIFICATIONS OF REED RELAYS & SENSITIVE RELAYS

REED RELAYS

RELAY MANUFACTURER	TYPE NO. OF SERIES	AC OPERATED	AC-DC	DC OPERATED	MULTIPLE COIL	GENERAL PURPOSE	CHOPPER	HIGH VOLTAGE	LATCHING	LOGIC	MAGNETIC SHIELDED	MERCURY WETTED	MINIATURE	MULTIPLE CONTACT	MULTIPLE REED	POLARIZED	RESONANT REED	STEPPER	SUBMINIATURE	TIME DELAY	NO. OF POLES	CONTACT FORM	NOM. CONTACT VOLTAGE (V)	NOM. CONTACT CURRENT (A)	NOM. CONTACT VA	NOM. COIL VOLTAGE (V)	NOM. COIL CURRENT (A)	NOM. OPER. SENSITIVITY (MW)	NOM. OPER. SPEED (MS)	MOLDED	ENCASED	PLUG-IN	P.C. MTG.	SIZE (CU. IN.)	WEIGHT (OZ)	MIL-R-5757 SPEC.
ALLEN-BRADLEY CO. 136 W. Greenfield Ave. Milwaukee 4, Wisc.	1610			X					X				X	X	X	X					3-12	A,B	150	2	15	24-48					X						
AUTOMATIC ELECTRIC CO. North Lake, Ill.	PC		X								X																									
	1A		X	X					X																											
	2A		X	X																																
	6A		X	X																																
	4A		X	X																																
C. P. CLARE CO. 3101 Piatt Blvd. Chicago, Ill.	CR			X		X															1	A,B	to 250	1	15	to 97		.7-6.5		X	X	X			
	CR2			X		X															2	A,B	to 250	1	15	to 149		.7-6.5		X	X	X			
	CR3			X		X															3	A	to 250	1	15	to 149		.7-6.5		X	X	X			
	CR5			X		X															5	A	to 250	1	15	to 200		to 7		X	X	X			
	CR6			X		X															6	A	to 250	1	15	to 255		to 7		X	X	X			
	CR8			X		X															8	A	to 250	1	15	to 327		to 7		X	X	X			
	CR12			X		X															12	A	to 250	1	15	to 180		to 10		X	X	X			
	CR42			X																	2,2	A,B,C	to 250	1	15	to 270				X	X	X			
	CR62			X																	3	C	to 250	1	15	to 405				X	X	X			
	CR82			X																	4,4	A,B,C	to 250	1	15	to 212				X	X	X			
	CR2			X						X											1,2	A								X	X	X			
COMPUTER COMPONENTS 88-06 Van Wyck Express Jamaica, N. Y.	CCMR					X							X										250	.5	12				1	X					
	CCLR					X							X										500	1	15/25				2	X					
	CCLR					X		X					X									C	250	1.5	10/40				2	X					
	CCLR											X	X										5K	3	25/50				3	X					
	CCLR											X	X										400	3	25				1	X					
	CCR	X				X															1,2	A,B,C	250	.12		6-32		150	1	X		X			
COTO-COIL 65 Pavillion Ave. Providence, R. I.	S			X		X									X						3	A,C,D	400	1		6-48		400		X		X			
	SR SF			X		X									X						3	A,C,D	400	1		6-48		330		X		X			
	SP			X		X									X						2	A,C	400	1		6-48		250		X		X			
	SA			X		X									X						2	C,D	400	1		6-48		575		X		X			
	SD			X		X									X						2	A,C,D	400	1		6-48		430		X		X			
	M			X		X									X						3	A,C,D	400	1		6-48		700		X		X			
	U			X		X										X					1	A	400	.5		6-48		240							
	UD			X		X										X					3	A,B,C	400	.5		6-48		400							
	UV			X		X										X					5	A,B,C	400	.5		6-48		300							
	T			X		X										X					6	A,B,C	400	.5		6-48		350							
DAVIS ELECTRIC CO. 230 Spring Ave. Cape Girardeau, Mo.	MR1A			X		X															1	A	250	.5		6-24		270	1	X	X				
	MR2A			X		X															2	A	250	.5		6-48		350	1	X	X				
	MR4A			X		X															4	A	250	.5		to 115		900	1	X	X				
	SR1A			X		X															1	A	250	1		to 115		200	2	X	X				
	SR2A			X		X															2	A	250	1		to 115		300	2	X	X				
	SR1C			X		X															1	C	250	.5		to 115		300	2	X	X				
	SR2C			X		X																C	250	.5		to 115		400	2	X	X				
	SR1CT			X		X															1	C	500	1.5		to 115		200	2	X	X				
	SR2CT			X		X															2	C	500	1.5		to 115		400	2	X	X				

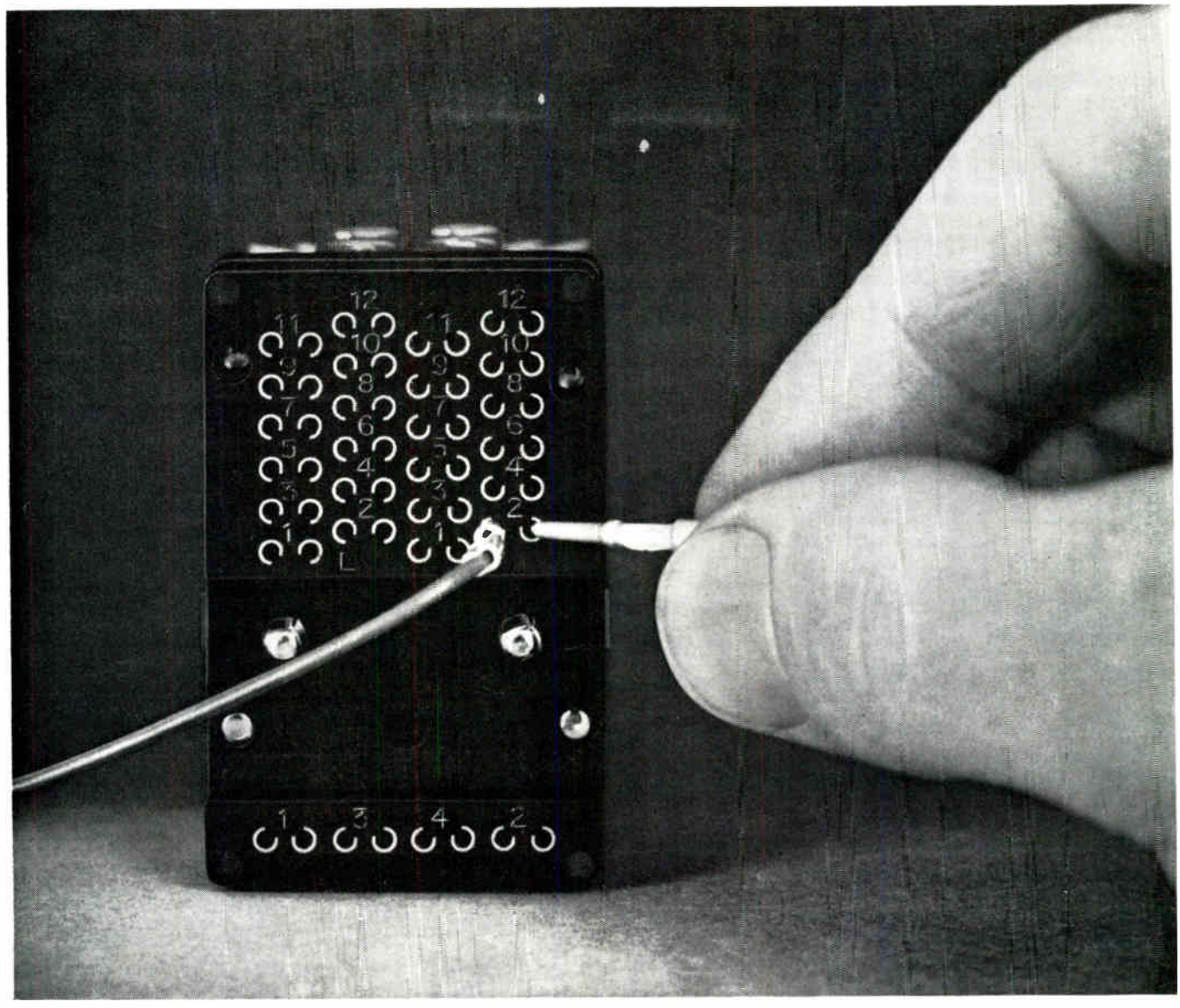
A STATE-OF-THE-ART REPORT

The following survey of technical specifications on reed relays and sensitive relays has been compiled by ELECTRONIC INDUSTRIES directly from information supplied by the individual manufacturers. The aim has been not so much to itemize each specific relay, but rather to guide the design engineer to the appropriate manufacturer and the series of relays which is most likely to fill his needs.

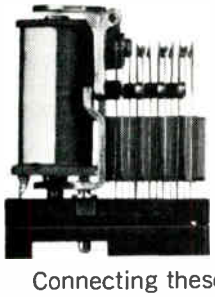
DORMEYER INDUSTRIES	4000			X		X							X	X							1-4	A	250	.125		6-48		100	2			X	X			
3418 Milwaukee Ave.	1000			X		X								X							2	DT	500	1.5		6-48	.1		2			X				
Chicago 41, Ill.	3000			X		X								X					X		1-2	DT	200	.25		6-24			2		X	X	X			
FISHER AKIN CO.	101			X									X									B	250	.5	12	15			.5					2		
1005 Sepulveda Blvd.	101-1							X				X									6	A,B,C		3		15										
Manhattan Beach, Calif.																																				
GENERAL AUTOMATIC CORP.	400	X		X										X							1	A,B,C	250	.125	12	6-48			1							
111 33rd St.	420	X		X										X							1	A,B,C	250	1	15	6-48			1							
Union City, N. J.	421	X		X										X							1	A,B,C	250	3	50	6-48			1							
GENERAL REED	400			X		X					X		X								1-3	A,C	120	1	15	6-28		150	1		X	X	X	½	12*	
174 Main St.	C			X		X							X								1,2	DT	115		15	6-28		150	1				X		8*	
Metuchen, N. J.																																				
GRIGSBY-BARTON	GB21			X		X						X							X			A/B	250	.5	12	6-24		200	1	X	X	X	X	.25		
107 N. Hickory Ave.	GB31C			X		X							X									C	28	.25		6-32		250	1	X			X			
Arlington Heights, Ill.	GB31A			X		X						X	X									A	28	3		6-32		250	1	X			X			
	GB41			X		X						X										A-C		3		6-24		250	1	X						
	GB70			X		X													X		2	ST/DT	28	.25		6-32		250	1	X		X	X	.13		X
	GB80			X		X	(¼ size crystal can)												X		2	DT	28	.25		6-32		250	1	X		X	X	.064	6grm	X
	GB31HW			X		X						X	X								1	A	28	3		6-32		250	1	X		X	X			
HATHAWAY INSTRUMENTS	J,K			X		X															1-4	ST,DT				6-26		200	1		X					
DIV., LIONEL CORP.	R			X		X															to 12	A,B,C				6-28				X						
5800 E. Jewell Ave.																																				
Denver, Colo.																																				
INDUSTRIAL ELECTRONICS, INC.	832			X		X	X		X							X							400	.5	12	12									2	
8060 Wheeler St. Detroit, Mich.																																				
JAIDINGER MFG. CO.	–					X																A	250	.5	6			40	1							
1921 W. Hubbard St.																																				
Chicago, Ill.																																				
LEDEX, INC.	RD7														X		X		X		1-2	2-4T						15						.5	1.2	
123 Webster St.	RD10																X					NO	12	.1							X	X				
Dayton, Ohio	RE1																X						12-24	.018							X	X				
	RD1																X						12	.1		24	.03				X	X				
LINE ELECTRIC CO.	FR			X		X								X	X						4-6	A,C	110	.5	10	6-24			3	X	X	X	X			
DIV., IND. TIME CORP.																																				
229 River St., Orange, N. J.																																				
MAGNECRAFT ELECTRIC CO.	132MPC			X								X									1	A	400		50	6-48		500	2		X	X	X			
5575 N. Lynch Ave.	133MPC			X								X									1	C	400		50	6-48		500	2		X	X	X			
Chicago 30, Ill.	133LMPC			X					X			X									1	C	400	2	50	6-24		150	3		X	X	X			
	102MPC			X		X															1	A	250	1	15	6-48		500	3		X	X	X			
	103MPC			X		X															1	C	250	.5	10	6-48		500	2		X	X	X			
	103LMPC			X		X			X												1	C	200	.2	10	6-24		150	2		X	X	X			
	102VMPC			X				X	X														5K		50W.						X					
MAGNETIC COMPONENTS, INC.	C1-12			X		X													X		1	A	200	.5	12	4-12				X	X			.1		X
Garden Grove, Calif.	C1C			X		X													X		1	C	28	.25		3-12			1	X	X			.1		X
	D1/DO1			X		X							X								1	A,B	200	.5	12	4-24			1	X	X					X
	D2/DO2			X		X							X								2	A,B	200	.5	12	4-24			1	X	X					X
	D3			X		X							X								3	A	200	.5	12	4-24			1	X	X					X
	RD			X		X	(Magnetic Bias)						X								1-4	ST	200	.5	12	4-24			1	X	X					X
	E1/EO1			X		X	(Magnetic Bias)						X								1	A,B	200	.5	12	4-24			1	X	X					X
MALLORY TIMERS CO.	RS					X									X	to 6		X					12	.1							X	X			to 2	
DIV. OF P. R. MALLORY	RRA					X			X						X	1-2		X			1	A	110	.1					150		X	X				
& CO., INC.	RRB					X			X						X	1-2		X			1,2	A,B,C		2					225		X	X				
3029 E. Washington St.	RRC					X			X						X	1-4		X			1	A		2					150		X	X				
Indianapolis, Ind.	RRD					X			X						X	1-4		X			1	A		2					150		X	X				

REED RELAYS (Continued)

RELAY MANUFACTURER	TYPE NO. OF SERIES	AC OPERATED	AC–DC	DC OPERATED	MULTIPLE COIL	GENERAL PURPOSE	CHOPPER	HIGH VOLTAGE	LATCHING	LOGIC	MAGNETIC SHIELDED	MERCURY WETTED	MINIATURE	MULTIPLE CONTACT	MULTIPLE REED	POLARIZED	RESONANT REED	STEPPER	SUBMINIATURE	TIME DELAY	NO. OF POLES	CONTACT FORM	NOM. CONTACT VOLTAGE (V)	NOM. CONTACT CURRENT (A)	NOM. CONTACT VA	NOM. COIL VOLTAGE (V)	NOM. COIL CURRENT (A)	NOM. OPER. SENSITIVITY (MW)	NOM. OPER. SPEED (MS)	MOLDED	ENCASED	PLUG-IN	P.C MTG.	SIZE (CU. IN.)	WEIGHT (OZ)	MIL-R-5757 SPEC.
MKC ELECTRONICS 454 E. Donavan Rd. Kansas City, Kans.	– – –					X X		X (Vacuum Contacts) (Coaxial Relay)						X					X		SPDT SPDT 1	SPDT A,B			to 25 12	3-24		100 25	1		X		X			
PERRY LABS, INC. 83 Perry St., Buffalo, N. Y.	WC252 DR5U					X							X		X		X X						150	.001				50 1.5	75		X X	X X			.5 .37	
PHIPPS PRECISION PRODUCTS 17100 Ventura Blvd. Encino, Calif.	PC OF RC							X	X X X		X X X	X	X X		X X X	X X X		X	 X 	X	7 1 1-2	A-M A-C A-C	250 250 250	.5 .5 .5	10W 10W 10W	 6-24 6-24	 .02 .02			X X	 X 	X 	X	7.2		
POTTER & BRUMFIELD DIV. OF AMERICAN FOUNDRY CO. Franklin, Ky.	JM				X	X	X				X	X									1-4	C,D	500	5	100			5	1		X	X			4	
DOUGLAS RANDALL, INC. 6 Pawtucket Ave. Westerly, R. I.	DR4 DR3	X X X		X X		X X X		X				X	X								1-4	A,B,C A,B,C A,B,C A,B,C	5K 250 400 500	 .5 3 1	50 12-50 25 15	125 115		400 10	1	X	X	 X	X	X		X
RBM DEVELOPMENT CORP. 174 Main St. Metuchen, N. J.	BRSR BRMR TRMR			X X X		X X X					X X X										1,2,4,6 1,2,4 1,2	NO NO DT	250 250 125		15 12 15	6-28 6-28 6-28		300 150 200			X X X				
SARGENT & GREENLEAF, INC. 24 Seneca Ave. Rochester 21, N. Y.	M510					X											X X		X				150 150	.002 .002		2		10	100	X	X X	X X	X	.37	.5	
SOLID STATE ELECTRONICS 15321 Rayen St. Sepulveda, Calif.	9000			X		X									X						1	A	250	.5	12	6-48			1	X				.5	
STEVENS, ARNOLD, INC. 7 Elkins St., S. Boston, Mass.	RR290	X	(avail. in freq. range 50–1565 cps)														X						50	.05		3		20				X				
STRUTHERS-DUNN, INC. Lambs Rd. Pitman, N. J.	RRLM RRL RR4					X			X	 X	X X X			 X	X X						to 12 4	 A	 250	 1	 4-15	6-48 6-48				X X	X X X	X X	X 			 X
TELEX/AEMCO DIV. **TELEX, INC.** 10 State St., Mankato, Minn.	152R MD20			X X															X X	 X	2 1	C ST/DT	26 250	.5 10W		30		250	5		X	X	X	.13	.4 .7	X
THERMOSEN, INC. 375 Fairchild Ave. Stamford, Conn.	A B			X X	3									X X	X X						4-8 3	C 2C	250 250	1 1	50 50	6-48 6-48		850 1W	10 5		X X	X X			4 4	X X
WHEELOCK SIGNALS, INC. Long Branch, N. J.	330 262 3002 3002HG 267 3015 360			X X X X 							X X X X X X X	 X X 	 X 	 X X	 X				X X		 1-5 1-4 4	 A,C A,B,C 	250 250 250 400 250 250	.12 .12 3 3 3 .12	 50W 10W 	3-24 6-48 6-48 6-120 6-48 6-120 6-24		150 125 160 200 200 150	.7 .9 3 2.5 1 3 .7		X X X X X X	X X X X X X	X X X X X X	 .37	.04 .2 1.39 2.3 .6	



Now you can quick-connect two wires to each socket terminal of the Class E relay



Here's new design flexibility—more than you've ever seen in plug-in Class E relays. The bottom view of our new ETP terminal* shows why.

For each terminal, the mating socket provides *two* taper pin receptacles. This is an AE exclusive, and it can *double* circuit capability: two wires on each contact terminal!

Connecting these wires is quick and easy. Just insert a taper pin—and get a connection that's even more secure than with conventional terminals.

And every time you make a circuit change, the connection is as good as the first one.

You can prewire the mating socket and later insert a standard Class E taper-tab relay. Add a plastic snap-on dust cover, and you've got a complete Series ETP assembly.

Sound interesting? Get some helpful details. Write for AE's Product News on the ETP socket.

Widest Mounting Choice

Besides this new ETP (taper pin) and the EIN (integral socket) versions, Class E relays are available with conventional solder, taper tabs, or w apped-wire terminals, or pins for plug mounting. This is the widest selection of Class E relay connections in the industry—another good reason to check Automatic Electric for *all* your relay needs. Write the Director, Relay Control Equipment Sales, Automatic Electric, Northlake, Illinois 60164. *Patent applied for

AUTOMATIC ELECTRIC

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS GT&E

SENSITIVE RELAYS

RELAY MANUFACTURER	TYPE NO.	AC OPERATED	AC-DC	DC OPERATED	GENERAL PURPOSE	HIGH SPEED	INDUSTRIAL CONTROL	LATCHING	LOW CURRENT	MERCURY-WETTED	MINIATURE	NEUTRAL	PLATE CIRCUIT	POLARIZED	SOLID STATE	SUBMINIATURE	TELEPHONE TYPE	INSTRUMENT RELAY	VOLT./CURRENT CHANGE DET.	NO. OF POLES	CONTACT FORM	NOM. CONTACT VOLTAGE (V)	NOM. CONTACT CURRENT (A)	NOM. OPR. VOLTAGE (V)	NOM. OPER. CURRENT (MA)	NOM. OPER. POWER (MW)	NOM. COIL RESISTANCE (KILOHMS)	NOM. OPER. TIME (SEC)	P.C MTG.	ENCASED	PLUG-IN	SIZE (CU. IN.)	WEIGHT (OZ)	MIL-R-5757 SPEC.	HERMETIC SEAL
ADAMS & WESTLAKE 1025 N. Michigan Elkhart, Ind.	MWS					X				X				X						1	C	to 500	2			15-60*	to 11		X	X	X	*Ampere-Turns			
ACOPIAN TECHNICAL CO. 927 Spruce St., Easton, Pa.	K101C1				X		X	(thyratron-operated relay)											X		SPDT	115	2	115						X	X		24		
ACROMAG, INC. 15360 Telegraph Rd. Detroit, Mich.	301/370 (Electronic Relay)																	X			DPDT		10	.001		.001									
AIRBORNE ACCESSORIES CORP. 1414 Chestnut Ave. Hillside, N. J.	ULTRELAY			X	X	(light/temp. sensitive relay)								X							SPST	115	400VA	(nom. input: 25 μw)						X	X		40		
AIRPAX ELECTRONICS, INC., SEMINOLE DIV. Ft. Lauderdale, Fla.	AMS45			X	(metering sensitivity: (1 microampere)									X				X	X		DPDT	115	2	(input signal: 0/1 ma.)						X					
ALLIED CONTROL CO., INC. Plantsville, Conn.	RSH			X	X															1,2	DT	115	1			30	to 28	.025		X	X		2	X	X
	SW			X	X															1,2	DT	115	2	to 32		10	to 14			X	X			X	X
	JSH			X	X															1,2	DT	115	1							X	X		2	X	X
	WJS			X	X															1,2	DT	115	1			30		.015		X	X		1	X	X
	CH12			X							X		X							4	DT				7-12					X			5	X	X
AMERICAN INSTRUMENT, INC. 8020 Georgia Ave. Silver Spring, Md.	4-5300/1	X			X		X	(transformer relay comb.)											X	1,2	ST/DT	500	to 30	230				.4		X		329	72		
	4-5303			X	X																SPDT	125	2	6-12	10		to 1			X	X	7.3	12		X
ARTESIAN ELECTRONICS CORP. 171 Ridgedale Ave. Morristown, N. J.	PE			X	X								X							1-3	DT	115	5			130	to 10		X	X	X		2.5		
BABCOCK RELAYS 3501 Harbor Blvd. Costa Mesa, Calif.	BW2			X	X					X										1	C		2			3.7	to 25	1.3		X	X				
	BW3			X	X					X										1	C		2			6.3	to 14	1.3		X	X				
	BW4			X	X					X										1	C		2			100	to 3	1.9		X	X				
	BW5/BW6			X	X					X										1	C		2			100	to 2	1.9	X	X	X				
	BR1/BR2			X	X															1	C	115	2	to 110		5-40	to 25			X	X		1.2	X	
	BR5			X	X																SPDT		to 1	18		100	2	.004				.048	.1	X	

ELECTRONIC INDUSTRIES

SENSITIVE RELAYS

SENSITIVE RELAYS

BARBER COLEMAN CO. **ELECTRONIC COMPONENTS DIV.** Rockford, Ill.	AYLZ			X				X						X					X		C,K,M	26/115	1			.04		.01		X	X	6.5	8	X	X
BOURNS, IND., **TRIMPOT DIV.** 1200 Columbia Ave. Riverside, Calif.	3100			X	X											X					SPDT	26	1	4-26		100	to 2	4		X		.48	.1	X	X
	3101			X	X											X					DPDT	26	1	6-33		160	to 2	4		X		.48	.1	X	X
CONTROL DATA CORP. **CONTROL SYSTEMS DIV.** 4455 Miramar Rd. La Jolla, Calif.	70			X				X	(Meter Monitor; sens-1 μA)						X			X	X					12	14			.1	X				3		
	77			X	(Meter Monitor; sens-1 μA)										X			X	X					12	50			.1					4½		
	80			X				X	(Comparator; sens-1 μA.)						X				X		SPST		1	30	30								4		
	82			X	(Comparator)										X				X		SPDT														
	175			X	(Hot Metal Detector)														X	3	DT			100		10W									
COOK ELECTRIC CO. **WIRECOM DIV.** 2700 N. Southport Ave. Chicago, Ill.	646				X	X	X							X							SPDT					1							15		
	645	X			X																4PDT	200	3	28/115	3			.01			X			*	X
COUCH ORDNANCE, INC. 3 Arlington St. N. Quincy, Mass.	2R202			X	X											X				2	C	30	1	26	2	25	to 10			X	X		.66	X	X
	2R			X	X											X				2	C	30	1.5	to 48		40-100	to 10			X	X		.66	X	X
CUTLER HAMMER, INC. 411 N. 12th St. Milwaukee, Wisc.	TF			X	X		X	(Electronic Relay)							X			X	X	2	DT	115	10	10	2			.010		X					
	TH				X		X	(Electronic Relay)							X			X	X	1,2	NO/NC	600	10	8	4.5			.025		X					
	RS						X	(Electronic Relay)										X	X	1,2	ST/DT	550	10												
EAGLE SIGNAL CO., **DIV. E.W. BLISS CO.** 736 Federal St., Davenport, Ia.	20BA			X	X							X									SPDT	115	5		6	150	to 10						2		
EBERT ELECTRONICS CORP. 130 Jericho Tpk. Floral Park, N. Y.	EM8	X			X					X*								X		1	NO/NC	115	35	230	12					X					
	HD8	X																X		1	NO/NC	115	60	230	12					X					
	A,B	X		X						X	(Electronic Relay)							X		1	NO/NC	115	to 60		.002					X					
EDISON, THOMAS A. INDUSTRIES 45 Lakeside Ave. W. Orange, N. J.	219			X	X													X			A-B	115	.7			.025	to 23	.15		X	X				X
ELECTRONIC SPECIALTY CO. 4561 Colorado Blvd. Los Angeles, Calif.	41,R400			X							X									2	DT	115	2,5		to 40	40	to 12	.035		X	X		3	X	X
	71R,80			X	X											X				2	DT	115	2,3		to 36	40	to 10	.015		X	X		1	X	X
	90			X	X											X				4	DT	115	2		to 56	80	to 10	.020		X	X		1.7	X	X
	55R,77R			X				X			X									2	DT	115	2		to 44	90	to 5			X	X		.5	X	X
	92N			X				X								X				4	DT	115	2		to 36	80	to 5	.009		X	X		1.7	X	X
	100N			X				X								X				6	DT	115	2		to 72	150	to 10	.018		X	X		2	X	X
FILTORS, INC. 65 Daly Rd. E. Northport, L. I., N. Y.	S			X	X											X*			X	1,2	DT		2	to 120			to 21	.006		X	X		.7	X	X
	JV			X	X											X*			X	1,2	DT		2	to 40		to 40	to 10	.015	X	X	X		1.1	X	X
	AV			X	X											X*				1,2	DT		2			40	to 10	.015	X	X	X		1.4	X	X
GENERAL AUTOMATIC CORP. 111 33rd St. Union City, N. J.	162			X	X															1-4	C	115	5	1	.01-.5			.02		X	X				X
	100	X		X	X															1-4	ST/DT	115	5			1	to 30			X	X		4.5		X
	300	X		X	X															1-4	C	115	5			1	to 30			X	X		4.5		X
	150	X		X	X															1-4	C	115	5			2	to 20			X	X				X
GENERAL ELECTRIC CO., **SPECIALTY CONTROLS DEPT.** P.O.B. 812, Waynesboro, Va.	AT			X	X											X				1	C	115	1			25		.01	X	X			.95		X
	AT			X	X											X				2	C	115	1			40		.01	X	X			.95		X

*Mil-R-6106C

*Mercury Plunger

*Microminiature

SENSITIVE RELAYS (Continued)

RELAY MANUFACTURER	TYPE NO.	AC OPERATED	AC-DC	DC OPERATED	GENERAL PURPOSE	HIGH SPEED	INDUSTRIAL CONTROL	LATCHING	LOW CURRENT	MERCURY-WETTED	MINIATURE	NEUTRAL	PLATE CIRCUIT	POLARIZED	SOLID STATE	SUBMINIATURE	TELEPHONE TYPE	INSTRUMENT RELAY	VOLT./CURRENT CHANGE DET.	NO. OF POLES	CONTACT FORM	NOM. CONTACT VOLTAGE (V)	NOM. CONTACT CURRENT (A)	NOM. OPR. VOLTAGE (V)	NOM. OPER. CURRENT (MA)	NOM. OPER. POWER (MW)	NOM. COIL RESISTANCE (KILOHMS)	NOM. OPER. TIME (SEC)	P-C MTG.	ENCASED	PLUG-IN	SIZE (CU. IN.)	WEIGHT (OZ)	MIL-R-5757 SPEC. HERMETIC SEAL
GLOBE ELECTRONIC MFG. CO. 1729 W. 134th St., Gardena, Calif.	Q	X		X													X			1-6	ST/DT	115	3	to 230						X				X X
GUARDIAN ELECTRIC MFG. CO. 1550 W. Carroll Chicago, Ill.	120	X			X																SPDT		to 12	230		1.5VA	to 3			X	X		3.8	
	125			X	X																SPDT		to 12	110		500	to 5			X	X		3.8	
	625			X			(Time Delay)						X							to 4	DT		to 8		6	.2W	to 11			X	X		5.2	
	405			X	X	X											X			to 10	DT		to 3	to 115				.005		X	X		9	
HI-G, INC. Spring St. R&E 75 Windsor Locks, Conn.	BA			X	X															2	DT	30	2	to 26		100		.006		X	X		.8	X X
	BK			X	X															1,2	DT	30	2	to 32		25/40	to 7	.005		X	X		1	X X
	BC			X	X															1,2	DT	30	2	to 32		25/40	to 10	.01		X	X		1	X X
	ABC			X	X															2	DT	30	2	to 150		12	to 15	.012		X	X		.95	X X
LARSON INSTRUMENT CO. Greenbush Rd. Orangburg, N. Y.	–			X			X	(Contactless Microammeter)							X			X	X				115	10		.015-.5		to 5	.15		X	X		21	
	–	X					X	(Contactless Microammeter)							X			X	X				115	10		to .5			.15		X	X		21	
	–		X				X	(Contactless Milliammeter)							X			X	X				115	10		to 1K			.15		X	X		21	
	–		X				X	(Contactless Voltmeter)							X			X	X				115	10	to 1K				.15		X	X		21	
			X				X	(Contactless Ammeter)							X			X	X				115	10		to 1KA.			.15		X	X		21	
LEACH CORP., RELAY DIV. 5915 Avalon Blvd. Los Angeles, Calif.	200			X	X															1,2	DT	115	8	32										
	300	X			X																	115	8	115										
	600			X	X																	115	2/8	115						X	X			
	700	X			X																	115	2/8	115						X	X			
MAGNAVOX CO. 2255 S. Carmelina Ave. Los Angeles, Calif.	87			X	X															1-3	DT	115	5			75		.02		X				X
	66			X																	SPDT	115	2	6-24	1.2	35	to 26			X	X			X
MAGNETICO, INC. 6 Righter Ct. E. Northport, L. I., N. Y.	MA72	X			X																DPDT	28	2	26	.1					X	X			
	MA143	X			X															2	C	28	2	115						X				
	T194			X	X																			28						X	X			
MANOSTAT CORP. 20-26 N. Moore St. New York, N. Y.	4			X						X*	(Electronic Relay)										SPST	115	35	7	.002	1W						*Mercury Contact		
MINIATURE ELECTRONIC COMPONENTS CORP. Holbrook, Mass.	MR2A			X	X											X				1	C	28	.05	6-28	6	140		.002	X	X		.075	X X
MOSSMAN-ELLIOTT CORP. 204 So. Larkin Ave. Joliet, Ill.	C	X		X	X												X				A-E			to 250		32/C		.002		X				
	F			X	X						X						X				A-E			to 150		40/C		.001		X				
	S			X	X						X										A,B,C			to 175		11/C	to 10	.002		X				

50% more display area . . . plus added capabilities for the same price

IMPROVED 545B oscilloscope

The Type 545B is an improved version of the Type 545A, which has proved itself of great service to a multitude of laboratories and industries throughout the years and has been considered a standard by which other oscilloscopes can be judged.

- Internal no-parallax illuminated graticule
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- Small spot size, uniform focus
- Fixed-tuned delay line
- Triggering beyond 30 Mc
- Sweep Delay
- Single Sweep
- Sweep Magnifier

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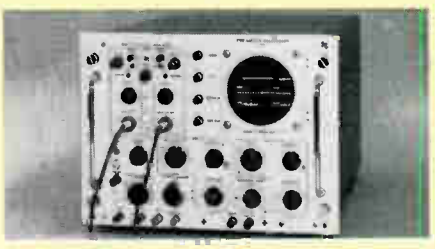
Type L-20 Spectrum Analyzer Plug-In Unit	$1995



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SENSITIVE RELAYS (Continued)

RELAY MANUFACTURER	TYPE NO.	AC OPERATED	AC-DC	DC OPERATED	GENERAL PURPOSE	HIGH SPEED	INDUSTRIAL CONTROL	LATCHING	LOW CURRENT	MERCURY-WETTED	MINIATURE	NEUTRAL	PLATE CIRCUIT	POLARIZED	SOLID STATE	SUBMINIATURE	TELEPHONE TYPE	INSTRUMENT RELAY	VOLT./CURRENT CHANGE DET.	NO. OF POLES	CONTACT FORM	NOM. CONTACT VOLTAGE (V)	NOM. CONTACT CURRENT (A)	NOM. OPR. VOLTAGE (V)	NOM. OPER. CURRENT (MA)	NOM. OPER. POWER (MW)	NOM. COIL RESISTANCE (KILOHMS)	NOM. OPER. TIME (SEC)	P-C MTG.	ENCASED	PLUG-IN	SIZE (CU. IN.)	WEIGHT (OZ)	MIL-R-5757 SPEC.	HERMETIC SEAL
NEW PROOUCTS, INC. Cameron Village Sta. Raleigh, N. C.	162			X	X	X										X						4W.	6	10	60		.008						.25		X
OHMITE MFG. CO. 3601 Howard St. Skokie, Ill.	DOSY DOY TT TO			X X X X							 X X		X X			 X X				1,2 4 4	DTDB DTDB DT	 115	15 10 to 5	120 115 115 to 220	7 7	 150 100	to 10 to 10 to 20			X X X	X X X		4½ 8 2 3.5	 X	X X X X
PENN KEYSTONE CORP. P.O.Box 350, Derby, Conn.	–			X	X			X			X										SPDT	28	2	28	3					X			37grm	X	X
PHAOSTRON INSTRUMENT & ELECTRONIC CO. 151 Pasadena Ave. S. Pasadena, Calif.	PR9100 PR9300			X	X X						X X									1-2 2	A,B,C DT	115 115	to 5 3			20 40	to 40 to 40	12		X X	X		3	X X	X X
PHILLIPS-AOVANCE Control Corp. Joliet, Ill.	80 NM VGS SV				X X X X											X X X					DPDT SPDT DPDT SPDT	26 26 26	3 .25 5 1	2-40 4-24 4-170	 .35	40 100 120 5	10 2 to 40	.010 .004 .005		X X X	 	.4 .04	1 .09 1.5 6.5	X X X	X X X
PHOTOBELL CO. 12 E. 22nd St., New York, N. Y.	– (Photo, sound, capacity and vibration-sensitive electronic relays)																																		
POLLAK CORP., JOSEPH 81 Freeport St., Boston, Mass.	RL2600			X	X																SPDT	28	1	to 120		50			X		X		1.2		
POTTER & BRUMFIELO 1200 E. Broadway Princeton, Ind.	MDP SS ML BS LM	 X 		 X X X	X X	X 								X 			X X X			6 6 2	SPDT C D C	115 28 115 115 115	.15 2 3 4 5	 to 110 to 110 to 230 	2-50 5	 2.5 20 25 15	 to 60 to 33 	 .03 .005 		X X X X X	X X X X	 3.5 	 3.7 2.5 10 5	X X 	 X
PRECISION THERMOMETER & INSTRUMENT CO. Southampton Industrial Park Southampton, Pa.	T699 T681 T689	 X		(Thermo Relay) (Thermostat Relay)	X 						 X				X X 						SPST	115	to 50 .005	10 110	.05 									30		
PRICE ELECTRONIC CORP. 323 Church St. Frederick, Md.	6B 1000 5300	 X 		X X X	X X X						 X		 X			X 				2 1 1,2	DT DT DT	28 26 115	2 1-3 2	to 120 to 120 	 3 	40 50 20	to 25 to 13 to 18	.015 .015	X X 	X X X	X X 	 	.7 1 2	X X	X X X
RBM CONTROLS OIV. **ESSEX WIRE CORP.** 131 Godfrey St., Logansport, Ind.	MS25 MS50			X X	X X						X X										SPDT DPDT 3PDT	115 115 115	2 2 2	6-24 6-24 6-24		40 125 200	to 15 to 15 to 15	.02		X X X	X X X				
SCHERMA, F. A., MFG. CO. 424 Broome St., New York, N. Y.	50 60	X 		 X	X X															1,2 1,2	A,B,C A,B,C	115 115	3 3	to 24 to 230		100	to 4			X X	X X				

This Is Not the First 1 13/16" 10-Turn Precision Potentiometer. Just the Best.

Bourns Model 3400 is the rugged result of a fresh design approach. In punishing side-by-side environmental tests, it performed dependably long after competitive units had sagged, sogged or snapped under the strain. In rotation-life tests, it displayed a longer useful life than any other unit. In vibration and shock tests, it kept operating after fragile terminations had put competitive units out of commission.

This sturdy newcomer has a molded, all-plastic case for superior humidity performance... sliding contacts to eliminate fragile pigtails... an extra-thick slider block for high stability... a shaft supported at both ends... a husky dual-collector pickoff. And it has the exclusive, virtually indestructible SILVERWELD® termination that replaces vulnerable single-wire terminations to overcome the chief cause of potentiometer failure.

Model 3400 undergoes 100% in-process and final inspections, and is subjected to the famous Bourns Reliability Assurance Program. In reliability and performance, it is a premium potentiometer. One of its best features is that there is no premium in price.

Write today for complete technical data.

Model 3400, 1 13/16" Diameter, Bushing Mount

LINEARITY:	±0.15%, STANDARD
Resistances:	100Ω to 1 Meg., standard
Temp. Coeff.:	20ppm wire over entire resistance range
Power rating:	5.0W at 40°C
Humidity:	Steady state
Operating temp. range:	−65 to +105°C
Resolution:	0.005 to 0.045%
Body length:	1.75" (12% shorter than competitive units!)

ONE-HALF ACTUAL SIZE

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CABLE: BOURNSINC.

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

Circle 30 on Inquiry Card

SENSITIVE RELAYS (Continued)

RELAY MANUFACTURER	TYPE NO.	AC OPERATED	AC-DC	DC OPERATED	GENERAL PURPOSE	HIGH SPEED	INDUSTRIAL CONTROL	LATCHING	LOW CURRENT	MERCURY-WETTED	MINIATURE	NEUTRAL	PLATE CIRCUIT	POLARIZED	SOLID STATE	SUBMINIATURE	TELEPHONE TYPE	INSTRUMENT RELAY	VOLT./CURRENT CHANGE DET.	NO. OF POLES	CONTACT FORM	NOM. CONTACT VOLTAGE (V)	NOM. CONTACT CURRENT (A)	NOM. OPR. VOLTAGE (V)	NOM. OPER. CURRENT (MA)	NOM. OPER. POWER (MW)	NOM. COIL RESISTANCE (KILOHMS)	NOM. OPER. TIME (SEC)	P-C MTG.	ENCASED	PLUG-IN	SIZE (CU. IN.)	WEIGHT (OZ)	MIL-R-5757 SPEC.	HERMETIC SEAL
SCHRACK ELECTRICAL SALES CORP. 1140 Broadway New York, N. Y.	CMD5D			X	X																SPDT	115	2	5-20	2	40	9.6	25		X	X				
	CMD11D			X	X																DPDT	115	2	5-21		60	7.3	30		X	X				
	CMD5A	X			X																SPDT	115	2	to 47		80	6.9	10		X	X				
SIGMA INSTRUMENTS, INC. 170 Pearl St. So. Braintree, Mass.	4			X	X							X	X						X		SPDT		2-3	6-24	1-4	45	to 10			X	X		X	X
	5			X	X							X	X						X		SPDT	120	.25-3	to 12	1-3	2	to 16			X	X		X	X
	22			X	X						X	X	X							1,2	DT		2	3-48		45	to 12			X	X		X	X
	26			X	X						X	X	X								SPDT		1		.7-2	12				X	X		X	X
	33			X	X									X							DPDT	28	2	26		100				X	X		X	X
	23			X	X									X						1,2	DT	28	2			10				X	X			X
	72			X	X									X							SPDT	28	2			.75				X	X			X
	73			X	X									X							SPDT	28	1.5			40				X	X			X
SIMPSON ELECTRIC CO. 5200 W. Kinzie St. Chicago, Ill.	3324XA						(Contactless)								X			X	X	2	DT	150	10	to .05	0-1										
STRUTHERS-DUNN, INC. Lambs Rd., Pitman, N. J.	112	X		X	X																SPDT	to 230	2	to 225	.6	15	to 34			X					
	29																				SPDT	to 230	6	to 270	.9		to 23			X					
	–									X				X							C,D		2,5			2					X				
TELEDYNE PRECISION, INC. 3155 W. El Segunda Hawthorne, Calif.	430/431			X	X											X					SPDT		to .5	28		40		.003		to 5			.14	X	X
TERADO CO. 1068 Raymond Ave. St. Paul, Minn.	106–110			X	X								X								SPDT	24	.5-1	1.5	5-80	7-120		.03			X	.73			X
	116–120			X	X								X								SPDT	24	.5-1	3	2.5-40	7-120		.03			X	.73			X
	126–130			X	X								X								SPDT	24	.5-1	6	1.2-20	7-120		.03			X	.73			X
	136–140			X	X								X								SPDT	24	.5-1	12	.6-10	7-120		.03			X	.73			X
	146–150			X	X								X								SPDT	24	.5-1	24	.3-5	7-120		.03			X	.73			X
	156–160			X	X								X								SPDT	24	.5-1		.6-2.5	7-120	to 19	.03			X	.73			X
WARD, LEONARD ELECTRIC CO. Mt. Vernon, N. Y.	250	X		X															X			125	1-2	to 48		14	to 31								
WESTON INSTRUMENTS DIV. 614 Frelinghuysen Ave. Newark 14, N. J.	534			X														X	X	2		6	.05	.1-1	7.5μA.					X			32		
	730			X														X	X	1,2		6	.035	.1-2	.2					X			15		
	813			X							X							X	X			6	.035	.1-1	25μA.					X			3.5		
	1081			X														X	X	2		6	.035		50μA.					X	X		1.1		X
	1091			X														X	X	2		6	.2	.1-1	7.5μA.					X			35		
	705	X		X														X	X	1,2					½μA.			.74		X			24		
	1085			X							X							X	X	1,2		115	.1	50-100	10μA.			1					14		
	1092			X														X	X			120	.1		0-50μA.	.006							5		
	1930/40			X	(Non-Physical Contact Relay)													X	X		SPDT	115	5		.2					X					

Why does this low-power 1030-Mc TRF amplifier...

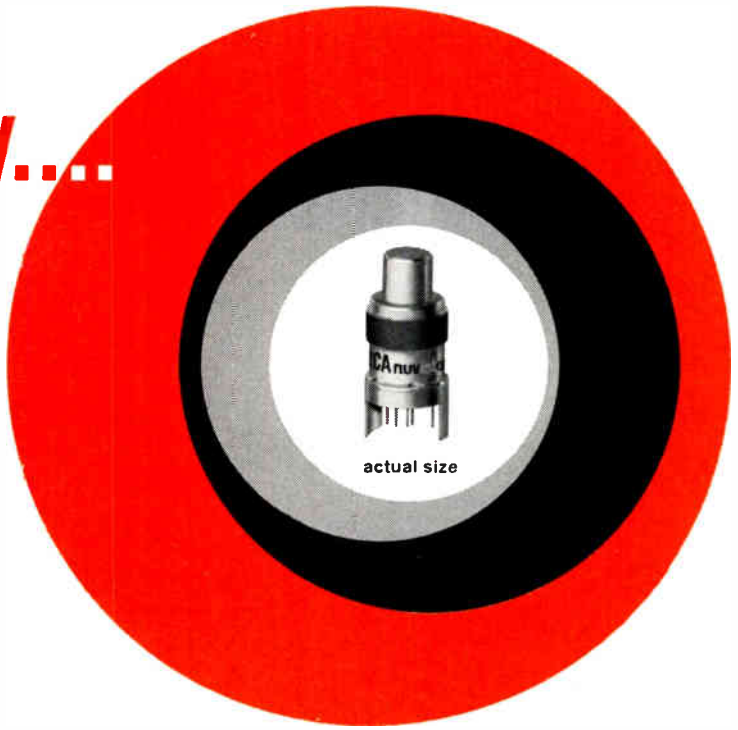
work so well...

GAIN: 45 db minimum, including RF filter loss
NOISE FIGURE: as low as 11 db, RF amplifier noise only
DYNAMIC RANGE: 56 db
BANDWIDTH: 7 Mc minimum at —6 db points, 50 Mc maximum at —60 db points
PACKAGE SIZE: 3-stage amplifier—1" diameter, 9" long

yet cost so little?

Much less than comparable amplifiers using solid-state or other ceramic electron-tube amplifying components

here's why...



Score another success for the remarkable RCA nuvistor: the integral-cavity RF amplifier shown above with accompanying band-pass filter, designed for use in airborne transponders and IFF beacons. Weighing only 7 ounces, the amplifier is a 3-stage modular unit with an average gain of 16 db per stage.

Thanks to nuvistors (three RCA-8058 high-mu double-ended triodes... one in each stage), the amplifier:

- **Outperforms units using comparably priced components**
- **Performs as well as units using higher priced components**

Nuvistorized small-signal integral-cavity RF amplifiers can be designed with 1, 2 or 3 stages covering L_P through L_K frequency band (390 Mc—1,200 Mc). Advantages of nuvistorized amplifiers include:

Wide dynamic range: permits amplifier to accept strong or weak signals.

Low power input requirement ▪ Small size and light weight ▪ Low cost ▪ Low noise

Long life and exceptional reliability: based on over 2,000,000 tube-hours of actual life tests, the RCA general-purpose nuvistor triode has an observed failure rate of less than 0.3% per 1,000 hours during the first 10,000 hours of operation. Latest data taken to 20,000 hours of operation indicate no significant change in failure rate.

Nuvistors in integral circuits or as individual tubes may be able to solve a problem for you, as they did in this airborne amplifier. Why not call your RCA Representative at the nearest District Office for more information on the nuvistorized amplifier. And, for technical data on the standard commercial line of nuvistor tubes, write to Commercial Engineering, RCA Electronic Components and Devices, Harrison, New Jersey.

The Most Trusted Name in Electronics

RCA DISTRICT OFFICES: EAST: 32 Green St., Newark, N. J. 07102, (201) 485-3900 • MID-ATLANTIC: 605 Marlton Pike, Haddonfield, N. J. 08034, (609) 428-4802 • MID-CENTRAL: 2511 East 46th St., Bldg. Q2, Atkinson Sq., Indianapolis, Ind. 46205, (317) 546-4001 CENTRAL: 446 East Howard Ave., Des Plaines, Ill. 60018, (312) 827-0033 • WEST: 6363 Sunset Blvd., Hollywood, Calif. 90028, (213) 461-9171

Technical papers program highlights five-day meeting at New York's Coliseum and Hilton Hotel. Medical electronics is featured among technical sessions.

I.E.E.E. Show & Convention Opens In New York, March 22nd

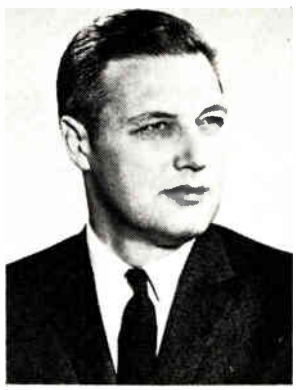
THE NEW YORK HILTON AND THE COLISEUM will be the sites for the 1965 IEEE Convention. The meeting this year will run five days, commencing March 22nd. The additional day has been added because of the expanded papers program. The exhibits, however, will be open only four days—March 22-25.

Papers Program

The technical program will consist of over 400 papers—an increase of 25% over last year. On Tuesday evening, March 23rd, a special symposium will be held on the subject "The World of Communications—Below the Sea, On the Surface, and In the Sky Above." This will be given in the Grand Ballroom of the Hilton from 8:00 to 10:30 P.M.

The IEEE Convention offers the engineer a rare opportunity to bring himself up-to-date on the latest technical developments. But too often it ends up as a foot race through the Coliseum and the Hilton. The reason? Many companies, especially in the Phila.-New York area, allow their engineers only one day at the Convention. It is too much to expect that a man see and evaluate new equipment and also attend papers sessions in one day. It appears to Electronic Industries that the extra money spent to allow an engineer at least two days at the Show would be more than repaid by his increased technical awareness.

Medical electronics is beginning to emerge as a real force in the industry. This year two sessions are scheduled as a symposium on artificial organs, prosthetic devices, and sensory aids. In a paper entitled, "The Challenge of Replacing Human Parts and Function," E. F. Murphy will discuss the problems in design of artificial organs, surgical implants, and prosthetic and sensory aids. Yukihiko Nose of the Cleveland Clinic Foundations will describe a mechanism that approximates the human heart shape and size, and pumps eight liters of blood per minute.

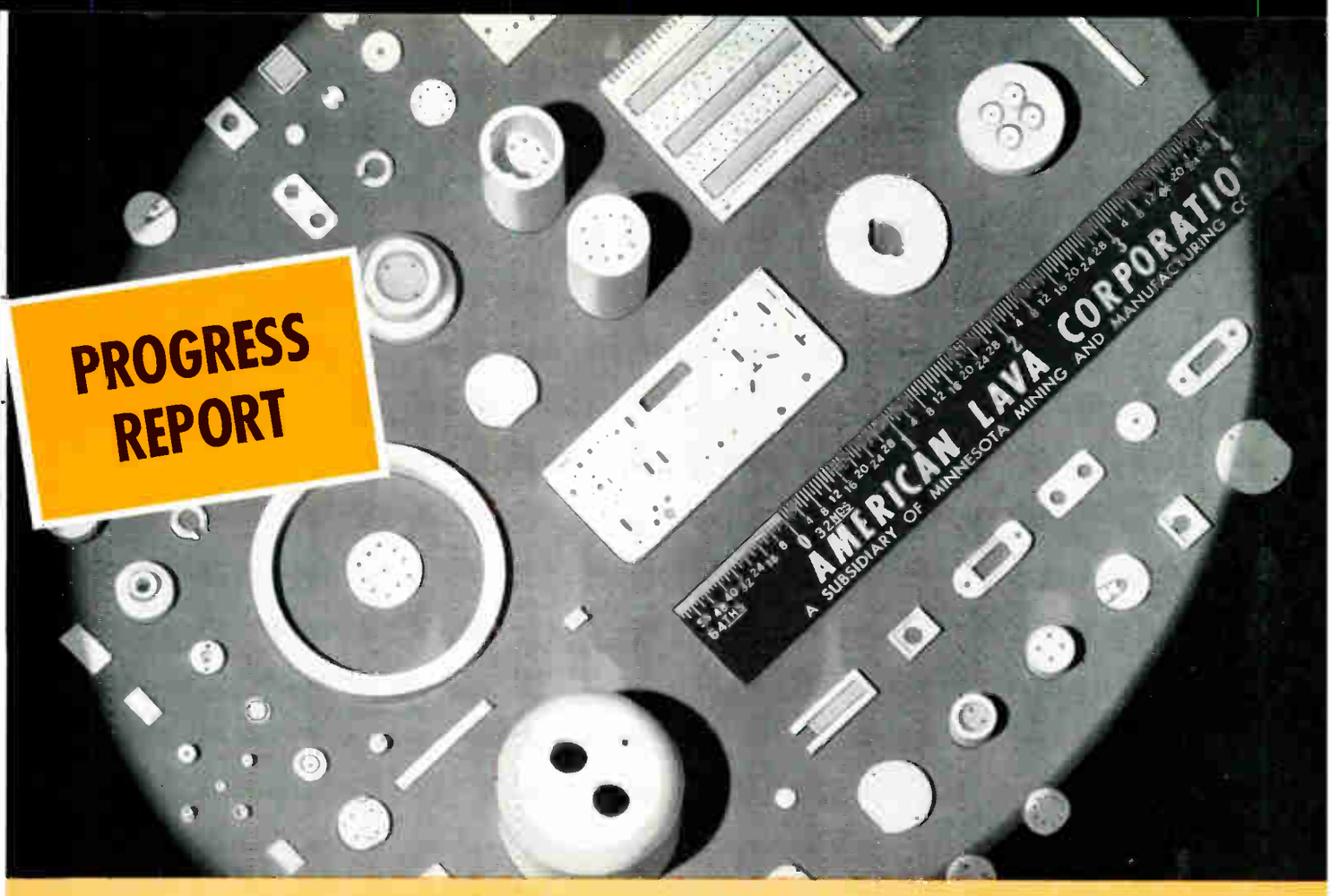


New President of IEEE is Bernard M. Oliver. Dr. Oliver, who is also V.P. in charge of R&D for Hewlett-Packard, was elected a fellow of IRE in 1954.

Although all the papers to be presented are truly state-of-the-art, particular attention will be paid to those on integrated and microelectronic circuits. More and more equipment is emerging using these devices.

Convention Record

For the first time a Convention Record will be available at time of registration. This Record will contain all available convention papers. This should be invaluable to engineers "back in the office" who are unable to attend the convention with you.



VOLUME PRODUCTION OF SMALL PRECISION ALSIMAG® CERAMICS

AlSiMag ceramics ± ½ % NLT ±.0005" on certain critical dimensions in sizes up to ½" O.D. and in a wide range of designs are being produced in volume without grinding. Production has risen steadily and is now several million precision ceramics each week.

The availability of small precision AlSiMag alumina ceramics in volume may be the key to advances in your product. These precision ceramics are finding increasing use as substrates, in packages and in a variety of applications in microminiatures. The natura surface has electrical characteristics suited to a wide range of applications.

Volume production of precision AlSiMag 754 beryllia ceramics is now well established. Beryllia has excellent electrical insulction characteristics and conducts heat away from sensitive devices, has "no-fire capabilities" that help in certain missile-ordnance applications and has demonstrated some advantages in microcircuitry, especially where high reliability is most important.

HAND MADE SAMPLES

A separate department handles expedited sample orders. It is usually possible to furnish prototypes promptly. The cost is reasonable. While you are running life tests on new designs, plans may be developed to schedule volume deliveries to match your needs. Our sales engineers will be glad to discuss your requirements.

American Lava Corporation A SUBSIDIARY OF 3M COMPANY

PHONE 615/265-3411 CHATTANOOGA, TENN. 37405

63rd YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining and Manufacturing Co. in these cities (see your local telephone directory): Birmingham, Michigan • Boston: Needham Heights, Mass. • Chicago: Bedford Park, Illinois Cleveland, Ohio • Laurens, S. C. • Los Angeles, Calif. • Minneapolis, Minn. • Metropolitan New York: Ridgefield, N. J. Up-State New York: Phelps, N. Y. • Philadelphia, Penn. • Richardson, Texas • Roanoke, Va. • South San Francisco, Calif. **All export except Canada:** Minnesota Mining and Manufacturing Co., International Division, 700 Grand Ave., Ridgefield, N. J.

Circle 144 on Inquiry Card

NEW PRODUCTS

At I.E.E.E.

TUNABLE MAGNETRON

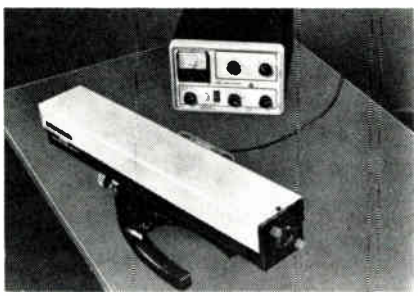
Model BTO-20 voltage-tunable magnetron is a low noise magnetically shielded tube. It delivers at least 10w. over any 600MC range specified between 2.6 to 3.7GC. It weighs 19 oz. with heat sink. See this tube at the Varian Center.

Circle 259 on Inquiry Card

LASER PROJECTOR

This laser projector permits the demonstration of single slit diffraction, multiple slit interference, and airy disc patterns. Output is a linearly polarized monochromatic beam at 6328 Å. Bausch & Lomb Inc. Booth 3312.

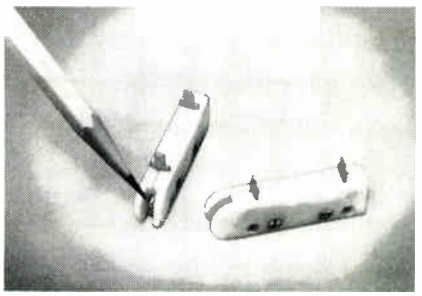
Circle 262 on Inquiry Card



EXPLOSION-PROOF SWITCH

The Seal-X switch is a SPST, Form A reedcapsule actuated by the movement of a permanent magnet. Operating speed is up to 100 CPS. Open switch capacitance is 0.2 pf (max.). Switching voltage is 150v. James Electronics Inc. Booth 2100.

Circle 265 on Inquiry Card



WHEATSTONE BRIDGE

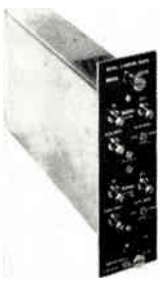
Model 4232-3B measures resistances from 1Ω to over 11KΩ. It gives precise readout to 6 figures. Guarded construction eliminates chance of leakage currents causing errors. Sensitivity is 0.001% from 10Ω to 10meg. Leeds & Northrup. Booths 2824-26.

Circle 260 on Inquiry Card

LINEAR GATE

The LG100 high-speed linear gate achieves high-speed gating of linear signals up to 200MC in the range of ±1v. with 1% linearity. It can be gated at rates up to 75MC by —700mv logic pulses. Edgerton, Germeshausen & Grier, Inc. Booths 3132-33.

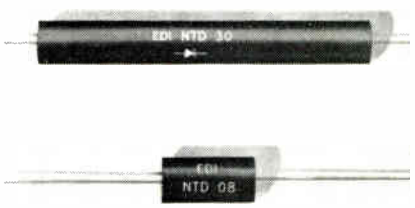
Circle 263 on Inquiry Card



CARTRIDGE RECTIFIERS

The silicon NTD series offer peak inverse voltage ranges from 4kv to 30kv. Forward currents are from 200 to 250ma. They are encased in an insulated tube. Units meet the requirements of Mil-S-19500. Electronic Devices Inc. Booth 1435.

Circle 266 on Inquiry Card



SWEEP GENERATOR

Model 890 is a 500KC to 1200MC sweep generator. The unit supplies a sweep signal with center at any freq. from 500KC to 1GC and with sweep-widths as broad as 200MC or as narrow as 100KC. It should have production-line uses. Jerrold Electronics. Booths 3822-24.

Circle 261 on Inquiry Card

METERING RELAYS

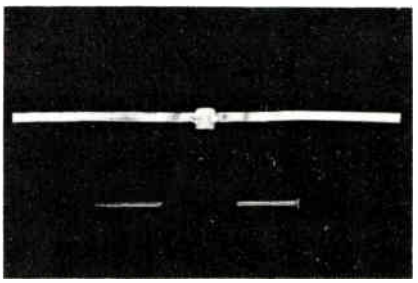
These solid-state metering relays provide input signal triggering setpoints to within 0.1μa or 0.1% full scale. Standard metering relays are available for 0-5μa, 0-10μa, 0-50μa, 0-100μa, 0-500μa, 0-1ma, and 0-5ma signal input ranges. Airpax Electronics Inc. Booth 2902.

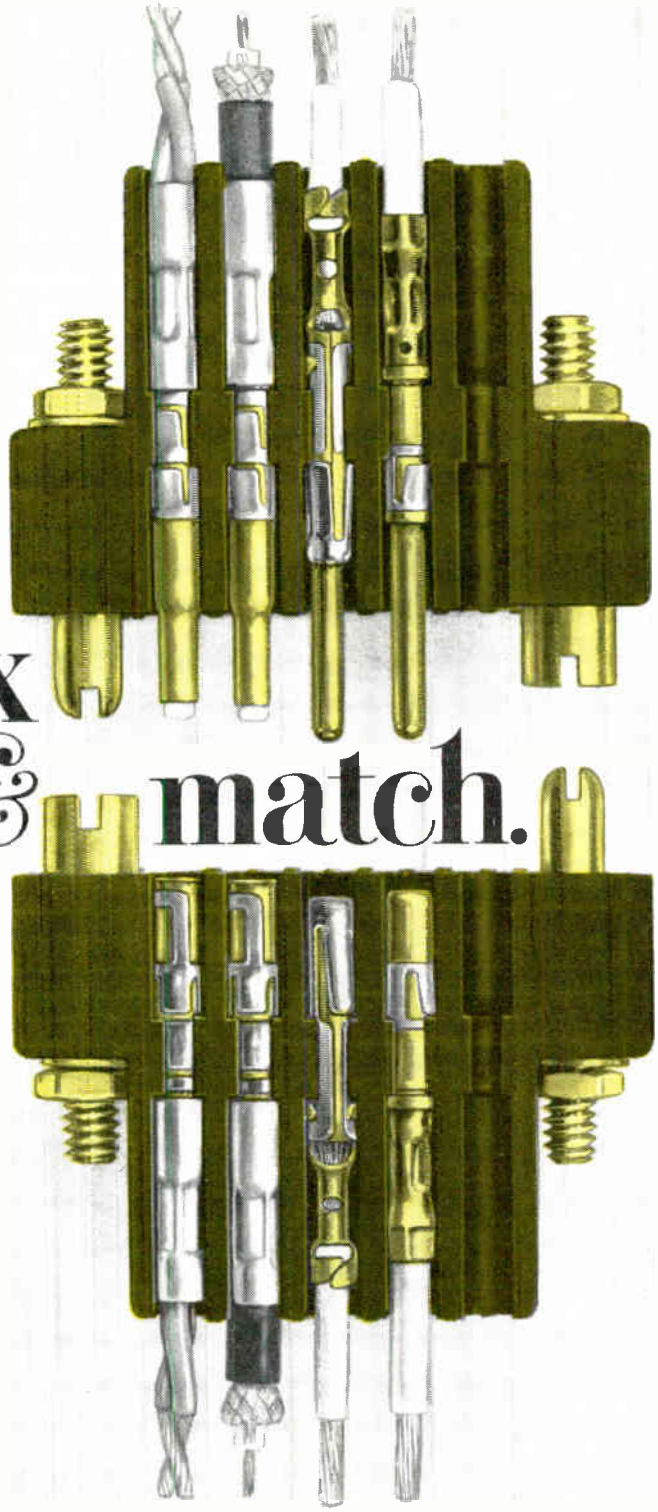
Circle 264 on Inquiry Card

CERAMIC CAPACITORS

Modutrim variable ceramic capacitors have delta C ranges to 5 to 50pf. Other features are Q of 500 @ 1MC, nominal temp. coefficient of —250 ±250 ppm/°C, and capacitance drift not above 0.75%. Working voltage is 50vdc. JFD Electronics Corp. Booth 1515.

Circle 267 on Inquiry Card





Mix & match.

From breadboard to prototype to production.

Sub-miniature coax, standard machined or formed strip contacts can be intermixed instantly in the same connector block.

You can begin wiring your breadboard or prototype with standard wire. If noise develops, just switch signal leads to sub-miniature coax without changing the connector block.

Here's a twist. You can also convert standard leads to twisted pair. In case we forgot to mention it, the sub-miniature coax contacts take twisted pairs as well as coax cable.

And the formed contact is a big money saver in initial and installed costs. Throw in the automatic Burndy Hyfematic,™ and crimp up to 3000 contacts per hour. Blocks available for 14 to 152 positions.

Now put it all together. Contact intermixing, economy, universality. Get in touch with Burndy for all the details. Hurry.

BURNDY

Norwalk Connecticut

Circle 145 on Inquiry Card

See more at IEEE Booths 1733-1737

NEW PRODUCTS

At I.E.E.E.

DIGITAL PHASE METER

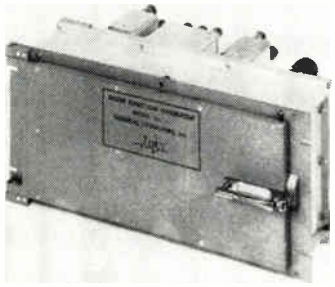
Type 524A2 requires no freq. adjustment from 20 CPS to 500KC; no amplitude adjustment from 0.3 to 50v. with accuracy of ±0.03°. It presents direct representation of phase angle in 4 or 5 digits. Ad-Yu Electronics, Inc. Booths 3707-09.

Circle 268 on Inquiry Card

CARD MEMORY

Model 120 punched card memory enables preprogramming and eliminates idle time when nonlinear functions are being programmed. Functions are composed of 10 or 20 contiguous line segments. General Computers Inc. Booth 3933.

Circle 271 on Inquiry Card



TIME DELAY GENERATOR

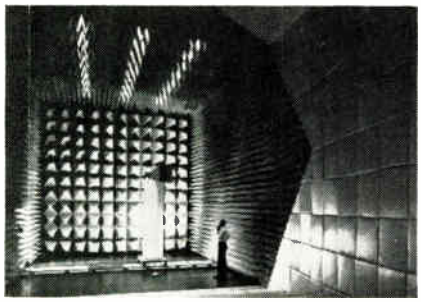
Model A10 features 3 outputs for each input trigger. Repetition rate for trigger signal is 1MC. Delay is 0 to 999999.9μsec.; incremental delay is 100nsec.; delay accuracy is 0.001% of set delay +2nsec. Rutherford Electronics. Booth 3702.

Circle 274 on Inquiry Card

MICROWAVE ABSORBER

Type RF-HT high-temp. resonant type microwave absorber provides continuous performance at 500°. The material is a lightweight, flexible silicone foam. Band width at X-band is greater than 1.11:1 at the 20db level. B. F. Goodrich. Booth 3041.

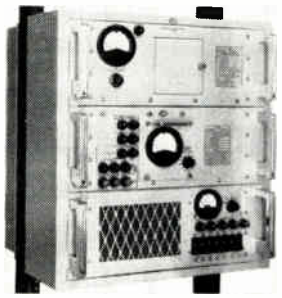
Circle 269 on Inquiry Card



TROPOSPHERIC SCATTER

The 2600 Series is used as a multi-purpose tropospheric scatter equipment that has a line-of-sight application. Capacity is 300 voice channels. Intermodulation for a receiver-transmitter combination is 55db. Radio Engineering Laboratories. Booths 1301-05.

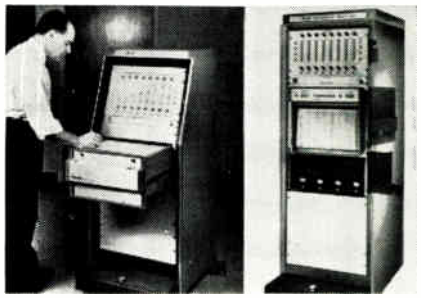
Circle 272 on Inquiry Card



DIRECT WRITING SYSTEM

With the Mark 200 Series 1707 units, hundreds of recording system configurations can be made up from all-solid-state subsystems. System accuracy is 0.5%. Chart speeds in 12 steps are pushbutton controlled. Brush Instrumentss. Booths 2616-26.

Circle 275 on Inquiry Card



REPEAT CYCLE TIMERS

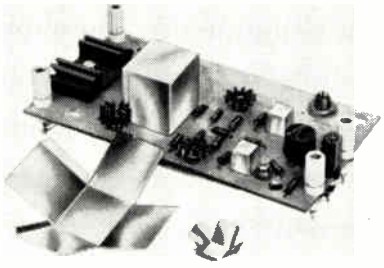
Over-all cycle time and on-off time are controlled with this unit. Both are adjustable over a wide time range: 0.5 sec. to 10 sec. and 5 sec. to 100 sec. The range desired can be selected by simple jumper connections on the unit. A. W. Haydon Co. Booths 1405-07.

Circle 270 on Inquiry Card

MAGNETIC SHIELDS

These shields allow high density packaging by enclosing magnetically sensitive components in shields which are easily, quickly cut to shape. Permanently preannealed Netic and/or Co-Netic foil alloys are used. Perfection Mica Co. Booth 4405.

Circle 273 on Inquiry Card



LEAK DETECTOR

The MS-U15 Leak Test Station has a response time in the mid-10^{-14} std. cc/sec. range of approx. 6 sec. Leaks in the 10^{-13} or 10^{-12} std. cc/sec. range have a shorter response time. The leak rate meter gives the leak rate directly in std. cc/sec. Vacuum Electronics Corp. Booths 3406-08.

Circle 276 on Inquiry Card

It makes all kinds

. . . only today, "cranking out" ice cream in a variety of flavors is easy because you can "crank in" coded information to control the exact ingredients for each production batch. In fact, if you are concerned with mixing foods or chemicals, operating a rolling mill, automating teaching devices, programming test equipment and ground support equipment, or controlling production lines —this A-MP ★ Card Programming System is the answer. It routes up to 960 individual circuits with one flip of the actuating lever.

This Card Programming System is available in rack-mounted or desk-top models and accepts standard punched tab cards. Any number of programs can be punched on cards and programs can be changed as quickly as you can remove and insert cards.

All contacts are gold-over-nickel plated and, coupled with AMP's exclusive double wiping action, long life and reliable performance is assured. Electrical interlocks determine proper card orientation and an AMPILLUME ★ Indicator light tells you that the card is in the "read" position.

In fact, everything about this unit is precision engineered to give you built-in quality. To name a few . . .

- two-way electrical interlocks prevent false output
- semi-automatic card ejection
- gold-over-nickel plated contact springs and board pads
- unique double-wiping action—contacts return from point of maximum travel on printed circuit board to pre-cleaned contact areas, assuring reliable sensing
- unit can be used for data read-out
- A variety of *prewired* models available

More information is yours for the asking. Why not write today.

★Trademark of AMP INCORPORATED

AMP INCORPORATED
Harrisburg, Pennsylvania

INDUSTRIAL SALES DIVISION

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

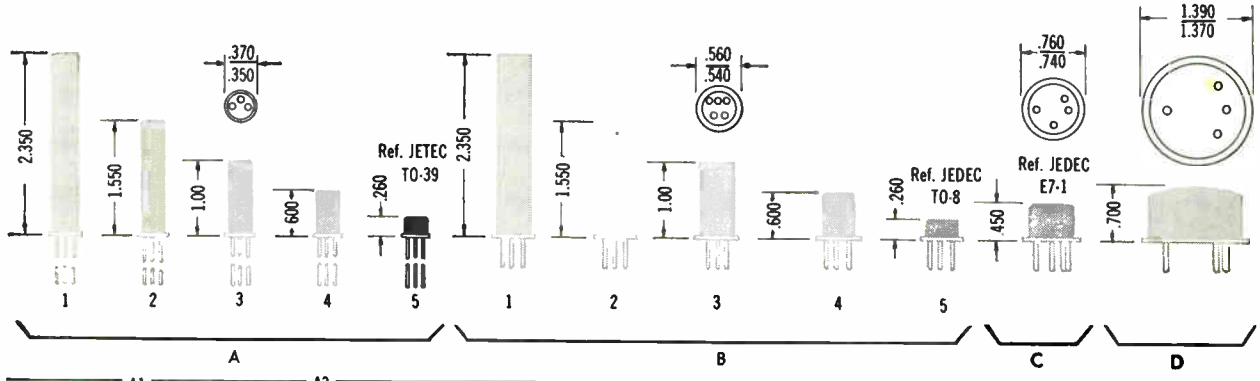
Meet us at the IEEE Show, Booths 2527-31 and 2438, March 22-25, 1965

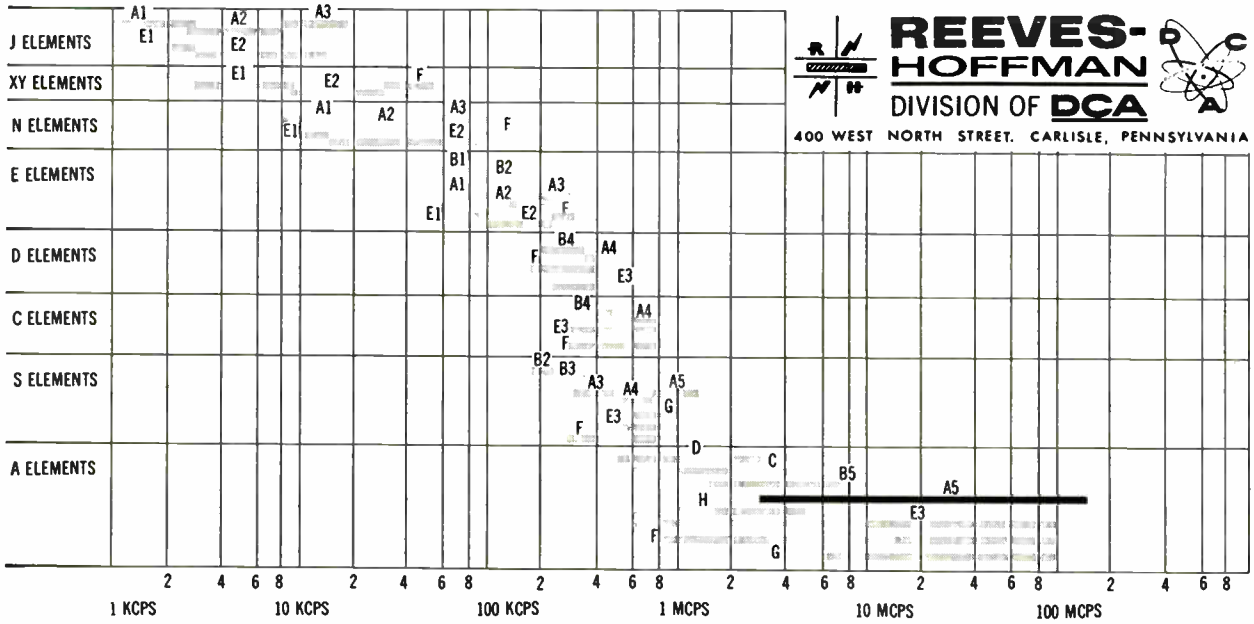
COLD WELDED CRYS[illegible]LS?

a little
make room for  the newest from

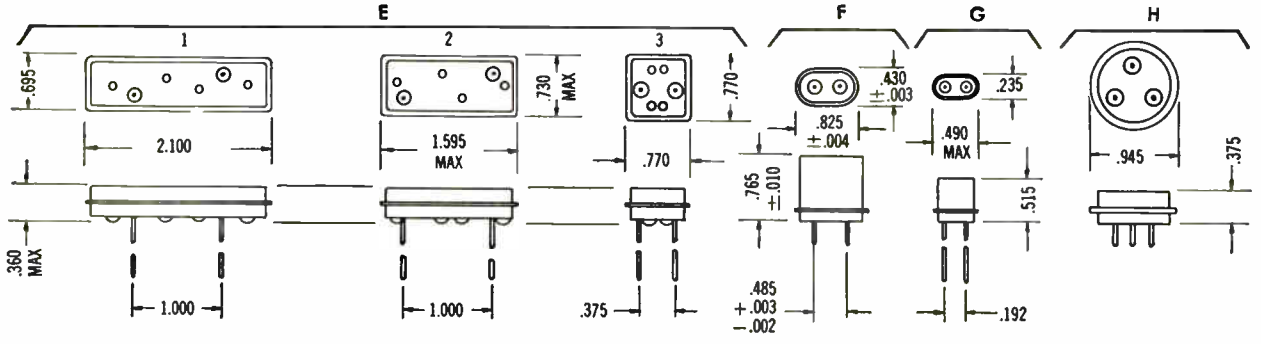
REEVES-HOFFMAN

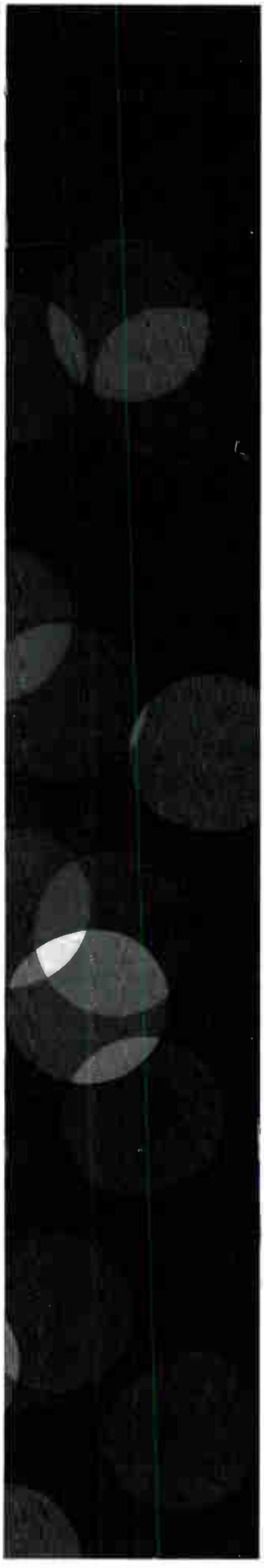
Reeves-Hoffman's newest series of crystals, packaged in cold-welded TO-5 transistor cans, are designed for operation at frequencies from 3 to 125 mc. Frequency tolerance over the temperature range from −55°C to +105°C is ±0.004%. (Upon special request, ±0.0025% can be provided.) Shock and vibration ratings exceed the requirements of MIL-Spec 3098D. Aging at 65°C is 6 parts in 10^6 per year. Cold welding eliminates solder and attendant flux and heat, removes undesirable damping and corrosion, solves problems of thermal isolation. Leak rate is better than 10^{-9} cc of helium per second. The results: substantial increases in the reliability and stability of crystal units. oscillators and filters; further opportunity for miniaturization; faster delivery; lower cost. Write for data.





REEVES-HOFFMAN
DIVISION OF DCA
400 WEST NORTH STREET, CARLISLE, PENNSYLVANIA





Does Mallinckrodt really know your dopant needs?

Look at our TransistAR line

More semiconductor devices have been processed with TransistAR® dopants than any other brand in the world.

That record reflects a lot of digging into your electronics processing problems: spiking, soft junctions, caking, crusting, trace impurities.

First hand digging—right in your own plants.

(We've got a big edge in producing dopants because we know how you *use* them.)

See if these don't answer some of your needs.

Phosphorus Pentoxide TransistAR

An improved N-type anhydrous diffusion dopant in charge-size bottles. No weighing, no moisture pickup. Consistent rates of vaporization and phosphorus concentration.

Phosphorus Nitride TransistAR

An N-type dopant ideal for microcircuitry devices. Will not penetrate a 0.4 micron SiO_2 mask. Doesn't pit or discolor wafer surfaces. Permits unusually low doping levels.

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A liquid N-type dopant for vapor-phase diffusion. Exceptionally free from moisture and particulate matter. Constant liquid surface area reduces variables.

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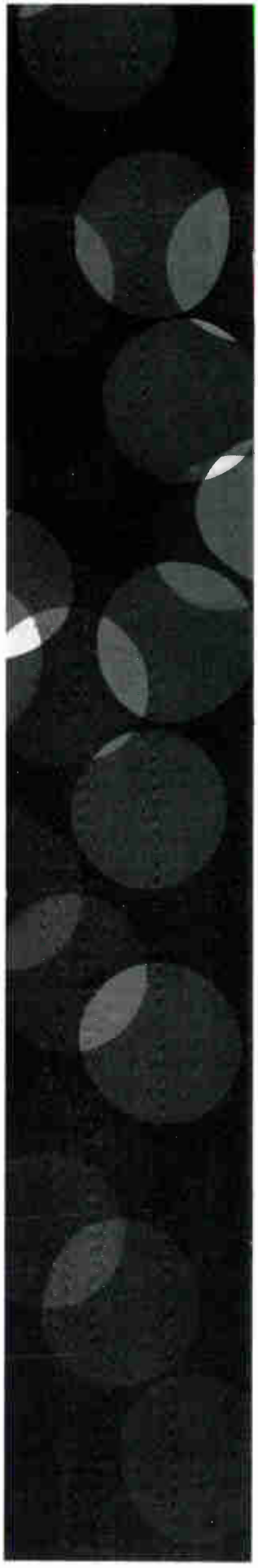


If you want it done right, do it yourself...so we do!

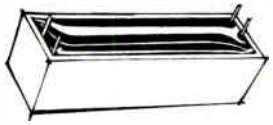
We make the reed we process

the tube  we make the switch

 we make the coil bobbin 

we make the coil  we make the case

 we carefully assemble all of them

into a relay  you can depend on–

the RBM BI-REED® Relay (both Standard and Miniature)

If you want it done right, specify RBM BI-REED Relays...every component manufactured, matched, and tested by RBM CONTROLS. Single source responsibility that means total reliability. Please write for Bulletin 2020 "BI-REED Miniature and Standard Switches and Relays."

RBM CONTROLS DIVISION
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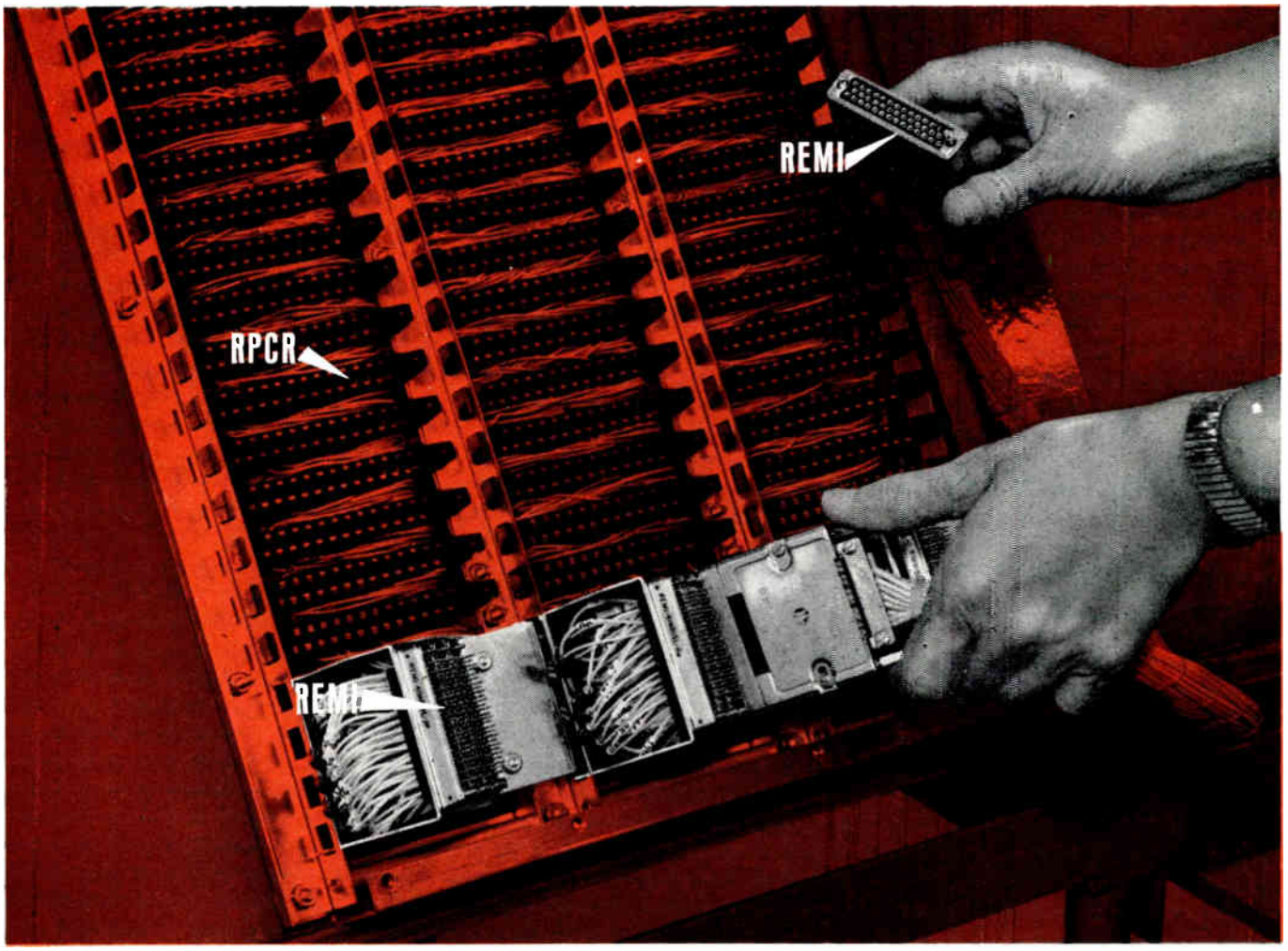
See us at the IEEE Show—Booth 2423

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

RCA 3301 REALCOM COMPUTER RELIES ON



U. S. C. REMI® and RPCR CONNECTORS

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

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

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

U.S.C. REMI Connectors

U.S.C. RPCR Connectors

U. S. COMPONENTS, INC.

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LOOK US UP IN U. S. COMPONENTS IEEE BOOTH NO. 2805

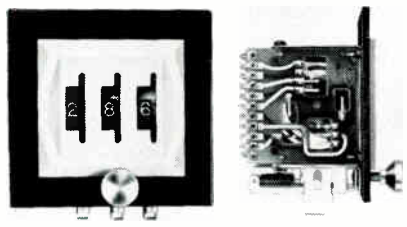
NEW PRODUCTS

At I.E.E.E.

THUMBWHEEL SWITCH

Series LR is a space-saving modular tab-type binary or decimal thumbwheel switch with pushbutton lock/release. It is available in 8, 10, 12 or 16 positions and with up to 12 PC wafer modules. Chicago Dynamic Industries. Booth 2114.

Circle 277 on Inquiry Card



CARD PRINTER

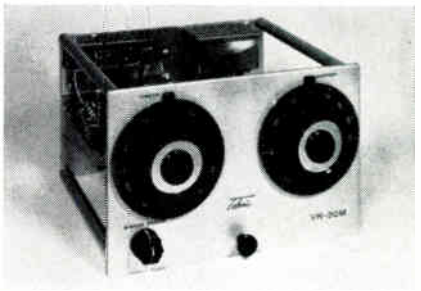
Moduprint D electrical data printer/counter accommodates a punched card on its long side: 7⅜ in. It can print anywhere in line on such a card, or others, to 8½ in. wide, up to 20 digits in line. Presin Co., Inc. Booth 3037.

Circle 280 on Inquiry Card

SWEEP GENERATOR

Solid-state Model VR-50M covers the 500 to 1000MC ranges. It eliminates the need for backward wave oscillators or heterodyned output using solid-state hybrid and nuvistor circuits. Telonic Industries. Booths 3110-11.

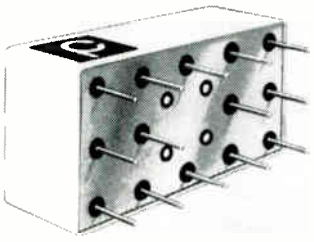
Circle 283 on Inquiry Card



HALF-SIZE RELAY

The type 64 four-pole, double-throw relay features all welded construction. It is available in various coil resistances and all popular header styles. It meets the reliability standard of Mil-R-5757/12A. Phillips Advance Control Co. Booths 2432-34.

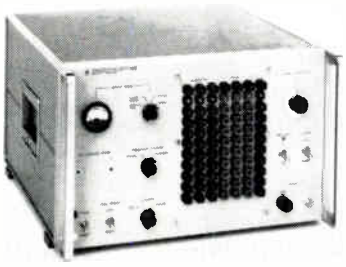
Circle 278 on Inquiry Card



FREQUENCY SYNTHESIZERS

Model 5102A uses the direct synthesis principle to translate the basic stability and purity of a single quartz oscillator into 19 million instantly selectable output freqs. Ranges to 1MC; it allows incremental changes as small as 0.01 CPS. Hewlett-Packard Co. Booths 3502-14.

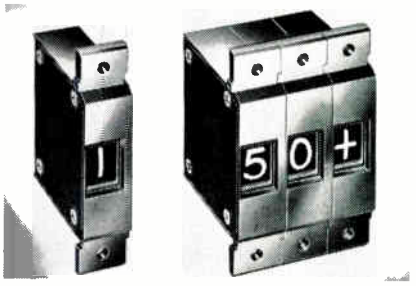
Circle 281 on Inquiry Card



ELECTROMAGNETIC INDICATOR

The 26000 series indicators operate directly from any of the 2 out of 5 codes which are commonly used in communication equipment. This eliminates decoding and driving circuits. The new series is offered in a 10-position unit. Patwin Electronics. Booth 3050.

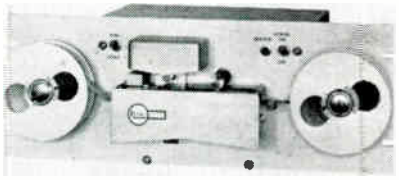
Circle 284 on Inquiry Card



READER/SPOOLER

Model RRS-302 includes a medium high-speed photocell reader with a spooler on 1 panel. The spooler features pushbutton or remote control rewind at a speed of 40 in./sec. The reader features reading speeds up to 300 characters/sec. Remex Electronics. Booths 3829-31.

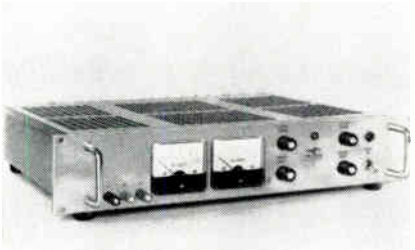
Circle 279 on Inquiry Card



SILICON POWER SUPPLY

The RS series features precision regulation at high power levels in a 3½ in. rack mount. Temp. range −20°C to +71°C. It features 0.01% regulation at power levels up to 500w. Units are available in a series of models up to 160v. Trygon Electronics, Inc. Booth 2216.

Circle 282 on Inquiry Card



DIGITAL VOLTMETER

Model 355 measures dc voltages from 0 to 1kv in 5 decade ranges, and ac from 0 to 1kv in 6 ranges. Freq. may be 30 CPS to 250KC. Accuracy is ¼% full scale up to 500v. and for mid-band frequencies on ac. Ballantine Laboratories. Booths 3402-04.

Circle 285 on Inquiry Card

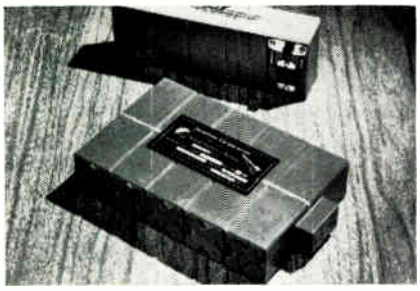
NEW PRODUCTS

At I.E.E.E.

NICKEL-CADMIUM BATTERY

This rechargeable nickel-cadmium battery can be used as a line filter, voltage regulator, and standby power supply. It will be demonstrated by Sonotone Corp. at Booth 2540.

Circle 286 on Inquiry Card



DATA TRANSLATOR

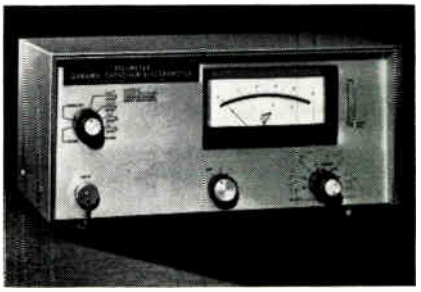
Model 800 data formatter translates parallel digital data into time serial form necessary for output to various printing and recording devices. Input capacity is 30 digits. Cubic Corp. Booths 3102-03.

Circle 289 on Inquiry Card

REED ELECTROMETER

The Model 474 Picometer is designed for everyday tests and measurements of current in the 10^{-14}a. range, and voltages from 10mv. Operates on line or battery. Victoreen Instrument Co., Booths 2301-03.

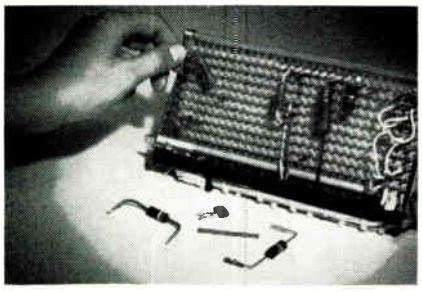
Circle 292 on Inquiry Card



SOLDERLESS TERMINAL BOARD

Connecto-Blok is a high density wiring block which accommodates solderless snap-on terminals, wire wrapped connections, or soldered installations. By using commoning bus connectors and jumper terminals, a complete circuit can be built up on the board. Thomas & Betts Co. Booth 2338.

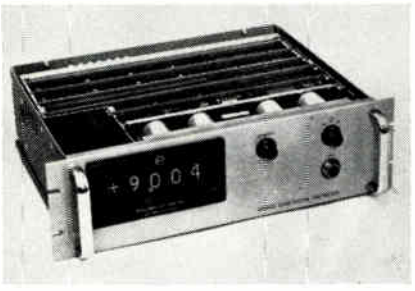
Circle 287 on Inquiry Card



DIGITAL VOLTMETER

Model 5005 features 4-digit display of dc voltages from ±0.001 to ±999.9v. in ranges of ±9.999/99.99/999.9v. Accuracy is ±0.01% of full scale +1 digit. It has a fully floating input circuit, 10 to 1000 megohm input resistance, and min. speed of 2 sec./reading. Non-Linear Systems Inc. Booths 3047-49.

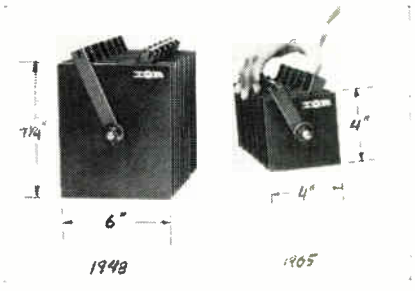
Circle 290 on Inquiry Card



SELENIUM RECTIFIERS

SD-7 series are said to have a 25% increase in the voltage and a 20% reduction in cu. volume over previous devices. Current-handling is 1.3a./sq. in. Standard density plates are rated to 50v.; double density to 36v., and the triple density to 40v. International Rectifier Corp. Booths 2633-37.

Circle 293 on Inquiry Card



POWER METER

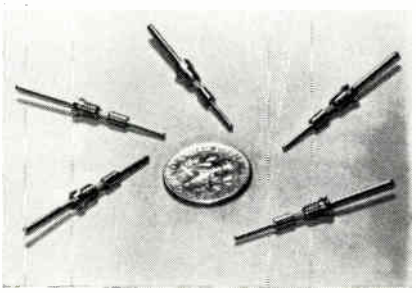
With the Microline® 66A3 peak power meter, microwave peak power measurements over the range of 3mw to 300mw can be made directly. Four full scale ranges of 10, 30, 100 and 300mw peak power are provided. Accuracy is ±5% of full scale. Sperry Microwave. Booth 3605.

Circle 288 on Inquiry Card

MINIATURE FUSES

The subminiature Picofuse is designed for multi-purpose uses in single and multi-pin connectors, rack and panel connectors, PC connectors, terminal strips, and terminal boards. They can be used where conventional fuse posts or holders cannot due to space limitations. Littlefuse Inc. Booth 2931.

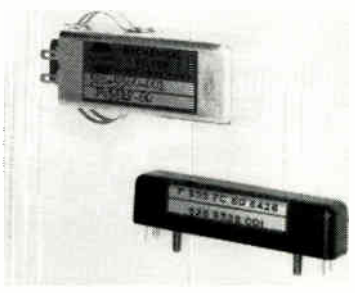
Circle 291 on Inquiry Card



MECHANICAL FILTER

The F4551F-60 is packaged in an i-f transformer case for uses in which it replaces the first i-f transformer in a circuit. It offers 6KC @ 3db, 20KC @ 60db, and freedom from aging breakdown or drift from extreme temp. or long continuous service. Collins Radio Co., Booths 2818-20.

Circle 294 on Inquiry Card



(More I.E.E.E. New Products on page 159)

DON'T try all these tests on any other resistor!

11-watt unit
enlarged 2½ times

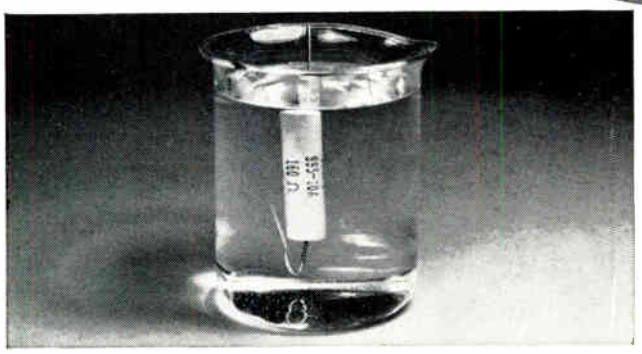
OHMITE Series 99

Insulated, Axial Lead Wire-Wound Resistors

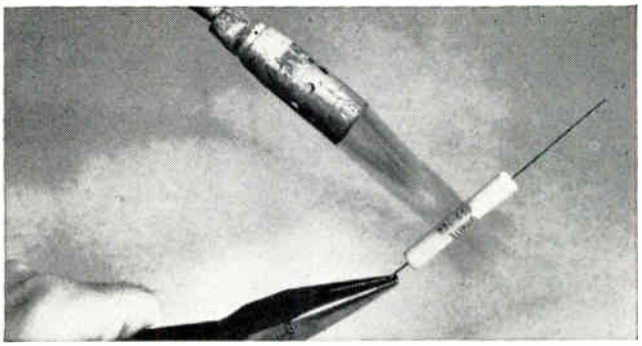
"molded" in vitreous enamel

...a new development in protective coatings.

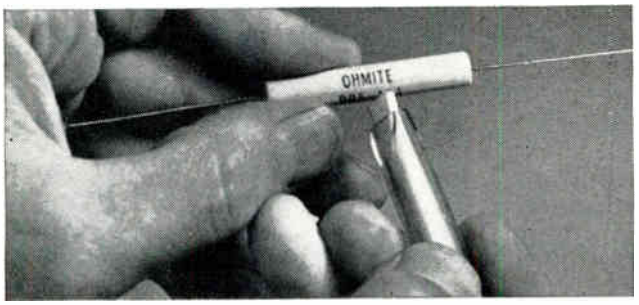
- Proved by over **24,500,000** unit-hours of load-life testing as of Oct. 1, 1964.
- Meet MIL-R-26C requirements.
- 1½, 2¼, 3¼, 5, 6½, 9, 11-watt sizes.
- Get the whole story on this important development. Write for Bulletin 103.



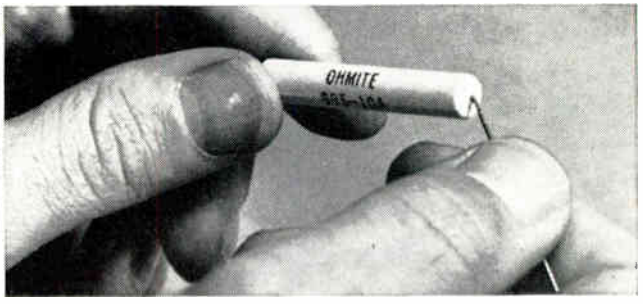
SOAK IT IN SOLVENT! Soak a Series 99 resistor in *any* organic solvent used in degreasing and flux removal. Then try to rub off the markings. You can't; they're *part* of the coating.



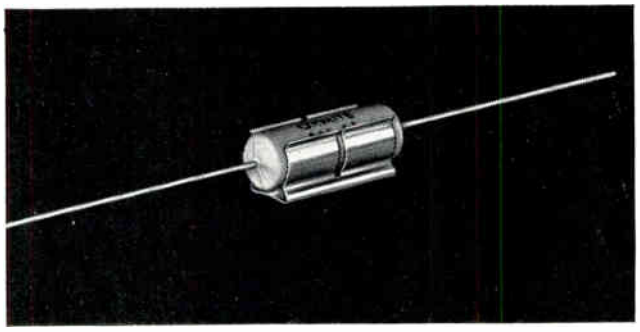
TORCH IT! Withstands temperatures of 1500°F without a sign of deformation. No other vitreous-enameled resistor will stand 1500°F without burning, softening, or dripping away. There's absolutely no effect on markings either.



ABRADE IT! Use a glass fiber eraser, for example, on the markings. Rub them hard. Nothing happens. The markings don't come off, because they are vitreous ceramic, *fired into* the molded vitreous coating.



BEND THE LEAD at the resistor body! There's no damage. Conventional (dipped) vitreous-enameled resistors have a meniscus at this point which ruptures, damaging the coating. Series 99 (molded) have no meniscus.



CLIP IT! Insert a molded Series 99 resistor into a metal clip. Don't baby it. The hard coating which provides 1000 VAC insulation won't cut, chip, or scratch. On a metal chassis, heat-sink action may increase wattage rating as much as 100%.

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Phone (312) ORchard 5-2600

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Let's talk facts about trimmer capacitor reliability

Only JFD gives you these design advantages...in the industry's broadest product line—over 500 standard models

Widest choice of drive mechanisms—All seven are engineered for greatest tuning linearity without reversals and for the ultimate in repeatability. Anti-backlash designs exceed Mil-C-14409B requirements.

Versatile choice of five dielectric materials to satisfy the most varied design parameters.

Actual size
Model VC 23G
0.8-18.0 pf.

Matched metalizing—Exclusive JFD metalizing processes form a homogeneous bond between dielectric and metal parts. There are no air gaps to widen tolerances and distort actual capacitances.

Industry's most comprehensive and advanced construction variations assure you the degree of reliability your application requires.

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High reliability of each individual unit is assured through the industry's most exacting quality control program.

That's why more JFD trimmer capacitors meet or exceed Mil-C-14409B than all other makes combined. JFD trimmer capacitors have been specified in the Apollo, Gemini, Minuteman and L. E. M. programs where high reliability is a must.

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Variable Trimmer Piston Capacitors ■ Metalized Inductors ■ LC Tuners ■ Ceramic Fixed and Variable Capacitors ■ Fixed and Variable Distributed and Lumped Constant Delay Lines

JFD-111

This is the world's smallest rotary switch for military applications.

This is the world's smallest rotary switch for commercial applications.

We make both.

Take your choice! Daven now offers two subminiature switches —Series G for military applications and Series K for commercial applications.

The renowned Series G has been redesigned to give increased reliability, higher dielectric strength and longer life. Manufactured in clean room environment, it meets applicable Mil specs on temperature, humidity, corrosion, vibration, acceleration, shock and immersion, as well as being explosion-proof and waterproof.

Now the new Series K gives you the same size, quality and electrical specifications as the Series G—but at a much lower cost—from **$4.85** to **$3.85** each, depending upon quantity. It was developed to meet instrument and commercial applications where low cost is important and the most exacting Mil specs need not be met. Yet it is a completely enclosed unit, offering such quality features as long life, low contact resistance, high dielectric strength, wide operating temperature range, positive detent action and resistance to corrosion, shock and vibration.

Both Series G and Series K switches are available in single deck, shorting and non-shorting. They may be obtained in various combinations up to 4 poles and 10 positions.

For complete details on either, write today!

DAVEN McGRAW EDISON

LIVINGSTON, NEW JERSEY

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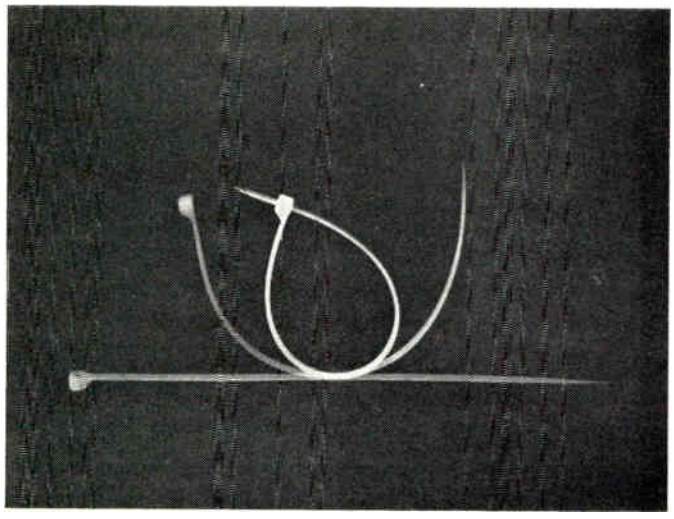
Samples available on letterhead request

NEW *TY-RAP*T.M. METHOD SIMPLIFIES HARNESS MAKING AND CABLE TYING

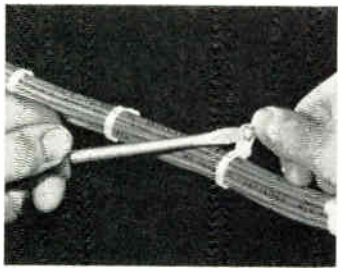
Fabrication costs are reduced, reliability factors improved



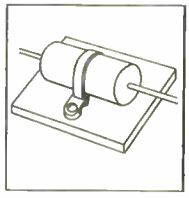
If you have a volume of harnesses or many ties to install you can immediately reduce costs by incorporating the TY-RAP METHOD. It simplifies all the steps in harness making and cable bundling. A step by step time and materials evaluation including the planning, fabrication, inspection and installation, will show you that the TY-RAP METHOD is easier and less costly than any other way. In fact, users of this method have saved over $8,000,000 in cost reductions of harnessing and point-to-point wire bundling. You will not only record cost savings but the packaging job gains in reliability which is evident with the high degree of inspectability.

To help you evaluate the TY-RAP METHOD, a fully illustrated 40 page brochure is now available. It describes tying, clamping and identifying techniques.

NEW ADJUSTABLE CLAMP FOR MOUNTING COMPONENTS OR WIRE BUNDLES

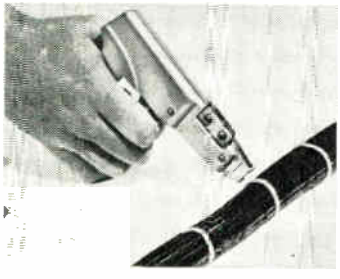


You can eliminate over 60 various sizes of plastic and metal clamps with only one size TY-RAP strap. It is infinitely adjustable over a range from 1/16" to 3-3/4" diameter. The TY-RAP clamp is a TY-RAP tie with the addition of a mounting hole. It is molded of DuPont Zytel† 101 (nylon). Since it is a tie as well as a clamp, it can be used as one of your ties during harness fabrication. Harnesses which include TY-RAP clamps install quickly in equipment and cabinets because they are prepositioned on the harness and eliminate extra components. Over 20 different catalog numbers are contained in the clamping section of the new 40-page brochure.

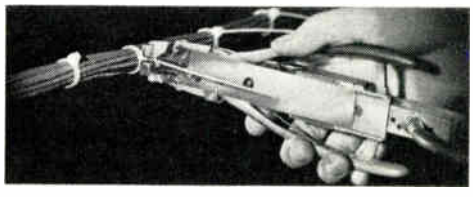


†Reg. TM of Dupont

TOOLS FOR HIGH SPEED TYING



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



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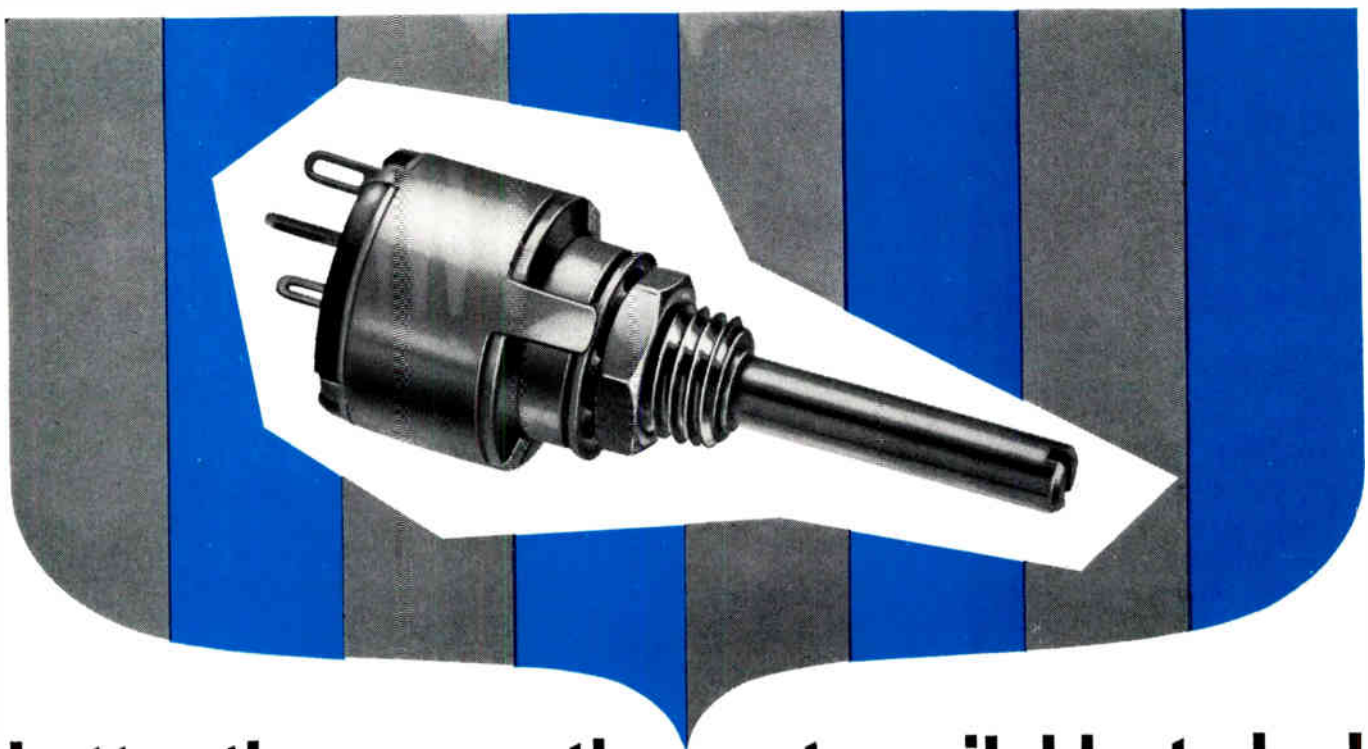

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SPECIFICATIONS: True compatibility, carbon-to-carbon and metal-to-metal moving contacts, giving you longer life, greater stability, and a lower noise level. High tensile, stress-relieved beryllium-copper contact spring. Strong metal stops eliminate non-metallic material failures. Power rating: 0.5 watt @ 70°C. Derated to 0 power @ 125°C. 350 VDC across end terminals. Resistance range 100 ohms to 1 megohm, linear. Mechanical and electrical rotation 295° (± 3°). Voltage breakdown 750 VAC between terminals and ground for 1 minute. Torque: standard bushing 0.5 to 6 oz. in. Locking type, 20 oz. in. minimum with jam nut tightened to 8 lb. in.

Feature-for-feature the new Clarostat RV6 is designed to work better and last longer. And most important . . . they're in stock at your local Clarostat Military Products Distributor for IMMEDIATE DELIVERY. Call him today for your RV6 requirements at factory prices.

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CLAROSTAT MFG. CO., INC. DOVER, NEW HAMPSHIRE

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Astrodata's New Astrolock*-loop FM Subcarrier Discriminator

Stability

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

Linearity

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

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

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

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

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

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

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

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

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

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The Navy's Approach to Telemetering

By T. BURR JACKSON
Head, Instrumentation Div.
Naval Ordnance Lab.
Corona, Calif.

The Navy's view is that units must be modular, capable of any packaging configuration, operate in the new UHF bands, and not become obsolete. These requirements will probably be those of other groups also.

THE NAVY'S APPROACH to coordinated and standardized instrumentation for use in its missile programs involves both the airborne transmitting system and the receiving and data handling systems for ship, shore and aircraft. Emphasis is being placed on R&D leading to a complete series of modular units and subsystems designed to work together in many combinations.

* * *

The modular approach to the telemetry transmitting system will eventually result in a set of "building blocks." Although standardized, these will provide for any reasonable data transmission format covered by the present IRIG Telemetry Standards, including FM/FM, PDM/FM, PAM/FM and PCM/FM and several combinations thereof.

Modular assemblies will make maximum use of miniature high packing density. This will lead to a second generation of equipment where size and weight will be greatly reduced and reliability increased by the use of microcircuits. Modules will be such that they may be arranged to fit the many and varied spaces allocated to telemetry without repackaging. Also, any module may be refined and improved, when necessary, without affecting others in the system.

Receiving and Processing

The above can be said for receiving and processing facilities. These units will allow operation in the new UHF bands and will handle standard data formats such as FM, PAM, PDM or PCM *on* FM or PM modulated carriers. Only the units needed to handle a particular type of data, such as FM/FM need be acquired for any given installation. Other basic units may be added at any time for one or more additional modes, such as PAM or PDM. The original units will not become obsolete when other units are added.

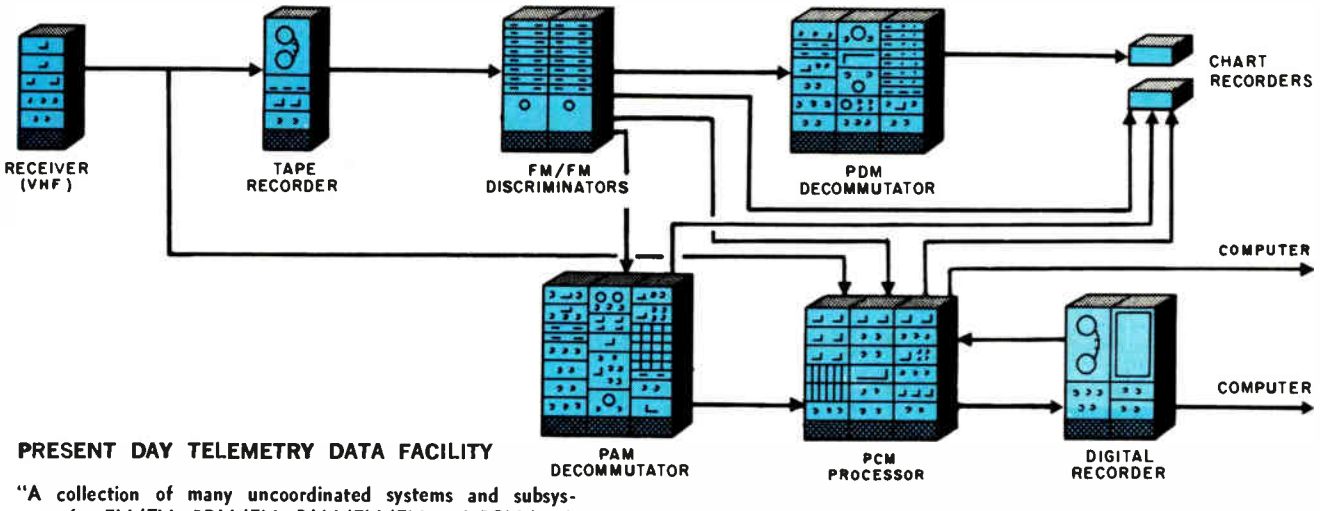
As in the case of the transmitting system, the receiving design approach will make use of replaceable circuit cards. These may be readily mounted in different cabinets, depending upon whether the equipment is to be installed in a ship, plane or shore facility. The design concept will also permit microcircuitry without the need for redesigning the basic system. Provisions will be made for accommodating improved ancillary equipment, such as high-speed electrostatic plotters, digital-data display boards and automatic alarm equipment. Optional auxiliary equipment for automatic system checkout will also be considered in the design concept.

Present Developments

The basic transmitter must provide for operation in either of the two UHF bands, handle any of the IRIG telemetry formats, and operate from both types of prime power sources used in Navy missiles. The modular units should fit many configurations typical of the space allocated. Three approaches to the basic transmitter have been investigated and compared through models. These include all solid-state and hybrid designs using frequency multiplier techniques, and the modulation and stabilization of UHF power oscillators by control loops. In each instance, the operating frequency band could be changed by changing one or two modular units. Performance requirements and physical limitations are listed in Table 1. Table shows the original design objectives, results obtained with models and results expected from advanced and preproduction models. An example of the modular approach is shown in Fig. 2. The all solid-state experimental transmitter was designed and developed by Electronic Communications, Inc. under a Navy contract.

R-F Power Amplifiers

Although a power output level of 2 to 3 watts is adequate for many Navy missile programs a level of 8-10 watts, 18-20 watts, or even higher may be needed for some long-range missiles. By combining the basic 2 watt modules with a UHF power amplifier (P. A.) and power supply, the useful operating distance of the transmitter may be greatly increased. Here again, the



PRESENT DAY TELEMETRY DATA FACILITY

"A collection of many uncoordinated systems and subsystems for FM/FM, PDM/FM, PAM/FM/FM and PCM/FM"

Fig. 1a: Diagram illustrates a present day telemetry facility which is a collection of units to do a specific job.

NAVY TELEMETERING (Continued)

modular approach to the power amplifier and its power supply provides flexibility.

It is considered practical for one basic P. A. to provide for various power output levels by simply changing power supplies. The P. A. now under development for the Navy by Eitel-McCullough, Inc. will provide the following: maximum dimensions 4x2½x1½ in.; maximum weight 1.5 lbs.; tuning range 2200-2300 mc (alternate unit for 1435-1535 mc); 20 mc bandwidth; 2 watts drive power; 8-20 watts minimum output power range (depending on supply voltages); 30% minimum operating efficiency; maximum phase jitter 2.5° peak and gain stability 0.5 db. An associated set of power supplies is under development for operation from either 28 vdc or 115 vac 400 CPS prime power sources.

Miniature Transmitter

Some missile programs will require very compact transmitters so that instrumentation may be provided and mounted in spaces like the base of a control fin or in a cable raceway. Such a transmitter is being developed under a Navy contract at the General Electric Co. in Oklahoma City. The transmitter, in its present form, is in a 1x1x6 in. module. A matching power supply is provided in a similar package.

The transmitter will provide at least 2 watts of power and is tuneable from 2200-2290 MC. R-F stability is within 0.001% of the assigned carrier frequency for ±125 KC deviation. The frequency response is flat with 1db from 100 CPS to over 100 KC. The device operates from a 28±4 vdc prime power source. Spurious and harmonic emissions are at least 60 db down from the carrier. The unit is expected to operate for at least 500 hours without service or adjustment. The model is designed with the general requirements of MIL-E-5400 and MIL-I-26600.

Multiband Receiver

An all solid-state, multi band telemetry receiver has been developed under Navy contract by Radiation, Inc. for general-purpose use at shore facilities and limited use in ship and aircraft. The receiver is provided with plug-in modules to operate with FM, PDM, PAM, or PCM telemetry formats on FM, PM or AM modulated carriers in the 215-315MC, 1435-1535MC and 2200-2300 MC bands. Modular construction is used throughout. Provisions are made for mounting in a standard 19 in. cabinet rack with 5¼ in. panel height. The frequency response, stability factors and tuning ranges are designed to match the transmitters described.

I-F and video filters provide selectable bandwidths from 12.5 KC to 1.5 MC. The receiver was designed for a noise figure of 7 db for the VHF band and 9.5 db for the UHF bands. In the models completed at this time some redesign is required to achieve these goals, and at the same time provide better front-end selectivity.

Models of the receiver have successfully completed the environmental tests per MIL-E-16400, plus the vibration requirements of MIL-E-5400. The same receivers were given the full series of interference tests per MIL-I-26600, and with minor exceptions satisfied all requirements.

Several manufacturers have been developing and producing general-purpose multi-band receivers that meet many of the outlined requirements. But in general, these equipments have not been designed to maintain performance under the rigorous environmental conditions set forth in military specs.

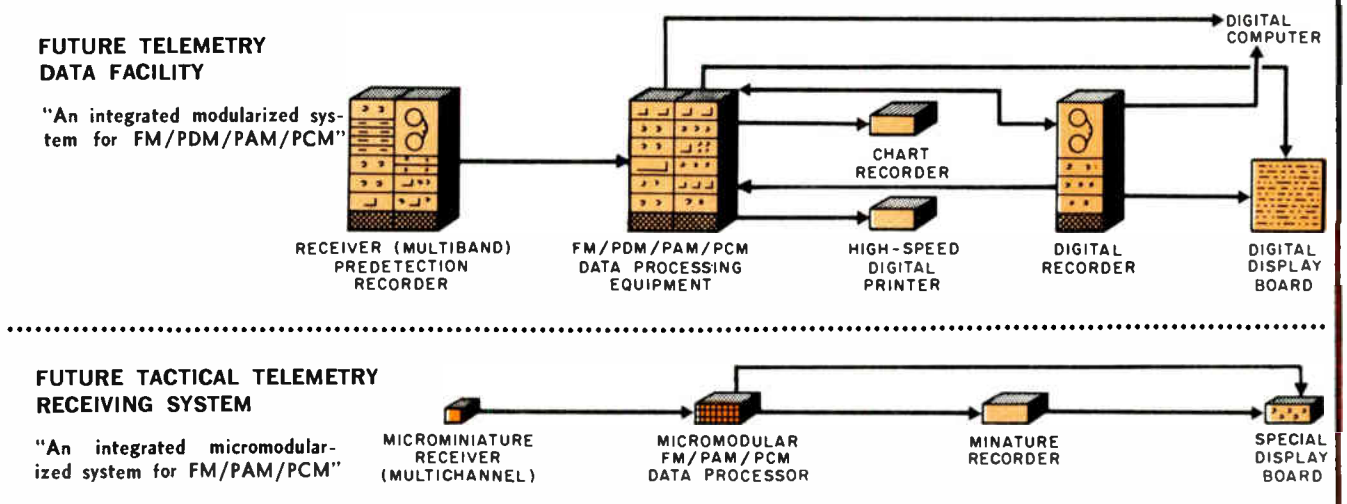


Fig. 1b: Future telemetry systems will be flexible, modular and eventual ly, micromodular using microcircuitry as much as possible.

UHF Airborne Receiver

A special-purpose miniature receiver, suitable for use in high performance aircraft, missiles and special instrumentation pods; is now being developed, under Navy contract, by R-S Electronics. The receiver is of the superheterodyne type with 3 basic modules; an r-f head, an i-f/video unit and a power supply. The units are contained in a single package 3x4x8 in.

Modules may be interchanged to operate in either the 1435 MC or 2200 MC bands, 150 KC or 300 KC i-f bandwidths and 115 vac 400 CPS or 27 vdc input power. Noise figure will not exceed 10 db and sensitivity will be at least —113 dbm for 150 KC bandwidths, and —109 dbm for 300 KC bandwidths. The receiver is designed to meet the MIL-E-5400 and MIL-I-6181D.

Automatic Data Reduction

The modular approach is also being used in the development of an all solid-state telemetry data handling system at the U. S. Naval Ordnance Lab., Corona, Calif. The preliminary design has been completed for a series of basic units or "building blocks" from which many different types of receiving and data processing systems may be assembled. The FM, PDM, PAM and PCM data formats as set forth in IRIG Telemetry Standards may be handled individually or in reasonable combinations.

Only those basic units required to handle a particular type of data need be acquired for any given installation. Other units may be added at any time for one or more additional modes. The original units will not be incom-

(*Continued on page* 182)

TABLE 1: CHARACTERISTICS OF BASIC UHF TRANSMITTER

Characteristic	Design Objective	Obtained With Experimental Model	Expected From Advanced Model
Total Volume:	50 cu. in. (max.)	42.9 cu. in.	30 cu. in.
Total Weight:	8 lbs. (max.)	2 lbs. 15 oz.	1 lb. 12 oz.
No. of modules:	5 or 6	6	5
Max. Module Size:	5 x 2.5 x 2.5 in.	5 x 2.5 x 1.25 in.	2.5 x 2.5 x 1.25 in.
Tuning Range:	1435–1535 MC 2200–2300 MC	1435–1535 MC 2200–2300 MC	1435–1535 MC 2200–2290 MC
Frequency Tolerance:	0.001%	0.003%	0.001%
R-F Output Power:	2 watts (min.)	2.6 watts (min.)	3.0 watts (min.)
FM Deviation Capability: Linearity for ±250 KC dev. Linearity for ±500 KC dev. Linearity for ±1.5 MC dev.	 0.5% 1% 5%	 0.5% 1% 2%	 0.5% 1% 2%
Incidental FM:	5 KC (max.)	3 KC	2 KC
AM Modulation:	1% (max.)	1%	0.5%
Frequency Response:	100 CPS to 800 KC (1db)	100 CPS to 800 KC	10 CPS to 1.2 MC
Warm-Up Time:	120 sec. (max.)	60 sec.	10 sec.
Max. Input Power:	40 watts	39 watts	30 watts
Prime Power:	27 ± 3 vdc 115 ± 12 vac (350–850 CPS)	27 ± 3 vdc 115 ± 12 vac (350–850 CPS)	27 ± 4 vdc 115 ± 15 vac (350–850 CPS)

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TYPE 18 SUB-SUBMINIATURE SWITCH

Double-break switches don't come any smaller than Licon's Type 18 Sub-Sub-miniature Switch. Measuring an incredible .200" x .500" x .350", this rugged mite packs all the reliability and precision performance of Licon's famous Type 16 Sub-miniature Switch. And despite its smallness, the Type 18 offers a big switch rating and a 20 million cycle life.

ELECTRICAL RATING

125/250 v AC: 10 Amps
30 v DC: Form X or Y—10 Amps Res.
Form X or Y— 5 Amps Ind.
Form Z— 10 Amps Res.
Form Z— 3 Amps Ind.

GENERAL PURPOSE!

TYPE 11 BASIC SWITCH

Ideal for a wide range of military and industrial applications. The Type 11 Basic Switch combines high electrical rating and long mechanical life into one compact package. Exceeds standard requirements of precision snap-action control, and is especially adaptable for direct cam actuation. Over 20 million mechanical cycles.

ELECTRICAL RATING

125/250 v AC: 10 Amps
125 v AC: ½ HP
250 v AC: ¾ HP
30 v DC: Form X or Y—15 Amps Res.
Form X or Y—10 Amps Ind.
Form Z— 10 Amps Res.
Form Z— 7 Amps Ind.

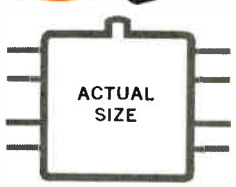
DOUBLE-POLE MIDGET!

TYPE 26 DOUBLE-POLE, SUBMINIATURE SWITCH

This subminiature double-pole switch utilizes two Licon Butterfly double-break mechanisms in one case. A special linkage between the mechanisms insures simultaneous operation of both poles. Type 26 simplifies control of multiple circuit applications by eliminating the need for dual components and complicated actuating mechanisms. Provides over 20 million cycles mechanical and pilot duty life. Rated for electrical life of 100,000 cycles.

ELECTRICAL RATING

125/250 v AC: 10 Amps
30 v DC: Form XX or YY—10 Amps Res.
Form XX or YY—7.5 Amps Ind.
Form ZZ— 10 Amps Res.
Form ZZ— 5 Amps Ind.



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Butterfly® double-break switches

The Exclusive Licon® **Butterfly**® double-break switch line sets a new standard of reliability in switch performance. In operation the contact blades flex like a butterfly's wings. Actuating pressure applied to spring-held blades provides a positive "snap" with a corresponding linear wiping action at each contact point. The result is simultaneous opening and closing—and no contact welding. Licon **Butterfly** switching is incorporated in a full line of double-break switches. Whatever your electro-mechanical requirements, Licon has the switch you need.

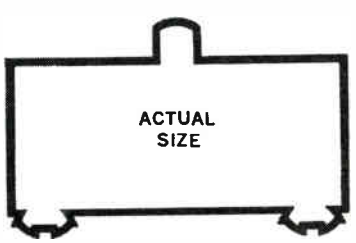
For complete information on the Licon line of Butterfly double-break switches, write for this new 8-page book. It contains complete data, specifications, and dimensions.

HEAVY DUTY!

TYPE 14 BASIC SWITCH

Here's the switch to use for industrial and machine tool applications where rugged dependability and precision performance are required. The Type 14 Basic Switch features extremely long mechanical life—exceeds 20 million cycles without failure. The snap-action switch mechanism is field-proven—assures positive contact, high vibration resistance, large contact surfaces and high electrical current capacity.

ELECTRICAL RATING
125/250/480 v AC: 20 Amps
30v DC: Form X or Y—25 Amps Res.
Form Z —10 Amps Res.

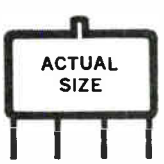


RATING DOUBLED!

TYPE 16 SUBMINIATURE SWITCH

Offers twice the electrical rating of most conventional subminiature switches—a big 10 Amps at 30 v AC resistive. The Type 16 Subminiature Switch features two circuit control, direct cam operation with double bearing guided button plus high shock and vibration resistance. Consistently achieves 20 million mechanical cycles, even at extreme over-travel. Minimum switch life of 100,000 cycles at a full 10 Amps, or 750,000 cycles at conventional 5 Amps.

ELECTRICAL RATING
125/250 v AC: 10 Amps
30 v DC: Form X or Y—10 Amps Res.
Form X or Y—7.5 Amps Ind.
Form Z— 10 Amps Res.
Form Z— 5 Amps Ind.

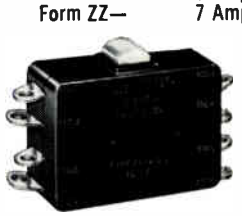


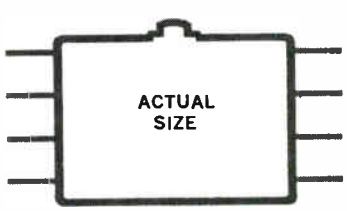
4-CIRCUIT CONTROL!

TYPE 22 DOUBLE-POLE, DOUBLE-THROW SWITCH

Positive electrical control of four independent switches—with one snap. That's what you get with the Licon Type 22 Switch. Type 22 insures exacting double-break switch performance for 3-phase motors, permits simplified controls for multiple circuit applications. Extra long and dependable operation (over 10 million cycles).

ELECTRICAL RATING
125/250 v AC: 10 Amps
125 v AC: ½ HP
250 v AC: ¾ HP
30 v AC: Form XX or YY—15 Amps Res.
Form XX or YY—10 Amps Ind.
Form ZZ— 10 Amps Res.
Form ZZ— 7 Amps Ind.





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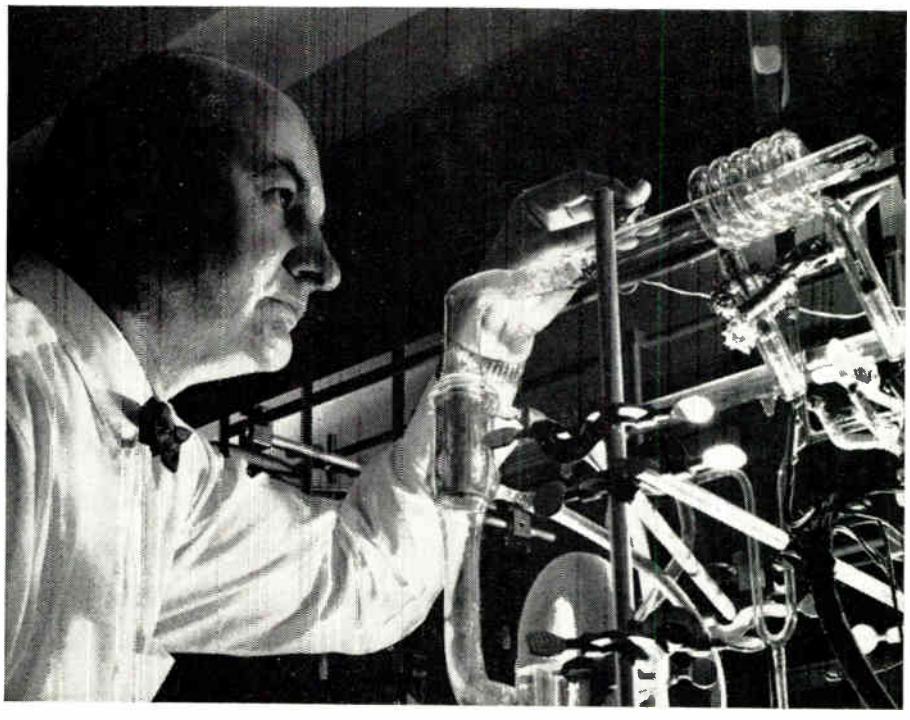


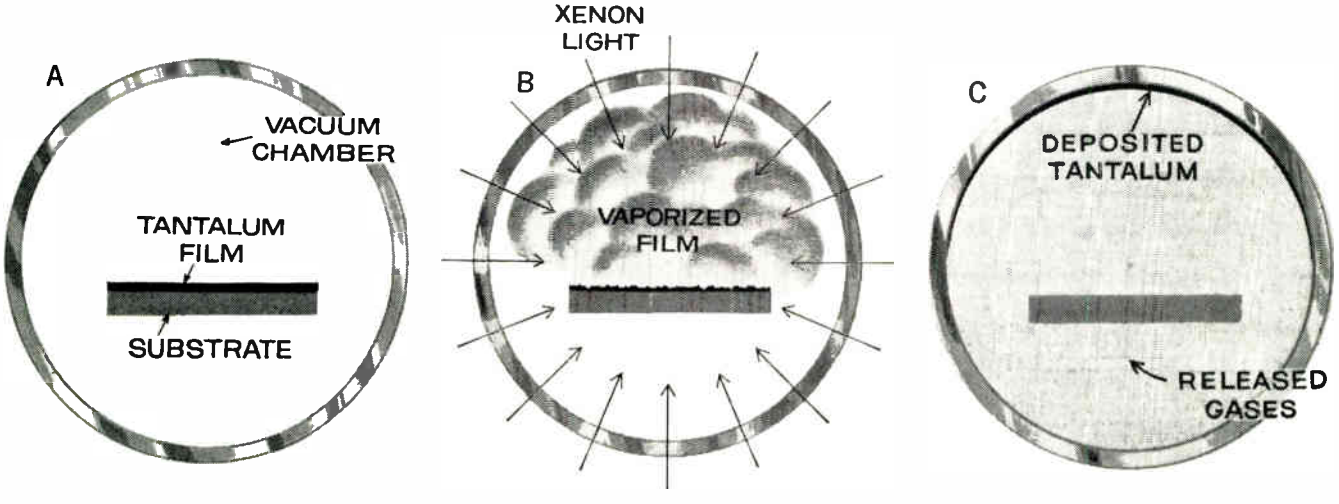
Chemist W. G. Guldner examines apparatus for "flashing" thin-film samples to remove gases for analysis. Helical tube is xenon flash surrounding vacuum chamber indicated in drawings below.

"FLASHING" THIN FILMS FOR QUANTITATIVE ANALYSIS

In making tantalum thin-film circuits, the tantalum is deposited on a substrate. Nitrogen is added during the deposition to form tantalum nitride, which helps stabilize resistance and capacitance values. After a film is formed, one then needs a quantitative analysis of the amount of nitrogen and other gaseous elements it contains.

A new technique has been developed at Bell Laboratories to perform this analysis quickly and accurately. As shown in the photograph above and in highly simplified form in drawing A, a sample of a film on its substrate is placed in a glass vacuum chamber. This chamber, surrounded by a xenon flash tube, is then subjected to a one-millisecond flash of light. As indicated in drawing B, the light energy is selectively absorbed by the film and has little effect on the substrate or on the walls of the glass chamber. The film is vaporized, and the temperature is high enough to dissociate the tantalum nitride.

Drawing C illustrates the chamber after the flash. Tantalum atoms have been driven to the inside walls of the chamber and are there condensed. Most of the released nitrogen and other elements are now in gaseous form within the chamber. These are pumped out for analysis by gas chromatography or other means.



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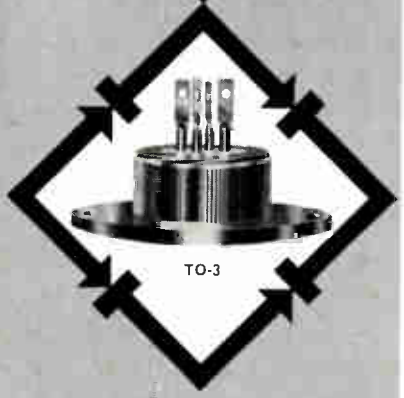
The problems of space, cost and reliability in full-wave rectification are being solved for industrial OEM's by Varo's IBR*.

The IBR* meets your small space and competitive cost requirements by giving you a full-wave bridge in a single, minimum-size package with circuit-to-case insulation of 2000 V min. Three versatile mounting methods simplify and even further reduce installation time.

In design considerations, SAR* (silicon avalanche rectifier) characteristics allow decreased PRV safety factors by controlling avalanche voltages and eliminating junction perimeter destruction from transient overvoltages.

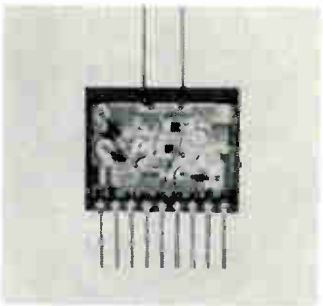
The 1N4436 (250 V BV_R min.) and 1N4437 (450 V BV_R min.) are designed for 140 and 280 V RMS operation. They feature 10 amps DC I_o at 100°C (T_C) and 100 amp, one-cycle current surge.

Available in press-fit, single stud and TO-3 mountings. Write for complete information and low OEM prices.



*T.M. VARO, INC.

TF CIRCUITS



Actual size: TF flip-flop

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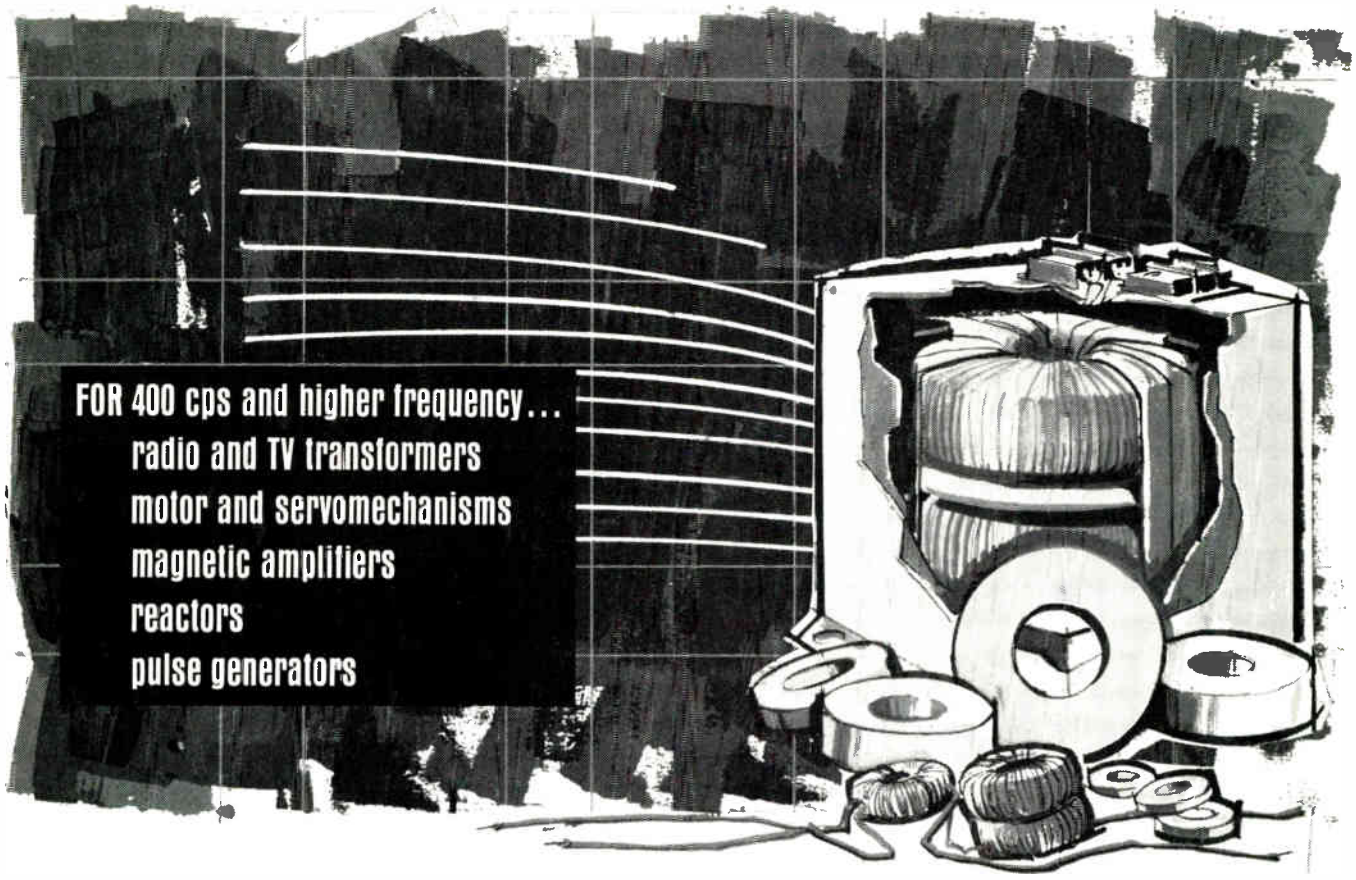

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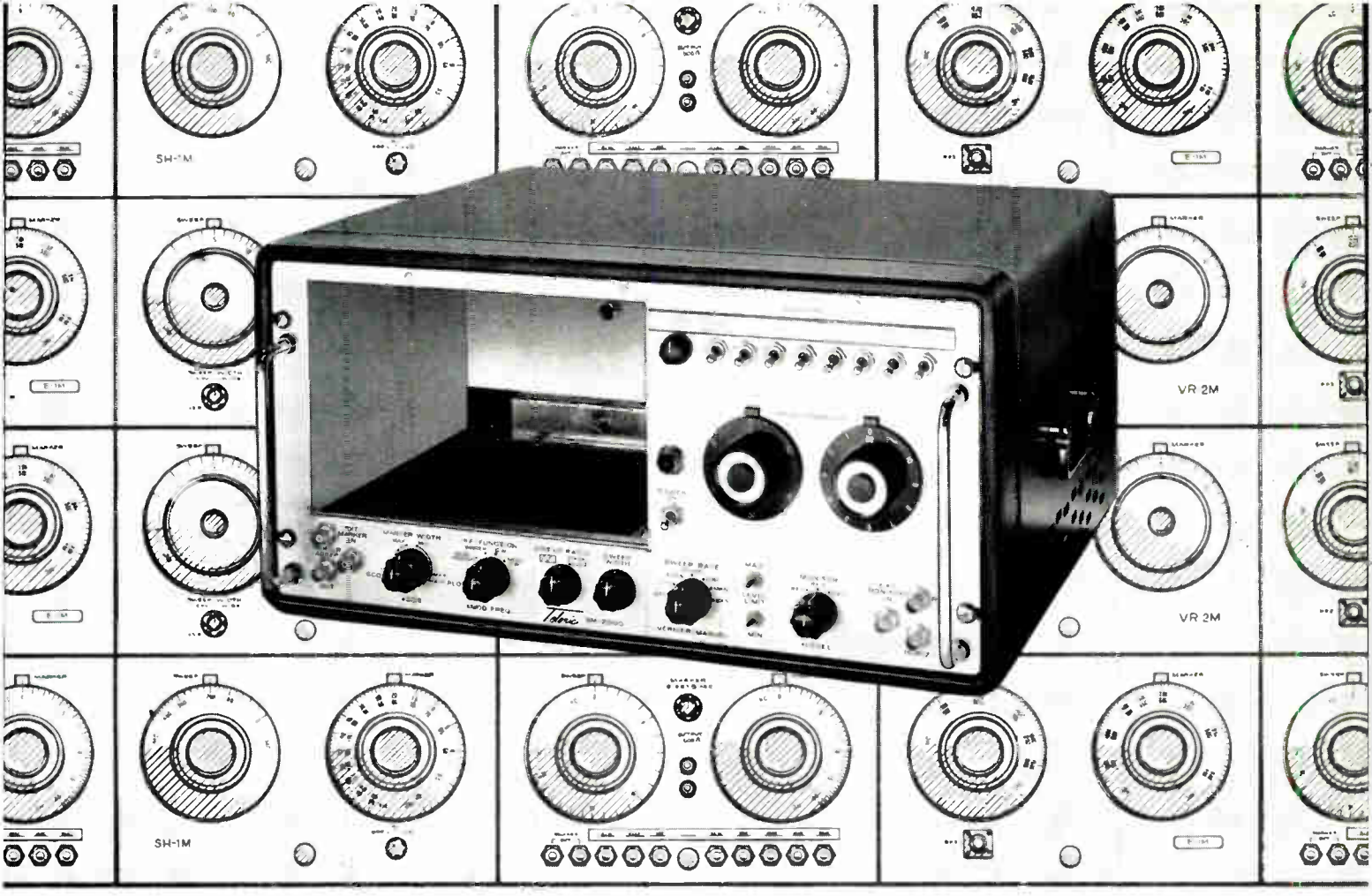

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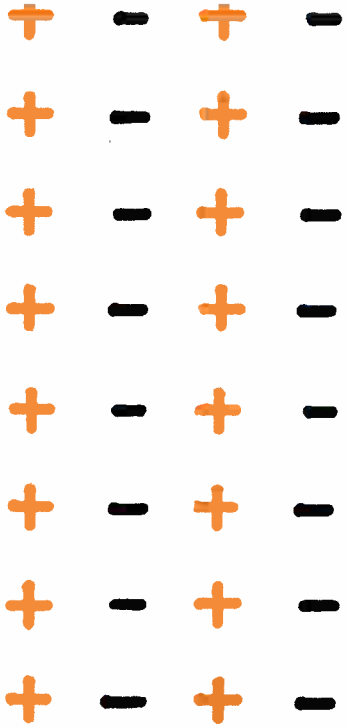


What Electronic Engineers Should Know About Plasma

Plasma is gaining increased attention from researchers. A large number of plasma devices and applications are tied directly to electronic engineering. This article describes plasma, how it is controlled and some of its applications.

By Dr. LEON W. ZELBY

Assoc. Prof., Moore School of E. E., Univ. of Pennsylvania, 200 So. 33rd St., Phila., Pa. 19104

Fig. 1: Collisionless plasma.

A PLASMA may be defined as an ionized gas, electrically neutral, in which the interactions between the constituents are important [1, 3]. In other words, plasma is an aggregation of neutral molecules, ions, electrons, and photons, overall electrically neutral, of relatively low densities. By low densities it is meant here that the constituents are relatively free, as distinct from bands in solids. Strictly speaking, this definition of plasma, without the restriction of low densities, also includes solid state plasmas. These will not be discussed here. Solid state plasma represent a separate topic not only in their properties and applications but also in methods of analysis.

* * *

The most important interactions between the plasma constituents are collisions between the electrons and neutral molecules, and coulomb interaction between the ions and electrons. The former result in ionization in the case of very energetic electrons; the latter, in plasma oscillations and/or recombinations, generally without emission of radiation.

Different regimes of plasma are described by their respective electron densities, frequently referred to as electron number densities. Dilute, or low density plasmas contain electron densities up to about 10^{18} m^{-3}. Higher densities constitute dense plasmas, with electron densities varying up to about 10^{24} m^{-3}. The division of plasma into these regimes is based not only on its applications, but also on the methods of analysis. The behavior of low density plasma is analyzed by consideration of the statistical average of its constituents. High density plasma behaves like a conducting fluid, and its behavior is analyzed in terms of hydrodynamic equations.

Low density devices have been in use for a long time. Among those are the mercury pool rectifiers, thyratrons, ignitrons, glow tubes, TR tubes, and others[4], all quite familiar to engineers. Some of the newer devices are less familiar, e.g. thermionic plasma diodes used for direct energy conversion; plasma amplifiers, TWTs using plasma to enhance microwave amplification; plasma propulsion devices for driving space vehicles. Of the high density region devices, the MHD generator received much publicity and is well known. Thermonuclear fusion plasma devices received much less public notice. It is nearly impossible to describe all aspects and uses of plasma in an article of this length. Hence, only those are presented which give a reasonable description of plasma properties, and some of the more common uses.

Physical Description

Consider the electrically neutral arrangement of electrons (−) and ions (+) shown in Fig. 1.

Assume that there is no magnetic field and neglect collisions. If the electrons are displaced from this equilibrium position, coulomb forces will act on them to restore equilibrium. In the absence of friction, the situation is analogous to spring-connected masses and will result in electron oscillations. The ions are assumed, essentially, stationary. The frequency of these oscillations is given by [5] $\omega_p^2 = \frac{n q^2}{m \epsilon_o}$, where n is the electron (ion) density; q the electronic charge; m, the electron (ion) mass; and ϵ the permittivity of free space. Clearly, the frequency of oscillation of plasma electrons is higher than that of the ions by the square root of the ratio of their respective masses. It is evident that plasma is polarizable. Since, in absence of collisions, the only restoring force is of electrostatic nature, the permittivity of the plasma will be the same as that of any dispersive dielectric without the effects of "quasi-elastic" forces which bound the electrons in

an atom to their rest position. The permittivity of a dispersive dielectric is

$$\epsilon = \epsilon_o \left(1 + \frac{n\,q^2}{m\,\epsilon_o\,(\omega_o^2 - \omega^2)}\right)$$

where $\omega^2{}_o = (f/m)$ expresses the effect of the "quasi-elastic" forces. When $\omega_o = 0$,

$$\epsilon_p = \epsilon_o \left(1 - \frac{\omega_p^2}{\omega^2}\right)$$

is the permittivity of plasma in absence of collisions (cold plasma). This result can be calculated very simply by considering electron oscillations about the ions. The presence of collisions modifies ϵ_p very slightly mathematically (ω^2 is replaced by $\omega^2\,(1 - i\nu/\omega)$, where ν is the collision frequency) but very significantly physically: the plasma is now dissipative since the permittivity is complex.

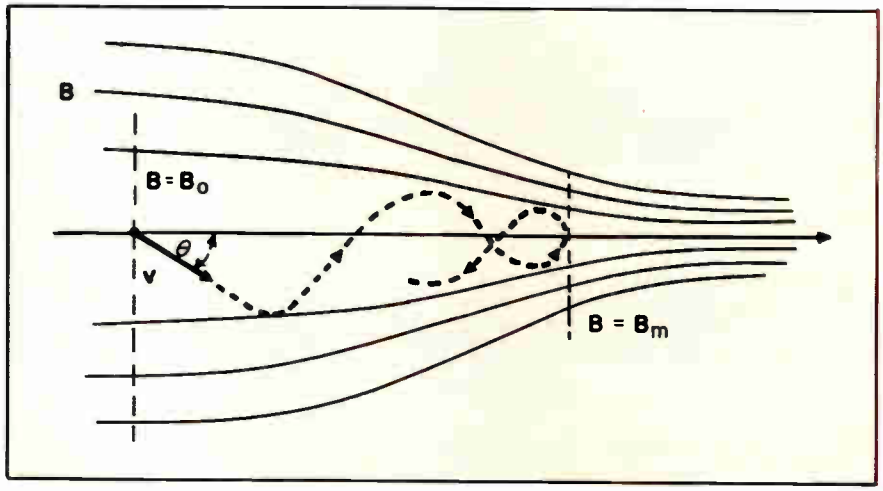


Fig. 3: The simple mirror machine is one of the newer plasma devices. It reflects particles and can be used to contain plasma. This device is called a "magnetic bottle."

Magnetostatic field impressed upon the system of Fig. 1 will strongly affect its properties in a direction transverse to the direction of the field. This will be due to the rotation of the charged particles about the lines of magnetic induction. The plasma will now be anisotropic, and the permittivity must be represented by an antisymmetric tensor. This is evident from the following observation: The charged particle motion along the field lines will be unaffected by the magnetic induction. In the plane transverse to the field line, the particles will rotate. Putting the origin of a coordinate system in the center of an orbit, the particle motion is antisymmetric about the origin.

Theory

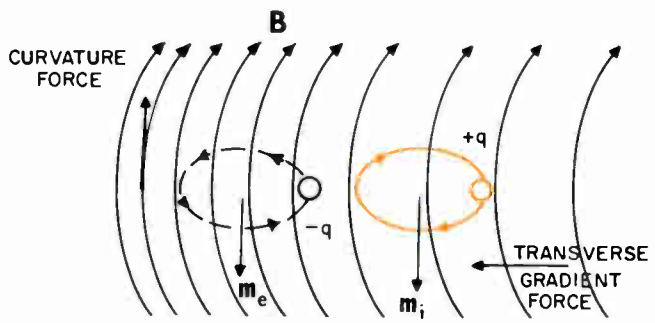
There are several mathematical techniques which are used to describe and analyze plasmas [1, 3, 5, 6]. The simplest of these is the orbit theory; the most detailed, the Boltzmann equation; the most convenient describing average properties, the hydrodynamic equations. All these, as well as Maxwell's equations, are shown in Table 1.

In spite of rather severe limitations, the orbit theory is very useful in explaining, qualitatively, a large number of phenomena. The basic assumption of the orbit theory is that the behavior of all particles of one type is the same, and that there is no interaction between them. Thus, it is enough to calculate the motion of an electron, and an ion, and to multiply the results by the respective densities to obtain the description of the behavior of the plasma. Sometimes it is convenient to relax the requirements of this theory to plasmas in which the collision frequency is small, not zero. In such cases, the results of calculation must be interpreted as some sort of average.

The important result of the orbit theory is that the magnetic moment of the charged particles is constant in magnetic induction field, **B**, which, relative to the total strength, has a small spatial or slow temporal variations. Orbits of an electron and ion in a static magnetic induction, with a slight curvature and transverse gradient, are shown in Fig. 2. Electrons ($-q$) and ions ($+q$) rotate in opposite directions. By definition, however, the direction of current is that of motion of a positive charge. Thus the magnetic moments, **m**, are in the same direction for both. Noting that these are in the direction opposite to that of the magnetic induction, it can be concluded that plasma is diamagnetic.

The constancy of the magnetic moment of the charged particle implies that the flux through the orbit is constant. This, in turn, implies a greater density of particles in regions of higher magnetic field

Fig. 2: Orbits are shown in B field with curvature and gradient. Minus "q" are electrons and positive "q" are ions in orbit.



intensity. Furthermore, the constancy of the moment implies that the motion of plasma constituents can be studied by consideration of the motion of the guiding center, the center of the orbit. The drift velocities of the guiding center, and the forces causing them, are given in Table 1.

It is worthwhile noting that only in the case when the external force field is electric, i.e., $\mathbf{F}_e = q\,\mathbf{E}$, the drift velocity is independent of the sign of the charge. Thus, drifts due to an external electric field result in no currents in a direction normal to **E** and **B**.

The Boltzmann equation describes the behavior of a system of particles in six-dimensional space (so-called phase space) in terms of a distribution function. The six-dimensional space comprises three spatial and three velocity coordinates. The derivation of the equation is based on the consideration of the net rate of change of the number of particles in an elementary volume. This rate is due to changes in velocity distribution of the particles within the volume, drift of the elementary volume under the influence of forces, and collisions within the volume. The force term in the Boltzmann equation (see Table 1) includes gravitational as well as electromagnetic, forces. Thus, the Boltzmann equation provides the most accurate description of plasma. It is also the most difficult to solve, except in a few simple cases.

The hydrodynamic equations for plasma describe the average behavior of the particles under the assumption that plasma is composed of three non-viscous fluids: electron, ion, and neutral particle. The total fluid is viscous, however, because of collisions between particles belonging to different fluids, i.e. electron-ion, electron-neutral, and ion-neutral collisions. There are three sets of hydrodynamic equations, one for each specie, which are coupled through the collision terms. Each set consists of a momentum transfer equation, continuity equation, and equation of state. These are shown in Table 1. The hydrodynamic equations are generally used to describe high density plasmas.

Each of these theories has been used extensively in plasma work, and lead to a more accurate description, to a prediction, or use, of one or another phenomenon.

Plasma Devices

There are many useful plasma devices: Some mentioned earlier, are well known to electrical engineers. Some are rather new and developed within relatively specialized areas. These escaped general recognition. The principles of operation of some of them will now be discussed.

The mirror machine[5] is among the better known of the "new" devices. As the name implies, it reflects particles and can be used for plasma containment. The principle of the simple mirror machine is based on the constancy of the magnetic moment (orbit theory) and on force due to the gradient of magnetic induction, which is in the direction of the less intense fields (see Table 1). The shape of the magnetic field lines is similar to that of a bottle, hence its common name is "the magnetic bottle." A sketch of the field lines, and an electron trajectory are shown in Fig. 3. All particles entering the field at an angle θ such that $\sin^2\theta \geqslant |\mathbf{B}_o|/|\mathbf{B}_m|$ will be reflected. If the velocity distribution of the entering particles is isotropic, the reflection co-efficient is $R = 1 - |\mathbf{B}_o|/|\mathbf{B}_m|$.

The thermionic plasma diode is a direct converter of heat to electricity[7]. Actually, it is only a simple diode with plasma to reduce space charge, and thus to increase efficiency and output. An electron potential energy diagram for such a diode is shown in Fig. 4. Electrons leaving the emitter obey the Richardson emission equation. On leaving the surface of the emitter, they encounter an accelerating field of the sheath (sheath will be discussed later) and enter the bulk

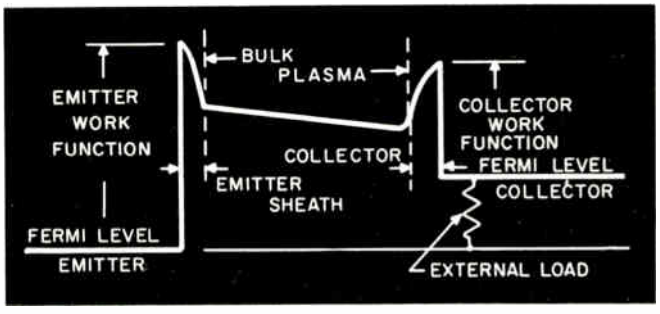


Fig. 4 (above): An electron potential energy diagram for a plasma diode. It is used as a direct converter of heat to electricity.

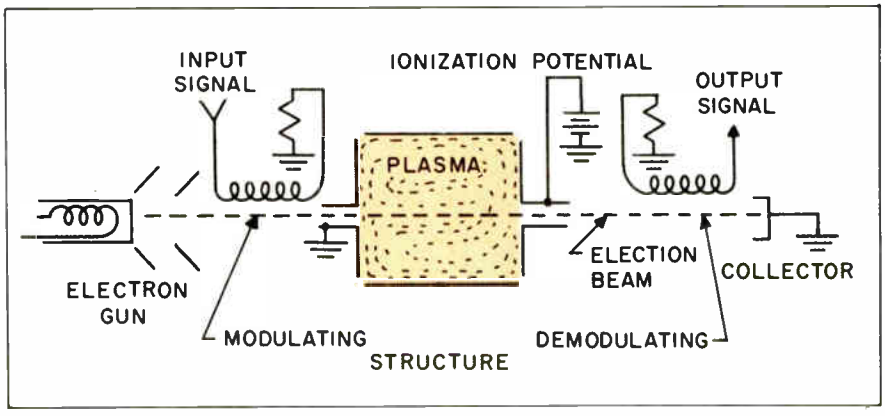


Fig. 5 (right): Electron beam plasma amplifiers are like modified traveling wave tubes. The region between electron beam modulating and demodulating is filled with plasma to enhance electronic gain in this device.

plasma. Before reaching the collector, the electrons are slightly decelerated by the sheath. Finally, they convert their potential energy to current in the external load. The efficiency of these devices is less than 20%, with current densities in excess of 10 amp/cm^2.

Electron beam-plasma amplifiers are modified TWTs. In these, the region between the electron beam modulating and demodulating structure is filled with plasma. The addition of plasma enhances the electronic gain. Gains of 30db/cm have been measured in such devices[8]. The amplification in the plasma is the result of interaction of the wave on the electron beam with the plasma electrons. If the plasma electrons velocity distribution is suitable (at least double humped[9]) amplification occurs. A sketch of the device is shown in Fig. 5.

Plasma propulsion devices are considered for deep space probes. Operation is based on interaction of plasma with crossed electric and magnetic field[5, 10]. This interaction ejects plasma in a preferred direction. One such device is shown in Fig. 6. It consists, essentially, of a length of a coaxial transmission line immersed in a magnetic field. A dc potential is established between the inner and outer conductors. Plasma is ejected from an annular opening in the inner coax. The electric field attracts electrons to the outer coax, and ions to the inner. The **v** x **B** force ejects both species, and the change in momentum propels the ship. Even though the ejected mass is small, quite high velocities have been obtained (about 10^7 cm/sec.).

The plasma device that received the most publicity is the MHD power generator. Whereas the devices mentioned above are low density devices, the MHD generator is a high density device in which plasma behaves, essentially, like a conducting fluid[11]. A diagram of MHD generator is shown in Fig. 8. Plasma flows into a region of magnetic induction. Due to the **v** x **B** forces, the electrons and ions are driven to opposite sides of the generator. This creates a difference of potential which can be connected to an external load. Although such devices are operative, their efficiency is low because of the high internal impedance. A substantial increase of the plasma conductivity will greatly enhance the efficiency of such generators.

The newest, and the most publicized plasma device is the CW gas laser[12]. It consists of a glass tube terminated by special end plates at Brewster's angle to the tube axis. The gas is ionized by r-f coils placed along the tube. Transitions within the gas molecules produce a nearly monochromatic, narrow beam whose frequency depends upon the types of gases used.

Problems

The large number of operational plasma devices may give the impression that plasma properties and its behavior are well understood. This is not quite the case. The problems are two-fold: theoretical and experimental. The theoretical problems lie in the complexity of the Boltzmann of hydrodynamic equations for a

(Continued on following page)

Table 1.

I. Orbit Theory Equations

Type	Forces
Gradient	$\mathbf{F} = -\mathbf{m}\,\nabla_\perp \lvert\mathbf{B}\rvert$
Curvature	$\mathbf{F}_c = -\frac{2W_{\parallel}}{\lvert\mathbf{B}\rvert^2}(\mathbf{B}\cdot\nabla)\,\mathbf{B}$
External field	$\mathbf{F}_e = \mathbf{F}_e$
Polarization	$\mathbf{F}_P = q\,\mathbf{E}_\perp(t)$

Velocities

Gradient	$\mathbf{u}_G = \frac{m}{q\lvert\mathbf{B}\rvert^2}\,\mathbf{B}\times\nabla_\perp\lvert\mathbf{B}\rvert$
Curvature	$\mathbf{u}_c = \frac{2W_{\parallel}}{q\lvert\mathbf{B}\rvert^4}\,\mathbf{B}\times[(\mathbf{B}\cdot\nabla)\,\mathbf{B}]$
External field	$\mathbf{u}_e = \frac{\mathbf{F}_e\times\mathbf{B}}{q\lvert\mathbf{B}\rvert^2}$
Polarization	$\mathbf{u}_P = \frac{m}{q\lvert\mathbf{B}\rvert^2}\frac{\partial\mathbf{E}_\perp}{\partial t}$

II. The Boltzmann Equation for a Specie

$$\frac{\partial f}{\partial t} + \mathbf{u}\cdot\nabla_r f + \frac{\mathbf{F}}{m}\cdot\nabla_u f = \left(\frac{\partial f}{\partial t}\right)_{\text{collisions}}$$

$f = f(\mathbf{r}, \mathbf{u}, t)$ distribution function

III. Hydrodynamic Equations for a Specie

momentum transfer equation

$$\frac{d\mathbf{v}}{dt} = -\frac{\nabla p}{n m} + \frac{Z q}{n m}(\mathbf{E} + \mathbf{v}\times\mathbf{B}) - \nu\,\mathbf{v}$$

continuity equation

$$\nabla\cdot(n\,\mathbf{v}) + \frac{\partial n}{\partial t} = 0$$

equation of state

$$p = n\,k\,T$$

IV. Maxwell's Equations

$$\nabla\times\mathbf{E} = -\frac{\partial\mathbf{B}}{\partial t} \qquad \nabla\times\mathbf{H} = \mathbf{J} + \frac{\partial\mathbf{D}}{\partial t}$$

$$\nabla\cdot\mathbf{D} = \rho \qquad \nabla\cdot\mathbf{B} = 0$$

Constitutive relations

$$\mathbf{B} = \mu\,\mathbf{H};\quad \mathbf{D} = \epsilon\,\mathbf{E}$$

List of symbols

$\mathbf{B}$ = magnetic induction	$\mathbf{v}$ = average velocity of a number of particles
$\mathbf{D}$ = electric displacement	$W_{\parallel}$ = kinetic energy of particle due to motion along magnetic field lines
$\mathbf{E}$ = electric field intensity	Z = number of charges
$\mathbf{F}$ = force	ϵ = permittivity
$\mathbf{H}$ = magnetic field intensity	μ = permeability
$\mathbf{J}$ = current density	ν = collision frequency
k = Boltzmann's constant	ρ = charge density
m = mass	∇_r = gradient with respect to spatial variables
$\mathbf{m}$ = magnetic moment	∇_u = gradient with respect to velocity variables
n = number density	
p = pressure	
q = charge	
T = temperature	
$\mathbf{u}$ = particle velocity	

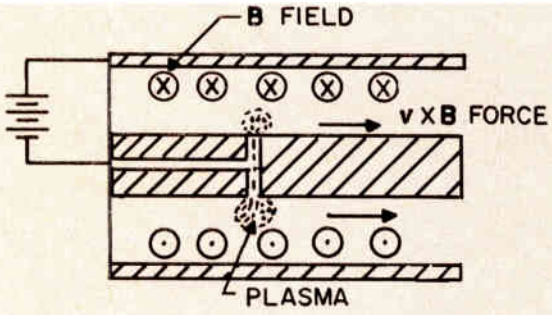


Fig. 6: Plasma propulsion devices are considered for deep space probes. Shown is a plasma propulsion gun device.

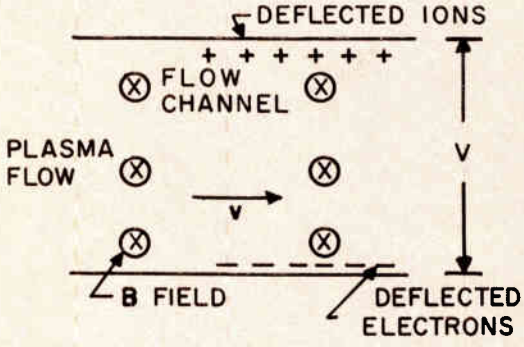


Fig. 7: The MHD power generator has been receiving much attention. These are high density devices in which the plasma behaves essentially like a conducting fluid.

PLASMA (Concluded)

realistic plasma model. As is usually the case, theoretically, to obtain some sort of solution the practice has been to solve rigorously an approximate model, or to solve approximately a realistic model. The experimental problems center, generally, about the sheath between the plasma and a foreign body in contact with it.

The sheath interferes with measurements of plasma properties — whether by probes, or interferometric methods—in the following way. When plasma is in contact with an object, the electrons, having higher mobilities than the ions, diffuse from the bulk plasma toward the object and charge it negatively. After equilibrium is established there is, effectively, a surface dipole layer at the boundary. This layer, the sheath, interferes strongly with plasma parameter measurements and interpretation of the results since neither the thickness of the layer, nor its composition, are known accurately.

This situation will not persist very much longer because of the attention of many investigators to some of these problems. It is hoped that some of the new diagnostic methods[13] will lead to a better understanding of the properties of the sheath, and a more accurate evaluation of electron density distribution. Be it as it may, plasma devices have been very useful, and it seems that the use of plasma in many areas are far from being exhausted.

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FETs as Voltage-Controlled Resistors

WITH SMALL VALUES of drain voltage, a field effect transistor (FET) behaves as a voltage-controlled, bipolar variable resistor. However, its resistance exhibits a considerable degree of nonlinearity for anything but the smallest voltages.

In Fig. 1, the FET is operated in a balanced circuit with the control voltage applied to the drain connection and the inverse of the control voltage applied to the source connection. This results in a condition, at the midpoint of the FET in the region of the gate, of virtual ground potential. The result is linear response of the FET over a wider range of control-voltage levels.

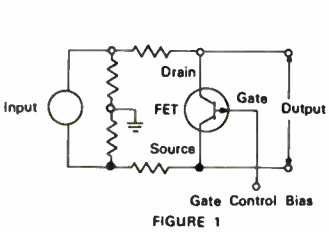


FIGURE 1

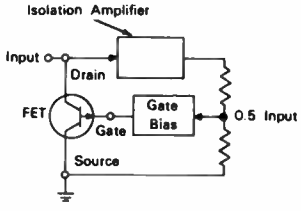


FIGURE 2

In Fig. 2, one-half of the control voltage appearing at the drain connection is capacitively coupled to the gate, thus cancelling the bias change that would otherwise result from a change of internal current resistance drop. This method results in linear response of the FET over a wider range of control-voltage levels than does the method previously outlined. The isolation amplifier may be removed from the circuit but maximum circuit resistance will then be limited by the sum of the resistors in the divider network.

These circuits would be useful in a variety of control and monitoring applications, i.e., audio and video AGC stages and bias drift monitors in precision input/output equipment such as analog-to-digital converters.

For further information contact: Technology Utilization Officer, Marshall Space Flight Center, Huntsville, Ala. 35812. Ref: B64-10163.

A mathematical model of a typical reference element is presented here and its terms analyzed. The result is a method of determining the best voltage reference element for the least cost.

Optimizing the Performance of Silicon Reference Elements

DEVELOPMENTS IN THE MILITARY, computer and instrumentation fields push the "state-of the-art and cost" of highly stable dc reference voltage sources. R ference voltage sources designed about silicon reference elements (SRE) offer the best compromises between overall voltage stability and environmental capabilities. This article discusses how a designer can optimize the performance of any voltage reference circuit.

* * *

Semiconductor manufacturers have expended much effort and expense in developing reference elements to cover most needs of the circuit designer. Premium type elements which have been aged and monitored over extended periods of time, and are certified, can cost over $100/device. At the other extreme, there are "fallout" units, i.e. out of specification as to voltage or T.C., which are available at about $2/device. With such a price range to select from, the designer's problem becomes one of balancing circuit performance against cost and/or obtaining the maximum performance from the unit selected.

In actual use, the SRE is much more than just a temperature compensated zener diode. This article offers a mathematical model of a typical reference element. The equation developed in this article is compared with those implied in sales specs. This reveals that insufficient data is supplied by the manufacturer to allow maximum use of the SRE's inherent thermal stability.

The introduction of SRE's to industry was accompanied by an oversimplified classification and manufacturing selection procedure. This procedure has not kept pace with the growth of the device applications. The device designer did not foresee that SRE's would be used at stability and accuracy levels where non-linear terms would be significant.

By CLARENCE L. WALLACE

Director of R & D
Viking Industries, Inc.
21343 Roscoe Blvd.
Canoga Park, Calif.

The Problem

The typical manufacturer specifies his SRE as if its performance was described by

$$V_R = V_{Ro} \pm \alpha\,(T_o - T) \text{ when } I_{Ro} = \text{specified current.} \quad (1)$$

where V_R = Reference voltage
V_{Ro} = Reference voltage at standard temperature T_o and standard current I_{Ro}
α = temp. coefficient (%/C°)
T = actual temp.

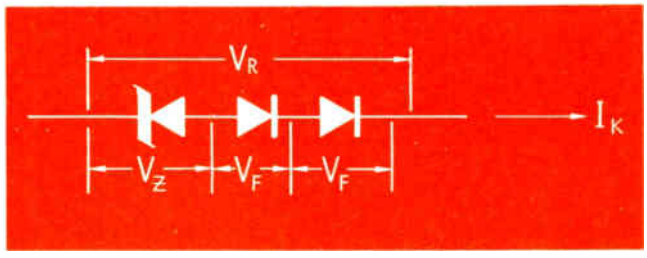


Fig. 1: Silicon reference element.

The general classification scheme consisted of establishing types of references. These were based on their voltage, such as 1N430 at 8.4 ± 5% v. or Type 1N800 at 6.2 ± 5% v. Grades were then established within type by their temp. coefficients, temp. ranges, and dynamic impedance, Table 1. This system reflects the nature of the manufacturing problem wherein a lot of devices are produced, then segregated into groups by later grading.

For SRE's, limiting of the grading operation for the total population to one test current has been costly. This artificial limitation resulted in lower yields of higher performance referenecs because a new distribution results with a different test current. Each winnowing of the device population with a different test current would have resulted in some extended yield of the tighter performance devices. The improved yield would result in lower prices to the user. It would enable the manufacturer to meet the demand for top performance devices. This was because, in some cases, the yield of

the top devices was not enough to meet the demand. This procedure is still available to the designer. It offers him the opportunity to use lower price devices in tight applications by searching out the optimum current for a given SRE.

To help understand the behavior of SRE's, a description of their basic components follows. A SRE is assembled using a zener diode and a number of silicon diodes in the forward conduction mode, Fig. 1.

Zener Diode

The zener diode is a non-linear device. It has a nearly constant voltage drop (V_Z) for a wide range of current (I_Z) when biased in the reverse direction, Fig. 2.

Actual V_Z of a given zener diode over a range of reverse currents and ambient temperatures is a function of several factors. A simplified model of a typical zener diode is given in Eq. 2. This empirical equation is limited to the following conditions, as generally found in actual reference uses.

V_{Fo}	= forward voltage of each diode under standard conditions of I_{Fo} and T_o defined by device manufacturer.	vdc
I_{Zo}	= I_o = I_F = standard current	ma
I_Z	= I_R = I_F = actual current	ma
i_Z	= i_R = i_F = $(I_F - I_{Fo})$	ma
T_o	= standard temp.	°C
T	= actual temp.	°C
t	= $(T - T_o)$	°C
α_F	= linear thermal coefficient	%/°C
N	= number of forward diodes in series.	

Combining Eqs. 2 & 3 and collecting like terms we have an equation (Eq. 4) which is useful in understanding the various mechanisms contributing to the performance of SRE's in circuitry use.

$$V_Z + V_F = [V_{Zo} + NV_{Fo}] + i\,[Z_{Zo} + NZ_{Fo}] + t\,[V_{Zo}\,(Z + ki) - NV_F\,F - V_{Zo}\beta t] \quad (4)$$

which is approximated by

$$V_R = V_{Ro} = iZ_{Ro} + V_{Ro}\,[\,(\alpha_R + ki)\,t] - V_{Zo}\,\beta t^2 \quad (4a)$$

V_R is the actual reference voltage at a particular temperature T and at a specific operating current I.

V_{Ro} is the actual reference voltage at a reference temperature T_o and at a reference current I_o. iZ_{Ro} is a voltage generated when the operating current I differs from I_o. $i = (I_o - I)$ This variation in current i through the reference impedance Z_{Ro} produces the voltage iZ_{Ro}.

$V_{Ro}\,[\,(\alpha_R + ki)\,t]$ is the 1st order thermal term and the area in which most of the controllable variables operate. V_{Ro} is a known value (above). t is the difference between the standard temp. T_o and actual temp. T. $t = (T_o - T)$. α_R is the linear thermal coefficient in %/C° and is only approximated by the manufacturer's figure. In most cases the manufacturer's T.C. figure is implied as a limit error criterion and has little mathematical value. k is a proportionality constant that relates the variation of α to a variation in I. This figure has to be empirically developed for each physical device type. The device package is of significance to this particular constant in that it establishes the thermal impedance of the actual junction to the thermal invironment. The relationship involved is that of the device junction temp. being varied independently by variations in I dependent on the thermal impedance.

Table 1

Reference Classifications

Type	V_R	I_{Ro}	Z_R (Impedance)	(T.C.)	Temp. Range
1N430	8.4 ± 5% vdc	10 ma	< 15Ω	± 0.002%/C°	− 55°C to 100°C
1N430A	"	"	"	± 0.001%/C°	" "
1N430B	"	"	"	"	− 55°C to 150°C
1N821	6.2 ± 5% vdc	7.5 ma	15Ω	± 0.01%/C°	− 55°C to 100°C
1N821A	"	"	10Ω	"	" "
1N823	"	"	15Ω	± .005%/C°	" "
1N823A	"	"	10Ω	± "	" "

5 ma < I_Z < 20 ma $-20° < T < 80$°C

$$V_Z = V_{Zo} + i_Z Z_{Zo} + V_{Zo}\,[\,(\alpha_Z + ki_Z)t - \beta_Z t^2] \quad (2)$$

V_Z	= actual zener voltage	vdc
V_{Zo}	= actual zener voltage under standard conditions of I_Z and T_o defined by device manufacturers.	vdc
I_{Zo}	= standard current	ma
I_Z	= actual current	ma
i_Z	= $(I_Z - I_{Zo})$	ma
T_o	= standard temperature	°C
T	= actual temperature	°C
t	= $(T - T_o)$	°C
α	= linear thermal coefficient at I_{Zo} and V_{Zo}	%/°C
β	= 2nd and order thermal coefficient at I_{Zo} and V_{Zo}	%/(°C)²
k	= $\Delta\,\alpha\,Z/\Delta\,I_{Zo}$	%/ma °C
Z_{Zo}	= $\Delta\,V_{Zo}/\Delta\,I_{Zo}$	Ohms

Eq. 3 is the mathematical model of the forward diode portion of a reference element.

$$V_F = N\,[V_{Fo} + i_F Z_{Fo} - V_{Fo}\,(\alpha_F t)\,] \quad (3)$$

V_F	= actual forward voltage	vdc

Effect of this localized resistive heating is to offset the effect on α of the change in I because of contributions from a later I^2 term in the overall reference equation. Suffice it to say from a design standpoint k is larger for metal packaged references than for glass diode types. With large k's a greater portion of a diode population can be adjusted to a tighter thermal performance. With small k's a diode population will have its thermal performance less sensitive to variations in its operating current.

$V_{Z_0}\beta I^2$ is the 2nd order or nonlinear term of Eq. 4a. Its chief interest is that this term establishes the limit of accuracy that can be obtained over a specified thermal range. β can be obtained only by population sampling.

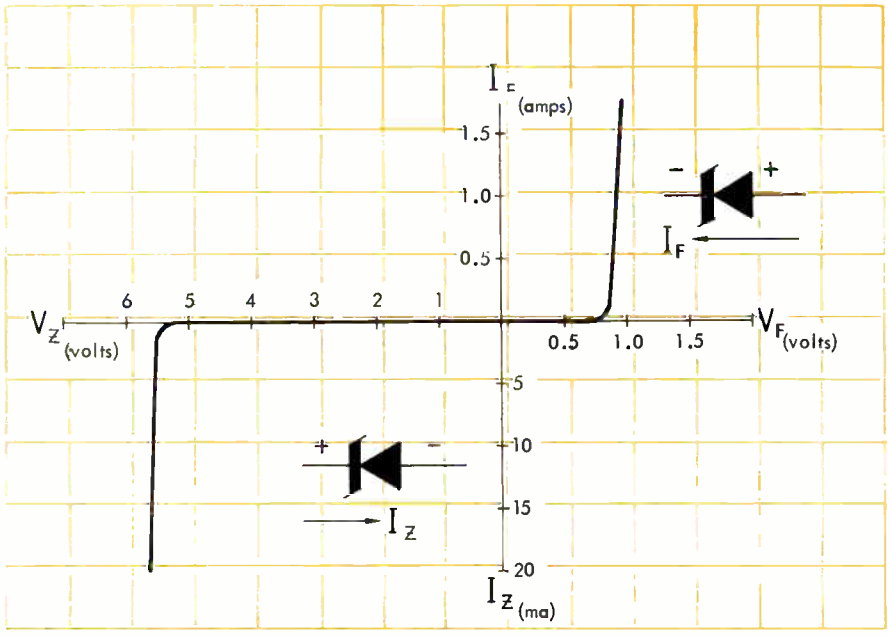


Fig. 2: Voltage current characteristic of typical zener diode.

Applying the Equation

The steps to take in applying Eq. 4 depend upon whether the solution will involve large numbers of similar circuits using identical components or whether only one or two test circuits are being contemplated. If a production run is to be made of a reference based circuit, it is worthwhile to evaluate many types of SRE's and attempt to establish the constants of Eq. 4 for each type, particularly k and β. That device family, which has the largest average k and smallest average β, other performance being satisfactory, would be the best production choice. Establishing optimum I_Z should be made part of the receiving tests with each SRE being tagged for the appropriate I_Z. β can be found from the same body of data which established I_Z and the tested SRE reclassified as to maximum thermal stability it can provide.

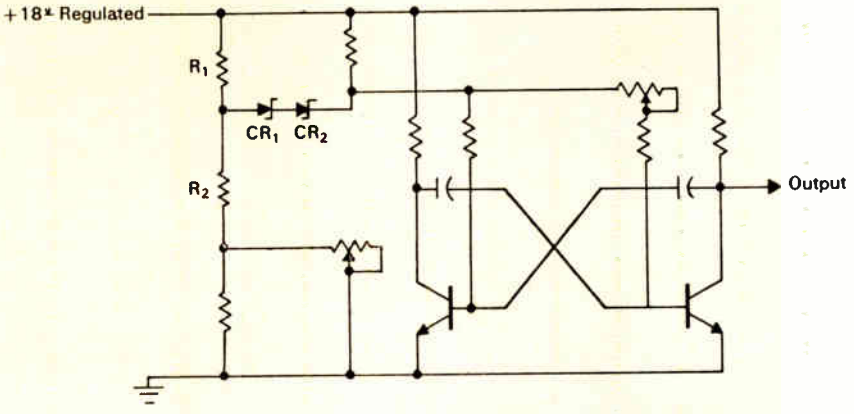
There are other equally important features of SRE's that have not been made part of this discussion because good expositions have been published elsewhere. Transitron publication AN-1352B 3-63 (Ultra Stable Semiconductor Voltage Reference) covers the subject of long term stability in depth. International Rectifier Corp.'s Zener Diode Handbook provides the necessary plotted parameter curves and theory from which Eq. 4 is synthesized.

Temperature-Sensitive Multivibrator

CONVENTIONAL ASTABLE MULTIVIBRATORS exhibit frequency instability in the presence of temperature variations. A simple network consisting of two zener diodes and five resistors to provide a temperature-sensitive voltage to drive the astable multivibrator is a solution.

The two zener diodes are referenced to a point held relatively stable at +9 volts by R_1 and R_3 which act as a conventional voltage divider. Acting together, the two zener diodes provide a voltage which, when referenced to ground, is inversely proportional to temperature because the zener diodes have a breakdown voltage that is inversely proportional to temperature. Under test this circuit yielded an output square wave at 2400 CPS varying from 2398.5 to 2401.1 CPS over a temperature range of −10° to +40°C.

With adequate shielding of the zener diodes, the circuit should exhibit an output constant to within 0.2 CPS. Potting should improve regulation even further.



The parameters of the network determine the locations of the poles and zeros. In a nonlinear network the parameters may be functions of voltage or current, in which case the poles and zeros may be functions of voltage or current.

Applying Poles and Zeros to Nonlinear

THE THEORY OF POLES AND ZEROS has been applied to linear networks with notable success. This article will show the application to nonlinear networks.

* * *

The pole and zero locations of a network are functions of the parameters. If the parameters are functions of time, the pole and zero locations are also functions of time. In a nonlinear network the parameters may be functions of voltage or current, in which case the pole and zero locations may be functions of voltage or current.

Linear Circuit

In linear circuit theory it is said that the poles and zeros determine network response. The poles and zeros are implied to be fixed. How then can the current in a network vary as a function of time? The answer is that the zero locations of the response may vary as a function of the response. Consider the network in Fig. 1.

Let the switch close at time τ when the initial current is

$$\rho = 1 - e^{-\tau} \tag{1}$$

The transform equation is

$$\frac{e^{-\tau s}}{s} = (s+1)\,I - e^{-\tau s}(1 - e^{-\tau}) \tag{2}$$

Solving for I:

$$I = \frac{[(1 - e^{-\tau})\,s + 1]\,e^{-\tau s}}{s\,(s+1)} \tag{3}$$

$$= (1 - e^{-\tau})\,\frac{\left[s + \dfrac{1}{1 - e^{-\tau}}\right]e^{-\tau s}}{s\,(s+1)} \tag{4}$$

This has poles at $s = 0$ and at $s = -1$, and zeros at $s = \infty$ and at $s = -1/\rho$.

Notice that, as ρ changes, the zero locations shift. The zero locations as a function of τ for this network are shown in Table 1.

For $\tau = -\infty$, the zero at the origin cancels the pole at the origin. For $\tau = +\infty$, the zero at $s = -1$ cancels the pole at $s = -1$. In general, when a zero cancels a pole in the right half plane (including the origin), the response function is unstable and will vary, causing the zeros to shift. But, when a zero cancels a pole in the left half plane, the response function is in a stable equilibrium and does not vary thereafter.

We can also write I in partial fraction form (from Eq. 3):

$$I = \frac{1}{s} - \frac{1}{s+1} \tag{5}$$

so that

$$i = 1 - e^{-t} \tag{6}$$

for $t \geqslant \tau$.

Thus, identical networks with exact driving functions will have exact responses after the switches are closed. This is provided initial conditions of the network, whose switch was closed last, are the same as those in the other net at the time the last switch was closed.

Poles and Zeros Shift

Poles and zeros of a response function may shift as time goes by if the poles and zeros of the driving function shift. This may happen if it takes several functions of time to describe the driving function during several different time intervals. For example, if

$$v = 0 \quad \text{for } t < 0 \tag{7}$$

$$v = 1 \quad \text{for } 0 < t < 1 \tag{8}$$

$$v = e^{-t} \quad \text{for } 1 < t \tag{9}$$

Then v will have no poles or zeros during the first interval, a pole at

Table 1:

Zero Locations as a Function of TAU

τ	zero located at s =
$-\infty$	0.
−6.	0.0025
−4.	0.0187
−2.	0.159
−1.	0.582
−.693	1.
−.405	2.
−.2875	3.
0	$\pm\infty$
0.1054	−10.
0.223	−5.
0.693	−2.
1.	−1.58
3.	−1.052
5.	−1.007
∞	−1.

By ARDEN THOMAS MOSES
Electro Mechanical Laboratories,
White Sands Missile Range,
Las Cruces, N. M.

Networks

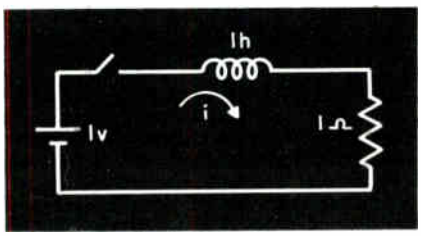


Fig. 1: A simple linear network.

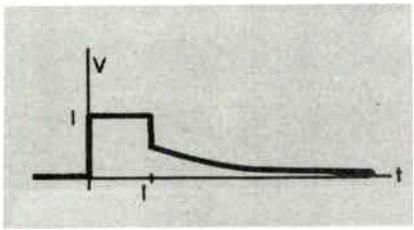


Fig. 2: v as a discontinuous function of t.

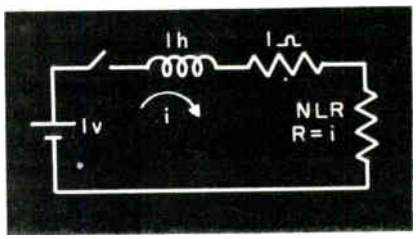


Fig. 3: A simple nonlinear circuit.

the origin during the second interval, and a pole at $s = -1$ for the last interval.

Nonlinear Circuit

In nonlinear networks the pole and zero locations move as functions of voltage or current (and thus of time). Let's investigate a simple nonlinear circuit, Fig. 3.

Let NLR be a nonlinear resistor whose resistance is equal to the current through it. Note that the resistance may be negative. Let the initial current be zero. At time 0+, the circuit reduces to that shown in Fig. 4.

The equation is $1 = i + di/dt$.

Taking the Laplace transform:

$$1/s = sI + I = (s + 1)\, I$$

or

$$I = \frac{1}{s\,(s + 1)}\,.$$

This gives poles at the origin and at $s = -1$, and zeros at $s = \pm\infty$.

At 0.1 sec., the current is 0.09486 amps. The circuit reduces to Fig. 5. The equation is

$$1 = 1.09486\, i + di/dt$$

with Laplace transform

$$1/s = sI - 0.09486 + 1.09486\, I$$

which can be solved for I:

$$I = 0.09486\,\frac{(s + 1/.09486)}{s\,(s + 1.09486)}$$

This has zeros at $s = -10.542$ and at $s = \infty$, and poles at the origin and at $s = -1.09486$. Table 2 shows the shift of poles and zeros.

Now let us consider the same circuit with initial current of -1.6 amps, Fig. 6.

Writing the equation

$$1 = -0.6\, i + di/dt$$

whose transform is

$$1/s = sI + 1.6 - 0.6\, I$$

Solving for I:

$$I = -1.6\,\frac{(s - 1/1.6)}{s\,(s - 0.6)}$$

This has poles at the origin and at $s = 0.6$, and zeros at ∞ and at $s = 0.625$. Note that there is a pole in the right half plane. This pole will move to the left so that this circuit will eventually become stable.

At $t = 2$ secs., $i = -1.096$ amps., Fig. 7.

The equation is now

$$1 = -0.096\, i + di/dt$$

Fig. 4: Circuit for zero current.

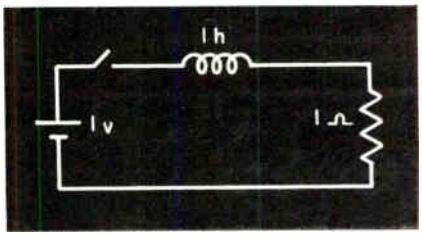
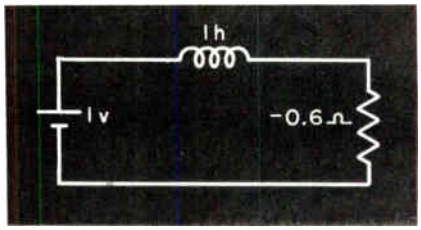


Fig. 6: Circuit for current of -1.6 amps.



with transform

$$1/s = sI + 1.096 - 0.096\, I$$

Solving for I:

$$I = -1.096\,\frac{(s - 1/1.096)}{s\,(s - 0.096)}$$

There are now poles at the origin and at $s = 0.096$, and zeros at $s = 0.912$ and at ∞. The pole in the right half plane has shifted from $s = 0.6$ to $s = 0.096$, while the zero has moved from $s = 0.625$ to $s = 0.912$.

Table 3 shows the pole and zero locations for initial current of -1.6a.

After $t = 2.98$ secs. the results are identical with Table 2 with 2.98 secs. added to t in Table 2.

In general, for this circuit there will be poles at the origin and at $s = -1 - i$. There will be zeros at ∞ and at $s = -1/i$.

If the initial current is -1.618 a., the circuit is shown in Fig. 8.

The equation is

$$1 = -0.618\, i + di/dt$$

and its transform is

$$1/s = sI + 1.618 - 0.618\, I$$

Solving for I:

Fig. 5: Circuit at 0.1 second.

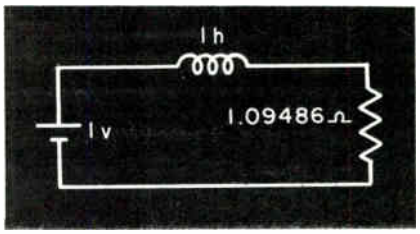
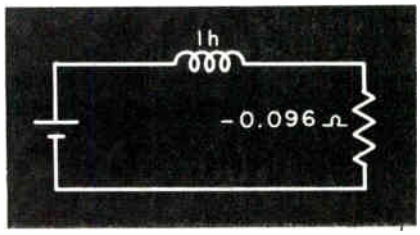


Fig. 7: Circuit for current of -1.096 amps.



$$I = \frac{-1.618}{s}\left(\frac{s-0.618}{s-0.618}\right) = \frac{-1.618}{s}$$

The pole and zero at $s = 0.618$ cancel each other. Since this occurs in the right half plane, the current is in unstable equilibrium. Any noise will cause the current to drift, and, once it departs from the unstable equilibrium, it will change until it reaches stable equilibrium, if ever.

On the other hand, if the initial current is 0.618 a., Fig. 9 is the equivalent circuit.

The equation is

$$1 = 1.618\, i + di/dt$$

with transform

$$1/s = sI - 0.618 + 1.618\, I$$

Solving for I:

$$I = \frac{0.618}{s}\left(\frac{s+1.618}{s+1.618}\right) = \frac{0.618}{s}$$

In this case, the pole and zero at $s = -1.618$ cancel each other. Since this occurs in the left half plane, the current is in stable equilibrium.

Table 2: Pole and Zero Locations

t sec	i amps	pole	pole	zero	zero
0	0	0	−1.0	−∞	∞
0.1	0.09486	0	−1.09486	−10.542	∞
0.25	0.21723	0	−1.21723	−4.6034	∞
0.5	0.36980	0	−1.36980	−2.7042	∞
1.	0.53033	0	−1.53033	−1.8856	∞
2.	0.60833	0	−1.60833	−1.6438	∞
3.	0.61700	0	−1.61700	−1.6207	∞
∞	0.61803	0	cancel each other at −1.61803		

Table 3: Pole and Zero Locations for initial Current of −1.6a.

t sec	i amps	pole	pole	zero	zero
0	−1.6	0	0.6	0.625	∞
2.	−1.096	0	0.096	0.912	∞
2.11	−1.	0	0	1.	∞
2.98	0	0	−1.	−∞	∞

Fig. 8: Circuit for current of −1.618 amps.

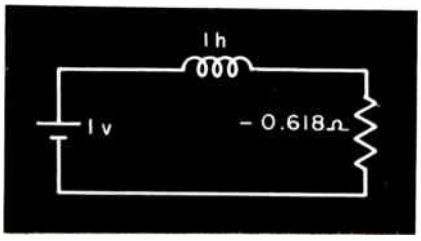
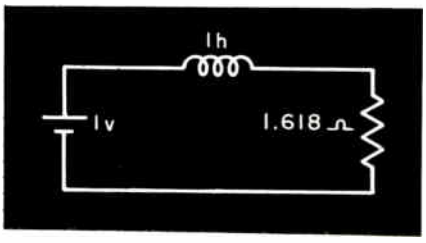


Fig. 9: Circuit for current of 0.618 amps.

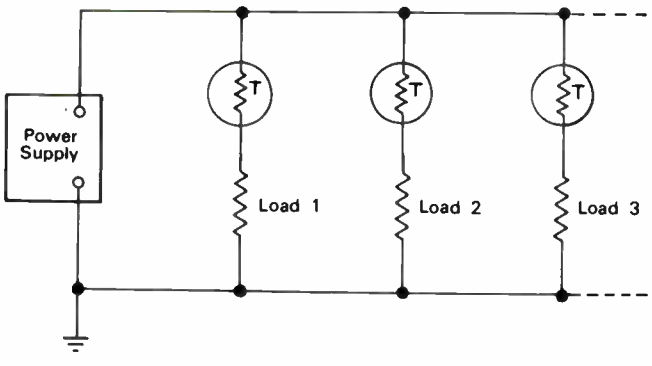


CIRCUIT-WISE

Protecting Multiloaded Power Supplies

PREVENTION OF POWER LOSS in parallel branches of a multiload circuit, should an overload occur in one of the branches was needed. The protective device must be self-resetting, capable of handling short-duration transients, and must withstand shock and vibration.

A PTC (positive-temperature-coefficient) thermistor was placed in series with each branch load. The thermistor should be selected so that (1) its nominal resistance is negligible compared to the branch load, (2) its response time is long enough to endure switching transients, and (3) its critical (Curie) temperature is well above the ambient temperature range in which the equipment operates.



An overload condition in any branch will cause excessive current to flow through the thermistor in that branch, and the I^2R increase will raise the temperature of the thermistor. The increase in resistance accompanying the temperature rise decreases the current flowing through the branch load to an equilibrium value. When the overload is corrected, the reduction in current will cause the PTC thermistor to revert to its nominal resistance.

To minimize the effects of ambient temperature on the thermistor, vacuum encapsulation is suggested. Individual uses will determine the thermistor parameters. These devices are available with the following characteristics: (1) nominal resistance values from about 1Ω to 10KΩ; (2) resistance change at the critical temperature from about 2.5 to 5 times nominal resistance; (3) response time from less than a second to 100 sec.; and (4) power dissipation from a few mw to 2w.

For further information contact: Technology Utilization Officer, Goddard Space Flight Center, Greenbelt, Md. 20774. Ref: B64-10281.

The demand for increased accuracy has brought significant improvements in the design of meter movements. The limiting factor now is the scale. Here is a unique automated method for accurate scale calibration.

Improving Meter Accuracy

ANALOG READOUT METERS have inherent limitations on accuracy. Three basic types are in general use:

The most familiar analog meter is the double pivot moving coil type. It is used in most of the switchboard and service type instruments. Inaccuracies in this type are caused by the fit of the pivots in the jewel bearings and the balance of the coil-pointer assembly. Eventual wear of pivot or bearings reduces the initial accuracy. Such bearing troubles show up generally as tap shift, wherein the pointer comes to a reading that changes slightly if the instrument is given a light tap. This tap overcomes the bearing friction.

The amount of inherent tap shift affects the scaling of an instrument. A small meter with a 1% tap shift may be scaled to a 2% accuracy and still allow for production variations between instruments.

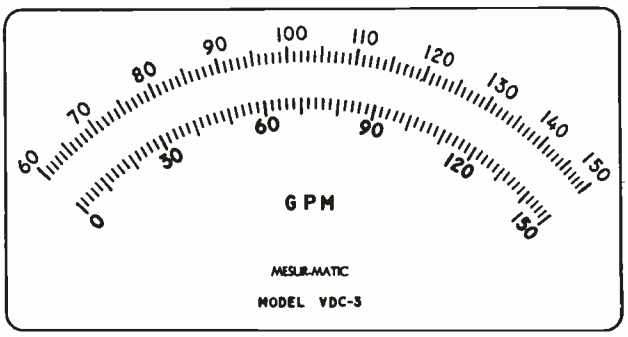
A second type of meter is the unipivot type. This type has been carried to a high degree of development in Europe and subsequently in this country. It has an inherently high degree of accuracy, because the single pivot construction makes it imperative that the meter be mounted on a level bench. In transport, lifting of the pivot protects the meter from coil or pivot damage. The meter is not particularly sensitive and is generally used as a laboratory standard. An accuracy of 0.1% is attainable. In production, a scaling accuracy of 0.25% is readily achieved.

A more recent meter development is the taut band meter. In this meter, the moving components are mounted on a metal band or wire suspension system completely eliminating all pivot trouble. But, this meter has other sources of inaccuracy. No matter how small the torsion on a material, there is some "set" to it. This results in a small amount of hysteresis which cannot be taken out of the reading by tapping the instrument.

Improving Scale Accuracy

In both the first and third types of meters discussed, the instrument scale has been a common source of error. A good meter, checked for repeatability, is inherently more accurate than the readout from commercial scale markings. Cost of individual scale markings has been prohibitive. A new approach to scaling was needed.

The first requirement in any instrument scaling is to establish a precision source of current or voltage. This is readily done by potentiometer techniques



Typical meter scale calibrated by the unique method described.

using a standard cell reference. In the CAL-O-MATIC™ system to be described, the reference source has been automated so that the desired voltages or currents are stepped through a predetermined sequence corresponding to each scale division.

The second requirement is to determine the mechanical position of the meter pointer for each scale increment. This is the first of the unique features of this system. The pointer is scanned by a roving light source consisting of two pulsed paths, one looking for the leading edge, the other for the trailing edge. These are electrically servo connected to the potentiometer source so that an absolute null results when the pointer is exactly between the two sources. By this means, the pointer position may be located mechanically to about 0.001 in., which is far in excess of the readability of the meter. A third light source marks this position on a photo-sensitive scale. The whole process is then advanced to the next division and repeated, and so on. The longer lines, which comprise the major scale divisions, are sequenced into the system so that any number of minor divisions may be programmed.

This system produces a finished scale calibrated for an individual meter. Precision photographic control in the development of the master assures minimum error. Meter and scale are permanent associates from this point on.

This process, applicable by making suitable jigs, can be used on any meter. Thus, it may be made available as a service to a user having sufficient quantity of calibration to justify it. The meter, thus scaled, is limited generally by its repeat accuracy, which is 0.25% on a high quality meter.

By WILBURT H. COOK,
Mesur-Matic Electronics Corp.,
Warner, New Hampshire

Choosing The Right Solder Alloy

The designer must think of soldering in broader terms than conventional tin-lead alloys. Here is a logical step-by-step method for considering all parameters involved in an alloy choice.

By **H. H. MANKO,** Director, Solder Research and Development, Alpha Metals, Inc., 56 Water St., Jersey City, N. J.

ELECTRONIC INDUSTRIES
STATE-OF-THE-ART
FEATURE

SOLDER ALLOY SELECTION is only one step in the basic considerations toward achieving solder-connecting reliability. Proper attention must be given not only to alloy selection, but also to the flux, application methods, and quality-control. Soldering shapes up as an economical and reliable joining method. It is the only metallurgical joining method which can be adequately inspected by a visual means.

* * *

Soldering is a metallurgical joining method using a filler metal (solder) with a melting point below 600°F. The 600°F melting point limit is arbitrary and many consider 800°F as the cut-off point. Frequently, the term "hard soldering" is used for the melting-point range between 600° and 800°F.

Soldering relies on wetting for the bond formation, and requires neither diffusion into, nor the melting of the base metal, to achieve bonding. If diffusion or intermetallic formations occur, these are only side effects. Where diffusion is essential to the bond, as in brazing, welding, diffusion bonding, and thermal compression bonding, an entirely different technique is being dealt with.

Brazing is a metallurgical joining method using a filler metal which melts over 800°F, and relies on diffusion as well as wetting. Welding is a joining process which relies on diffusion of the base metal with or without the filler metal for joint formation.

Within the temperature range allocated for solder, the common tin-lead alloys cover only part of the picture. Table 1 gives a partial list of alloys widely used. With this diversity to choose from, it is obvious that guidelines for proper selection of soldering alloys are needed.

Solder-Selection Guidelines

The following check list provides the parameters to be considered in making a selection. It is based on the assumption that base-metal selection is determined by the mechanical and electrical properties required.

Flux Selection. The choice of base metal dictates both the type of flux required and its use. If the flux is not suitable for the assembly, the base metal must be changed, or its surface modified. This can be done by pretinning or plating to allow the use of a more suitable flux. Although flux selection is a problem in itself, our concern is limited only to proper alloy selection.

Temperature Considerations. In electronic assemblies, temperature is a critical parameter. Some assemblies require a minimum temperature at which the solder is still solid. Others require a maximum temperature during soldering. In the former the solidus temperature of the alloy is critical; in the latter, the liquidus is most important. However, neither the solidus nor the liquidus of an alloy are the actual soldering temperatures. A temperature gradient of 60° to 150°F is required over the melting point for good wetting action. The lower rise of 60°F applies to lower melting point alloys. As a rule the alloys in the tin-lead family require about 100°F over the liquidus. Once the temperature range for an assembly has been set, it is possible to narrow down the selection to a group of alloys falling into this category.

Freezing Range. Eutectic alloys have a defined and narrow freezing range. The non-eutectic alloys have a "pasty range." Here the solder gradually freezes over a wide temperature range and, during cooling, crystals of the solid solder are mixed with liquid solder. If assembly movement occurs during this freezing period, a cold solder joint results. A cold joint has doubtful quality and could become a fractured joint. Therefore it is vital that the alloy's pasty range and the method of application be considered when selecting the material.

Mechanical Properties. For structural design, the alloy's mechanical properties must be related to the base metal's mechanical properties. Table 1 lists tensile and shear strength available. It is important that all stress concentrations be eliminated from the solder fillet.

Electrical Properties. In electrical and electronic assemblies, the solder-joint shape and the alloy's resistivity determine the current-carrying capacity and voltage drop. These characteristics can always be matched to those required in the circuit.

Special Characteristics. The following special characteristics of an alloy must be considered: its behavior during expansion and cooling; the scavaging of platings (such as gold and silver) from surfaces; and the ductility and/or brittleness of intermetallics formed in the solder system during the application.

Economy. Price is a factor if similar alloys are being compared. Table 2 shows the commodity price of the various elements used in solder alloys. This table should serve as a guide to find the relative price for certain alloys for specific uses.

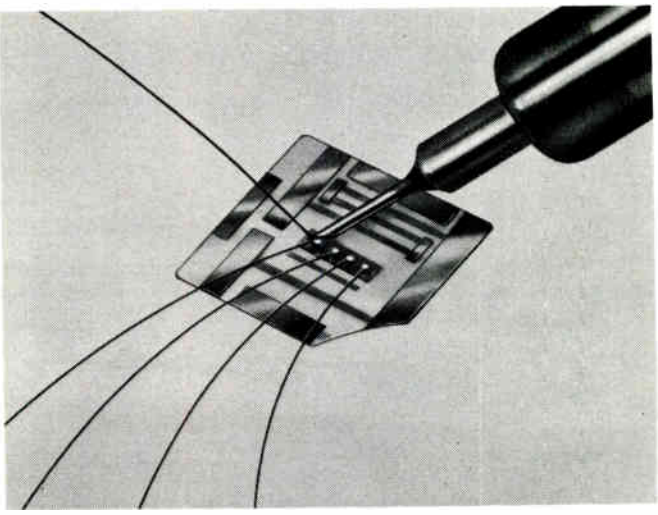
Compatibility Checks. In a soldered joint, two types of compatibility are important: galvanic compatibility of the solder alloy and the base metal; and chemical compatibility of the flux with the metals and non-metallic components in the system. In some cases, the galvanic potential formed between two dissimilar metals can cause rapid deterioration of the base metal or solder. For example, if tin-lead is used on aluminum, a potential of over 1½ volts is produced. This is sufficient to consume the aluminum and destroy the joint.

The effect of flux is not important if it can be properly removed, provided it does not attack the assembly in its raw state. If it is to remain on the assembly, it must be compatible.

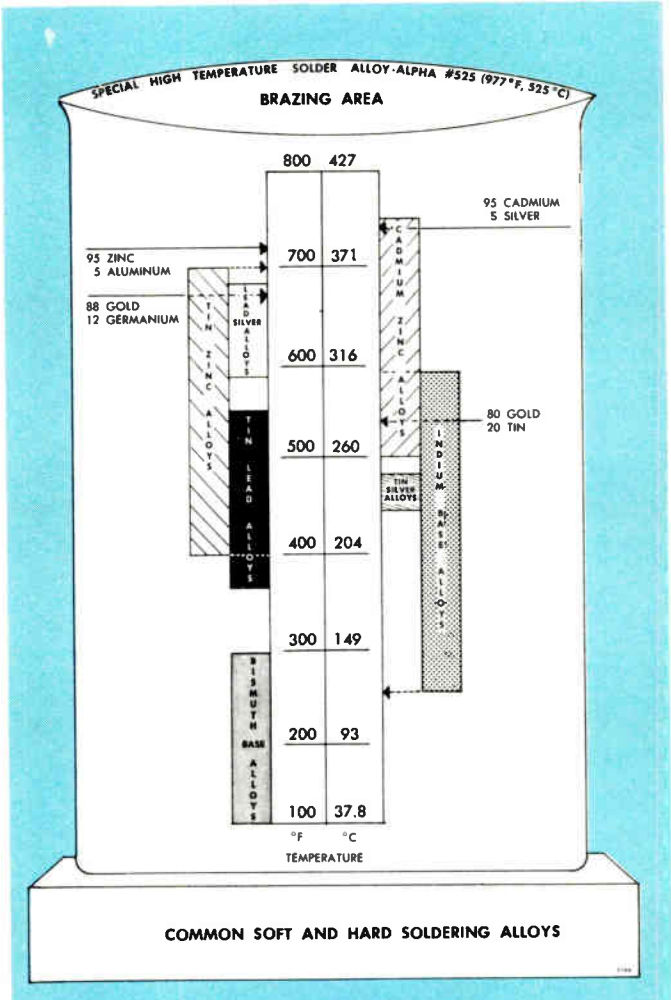
Manufacture Suitability. Material selection alone is not enough to ensure manufacturing ease and production success. The soldering equipment used, the mode of heat transfer into the joint area, pre- and post-soldering operation and similar factors should be checked out against the material selected. Since any heating method that provides the proper caloric supply for bond formation can be considered, there is no end to the variations available. But remember, the selection of the solder alloy must be related to the equipment used.

Proper Joint Design. The solder joint must be designed around its electrical and mechanical properties. The bulk-solder strength should be considered for calculation purposes, and a small safety factor included. In most cases, the base metal goes into metallurgical solution in the solder alloy, and a mechanism called solution strengthening increases the solder strength in the joint area. But since this is not uniform throughout the joint, it should not be counted on for the added strength it imparts to the solder.

The spacing between the surfaces is important. Maximum strength can be obtained anywhere between 0.0020 and 0.005 in., with the optimum around 0.003 in. If the clearance between the surfaces is less than 0.001 in., the flux and the absorbed air



The Hexacon Hornet is a constant-heat iron used for soldering microminiature glass substrates. It gives close directional control since the hand is less than 2 in. from the work tip.



COMMON SOFT AND HARD SOLDERING ALLOYS

Shown above is a family of common soft and hard soldering alloys. The temperatures shown are the liquid points of the solder. When selecting a solder, the operating temperature of the equipment it is being used with must be considered. A solder must be used that has a liquid point that will not be exceeded by the equipment's operating temperature. Various liquid points also allows piggyback soldering. Here, a solder with a low liquid point may be soldered to one with a high liquid temperature.

present before the bond formation does not have adequate exit space. Therefore, it interferes with the joint formation. If the distance between the surfaces becomes too large, capillary forces no longer will help draw the solder in between the surfaces. Voids or gaps can exist.

Case History

Now that some of the most important points for selecting a proper soldering alloy have been explained, we will apply them by solving a practical solder-alloy selection problem.

The problem calls for bonding a silver-fired ceramic surface to a #22 copper wire. The assembly is part of a very sensitive circuit and no current leakage can be tolerated. Ambient temperatures at which the assembly will operate may reach 430°F. No mechanical load on the assembly is anticipated. The base metals are fixed; the flux and solder alloy must be selected.

Step 1—Flux Selection. The flux must be one that will withstand the high solder-melting heat required and the high ambient. It must be entirely soluble so that no residues, which might cause current leakage, are left behind. These requirements are met by using a water-soluble, acid-type flux. The soldering must be followed by washing and cleaning. If no cleaning is possible, a mildly activated, water-white rosin-type flux having a high heat-stable vehicle could be used.

Step 2—Temperature Considerations. To be useful in the operating temperature range, the solder alloy must have a solidus temperature of over 430°F. As seen in Table 1, this leaves alloys Nos. 14, 16, 19 and 20 to choose from. Of these, only the latter two have a temperature gradient large enough above ambient to provide some strength in the joint if the operating temperature should vary more than anticipated.

Step 3—Freezing Range. Since both alloys 19 and 20 are eutectics, they are acceptable, and no danger of a pasty range is possible.

Step 4—Mechanical Properties. The mechanical strengths of alloys 19 and 20 are nearly equal.

Step 5—Electrical Properties. The conductivity of alloy 19 is slightly better than that of alloy 20.

Table 1. Common Soldering Alloys*

	SOLDER ALLOY	MAJOR CONSTITUENTS							MELTING TEMPERATURES, °F	
		Sn	Pb	Bi	In	Sb	Cd	Ag	Solidus	Liquidus
1.	5-component Bi alloy	X		X	X		X		—	117
2.	Woods Metal	X		X			X		158	165
3.	Quaternary Bi alloy	X	X	X			X		160	190
4.	Tin-indium	X			X				—	243
5.	Tin-bismuth eutectic	X		X					—	281
6.	Pure indium (eutectic)				X				—	314
7.	63/37 tin-lead (eutectic)	X	X						—	361
8.	70/30 tin-lead	X	X						361	367
9.	60/40 tin-lead	X	X						361	370
10.	Tin-lead-antimonide	X	X			X			365	399
11.	50/50 tin-lead	X	X						361	417
12.	Tin-indium (eutectic)	X			X				—	419
13.	Tin-lead-silver (eutectic)	X	X					X	—	430
14.	Indium-silver (eutectic)				X			X	—	448
15.	40/60 tin-lead	X	X						361	460
16.	Tin-antimonide	X				X			452	464
17.	Tin-silver	X						X	430	473
18.	20/80 tin-lead	X	X						361	531
19.	Lead-silver (eutectic)		X					X	—	579
20.	Lead-indium (eutectic)		X		X				—	599

Note: (1) Ultimate stress of alloy alone. (2) Recommended working stress in joint. (3) Ultimate stress in joint.
*Reproduced from SOLDER AND SOLDERING, H. H. Manko, McGraw-Hill Book Co., New York, N. Y., March 1964.

Step 6—Special Characteristics. Since there is already some silver in lead-eutectic alloy 19, its silver scavaging action would be greatly reduced compared with alloy 20. This is an advantage for this alloy.

Step 7—Economy. A further consideration is the fact that the price of alloy 19 is much less than the price of alloy 20 (table 2).

Step 8—Compatibility Checks. Both alloys have high lead content and are extremely ductile. The coefficient of thermal expansion is not important in this use, since the strain will be absorbed. With alloy 19, which contains silver, there is no further galvanic potential between the silver-fired ceramic body and the solder alloy.

Step 9—Manufacturing Considerations. No special production problems in applying alloy 19 are anticipated. The flux used for tinning the assembly should leave no residues on the surface. The flux material should be very temperature stable. This allows assembly to be preheated to nearly soldering temperatures in the flux medium, and minimizes thermal shock to the ceramic body during soldering. Dip soldering, wave soldering, and many other methods are suitable for this task. But it is important not to overexceed the time-temperature minimum required for good wetting. This precaution is taken because a certain amount of silver scavenging from the surface occurs on prolonged heating at high temperatures.

Note that in this example it is assumed that the task is to join the silver-fired ceramic surface rather than the copper wire. In soldering, it is always advisable to consider the more difficult of the two metals to be soldered. If the difficult soldering job can be done, the rest of the assembly presents no problem.

Table 2

Solder-Element Melting Temperatures

Metal element	Melting point/°F	Price/lb.
Indium	313.5	$21.90 $33.00
Tin	449.4	$ 1.30–$ 1.50
Bismuth	530.3	$ 2.25
Cadmium	609.6	$ 3.40 $ 3.60
Lead	621.3	$ 0.13
Antimony	1166.9	$ 0.35–$ 0.44
Silver	1706.9	$19.50

MECHANICAL PROPERTIES Tensile Strength, PSI	MECHANICAL PROPERTIES Shear Strength, PSI	PHYSICAL PROPERTIES Electri-conductivity, % IACS	PHYSICAL PROPERTIES Expansion coef. (in./in. °F)	Notes
5400	NA	3.3	13.9	Expands then shrinks to zero in 30 min.
4550	NA	3.1	NA	Non-electric solder for low ambient temp.
5400	300[2]	4.3	NA	Shrinks to 0.0025 in./in. then expands to zero in 60 min.
1720	1630[3]	11.7	NA	Low vapor pressure, good for glass. (Alpha indium #1).
8000	500[2]	5.0	8.3	Expands to 0.0007 in./in. then shrinks to 0.0005 in./in.
515	890[3]	24.0	18.3	Expensive, bonds to non-metals.
7700	5400	11.5	13.7	Used where pasty range is intolerable.
7800	5000	12.5	12.0	Good pretinning alloy (ASTM 70A).
7600	5600	11.5	13.3	Good electric grade solder (ASTM 60A).
8400	6850	9.6	NA	Similar to 50/50 Sn-Pb, resists creep well. (Alpha #236).
6200	5200	10.9	13.0	General purpose solder (ASTM 50A).
4670	2680[3]	6.0	NA	Very good resistance to alkaline corrosion. (Alpha indium #7).
2860	NA	14.0	NA	High temp. electrical solder for instruments. (Alpha #33).
1650	1600[3]	22.1	NA	Solders silver-fired glass and ceramics. (Alpha indium #3).
5400	4800	10.1	13.9	Inexpensive electrical solder (ASTM 40A).
5900	6000	NA	15.0	Lead-free, used in food equipment. (Alpha #112).
8000	NA	12.6	NA	High-temp. electrical instrument solder. (Alpha #153).
4800	4200	8.7	14.7	Wiping solder for body work and plumbing. (ASTM 20A).
4400	2900	8.8	NA	Torch solder, poor corrosion resistance. (Alpha #106).
4330	3220[3]	5.1	NA	High-temp. zinc-free indium solder. (Alpha indium #11).

WHAT'S NEW

LIGHTWEIGHT IMAGE ORTHICON

REDUCED SIZE, WEIGHT, AND POWER are principal features of a new orthicon developed by General Electric, Syracuse, N.Y. The tube, Z7804 realizes these reductions by controlling the beam by electrostatic focusing instead of heavy, bulky magnetic focus and deflection yokes used on conventional units.

Overall length of the tube is 13 in. and weight is 11 oz. Conventional orthicons weigh more than 14 lbs. While conventional units require 30 watts for the associated yokes, the Z7804 needs only 1 watt.

The tube features a high-gain, thin-film magnesium oxide target with a sensitivity 10 to 20 times that of glass targets. The target is capable of storing signals for long periods prior to readout. This provides great sensitivity with low frame rates or beam pulsing. The Z7804 minimizes halo and blooming caused by bright, shiny objects.

Deflection and focusing of the beam are done with tiny, lightweight components contained within the tube. The target is scanned by the beam which is electrostatically reflected by means of a Deflectron. This unit has a common center of deflection for both vertical and horizontal beams. An Engel lens focuses the beam with an electrostatic field which is changed by varying the voltage. A non-linear spiral lens colliminates the beam so that it strikes the target at precisely a 90° angle. This insures there will be no shading in image quality.

Another version of this tube uses a fiber optic face plate with an S-20 photo-cathode. When used in combination with visible, infrared, or ultra-violet image intensifiers with fiber-optic face plates, it improves tube sensitivity an additional 10 to 30 times. This makes it useful for starlight conditions.

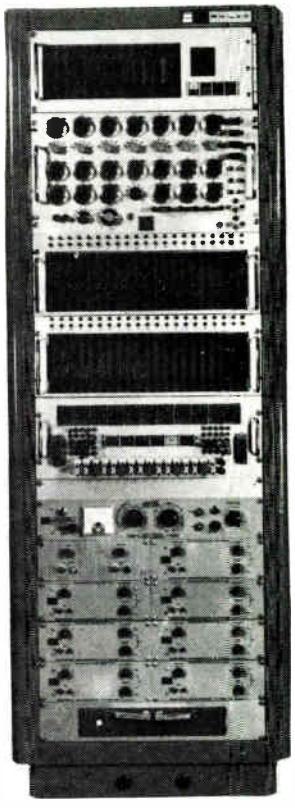
Electrostatically focused and deflected image orthicon requires no magnetic focus and deflection yokes.

COVER STORY

Checking the Quality Of Integrated Circuits

Solid state logic circuitry and reed relays are the key elements in this unique tester that makes up to 34 separate tests on microcircuits in less than 2 seconds.

By R. W. BOOHER, Lansdale Division, Philco Corporation



BOTH INTEGRATED CIRCUITS MANUFACTURERS and equipment manufacturers are looking for quick, economical methods of checking the quality of microcircuits. The IC manufacturer uses the tests for pre-sorting—to avoid the expense of packaging defective circuits—and for in-process control. The equipment manufacturer uses the tests for incoming inspection. In both cases, the test functions are ideally combined in a single piece of equipment.

The Philco Automatic Circuit Tester (PACT) is a high speed go/no-go tester designed to sort the many circuits on a wafer into good and bad categories. It is capable of making from one to thirty-four tests on devices with a maximum of sixteen terminals.

The speed of testing is currently set to make all thirty-four tests in less than two seconds. The tester can be set to stop on the first reject or no-go that occurs. This eliminates any further testing and results in a substantial saving in time.

Solid state logic circuitry automatically and sequentially steps the PACT tester through its tests. A six-stage binary counter and two memory systems are employed. The logic sets soak time intervals, produces device setting pulses, interrogates the comparator and provides the general timing. The automatic operation can be switched into manual operation for looking at any individual test.

The device under test is connected to the PACT by means of either of two parallel Kelvin connectors on the front panel. The connectors also contain start, stop and go/no-go information lines.

Since a variety of circuits, are to be checked, a method of changing over quickly from one type of circuit to another, along with changing any individual test in a series, is required. This requirement is met by using small individual printed circuit cards for programming; one card for each test. Wire jumpers on each card define the test, although special components such as relays, diodes, resistors, etc. can be mounted on the board for special test conditions.

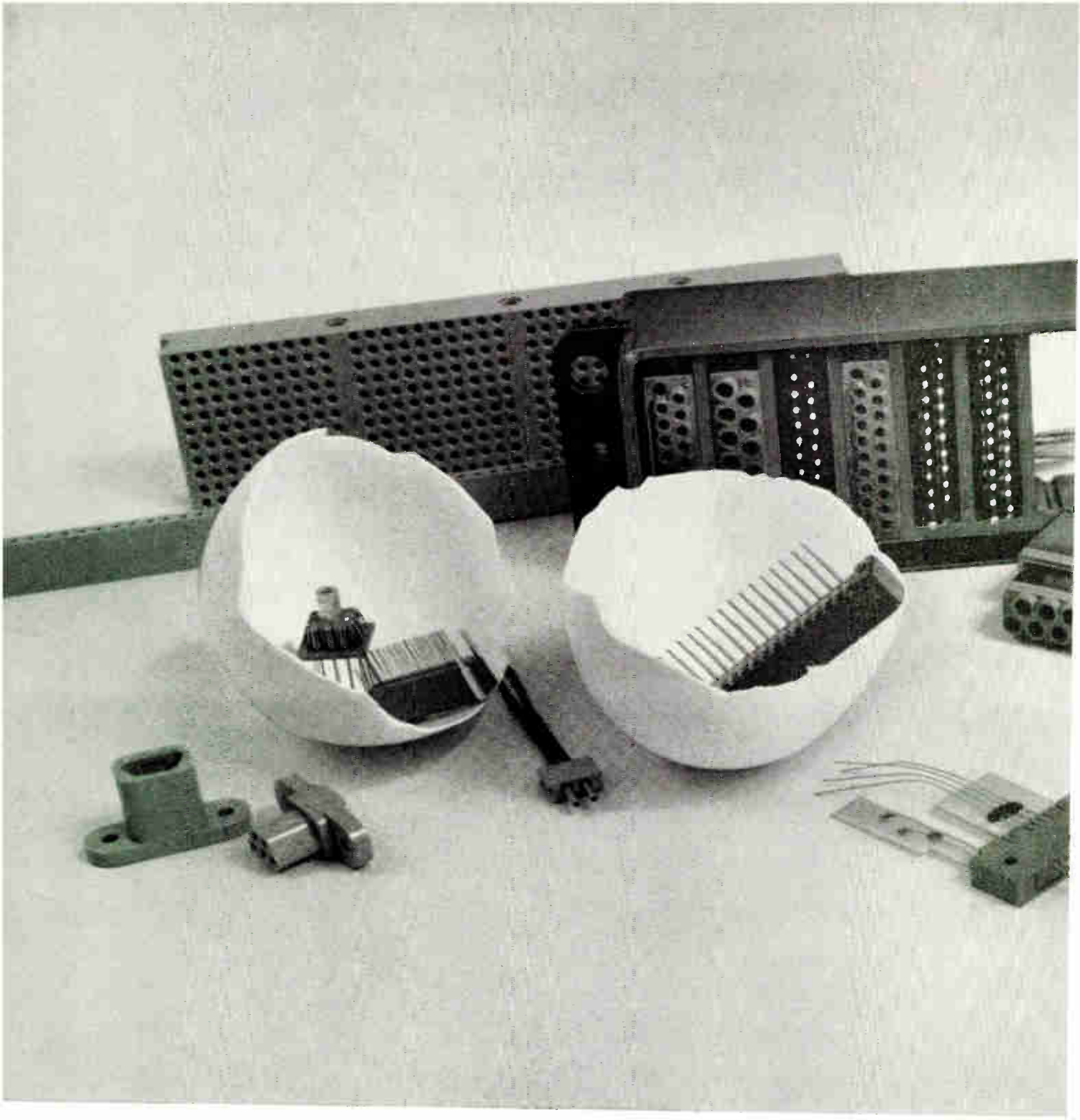
A complete changeover from the testing of one type integrated circuit element to another can be made in less than one-half hour.

The PACT has seven bias voltage levels and three constant current levels available for a program. Each of the seven bias levels can be positive or negative from zero to one hundred volts. In addition to the bias and current levels, ten reference voltage limit levels are available for go/no-go limits. The solid-state dual-limit comparator allows both a high and low go/no-go decision to be made on a single test. The comparator employs the summing point amplifier technique. Two consecutive adjustable pulses are available. Each can apply twenty-four volts, ground, any one of the seven bias voltages or any other level required for setting or pulsing the device under test. The pulse widths are adjustable from the front panel and all connections are made by a jack panel.

When first put into operation at Philco, it was intended to use the PACT for a quick presort and then go on to a more sophisticated final tester after packaging. It was later determined that the accuracy and control available from the PACT was extremely good. The test limits and specifications at the wafer presort stage were tightened so that almost all final test failures were eliminated.

Reject information on which tests the devices are failing and the frequency of failures can be accumulated for diagnoses of problems in the circuit forming stage. This is accomplished through the use of any one of ten available test fail counters connected by a jack panel to any one of the thirty-four tests.

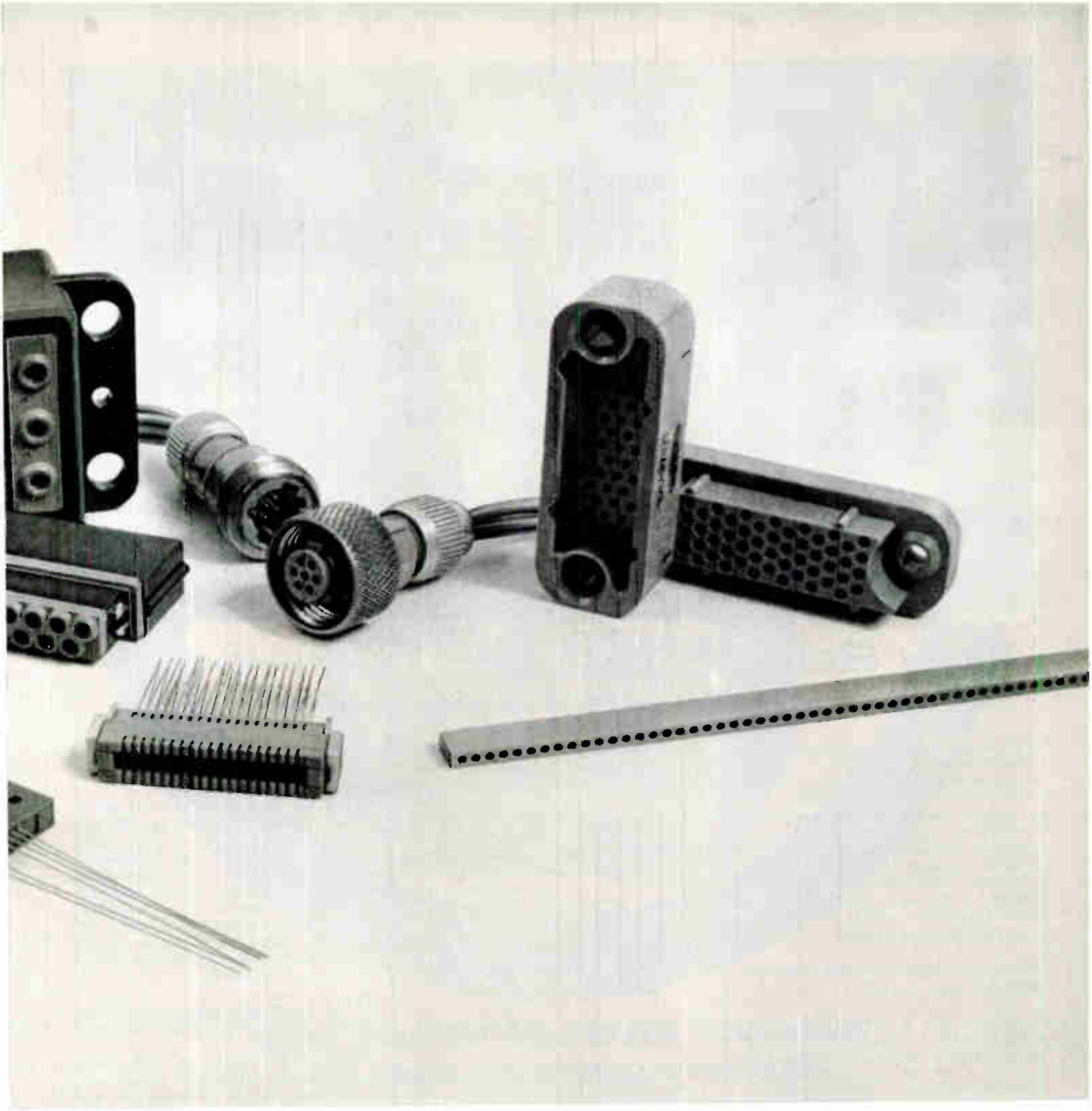
The reed relay is the work horse of the PACT. The PACT contains twelve hundred reeds. A very conservative estimate shows a minimum of one million reed operations per month during normal use.—R. W. B.



How Amphenol's 108 microminiature connectors help you hatch new ideas

They give engineers the complete selection needed to break out of the shell . . . to innovate . . . to design smaller, cheaper and more reliable equipment.

Now, you can choose from the most complete line of standard microminiature connectors in the industry. Amphenol builds connectors for printed circuit board, rack and panel and modular applications; min-



iature circuitry and thin film networks; cable-to-cable and cable-to-chassis connections. Many of which meet unusual environmental requirements.

Amphenol builds specials, too. Some are variations of standards. Others were hatched to solve one-of-a-kind interconnection problems.

For instance, Amphenol designed and built a new high density micro-miniature "Multi-Mod" connector with environmental seals, removable contacts and full modular construction. You can program both the contacts and the modules.

Amphenol's tiny Micro-Med bipolar probes are helping medical technicians make inexpensive brain implantations in laboratory animals.

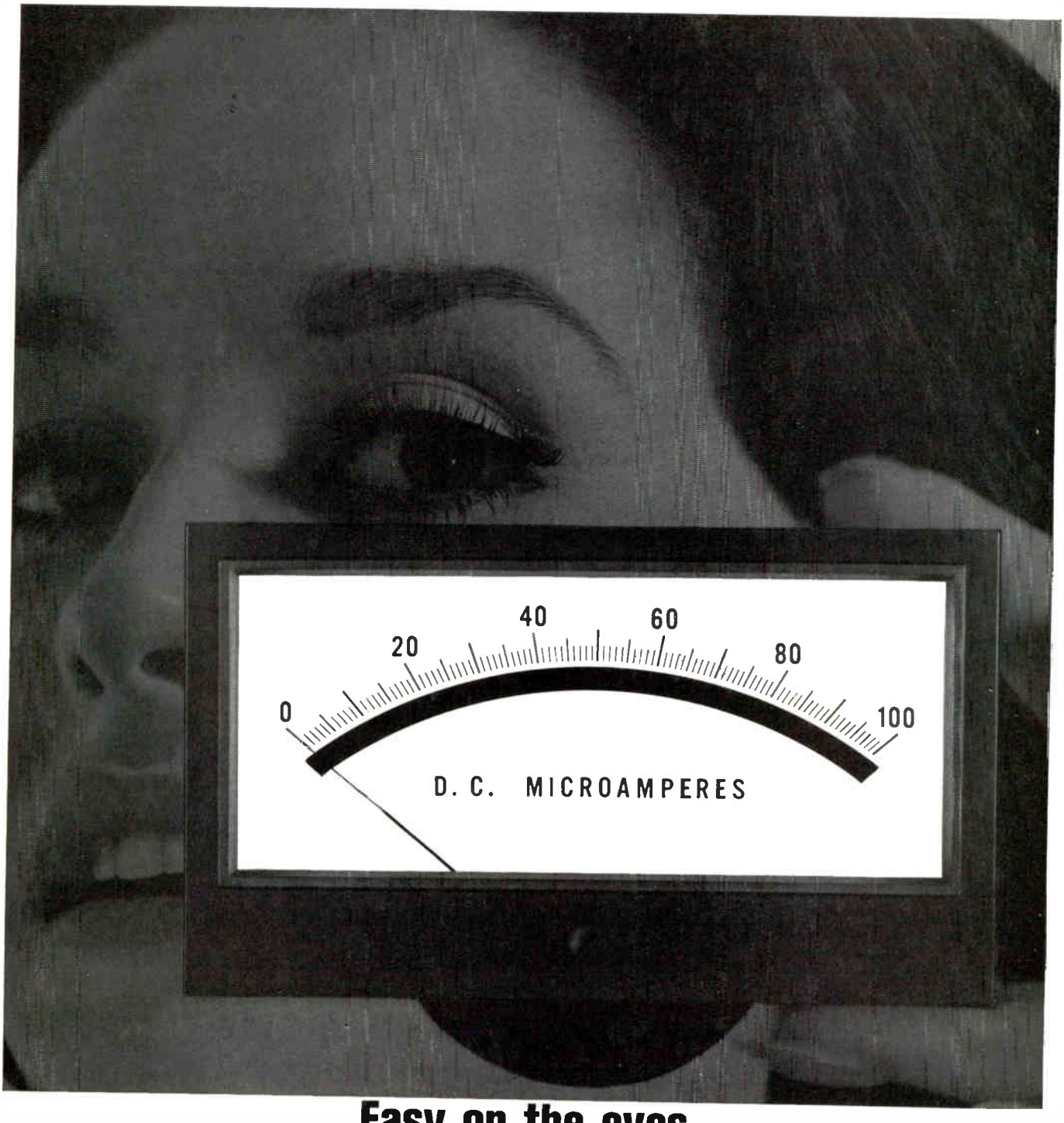
And a modification of our 74 Series Micro-Min® connector is delivering new cost and reliability advantages in a high-volume communication handset.

Ask an Amphenol Sales Engineer to show you how we can help you hatch a new idea in microelectronics and microminiature interconnection techniques. For a handy reference, write for our new catalog: *Amphenol Microelectronics, 2837 S. 25th Ave., Broadview, Illinois 60155.*

Amphenol® MICROELECTRONICS

AMPHENOL-BORG ELECTRONICS CORPORATION

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



Easy on the eyes

Meet the new Honeywell "65", the meter that mounts behind the panel. It's good-looking and easy to read. For one thing, the dial is up front (almost flush with the panel) to eliminate the "tunneling" effect. The dial also features an anti-parallax mirror scale (standard equipment) to permit more accurate readings. ■ The Honeywell "65" is interchangeable with similar 5-inch meters, and you can mount it in minutes without tools (simply screw on two wing nuts). It has a glass window. And it's available with pivot and jewel or taut-band mechanism. For more information about this new "behind the panel meter" (and a copy of our latest catalog) write to Honeywell, Precision Meter Division, Manchester, N. H. 03105. In Canada, Toronto 17, Ontario.

Honeywell

NEW TECH DATA

Digital Indicators

Bulletin E222, 2 colors, covers the accra-count digital position indicators. Applications, features and benefits are outlined, and typical positioning uses are diagrammed. Other data includes standard operating specs., selection of compatible sensors, optional equipment, and dimension data. Emerson Electric, 8100 Florissant Ave., St. Louis, Mo.

Circle 161 on Inquiry Card

Signal Sensors

These signal sensors activate a relay when an input signal reaches a predetermined value. The nominal voltage required to trip a relay in the C70 4889 001 signal sensor is 20v. RMS. C70 4889 002 operates a relay at an input voltage level of 100mv RMS, while the relay-tripping level for C70 4889 004 is 5v. RMS. Modified units can be supplied with input ranging from 50mv to 30v. RMS. Complete data available from Kearfott Div., General Precision Inc., Aerospace Group, Little Falls, N. J.

Circle 162 on Inquiry Card

Time-Mark Generators

This 2-color brochure lists a complete line of time-mark generators. The brochure contains photos, specs., and a description of each unit. One unit described has time markers from 100nsec. to 1 sec. Accutronics, Inc., 12 South Island, Batavia, Ill.

Circle 163 on Inquiry Card

Measurement System

This data describes a measurement system based on variable capacitance principle: variations in capacitance caused by the displacement of a sensing element toward a stator plate will detune a resonant circuit. The system, for pressure, acceleration, vibration, displacement and force measurement, consists of a sensing element (sensor), a converter, and a source of power (external or internal). Complete details may be obtained from Omega Instruments Div., Dressen-Barnes Electronics Corp., 2599 N. Fair Oaks Ave., Altadena, Calif.

Circle 164 on Inquiry Card

General-Purpose Counter

Data is available on a general-purpose counter for industrial uses. Available in 2 models (CM62 & 64) with either 6 or 7 digits, the mechanical device operates at speeds of up to 1000 counts/min. for the CM62 stroke counter, and 2000 counts/min. with the CM64 counters. The 90° stroke, including pre-travel and overtravel, on the CM62 can be field adjusted to meet specific requirements. The unit can be set for a stroke up to 270°. ITT General Controls Inc., 2000 Wolf Rd., Des Plaines, Ill.

Circle 165 on Inquiry Card

Slide Calculator

A slide calculator, providing a convenient means of converting from standard sizes of copper or aluminum wire to an equivalent aluminum magnet strip conductor, is available. It allows quick conversion of wire gages to electrically equivalent aluminum strip ranging from 1 to 36 in. wide and 0.001 to 0.100 in. thick. Write on company letterhead to Aluminum Co. of America, Alcoa Bldg., Pittsburgh, Pa.

Test Set

Transient generator test set Model 2301 permits power line transient testing of avionic equipment in accordance with Mil-STD-704. The unit is a signal generator that modulates a 115v., 400 cycle, either single of 3 phase, or 28vdc power lines with a variety of transient functions. It can be used by design, environmental, and quality control test engineers. Complete details available from Sanders Associates, Inc., 95 Canal St., Nashua, N. H.

Circle 166 on Inquiry Card

Strain Gage Indicator

Model 711 gives precise, large-scale indication of load, torque, pressure, thrust, etc. The transistorized null-balance servo instrument is accurate to 0.25% and has a full scale balance time of less than 2 sec. Widely adjustable zero and span provide versatility in adapting to a variety of transducer types. Following initial calibration, the drift-free instrument requires no further adjustment. It is suitable for either bench-top operation or flush panel mounting. Complete details available from Daytronic Corp., 2875 Culver Ave., Dayton, Ohio.

Circle 167 on Inquiry Card

Meter Protector

Bulletin 806 describes the Metersaver meter protector. This is an easy-to-connect semiconductor device which converts overloads of 200 times to 3 times, well within the capability of most meters. The device also permits use of considerably less expensive meter fuses. Ohmite Mfg. Co., 3639 Howard St., Skokie, Ill.

Circle 168 on Inquiry Card

Diode Test Set

Model 450 diode automatic recovery test set is used with a dual-channel sampling oscilloscope. It measures both inverse and forward recovery time of nsec. switching diodes and sorts accordingly. The automatic readout for the diode recovery waveforms appears on the oscilloscope screen. Complete details available from General Applied Science Laboratories, Inc., Merrick & Stewart Aves., Westbury, L. I., N. Y.

Circle 169 on Inquiry Card

NEW TECH DATA

Oscilloscope Catalog

This short-form, 2-color catalog lists a complete line of oscilloscopes with built-in and plug-in amplifiers. It is fully illustrated and contains data on amplifier characteristics, time bases, CRT, physical dimensions and prices. Data Instruments, 7300 Crescent Blvd., Pennsauken, N. J.

Circle 175 on Inquiry Card

X-Y Recorder

Model HR-197 is transistorized and features speeds greater than 15 in./sec. Accuracy is 0.02%. Repeatability is 0.1% and adjustable sensitivities are from 0.1mv/in. to 100v. full scale. It can be floated to 200vdc. Complete details available from Houston Instruments Corp., 4950 Terminal Ave., Bellaire, Tex.

Circle 176 on Inquiry Card

Distortion Meters

Two r-f distortion meters and a UHF grid dip meter are outlined in a new technical data sheet. The distortion meters, Models 85B and 85C, accept fundamental freqs. from 1.0 to 100MC and 0.1 to 6MC respectively. Both measure total harmonic content up to approx. 300MC. The Model 101B UHF grid dip meter operates from 300MC to 1GC. Boonton Electronics Corp., Parsippany, N. J.

Circle 177 on Inquiry Card

Oscillator Bulletin

Bulletin 1005 gives specs. for a complete line of highly accurate, ultrastable tunable local oscillators. Seventeen standard microwave tunable Stalos are covered. The data includes freq. ranges (between 245MC and 7GC), uses, stability factors and performance characteristics. Pitometer Log Corp., subs. of The G. C. Dewey Corp., 202 E. 44th St., New York, N. Y.

Circle 178 on Inquiry Card

Bus-Bar Brochure

This brochure presents data on a bus-bar product line and manufacturing capabilities. It contains detailed information on many types of bus-bars which include units with solder, quick connect, spade or ring lug, screw and wire wrap termination methods. Methode Mfg. Corp., 1700 Hicks Rd., Rolling Meadows, Ill.

Circle 179 on Inquiry Card

Switch Catalog

This 40-page, 2-color catalog contains dimensional drawings, illustrations and technical data on a complete line of precision thumbwheel, rotary, and pushbutton switches. They have positive readout and with typical life of over 100K cycles. Included are miniature decimal and binary thumbwheel switches, tab-type and regular decimal or binary thumbwheel switches, a line of binary and decimal pushbutton switches, rotary selector switches, and pre-wired module panels and switches. Chicago Dynamic Industries, Inc., Precision Products Div., 1725 Diversey Blvd., Chicago, Ill.

Circle 180 on Inquiry Card

New Sanborn Tape System

7 CHANNELS plus monitoring track

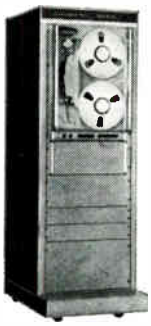
6 ELECTRICAL SPEEDS without capstan change

40 db or better SIGNAL/NOISE RATIO

0.2% P-P FLUTTER

IRIG compatibility

for under $9,000



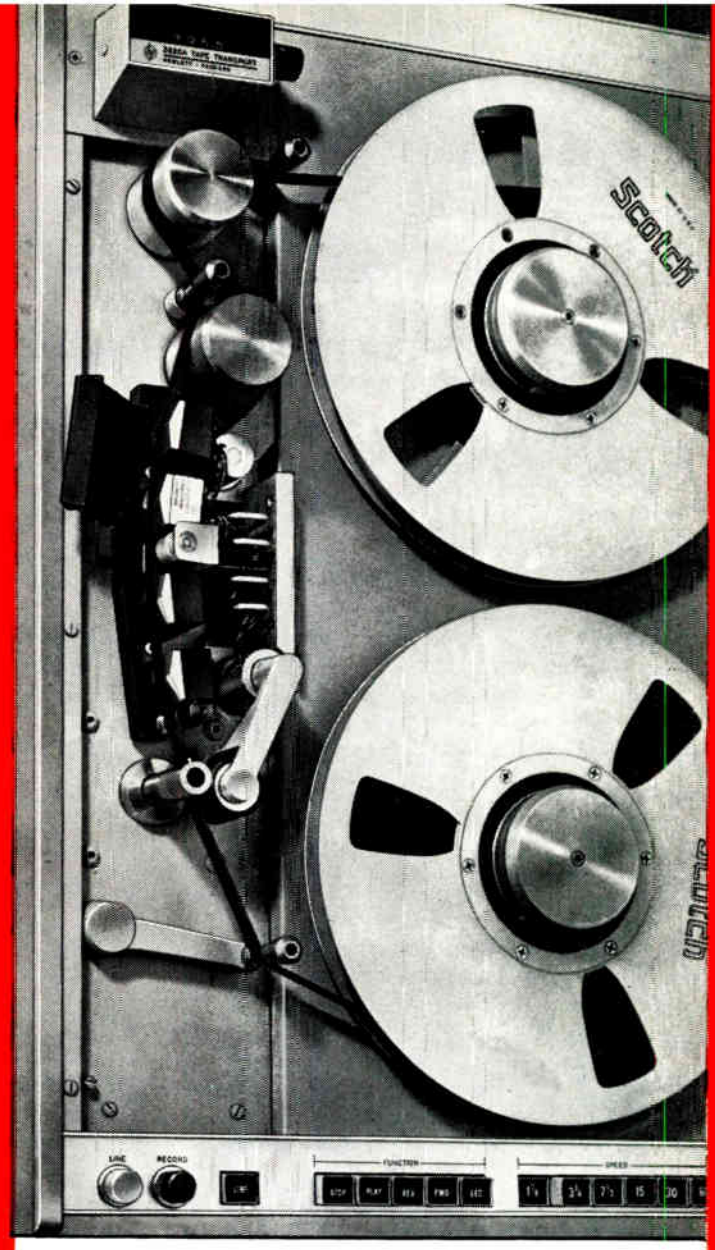
Now you can have precision instrumentation tape system performance at *substantially lower cost than ever before*, with this completely new Sanborn 3900 Series incorporating a specially-designed Hewlett-Packard transport. The primary objective was to provide a highly flexible, reliably useful system with *stable* tape motion, *simple* operation and *no* maintenance — at a significantly *lower cost*. These objectives have been successfully accomplished, in a system which has:

• Greatly reduced interchannel crosstalk with a new magnetic head assembly design using improved shielding. • High signal/noise ratio, gentle tape handling and reduced tape wear, through precisely controlled tape tension, driving and braking torques, and guide element designs. • Plug-in solid-state electronics with record/reproduce amplifiers on the same cards, and equalization plug-ins necessary only for speeds to be used. • No need for maintenance or lubrication, except for cleaning tape path. • Built-in footage counter accurate to 99.95%. • Quick, easy snap-on tape reel loading. • Cabinet, rack or portable case mounting.

Check the key specifications here, then call your local H-P Field Engineering Office for complete details and prices. Or write Sanborn Company, Industrial Division, 175 Wyman Street, Waltham, Massachusetts 02154.

SERIES 3907A (7-channel), 3914A (14-channel)

SPEEDS	6, electrically controlled, pushbutton selected, 1⅞ to 60 ips; other speed ranges optional. Max. start 2 sec., max. stop 1 sec.; ±0.25% max. variation in tape speed at nominal line frequency.
TAPE	7-channel ½"; 14-channel 1"; 2400 feet 1.5 mil, 3600 feet 1.0 mil; 4800 feet 0.65 mil; 10½" reels.
RECORDING MODES	Direct, FM or Pulse Record/Reproduce via interchangeable solid state plug-in electronics; 7-channels in 7½" panel space. Single-ended inputs, push-pull with optional coupler. Adjustable input/output levels.



BANDWIDTH	RESPONSE	SIGNAL/NOISE RATIO (RMS)
Direct (60 ips) 100-100,000 cps	±3 db	40 db
FM (60 ips) 0-10,000 cps (Wideband systems available soon — 250 KC direct, 20 KC FM)	±0, −1 db	44 db without flutter compensation 48 db with flutter compensation
P-P FLUTTER (30 & 60 ips)	0-1 KC, 0.2% max. 0-5 KC, 0.5% max.	
CONTROLS	Power, Stop, Play, Reverse, Fast Forward, Record; all can be remotely controlled	

PRICES (f.o.b. Waltham, Mass.) (Systems represent two of many choices available. Prices are correspondingly lower for fewer speed filters, or where direct record/reproduce electronics are specified, and higher when filters for all six speeds are ordered.)

Complete 7-channel system for FM recording and reproducing, with filters for 3 speeds, extra (8th) channel for monitoring, and console cabinet: **$8900**

Same system, for **14-channels: $13,370**

SANBORN
A DIVISION OF HEWLETT-PACKARD hp

See our dynamic display of measuring, recording and readout instruments at IEEE Booths 3513, 3515, 3517

Circle 60 on Inquiry Card

NEW TECH DATA

Time Delay Comparator

The Model 203/620 psec. resolution delay comparator system is described in this data sheet. It contains the principle of coincidence detection between an unknown delay and the included variable calibrated delay. It may be used to measure delays of cables, coaxial connectors, delay lines, circuit elements, and for equipment calibration. The sheet gives pertinent data for the 2 psec. calibrated measurement set-up. Eldorado Electronics, 601 Chalomar Rd., Concord, Calif.

Circle 187 on Inquiry Card

Display Modules

Integral translator-drivers now permit Dialco 7 segment display modules to operate from binary coded decimal input. The translator-driver requires 7 instead of the usual 10 transistors needed. Translation is provided by diode gates. Standard circuits are available for many conditions. Translator-drivers with modified circuits can be designed to suit the specific use. Dialight Corp., 60 Stewart Ave., Brooklyn, N. Y.

Circle 188 on Inquiry Card

Integrated Logic

Bulletin 1000 describes the Series A integrated logic circuits. These circuits operate in the μw range, rather than in the standard mw range. For these units, a special fabrication technique is used. Here passivated deposited thin-film elements and diffused epitaxial transistors and diodes form a monolithic structure in a single silicon wafer. CBS Laboratories, Stamford, Conn.

Circle 189 on Inquiry Card

Capacitor Catalog

This 2-color catalog covers a line of ⅜ in. sq. trimming potentiometers. The technical data includes detailed specs. for electrical, mechanical and environmental qualities, as well as power rating and standard resistance-resolution charts. Techno-Components Corp., 7803 Lemona Ave., Van Nuys, Calif.

Circle 190 on Inquiry Card

Computing Systems

Bulletin DC-64120 features the 8400 Digital Computing System and the 8800 Analog/Hybrid Computing System. The fully-illustrated bulletin gives details of the 2 computers, discusses program flexibility, performance characteristics and breadth of uses. Each computer is illustrated and the brochure is pre-punched for easy filing. Electronic Associates, Inc., West Long Branch, N. J.

Circle 191 on Inquiry Card

Facilities Brochure

This pamphlet entitled, "Amplifiers for Industry" gives a quick insight into what Melcor is and does. It contains photos, facility data, and general product descriptions. Melcor Electronics Corp., 1750 New Highway, Farmingdale, L. I., N. Y.

Circle 192 on Inquiry Card

DC Voltage Standard

Model 323 has output voltages from 0 to over 1110v. and accuracy within 0.01%. Stability is 0.0025% for 8 hrs. or 0.005% for 30 days. Six 11-position dials set output voltages in steps as small as 10μv. More data available from Colu Electronics, Inc., Kintel Div., Box 623, San Diego, Calif.

Circle 181 on Inquiry Card

Coaxial Cables

This illustrated, coaxial cables brochure contains a detailed chart of 31 Teflon cable constructions (Mil-C-17D). These Teflon insulated coaxial cables conform to the tolerance requirements of Mil-C-17. The basic coaxial cable is described and illustrated in detail by line drawings, and formulae used in the determining coaxial cable characteristics are provided. Haveg/Super-Temperature Wires, Inc., 50 W. Canal St., Winooski, Vt.

Circle 182 on Inquiry Card

Coating Uses

The use of Metco 404 Nickel Aluminide coatings is described in this illustrated technical report. It tells how the flame-sprayed coatings can be used for bonding, as a refractory, as an oxygen barrier, as a protective layer under ceramic coatings, and as an engineering material. Metco Inc., Dept. 211, Westbury, N. Y.

Circle 183 on Inquiry Card

Current Cutout Bulletin

Bulletin RCC-100 describes the functions of reverse-current cutouts for military, commercial and industrial dc generator protection. It contains photographs, drawings and wiring diagrams, for 6 styles of Mil. Standard, high-voltage and high-current, differential-voltage, reverse-current cutouts. In addition, 4 types of commercial types are described. Hartman Electrical Mfg. Co., 175 N. Diamond St., Mansfield, Ohio.

Circle 184 on Inquiry Card

Control Drives

Illustrated product spec. brochure CE81-2 describes modulating electric control drives. These units provide remote-controlled power for precise positioning of regulating devices in power and process industries. Outlined are specific uses, features and operating characteristics. Drive construction and physical characteristics are illustrated and explained. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle 185 on Inquiry Card

Shielded Panels

EMC-Glas shielded panels not only permit reading of read-out devices inside RFI/EMC-shielded electronic enclosures, but avoid the hazards of polarization at h-f which can degrade the shielding effectiveness of the panels. They contain mesh treated to make it equally conductive in all directions, to all field polarizations. Thomas & White, Inc., 72 Prospect St., E. Orange, N. J.

Circle 186 on Inquiry Card

Circle 63 on Inquiry Card

NEW TECH DATA

Program Board

Data is available on program board modules which enable the user to make up configurations to suit his specific requirements. The unit may be mounted in standard EIA 19 in. relay rack or bench cabinets. The system consists of 10 x 10 matrixes, blank filler panels, end pieces, mounting rails, and buss jumpers. Sealectro Corp., Mamaroneck, N. Y.

Circle 211 on Inquiry Card

Special Inks

Three technical data sheets are available which contain helpful information for anyone concerned with identification printing of electronic components. The bulletins are the first in a planned series designed to provide actual experience data and test results on various specialty inks and printing methods. Marken Machine Co., Keene, N. H.

Circle 212 on Inquiry Card

Bobbin Winder

Model 777 winds bobbin, solenoid, and relay coils. It accommodates wire sizes from #20 to #50 AWG. Winding speed is variable up to 12,000 RPM. Additional data available from Elden Mfg. Co., 2712 N. Elston Ave., Chicago, Ill.

Circle 213 on Inquiry Card

High-Power Transistor

Data is available on a new overlay transistor which features 2-fold power improvement over previous units. The RCA 2N3632 n-p-n transistor provides a power output of 13.5w. (min.) @ 175MC and 10w. (typical) @ 260MC. Commercial Engineering, RCA Electronic Components and Devices, Harrison, N. J.

Circle 214 on Inquiry Card

Shorting Switches

Data is available on a complete series of waveguide shorting switches in 7 standard models. They cover the range of 2.6 to 40.0GC. VSWR in the open position is 1.02 max.; VSWR in the closed or short position is 125 minimum; insertion loss in either closed, or open position is negligible. These items are hand operated, plunger type, on-off switches that provide a convenient means of establishing a removable short in a waveguide transmission system. Waveline Inc., Caldwell, N. J.

Circle 215 on Inquiry Card

Diode Data

An application bulletin (E-506) on 4-layer diodes is available. It is devoted to multivibrator circuits, and examples of astable, monostable, bistable and polarized types are given. Circuit values are provided and temp. compensating suggestions are offered. High speed switching is covered in a separate section containing methods which allow these circuits to operate at 500KC or higher. National Transistor, 500 Broadway, Lawrence, Mass.

Circle 216 on Inquiry Card

Coaxial Components Catalog

Electrical and physical specs. for a wide range of coaxial components and semiconductor devices are given in 15-page catalog No. 1-64. Included are subminiature precision attenuators, and subminiature terminations supplied with connectors to mate with BRM or OSM Series 200 connectors, high power terminations, low and high pass filters, and directional couplers. Engelmann Microwave Co., 1259 U.S. Highway 46, Parsipanny, N. J.

Circle 217 on Inquiry Card

Relay Catalog

This 60-page catalog lists over 2 million relays in approx. 40,000 types. All merchandise is guaranteed, subject to customer's inspection and approval, and may be returned within 30 days for replacement or credit. Universal Relay Corp, 42 White St., New York, N. Y.

Circle 218 on Inquiry Card

Pulse Transformers

A new engineering bulletin, describing pulse transformers for SCR uses, is now available. It describes important parameters and shows simple mathematical relationships for determining these parameters. Complete data is also given on specific transformers suitable for SCR applications. The Gudeman Co., 340 W. Huron St., Chicago, Ill.

Circle 219 on Inquiry Card

Adhesives/Coatings Specs.

This 16-page catalog lists Government specs. and Federal stock numbers for a wide variety of adhesives, coatings and sealers. One section describes Mil specs. definitions, intended application, and the corresponding 3M adhesive, coating, or sealer that meets the specs. Another section describes Federal stock numbers, container sizes, Federal stock number description, quantity/case and product description for 3M adhesives, coatings, and sealers. Adhesives, Coatings & Sealers Div., 3M Co., 2501 Hudson Rd., St. Paul, Minn.

Circle 220 on Inquiry Card

Monolithic Capacitors

This catalog covers a complete line of Ceralam ceramic capacitors. They are available in a wide variety of sizes and geometric configurations with exceptional volumetric efficiency, permitting max capacitance for specific materials. The monolithic structure offers high reliability. Catalog contains complete specs. Aerovox Corp., Olean, N. Y.

Circle 221 on Inquiry Card

Transfer Lettering

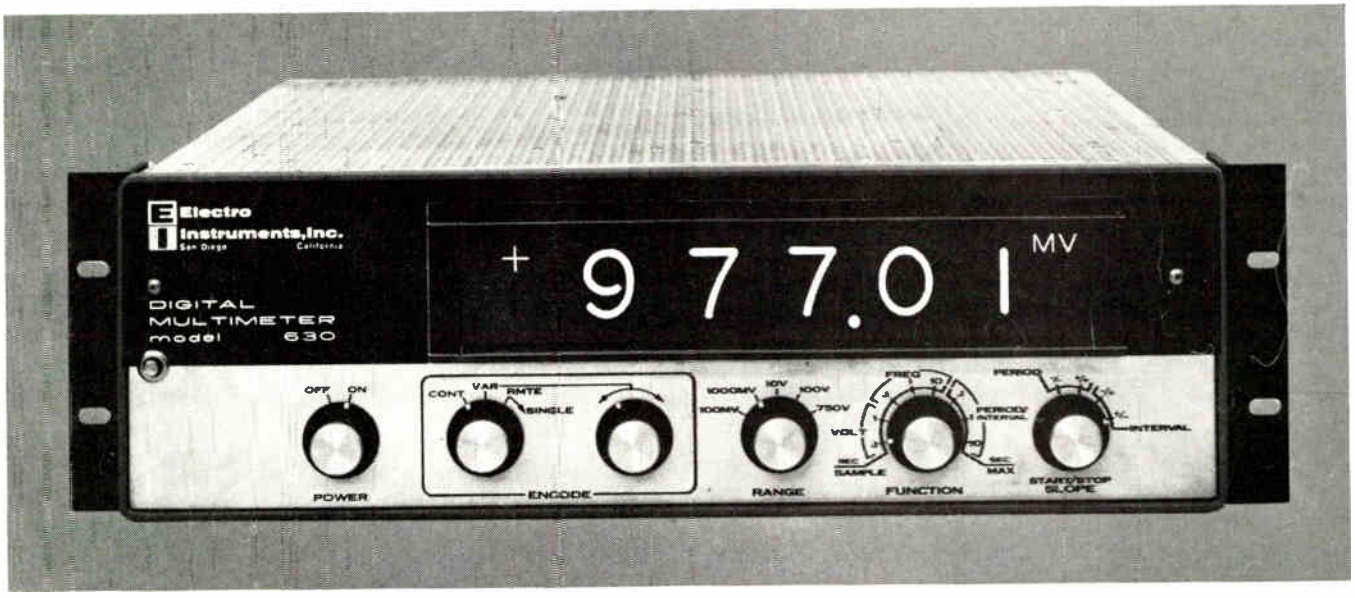
This fully-illustrated folder outlines the specs., descriptions, colors, alphabet samples, uses and ordering data for Deca-Dry transfer letterings. Deca-Dry provides quick, easy, distortion free lettering. A wax free backing allows images to transfer to any dry surface without shadows or ghosts. Chart-Pak, Inc., One River Rd., Leeds, Mass.

Circle 222 on Inquiry Card

LOOK!

This Model 630 Integrating Digital Multimeter From Electro Instruments Is The World's

MOST VERSATILE



It has 1 megacycle frequency counter... eliminates errors in measurements near zero and/or involving polarity changes...lets you measure DC voltages, frequencies and time intervals with one instrument...has built-in storage to eliminate "rolling" of digits in readouts...and 1 microvolt resolution. And its price is only

$3,295

Electro Instruments, Inc.
8611 Balboa Avenue San Diego, California 92112
Electro International, Inc., Annapolis, Md.

WEATHER MEASUREMENTS

A meteorological research instrument called a radio dropsonde provides data about the characteristics of storm clouds. Several units may be dropped from a plane over a storm cloud area. During freefall it measures the speed of updrafts and downdrafts to learn more about the formation of rain and hail. An FM/FM transmitter relays this data to ground stations. The system was developed by Automation Industries, 650 N. Sepulveda Blvd., El Segundo, Calif.

Specially insulated oscillographic galvanometers have been developed to withstand 5kv transient and 2.5kv continuous between coil and ground. The galvanometer suspension is contained within an outer tube of plastic instead of metal. They permit recording of dynamic data from high-voltage sources, and must be used in high-voltage magnet banks. The unit is made by Honeywell, Denver Div., 4800 E. Dry Creek Rd., Denver, Colo.

Specs. for equipment that measures radio noise and field strength in the bands covering such uses as TV and FM transmission, radar, marine and amateur communications, and telemetering, have been set by the nation's electronics industry and allied interests. Copies of American Standards Specs. C63.2 and C63.4 are available at $1.60 and $2.30 per copy from ASA, 10 E. 40th St., New York, N. Y.

An ultra-stable voltage reference for unregulated inputs over extended periods of time and wide temp. ranges is provided by the Transreference. A product of Transitron Electronic Corp., Wakefield, Mass., it features a miniature package; 500 hr. certified voltage stability of ±0.005%; temp. coefficients of ±0.0005%/°C; and voltage regulation of 0.002% for a 10% input variation.

A system which monitors the rate of deterioration of the useful life of a jet engine is described in a bulletin entitled. "Automatic Airborne Jet Engine Analyzer." The system also indicates the accumulated time the engine has been subjected to specific temp. levels. Bulletin H150 is available from Howell Instruments, Inc., 3479 W. Vickery Blvd., Ft. Worth, Tex.

A self-contained X-ray system, called the Hotshot, can radiograph diodes, transistors and other small electronic components, as well as thin sections of high-density materials. This versatile unit, by Picker X-Ray Corp., White Plains, N. Y., will be on display at the IEEE Convention at Booth 3054 (Coliseum).

An instrument for measuring the temp. of wire during wire and cable extrusion has been introduced by Addison Electric Co., Inc., of Mountainside, N. J. Type 425 Mark III comprises two spring-loaded measuring rollers, arranged opposite each other. These rollers are pulled apart by a lever at the side of the case to allow insertion of the wire. The direct reading meter is calibrated from 0 to 300°C and 32 to 570°F, and has an accuracy of ±5°C.

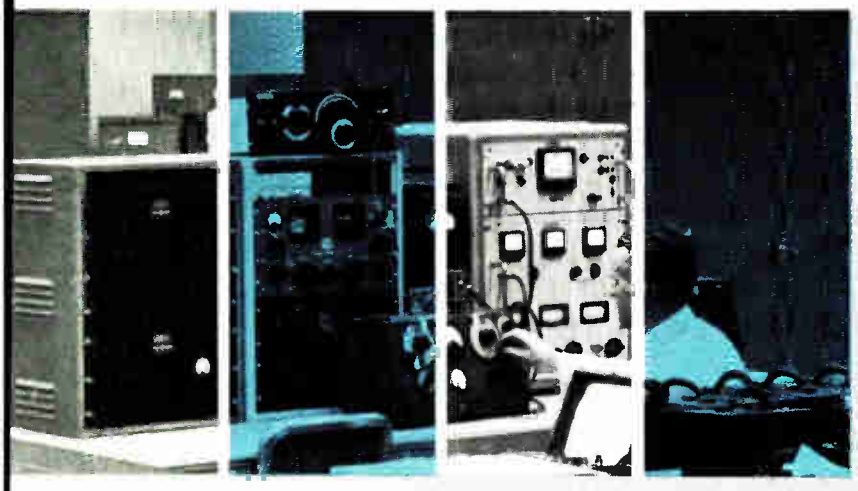
The entire span of today's knowledge of materials and materials testing is reflected in the 1965 Book of ASTM Standards published by the American Society for Testing and Materials, 1916 Race St., Phila., Pa. Issued periodically in 32 parts, the 1965 volume will contain 23,000 pages and about 3700 standards, of which more than 1260 wil be new or revised.

A liquid hydrogen level indicating system, which provides accuracies of ±0.250 in. and introduces no electrical output into the dewar, has just been announced by Cryogenics, Inc., Baileys Crossroads, Va. The system, Model 900 I-2, is a 2-channel fixed-point indicator. It indicates an upper and lower level in the same dewar, or a single point level in two separate dewars.

An electronic newsletter, "Testing Topics," covering the field of component testing, evaluation, inspection and classification is available from Teradyne, Inc., 87 Summer St., Boston, Mass.

FUNCTIONAL TESTING FOR RELAYS

Functional testing of precision relays at Sigma Instruments has been simplified by a two-channel portable recording oscillograph. Supplied by Baldwin-Lima-Hamilton Corp., Waltham, Mass. it investigates possible chatter of ac units and contact bounce on dc relays.



Making Meaningful Measurements

In making measurements, one must consider the environmental conditions which will prevail while the various measurements are being taken. If these conditions will affect the accuracy of the measurement, the engineer must provide a warning in his test procedure to alert the tester of the potential error.

A high shop ambient temperature may adversely affect the accuracy of a measurement. A machine operating near the test position may set up vibrations that will alter a meter reading. To use a meter vertically that was calibrated in a horizontal position, can result in inaccuracy. Transients, and fluctuations in power and frequency of the input sources, can affect accuracy as can the radio interference from neighboring equipment.

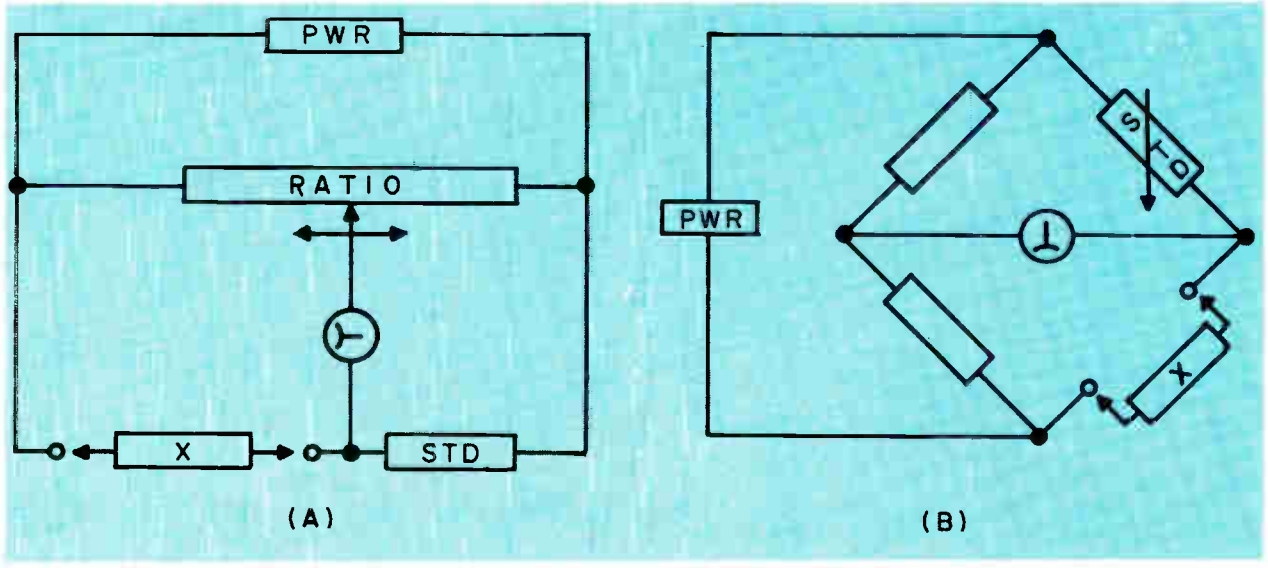
It is important that the test engineer attempt to control only those environmental conditions which will affect significantly the specified accuracy of the measurement being taken. While it is axiomatic that precise measurements must be taken under controlled atmospheric conditions, it is not necessary that all measurements be made in an air-conditioned, humidity controlled laboratory. It should also be recognized that measurements taken in a controlled laboratory atmosphere can still suffer errors due to environmental conditions. For instance, an inspector working in an air-conditioned room could easily nullify the effects of the temperature controlled atmosphere, by holding the part being measured in his hand for a sufficient time to cause it to be heated above ambient by body temperature.

Selection of the Measuring Devices

In the measurement process, selection and proper use of the measuring equipment contributes most significantly to the accuracy of obtained data.

A rule of thumb in the selection of measuring equipment has been that its accuracy be ten times the required accuracy of the part to be measured. Basis for this has been that the error of the measuring device is added to that of the device under test. By employing the 10:1 rule, the effect of the accuracy of the measuring device on the reading would show up in the next significant figure beyond that required by the product specification. Thus, using the rounding off principle discussed in Part I, the significant figure for the measuring device would be

Fig. 3: Calibration Standards.*



Part 2

In Part 1, the authors discussed basic principles of measurement. Here they discuss selection of proper test equipment, use of such equipment and calibration procedures.

By S. SILVERMAN and C. SUNTAG
ITT Federal Laboratories
Nutley, N. J.

dropped away, and would thus not affect the final result.

Today, however, the degree of accuracy required for a product is at times greater than that originally required for the measuring device. The comfortable factor of safety of 10:1 accuracy can thus no longer be economically realized. Consideration must therefore be given to more refined methods of defining the accuracy of the measuring device.

At the other extreme, it is important to recognize the effect of utilizing measuring equipment of a higher degree of accuracy than needed to measure a given product. Besides the economical implications, there is a need to provide interchangeable measurements for the same item by different sources. For instance, a vendor may check his product with a gage of the required degree of accuracy, only to have the product rejected by his customer who utilizes a more precise gage!

By example, a product specification asks for a tolerance 0.105 + 0.001. The gage used should be accurate to the fourth significant figure, 0.0001. Thus, if the part measures 0.1038, it is considered acceptable, even though it is below the lower limit of the spec, 0.104. This is based upon the concept previously described that a measurement at the significant figure beyond the product tolerance should be rounded off to the next significant figure. Thus, rounding off the measurement of 0.1038 would produce a value of 0.104, the lower spec limit and thus cause the acceptance of the product.

When the measuring device is not of the required degree of accuracy, the results may still be of use, provided the actual accuracy of the measuring device is known and compensation is made. Many times, however, the non-availability of proper measuring equipment of the required accuracy results in the product tolerance being "robbed" by the degree of error or of uncertainty of the measuring device; and items are rejected when they may actually lie within the product tolerance. (*Continued on page* 126)

*Figs. 3, 4 and 5 in this part replace Fig. 3 in Part 1.

MEANINGFUL MEASUREMENTS (Continued)

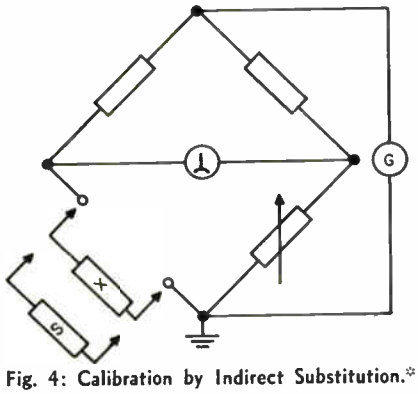


Fig. 4: Calibration by Indirect Substitution.*

Use and Care of Measuring Equipment

To insure that the measuring equipment retains its required accuracy, a systematic and regularly scheduled calibration program should be maintained. This program provides for a recall of all measuring equipment at specified intervals for comparison with standards of measurement traceable to the National Bureau of Standards. This periodic recall also enables proper preventative and corrective maintenance.

It is important to recognize, however, that the calibration of a measuring device does not necessarily insure that it will maintain its accuracy over its entire period of use. The accuracy certified is only that accuracy noted at the time the instrument was calibrated. Environmental conditions, storage effects, handling and use can degrade the calibrated accuracy. It is therefore essential that all who utilize and handle precision test equipment understand and respect the care needed to retain its accuracy. If dropped, overloaded or otherwise treated in a manner that makes its accuracy suspect, it must be returned to the calibration facility for a recertification.

Instrument Calibration

Calibration is a measurement. Thus, the same rules of accuracy apply when calibrating measuring instruments, namely, that the magnitude of uncertainty of the standard value can not affect the accuracy of the calibration. The ten times rule on accuracy of the standard is often impractical because it could exceed the state of the art. Thus, one must resort to the use of statistical techniques of applying the known uncertainty of the standard to the calibration of the measuring instrument in such cases.

An error curve or chart can be prepared for the measuring instrument which will reflect the uncertainty of the calibration technique and instrument error. Then, by applying this error curve to the instrument readings, a known degree of accuracy is

achieved. If the combined uncertainty of the error curve and the inherent instrument accuracy approaches the specification tolerance limit of the required measurement, a referee measurement with a more accurate instrument may be made, or the mean of several measurements can be taken using the same instrument.

A multi-purpose meter, which has one of its functions inoperative, may still be calibrated on the remaining functions. The limited use of the instrument should be explicitly described on a sticker affixed to its face. Often, the published specification can only be attained in a laboratory or under rigid environmental conditions or with highly specialized operator skills. The useful accuracy of such instruments may be downgraded so they can be employed by unskilled or semiskilled personnel.

In research and development, a periodic instrument recall system for purposes of calibration may interfere with engineering work. Often, at the beginning of a research and development program, the engineer is concerned with relative or ball park readings; and, therefore, he is not actually concerned with the absolute accuracy of his measurement. When he has progressed in his work where he begins to take meaningful measurements which will result in establishing limits or specifications, all of his laboratory instruments must be accurately calibrated.

Recall periods based on actual hours of operation are currently gaining favor. This is made possible by the development of relatively inexpensive elapsed time meters. These timers are connected in the power supply circuits to the instruments concerned.

Traceability

The main purpose of calibration is to assure that instruments function correctly, that uniformity of measurements within the company are guaranteed and that agreement is reached among companies related on a common contract as to conformance to specifications. The latter is accomplished when each company relates its calibration program to the National Standards, thus establishing *traceability* to NBS Standards.

Traceability is accomplished through the use of a series of transfer standards maintained in each instrument room, calibration lab, standards lab, and finally the National Laboratory. By comparing the standard of each laboratory with the corresponding standard of the next higher echelon laboratory, which in turn has its standard compared with the National Bureau of Standards standard, the meas-

(*Continued on following page*)

MEANINGFUL MEASUREMENTS (Continued)

urement of the product in any factory can be related in terms of the National Standard.

While there is no indication concerning the relative accuracy of the various order of standards, some degradation is implied in going from the National Standard to the working standards used in the manufacturing organizations. The calibration of standards depends not only on the accuracy of the standard of comparison, but also on the techniques used in making the comparison. Therefore, a standards laboratory must be able to define the limits of accuracy and precision in the specified results.

Each calibration laboratory may decide on the method of test and the standards to be used for each item calibrated. The certification must, however, specify the standard used; and, the measured value must be noted in terms of the National Standard for the quantity measured. The results must also be specified in terms of the limits of accuracy. For example: An item was found to have a value of 1.00024 at 20°C; and, at the time of the test, was correct to within two units in the fifth place.

The National Bureau of Standards does not detail its method of calibration. However, its certification is given in terms of the National Standard, and the limits of uncertainty include the errors accrued in the NBS methods of comparison with these standards.

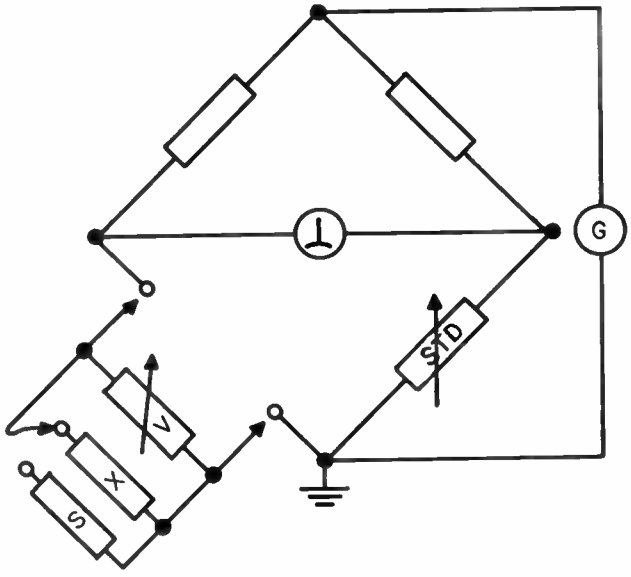


Fig. 5: Calibration by Direct Substitution.*

It must be emphasized that NBS assumes no responsibility to assure the accuracy of a device during use. The fact that an instrument has been calibrated at some time through a chain of events terminating with a NBS Standard does not assure the accuracy of any of the checks in the series, since each check

performed by the lower echelon laboratory or instrument room is associated with it's own lack of precision.

It is, therefore, the responsibility of the organization using the services of the next higher laboratory to assure itself that this service is in fact capable of performing the calibration with the required degree of accuracy and precision.

Where the accuracy requirements are critical, a practice is commonly established whereby a package of instruments or standards are sent to a number of laboratories, and the results evaluated against each other. Several techniques are utilized to rank the laboratories on the basis of these results.

Currently, corporate standards laboratories have developed interlaboratory standards which are used to compare reference standards of one laboratory against those of another, and thus establish compatibility with each other. This practice is also being followed by comparing standards of a vendor with those of its customers.

Calibration Methods

A bridge type instrument is employed in a Standards Laboratory for determining the values of the reference or transfer standards used to calibrate the laboratory equipment. There are two basic types of bridges used as shown in Fig. 3: (A) Where the standard arm is fixed and the ratio arms are adjusted to obtain bridge balance and (B) Where the ratio arms are fixed and the standard arm is varied for bridge balance.

Type A is more accurate and precise than type B, because the standard arm is fixed, and its stability is not disturbed by being adjusted or switched. The resolution or the read-out is determined by the ratio arms. For dc bridges, an accuracy of 0.001% with a resolution better than 1 ppm is obtained. Ac bridges have an accuracy of 0.01% and a resolution of 1 ppm and employ precisely wound ratio transformers.

Type B dc bridges are accurate to 0.01%, and type B ac bridges are accurate to 0.1%. However, greater accuracy can be obtained by substitution calibration methods. An indirect substitution calibration method is shown in Fig. 4. A measurement is made with the unknown connected to the bridge "x" terminals, and the standard arm is adjusted for balance. Then, an external standard is connected to the "x" terminals and the standard arm again adjusted for balance. The accuracy of the external standard is greater than that of the bridge, and the nominal value is the same as that of the unknown being calibrated. Several sets of readings are taken, and from the average of these readings the value of the unknown is calculated. Thus, the accuracy of the bridge reading can be increased by employing appropriate external standards.

(Continued on following page)

MEANINGFUL MEASUREMENTS (Continued)

If the basic resolution is inadequate or greater resolution is required, a direct substitution method can be employed as shown in Fig. 5. A precision variable remains connected across the bridge unknown terminals during the entire measurement procedure. First, the bridge is balanced with the unknown connected to the bridge, and the setting on the precision variable is noted. Then, the high terminal is removed from the unknown and connected to the external standard. The bridge is balanced by adjusting the precision variable. The change in the precision variable reading, applied in the proper direction to the calibrated value of external standard, is the value of the unknown.

Even under the most scrupulous methods employed by a measuring laboratory, some degree of error must be present and reflected in the results. If recognized, and if some quantitative measure of the degree of error is available, the resulting measurements are useful. When the order of error is within the calibration limits, no problem exists in using resulting data. When these limits are exceeded, and the limits of uncertainty are defined, these limits may be applied to the calibration error and be used to the extent specified.

Evaluation of Measurement Results

The prime purpose of a measurement is to provide a number, which when compared with a specified number, will provide the basis for a decision concerning the disposition of the item being measured.

Normally, if the observed value of a measurement lies within a specified tolerance limit, a device is accepted; or, if the observed value is found beyond the specified limit, the device is rejected. Such action is predicated on the assumption that:

- The measuring process has been precisely defined and is performed as defined (the definition may be implied); and
- The accuracy and precision of the measurement process are within the allowable limits of the measuring system.

However, when either one or both of these criteria are not evident, an evaluation of the measurement results must be made before disposition of the device. This evaluation may be performed by one of several methods:

- One method (when the accuracy of the measuring system is known) is to deduct the error of the measuring system from the allowable product tolerance; in short—"rob" the product of it's full manufacturing tolerance.
- A second method is to divide the limit of uncertainty of the measurement process between the supplier and the user; e.g., the user widens the prod-

uct tolerance by one half the measurement error and the supplier narrows the tolerance by a like amount.

- A third method is to evaluate the total cost of the measurement error and assign the risks on an economical basis, such as:

1. Make the risk of rejecting good units equal to the risk of accepting bad units;
2. Make the sum of the user's and supplier's risk a minimum; or
3. Minimize the total cost of making a wrong decision.

- Still another method is to take a series of measurements for a specific product, calculate the mean and error of the mean, then increase the number of samples to reduce the sampling error, thus reducing the range of the limits of uncertainty of the measurement process.
- Finally, the most desirable method is to establish a state of statistical control over the entire measurement process, calculate the control limits and investigate each out of control condition. The results of these investigations and the ensuing corrective measures should serve to eliminate many contributing causes to the lack of precision of the measuring system.

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MICROELECTRONIC AEROSPACE COMPUTER

Production model of Univac 1824 Microelectronic aerospace computer weighs under 46 lbs. and uses only 140w. Rugged, durable and resistant to extreme pressures and temperatures, 1824's thin-film memory consists of 4,096 48-bit words of NDRO, and 512 24-bit words of DRO. It combines thin-film memory with 100% integrated circuitry.

BOOKS

Electron-Stream Interaction with Plasmas

By Richard J. Briggs. Published 1964 by The M.I.T. Press, Cambridge, Mass. 02142. Price $7.50. 187 pages.

This study considers the instabilities that result when an electron beam is injected into a plasma. Many different models of the system are considered, and all instabilities are classified according to whether they are convective (amplifying waves) or nonconvective (absolute). The study also analyzes the instabilities in unbounded beam-plasma systems and in systems of finite extent transverse to the electron stream. It gives a detailed consideration of the possibility of a strong interaction with the ions in a hot-electron plasma.

Understanding Superconductivity — 1964 Lecture on Outstanding Research

By John Bardeen. Published 1964 by the American Society for Testing and Materials (ASTM), 1916 Race St., Phila., Pa. 19103. Price if prepaid: $1.25; to ASTM members: $0.90. 14 pages, paperback.

Dr. Bardeen's lecture, presented during the 1964 ASTM Committee Week, traces origins of some of the major theoretical and experimental advances which have led to the development of a successful microscopic theory of superconductivity and indicates some current problems. He also discusses recent work on flux creep in hard superconductors.

Techniques of Process Control

By Page S. Buckley. Published 1964 by John Wiley & Sons, Inc., Publishers, 605 Third Ave., New York, N. Y. 10016. Price $15.00. 303 pages.

The material in this book is divided into two parts. The first part is concerned with the basic mathematics and theory of process control and with a systematic strategy of "dynamic process control." The second part examines many commonly encountered process control situations. This examination leads to new, recommended practices; it also leads to working equations for complete systems or for subsystems.

Radar System Analysis

By David K. Barton. Published 1964 by Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. Price $16.95. 608 pages.

The author undertakes a systematic examination of the performance of the radar unit and its function as an information gathering component of a larger system. Using simple mathematics, he presents the theory of radar and relates it to the specification and design of practical equipment. Procedures are developed for the analysis and evaluation of existing systems, as well as for the synthesis of new systems intended to meet specific performance requirements.

Investigations into Electrical Discharges in Gases

Edited by B. N. Klyarfel'd. Published 1964 by Pergamon Press Ltd., and distributed by The MacMillan Co., 60 Fifth Ave., New York 11, N. Y. Price $12.00. 283 pages.

This book contains a number of original theoretical and experimental papers by a group of distinguished Russian research workers in the field of electrical discharges in gases. Many experiments are described in detail.

Physical Electronics

By G. F. Alfrey. Published 1964 by D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. Price $8.50. 220 pages.

Book is a unified and logical introduction to the physical principles governing the operation of electronic devices. The treatment is descriptive rather than mathematical. Practical topics such as cathode-ray and kindred tubes, conventional and microwave thermionic tubes, transistors, gas-discharge devices, semiconductors, masers and lasers are included.

Listen to Leaders in Engineering

Edited by Albert Love & James Saxon Childers. Published 1965 by Tupper and Love, Inc., Atlanta, and David McKay Co., Inc., 750 Third Ave., New York, N.Y. 10017. Price $5.95. 338 pages.

Book is comprised of original pieces by some outstanding men in engineering, writing on the aspect of his profession that he knows best. Each contributor has written, in non-technical language, on the excitement and challenge of his field.

Books Received

Electronic Precision Measurement Techniques and Experiments

By members of the Staff of Philco Technological Center. Published 1964 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 07632. Price $13.00. 336 pages.

Physics of III-V Compounds

By Prof. Dr. Otfried Madelung and translated by Dr. Dietrich Meyerhofer. Published 1964 John Wiley & Sons, Inc., Publishers, 605 Third Ave., New York, N. Y. 10016. Price $13.00. 409 pages.

Traveling Waves on Transmission Systems, 2nd Ed.

By L. V. Bewley. Published 1964 by Dover Publications, Inc., 180 Varick St., New York 14, N. Y. Price $3.00. 543 pages, paperback.

Transistor Circuits in Electronics

By S. S. Hakim & R. Barrett. Published 1964 by New York Hayden Book Co., Inc., a division of Hayden Publishing Co., Inc., 850 Third Ave., New York, N. Y. Price $10.95. 341 pages.

Electromagnetism for Engineers

By P. Hammond. Published 1964 by The Macmillan Co., 60 Fifth Ave., New York 11, N. Y. Price $5.00. 209 pages.

Optoelectronic Devices and Circuits

By Samuel Weber. Published 1964 by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 10036. Price $15.00. 360 pages.

PERT Cost—A Programmed Instruction Manual

By Stuart M. Rothfeld. Published 1964 by Federal Electric Corp., Industrial Park, Paramus, N. J. Price $6.50. 171 pages.

Training Sales Engineers

By E. Patrick McGuire. Published 1964 by Padric Publishing Co., Mountainside, N. J. Price $9.50. 227 pages.

EDITOR'S NOTEBOOK

ELECTRON BEAM fluctuations are being studied by University of Colorado researchers led by Dr. John C. Twombly. Effort is to understand dynamic behavior caused by electric field inherent in moving electron beams. When dense beam of electrons is sent down a tube some electronics are stopped or are pushed back. This generates "noisiness" in the beam, as well as coherent, and useful, oscillations. Research is aimed at reducing the noisiness.

PUSH-BUTTON WHISKY STILL is attracting thousands to see the modern marvel of electronic engineering displayed in Chatsworth, Ga., Courthouse. The still, which only an engineer could have put together, is capable of producing 1,000 gallons of joy juice within 24 hours. Cost of the still is estimated at about $12,000.

VOICE SYSTEM offering wide variety of services has ben installed at Philadelphia Electric's new atomic power station at Peach Bottom, Pa., by a subsidiary of General Telephone & Electronics Corp. The speaker can produce the most powerful voice sounds to be heard five miles up the Susquehanna River. Facilities also include special intercom. An employee, using a telephone handset, can broadcast his voice all over the installation, inside and out.

SOUND WAVES underwater are used by sharks to "home" in on a suspected food source, according to evidence gathered by airborne University of Miami scientists. It seems a struggling fish or threshing swimmer generates a low frequency "dinner bell." Sharks can hear up to 400CPS more than 200 yards away, far beyond visual range. Sharks appear when low frequency pulsed or threshing sounds are made, but not for low frequency continuous waves nor for high frequency pulsed waves.

COMPUTER at Purdue University is learning to read handwriting and handprinting ranging in legibility from grade school to the fast scribbles of professors. We are closer to the day, according to Purdue engineers, when computers can tackle income tax returns, bank checks, and weather maps —without supervision. The computer is operated on a sequential decision procedure not previously used.

HERE'S A SHOCKER—Host Steve Allen on "I've Got A Secret" challenged the panel to guess the names of contestants. (Names still mean something despite computer code numbers.) After a battery of electrifying questions, panelist Bill Cullen made the only correct identifications—Tontogany, Ohio, father and son team of electricians named D. C. Current and A. C. Current.

THE 9" BAZOOKA SHELL lobbed at the U. N. building in New York didn't quite make it, you may remember, but the time trigger, connected with Mueller clips, worked very well. Mueller Electric Co. wants it a matter of record that their clips did not fail. Their comment: "Ah well, another testimonial we may never get."

COMMUNITY EDP is one of the newest things in banking circles. The First National of St. Louis, Mo., last month joined with two savings and loan associations in nearby Illinois towns, tieing in operations with First National's computer. Using two-way lines, passbooks and accounts posted at the S&L offices will be instantly updated in St. Louis.

NO IMAGINATION IN AUTO ELECTRONICS, SAYS EDUCATOR

The automotive industry is "approaching a new frontier of its own faster than most of the men setting its autopilot responses have yet realized," in the opinion of William G. Dow, professor of electrical engineering, University of Michigan.

He predicted that control-system technology will dominate, as circuit theory has for the past two generations. But in the next car he buys, Professor Dow said, the most he could hope for was some kind of semi-automatic speed control. He reported being discouraged by the lack of imagination displayed in ignition wiring.

A far simpler system, "based on solid-state switching, possibly in other ways totally unlike the present . . . could not only exist now, but at a lower cost, provided," Professor Dow emphasized, "that adequate development effort were invested."

"But I see no immediate prospect of such investment being made, except perhaps by the foreign investor."

IT KNOWS SIX FROM SEX

The girl addresses a SCEPTRON™ pattern recognizer made by Sperry Gyroscope Company. The tiny device is programmed to recognize the word "six" from all similar words such as "sex" or "sick." Pattern recognizers can be linked together to produce devices that will act upon complex commands.

INTENSIFIER TUBE TRIPLES TELESCOPE BRIGHTNESS

Electronic image intensifier tubes have been added to photographic telescopes to triple brightness of astronomical images, according to a joint announcement from Carnegie Institute and RCA.

Dr. Merle Tuve, director of Carnegie's Department of Terrestrial Magnetism, reports that an intensifier tube enables a 60-inch reflector telescope to photograph faint star images or objects now only possible with a 180-inch instrument. The tube is efficient also in the infrared region where photo emulsions are somewhat insensitive.

The tube (RCA - C33011) weighs four pounds, and is three inches wide by five inches long. It uses magnetic focusing and consists of two stages coupled by an intensifying screen.

FREE YEAR SERVICE OFFERED WITH ADMIRAL COLOR TV

The Chicago division of Admiral Corporation announced that all 1965 Admiral color television receivers will be sold in the Chicago area with a one year parts and labor warranty at no additional cost, effective immediately.

Prices for Admiral 21-inch color TV will include set-up and delivery in the customer's home, hook-up to an existing antenna, and complete service for 12 months, including replacement or repair of defective parts and tubes.

The unconditional service and parts guarantee is believed to be the only one of its kind in the industry.

INTERNATIONAL NEWS

London—Low-cost digital voltmeter by International Electronics, Ltd. uses analog-to-digital conversion to eliminate a large number of close tolerance components.

Portsmouth—Sealectro Corp., maker of automatic control devices and systems, disclosed that its new 23,000-sq. ft. factory in Portsmouth will open in April, 1965.

Berne—A sales office has been set up at Montreux, Switzerland, by Benrus Technical Products as a base for expansion of its electronic products program in Europe.

Paris—First direct customer-to-customer dialing service from France to subscribers in England and Germany has begun. Service was made possible by the cutover of a Pentaconta automatic telephone exchange installed by Le Material Telephonique.

Munich—New headquarters for distribution of Siemens Components throughout the U.S. has been set up at 230 Ferris Ave., White Plains, N. Y., according to Siemens and Halske AG, Munich.

British Columbia—First educational TV system in B.C. public schools is being used in North Kamloops to teach 8th and 9th grades. The system, installed by British Columbia Telephone Co., subsidiary of GT&E Corp., links 18 classrooms to mobile equipment.

Sao Paulo—With the rapidly expanding television receiver manufacturing industry in Brazil, Sylvania Produtos Eletricos Ltda., a GT&E International subsidiary, is expected to provide about 50% of the industry's picture tubes this year.

Sydney — Modern aircraft telecommunications, electronic products and industrial hydraulics were range of products displayed at the Plessey Overseas Ltd. stand at the British Exhibition in Sydney. Items included an electronic mail sorter, solar-powered alarm system, new 'crossbar' automatic telephone exchange and record players.

Tokyo—Yuasa Battery Co., largest producer of batteries and rectifiers in Japan, has developed experimental fuel cells with 150 ampere-hour capacity—one step closer to practical application of fuel cells for submarines and other uses.

Milan — ITT Corp. has announced that Face Standard, an Italian subsidiary, has been named to receive a special award for its outstanding contribution to the industrial development of southern Italy. The firm's plant at Maddaloni makes telephones for Italian and foreign markets.

Liverpool—Visitors to Liverpool Airport can now see arrival and departure data displayed on closed-circuit TV at several points in lounges and restaurants. System was installed by Standard Telephones and Cables Ltd. and EMI Electronics Ltd.

Munich—Electronica—the first international trade fair for electronic components held in Germany has been declared a success. Plans for a similar event in 1966 are underway.

Turin—More than 100 American firms have presented $600,000 in new machinery, tools, and instruments, including electronic equipment, to the UN-sponsored International Center For Advanced Technical and Vocational Training facility in Turin, Italy, through Tools For Freedom.

Amsterdam—Royal Verkade Co. currently praises British automatic control system in operation at its bakery at Zaandam. Advantages of EMI Electronics Ltd. system credited by Verkade are accelerated and simplified handling of raw materials, uniform and constant quality, improved hygiene, less waste, larger output.

Pretoria—English Electric Leo Marconi will install a LEO III computer system for Consolidated Glass Works Ltd., of nearby Wadeville, Germiston. The system, for delivery at 1965 end, will control commercial and production aspects of South Africa's largest glass producer.

London—A process control simulator designed to teach control engineers has been developed by Feedback Ltd., Crowborough, Sussex, to serve as an electrical analog of a process and its controller. Used for process control demonstrations and quantitative experiments, advantages include less teaching time and elimination of hazard to processes.

Buenos Aires—IGE Export Division of GE will supply TV studio equipment to Rio de la Plata TV Channel 13 and Producciones Argentinas de Televisione, S.A. (PROARTEL). Seven cameras with 4½-inch image-orthicons will equip three new studios completed in Buenos Aires by Channel 13, one of four channels operating in the city.

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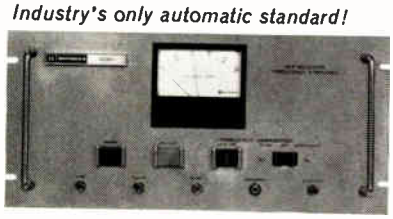

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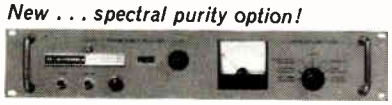
3 *New . . . spectral purity option!*



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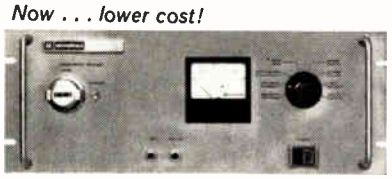
4 *Now . . . lower cost!*



Motorola S1065AR Frequency Standard—1×10^{-11} Setability • Less than 5×10^{-11} Aging Per Day and 1 Second Short Term Stability • Proportional double oven construction • Pre-aged 2.5 mc 5th overtone crystals • Digital reading linear fine frequency adjust • Solid State silicon design • Model S1065AR $3,450 including power supply, rack mounting and 15 hour battery • Spectrally pure 5 mc output $250.00.

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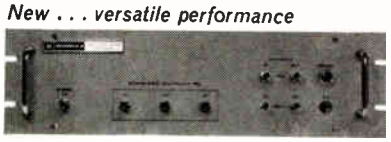

Motorola S1061BR Frequency Error Expander—This frequency comparator allows high resolution, accurate frequency comparisons to be made quickly on a digital counter directly in parts in 10^9 in 1 second, parts in 10^{10} in 10 seconds, parts in 10^{11} in 100 seconds. Accepts 100, 250, 500 kc and 1, 2, 3, 4, 5 mc Test Inputs. Model S1061BR $1,495.

6 Standard 1 mc Electronic Digital Counter

7 Standard 1 ma Strip Chart Recorder.

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ELECTRONIC INDUSTRIES

PROFESSIONAL GUIDELINES

Reporting late developments affecting the employment picture in the Electronic Industries

EXECUTIVE DEMAND IS HIGH, BUT RATE OF GAIN SLOWS

Nationwide demand for executives in three months ending December, 1964 rose to a record level, but the rate of gain slowed somewhat.

EXECUTREND, management survey by Heidrick and Struggles, a national executive recruiting firm in Chicago, reports that the national demand rose 8% from the third quarter, reaching a monthly peak at the end of the year. The third quarter had shown an increase of 19% over the second quarter.

Engineering and science continued to represent the greatest number of executive opportunities, accounting for more than half of the total demand. This great demand comes from current emphasis on research and development—and automation, according to partner John Struggles.

He makes these observations: the demand for good top management people exceeds the supply; business/profit pressure camplexities are rising and executives are moving more quickly to make needed replacements; salaries are advancing.

TAX BREAK SUGGESTED TO SPARK CONSUMER R&D

Research and development aimed toward more consumer products is the objective of a proposal offered by Vice President Hubert H. Humphrey. In the proposal, which the Administration is reportedly studying, firms taking on new R&D directed at consumer goods would be given substantial tax breaks.

The proposal, still in early stages, would allow businesses to deduct about 75% of research expenses directly from taxes due, provided costs represent "new" R&D, and not merely that which the firm had previously kept going at its own expense.

Prompting the plan is concern that: too many research engineers and scientists have been removed from the consumer product field; and heavy Federal activity in space research is not producing sufficient "spin-off" consumer goods.

FLIGHT COMPUTER

Donald C. Colbert (left) manager of space instrumentation, Electronic Communications, Inc., explains flight control computer for Saturn 1B to Astronaut David R. Scott, Air Force captain now in manned space training. Computer is one of a series ECI is supplying NASA for the Saturn program. The computer features triple redundancy.

TRY OUT MANAGEMENT ROLE, YOUNG ENGINEERS ADVISED

How can a young engineer decide whether to work toward becoming an executive or remain in research full-time? "Try it and see," advises L. J. Weigle, Corporate Secretary of Humble Oil and Refining Co.

"Fortunately," he said, "there is often an opportunity for an engineer to see and get the feel for management before he gets too far into a commitment. He gets leadership roles, he accepts responsibility for directing functional groups. During the first two to ten years of his career he will be faced with the choice, while it's not too late to make it."

Mr. Weigle suggested some qualifications the man starting his technical career might search for in himself. He might look for his ability to envision and attain realistic goals, as well as his willingness to accept responsibility. He might try to find out whether he has mature judgement with intelligence, and an interest in working through problems with people.

1964 DEMAND FOR ENGINEERS WAS LOWEST IN 4 YEARS

Demand for engineers and scientists during 1964 was the lowest so far registered by the Deutsch & Shea Engineer/Scientist Demand Index.

The 1964 average of 76.7 is 21 points below 1963's 97.7 average. The 1962 average was 127.1; 1961, the baseyear for the Index, was 100.0. The high for 1964 was 91.8 in November; the low was 68.9 in July.

Contributing to the low average for 1964 was a substantial drop in recruitment during December. The Index registered 69.3, a downward change of 22.5, ending a three-month rise. This December drop is regarded as primarily seasonal. The figure is above that of the same month in 1963.

MICHIGAN OFFERS COURSES TO UP-DATE ENGINEERS

University of Michigan at Ann Arbor is again offering a series of non-credit courses at its college of engineering designed for practicing engineers and scientists in rapidly developing technology.

Among the one-week courses, which begin on May 10, and extend end to end through July 23, are lasers, semiconductors, circuitry, infrared, precision radiometry, and communications theory.

For complete data write to: Engineering Summer Conferences, West Engineering Building, University of Michigan, Ann Arbor, Mich.

CALIFORNIA EDP CENTER SLATED FOR HIGH SCHOOLS

Plans for a data processing center to enable high school and junior college students to learn how to operate a computer were disclosed by the California department of public instruction.

The center, believed to be the first of its kind in any U.S. public school system, is expected to be operable in the Sacramento County office of education by mid-1965. Plans are also being made for up to ten such regional centers to be in operation in the next five to ten years.

'LEARN TO COMMUNICATE', TECHNICAL MEN URGED

A technical writing manager for Honeywell Inc., James M. Lufkin, has made a plea for scientists and engineers to learn how to communicate with laymen.

Mr. Lufkin attributed failure of scientists and literary men to communicate chiefly to deficiencies in the educational system. He asserted that we allow the gifted students in high school to drift through in a "convoy" system, proceeding at the speed of the slowest.

A second deficiency, according to Mr. Lufkin, is specialization too early, which leaves any professional man ignorant of the other sciences and of the humanities and social sciences. This leaves him unprepared and unable to communicate well within his own profession.

A student brilliant in mathematics is also capable of the abstractions of chemistry, of physics, of languages and the arts, Mr. Lufkin said. Yet, campuses are swarming with students who strongly believe they have a special talent for one subject and for no others.

He claims the ideal arrangement is a "combination of major sequence and the broadest possible liberal or general educations. We are drifting farther away from even the pretense that the B.A. or the B.S. in this country represents a standard, more or less liberal education."

SMALL FIRM CONTRACTS RISE, GENERAL R&D WORK DECLINES

Department of Defense reports that the percentage of prime contracts to small manufacturers rose from 16.5% to 18% in the two-year period ended July. The trend, though encouraging, however, was diluted somewhat by another study showing that research and experimental work declined during the same period.

In addition, the total of new prime contracts for missiles fell by $1.1 billion, and contracts for other military hard goods were down by $267 million. Air Force procurement alone for research dropped from $548 million to $114 million.

Air Force spending for development, test and experimental work, including research, dropped from $3.8 billion to $3.3 billion. Navy share dropped from contract awards. Such attempt would demand continuous efforts for a long time with a high failure risk.

ELECTRONIC INDUSTRIES Electronic Engineering Profile—1965

Here's your chance to help the editors of ELECTRONIC INDUSTRIES develop important information about you, and about our industry. Won't you please read, fill out, and return this questionnaire to us at your earliest convenience?

We are gathering this information in order to update our present Electronic Engineering Profile records. You are not required to sign your name or identify your company. However, if you so desire, we will be glad to send you a copy of our 1965 Electromagnetic Spectrum Chart in appreciation of your cooperation and assistance.

Previous profile surveys were conducted in 1959 and in 1962. The questions being asked at this time are designed to reflect the effects of occupational changes that have taken place in our industry over the past two years. We are particularly interested in your present day attitude and future outlook on such topics as technological obsolescence, continuing education, commercial-industrial interests, etc.

We would like to have all readers participate in this year's Electronic Engineering Profile Study!

If you pass your copy of ELECTRONIC INDUSTRIES on to other readers, won't you please leave a note in this issue telling them that additional copies of the questionnaire may be obtained by sending us a postcard or a letter requesting "Electronic Engineering Profile-1965." Our address is:

ELECTRONIC INDUSTRIES, Chestnut & 56th Streets
Philadelphia, Pa. 19139

Tear along this line.

1. Which of these is your ultimate goal?

	(CHECK ONE)
Design Engineering	1
Supervisory Engineering	2
Engineering Research	3
Sales Engineering	4
Corporate Management	5
Other (specify)	6

2. If you had to decide your career all over again what would you do? Would you:

	(CHECK ONE)
Consider study in a different field?	1
Study engineering in a different field?	2
Study engineering and management?	3
Follow the same field of study?	4

3. If Applicable: What would you do differently? Give an example if possible.

4. If a high school student came to you for advice about his career, would you recommend electrical engineering? (Check one)

Yes	1
No	2

4a. (If not) Why not?

5. In which of these areas do you feel that you would have liked to have additional education or training?

	(CHECK) YES	NO
Social Studies	1	2
English	1	2
Mathematics	1	2
Business Administration	1	2
Marketing	1	2
Other – What:	1	2

6. How secure do you feel in your present job?

	(CHECK)
Very secure	1
Secure	2
Not secure at all	3

7. What future prospects do you see in your present job?

8. Place a check below in the first column opposite the area in which you are now working, and another check in the second column to indicate the area you would like to change to.

	(CHECK) Area In Now	Want To Change To
Defense Electronics	1	1
Aerospace Electronics	2	2
Consumer Electronics	3	3
Industrial Electronics	4	4
Other – What?		

9. When is your anticipated next promotion?

	(CHECK)
Within 3 months	1
Within 6 months	2
Within 1 year	3
Don't Know	4

10. Suppose you were to consider a new job with another company, how would you rank the following aspects of employment?

	RANK FROM 1 TO 6
Year-round recreational facilities	1
Freedom to work with less tape	2
Opportunities for further education	3
Added fringe benefits	4
Security	5
Geographical location	6

11. As the situation stands now, would you say that:

	(CHECK ONE)
You are satisfied with your job?	1
You have already looked for a new job?	2
You are just now looking for a new job?	3
You are just thinking about looking for a new job?	4

"PROFILE OF TODAY'S ELECTRONIC ENGINEER—1965"

12. (If Applicable:) What are the main reasons why you are thinking about or looking for a new job?

13. Have you ever considered working as a technical civil service employee for a Federal Government agency in an administrative, engineering or other capacity?

	(CHECK ONE)
Yes, administrative capacity	1
Yes, engineering capacity	2
Yes, other capacity What?	3
No	4

14. Which of the following sources do you use most often to keep up to date technically?

Read trade magazines?	1
Read professional journals?	2
Attend technical meetings?	3
Attend conventions and exhibits?	4
Read books?	5
Other – What? _____	

15. Place a check in the box which indicates how interested you are in:

	Very Int.	Int.	Mildly Int.	Not Int.
Business/Industry?	1	2	3	4
Engineer Personnel?	1	2	3	4
Book Reviews?	1	2	3	4
International News?	1	2	3	4
Stock Market?	1	2	3	4
Political News?	1	2	3	4
Technical News?	1	2	3	4

16. To enable magazines to help you as a continuing means of adult education, how would you rank the following typical editorial features in order of preference?

	RANK FROM 1 TO 7
Feature design articles	1
State of the art reports	2
Management articles	3
Marketing articles	4
How-to-design articles	5
Staff studies on specific subjects	6
Others – What?	7

17. How important would you say technical magazines are in your job?

	(CHECK)
A must	1
Very important	2
Useful	3
Marginal	4
Little value	5

18. In time of professional and vocational need, to what groups or organizations do you believe the engineer may turn?

19. Following is a list of statements about different feelings engineers may have about themselves or their jobs. Based on your first impressions, just check the box corresponding to how strongly you agree or disagree with each statement.

	STRONGLY AGREE	MILDLY AGREE	NEITHER AGREE OR DISAGREE	MILDLY DISAGREE	STRONGLY DISAGREE
Electrical engineers have actually achieved a very small degree of professionalism.	1	2	3	4	5
In my present job, I consider myself to be a professional part of labor.	1	2	3	4	5
In my present job, I consider myself to be a part of management.	1	2	3	4	5
Engineers should not belong to unions.	1	2	3	4	5
In most cases, engineers are being exploited.	1	2	3	4	5
A lot of the work engineers do can actually be done by technicians.	1	2	3	4	5
Much of an engineer's work is actually sub-professional work.	1	2	3	4	5
Working overtime without pay is part of an engineer's job.	1	2	3	4	5
Most engineers have a non-professional attitude.	1	2	3	4	5

20. Now just a few questions about you, your background and interests: First of all . . . . How old are you?

	(CHECK)
Under 25	1
25 – 29	2
30 – 34	3
35 – 39	4
40 – 44	5
45 – 49	6
50 – 54	7
55 or over	8

21. How many different companies have you worked for since you started your career in engineering?

# OF COMPANIES	

22. We are interested in your job functions, past and present. Please do the following:

-- In column 1, check off all functions you have ever done since you started your career.

-- In column 2, check off all functions you now do.

-- In column 3, check off the one function you consider to be your primary function.

Job Functions	Col. 1 All Functions	Col. 2 Current Functions	Col. 3 Primary Functions
Corporate Management	1	1	1
Operating or Production Management	2	2	2
Technical or Engineering Management	3	3	3
Design Engineering: Equipment Design	4	4	4
Design Engineering: Systems Design	5	5	5
Design Engineering: Components Design	6	6	6
Research and Development Engineering	7	7	7
Reliability & Quality Control Engineering	8	8	8
Mechanical & Electromechanical Engineering	9	9	9
Value and Evaluation Engineering	0	0	0
Standard and Test Engineering	1	1	1
Application Engineering	2	2	2
Production Engineering	3	3	3
Sales and Advertising	4	4	4
Purchasing	5	5	5
Other (PLEASE SPECIFY BELOW)			

"PROFILE OF TODAY'S ELECTRONIC ENGINEER—1965"

23. Which group represents your total annual salary before taxes?

	(CHECK ONE)
Under $ 6,000	1
6,000 – 7,449	2
7,500 – 9,999	3
10,000 – 12,449	4
12,500 – 14,999	5
15,000 – 17,999	6
18,000 and over	

24. How many persons are there in your household including yourself?

Number: ____

25. What is the highest level of education you have attained thus far and year completed?

	(CHECK)	YEAR COMPLETED
Some college	1	
College degree	2	
Degree plus graduate work	3	
Master's Degree	4	
Doctorate	5	
Other – What? ____		

26. Please list courses of study in which you obtained degrees.

DEGREE	STUDY

27. Since your last degree have you pursued studies in any subject to further your education?

	(CHECK)
Yes	1
No	2

28. (If applicable:) What subjects or courses and at what college or university? (List below)

NAME OF COURSE OF STUDY	COLLEGE

29. Have you ever taught school, contemplated teaching or do you actually plan to teach?

	(CHECK)
Taught school	1
Contemplated	2
Plan to teach	3
None of above	4

30. Please check any of the following activities in which you participate?

	CHECK AS MANY AS APPLY
Civic Organizations	1
Social Welfare	2
Veteran's Organizations	3
Church groups	4
Fraternal and Service Organizations	5
Country Clubs	6
Other Sports Clubs	7
Professional Business Associations	8
Other Organizations	
What? ____	

31. Do you hold any outside remunerative jobs after hours?

	(CHECK)
Yes	1
No	2

32. (If applicable:) Is this job in the electronic field or is it outside of the electronic field?

	(CHECK)
Electronic Field	1
Outside of electronic field	2
Specify ____	

33. Which of the following are included in your retirement plans from an electronic field?

	CHECK AS MANY AS APPLY
Pension Plan – Company	1
Pension Plan – Personal	2
Profit Sharing	3
Own Business	4
Own Stocks	5
Mutual Funds	6
Other – What? ____	

34. Do you own stock?

	(CHECK)
Yes	1
No	2

35. Do you own stock in your own company?

	(CHECK)
Yes	1
No	2

36. In what state do you work?

____

37. Please add any additional comments or opinions here.

WHAT'S NEW

PROBE AIDS CRYOSURGERY

CRYOSURGERY IS A METHOD BY WHICH DISEASED TISSUE is selectively destroyed by touching them with an instrument using extreme cold. One of the greatest prob-

Contactless controlling pyrometer holds sub-zero temp. to ±0.5°C.

lems in this technique, however, is maintaining the low temperatures within certain tolerances. Any great deviation in temperature will cause uncontrollable damage to tissues touched.

One of the newest instruments available in cryosurgery is a probe which is used to perform surgery on the inner ear. The probe was developed at Presbyterian Hospital in Phila., and is cooled by liquid nitrogen flowing through a copper tube from a 150-cc reservoir within the probe. If heat were not controlled, the tip temperature would fluctuate between −190° and −150°C, well within the danger range of destroying tissue.

In the probe, temperature is held within ±0.5°C by a sensitive proportioning control connected to a special coaxial thermocouple at the surgical tip. The thermocouple consists of a short length of 3-mil copper wire spot welded to the tip of a constatan sheath. The thermocouple is then soldered to the tip of the probe.

The temperature controller, a standard model furnished by API Instruments Co., Chesterland, Ohio, includes a contactless (optical) controlling pyrometer (Model 502-L) with a circuit module (No. 915 A) whose pulses fire two SCRs. The SCRs, in turn, control power to a 5Ω heater winding of 5-mil constantan wire, which is bonded to the nitrogen conduction tube. Set points may be knob-adjusted anywhere on the scale of the pyrometer, which is calibrated from −130°C

(Continued on following page)

CRYOSURGERY (Continued)

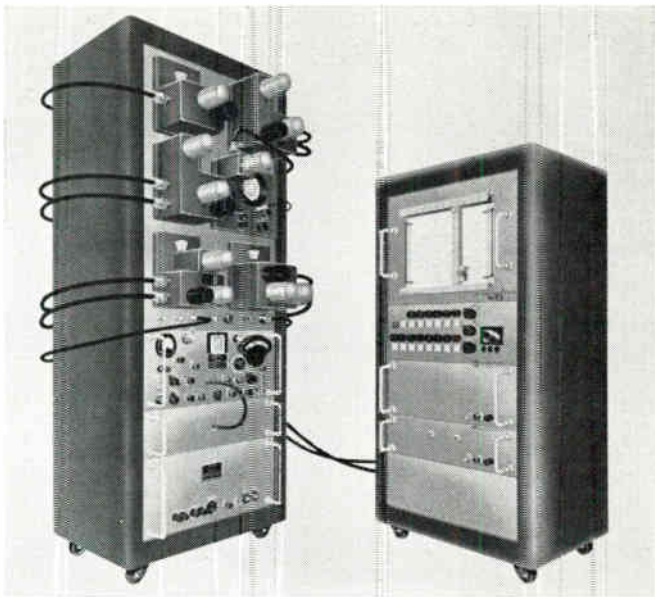
to +40°C. The control detects the small signal from the thermocouple and indicates it at all times, without amplification, on the pyrometer face.

The tip temperature is maintained by varying the power from the two SCRs in proportion to the error signal sensed by the thermocouple. The SCR driver in the control module adjusts the electrical firing angle of the SCRs. The earlier the SCRs fire, the longer power is furnished to the heater. In turn, the SCR driver pulses more quickly as the resistance decreases in a photoconductive cell in the meter-relay. This resistance changes as a vane, attached to the signal pointer in the meter-relay, alters the amount of light reaching the cell.

MULTI-USE CONSOLE WELDER

MICROSOLDERING, MICROWELDING, AND DIFFUSION BONDING are easily performed by the Model 700 Polytronic Welder. The system, a product of the Weltek Division of Wells Electronics, Inc., South Bend, Ind., consists of a miniature ac power supply, an all purpose weld head, a micro-positioner, binocular swing away Stereozoom optics, light source, and accessories.

The power supply may be cycled continuously and at very fast rates since it does not depend on capacitors



Versatile unit performs 5 different kinds of miniature welding.

or batteries. Energy pulses are controllable down to 1 msec and up to 800 msec. Both constant current and constant voltage sources are available, along with automatic resistance feedback controls.

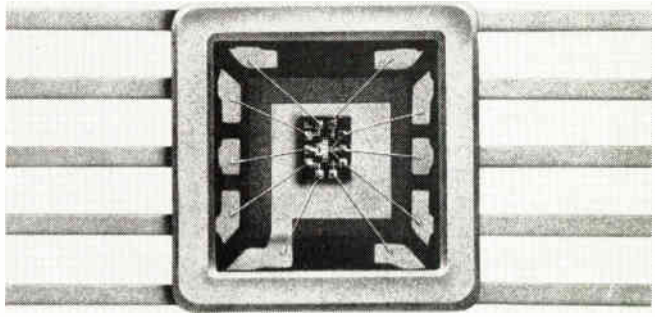
The all purpose weld head can be set up to do 5 different kinds of miniature welding plus micro-soldering and diffusion bonding. The force range is 3 oz. to 20 lbs. The micro-positioner is accurate to ±0.0005, and the optics permit a magnification of 7X to 30X.

INTEGRATED INPUT GATE

ANY GATING CIRCUIT WILL PRODUCE HIGH SPEEDS if enough power is provided. This microelectronic dual-3 input gate, known as MW/3, features high speeds but with low input power.

A product of Philco Corp., Lansdale, Pa., the RTL type unit has a typical propagation delay of 13 nsec./gate. With a 3 mw dissipation, its speed-power product is 39. The MW/3 comes in a flat package with two gates to the package. It has a fanout of 5 and operates over the temperature range of −55° to 125°C.

High speed and low power consumption are features of this gate.



TINY CB RADIO

All-transistor two-way radio is only half the size of tube models. Can be installed in glove compartments of most autos. Raytheon RAY-TEL TWR-5 offers choice of 11 citizens band channels for home, office, service stations, motels, etc. Uses 14 transistors and 5 diodes.

DR. BERNARD OLIVER ELECTED PRESIDENT OF IEEE

Dr. Bernard Oliver, Vice President of Research and Development, Hewlett-Packard Co., has been elected President of the Institute of Electrical and Electronic Engineers for 1965, it was announced by the IEEE board.

Dr. Oliver succeeds Clarence H. Linder, retired General Electric Vice President, who was IEEE President for 1964. Dr. Oliver will head the world's largest engineering society, which now has an international membership of more than 155,000 engineers and scientists.

IEEE Vice Presidents for 1965 will be Dr. W. G. Shepherd, Professor and Director of the Electrical Engineering Department of the University of Minnesota, and Hendley Blackmon, Engineering Manager, Association Activities, Westinghouse Electric Corp.

SONAR PROFILER MAKES FAST DEPTH READINGS

A new sonar device for "fast, accurate and permanent measure of river channels and ocean bottoms" has been developed by the Seattle Development Laboratory of Honeywell, Inc.

The sonar set is a portable range-measuring and recording system, and is designed for survey and dredging operations in shallow water. It can operate at depths of 10 to 480 feet, and can plot a complete profile in ten seconds, reports Honeywell.

Vessels carrying the profiler aren't required to traverse the survey area repeatedly. The device has a horizontal range of 480 feet from the underwater sonar transducer fastened to the vessel.

IDLE PHONE TIME MAY BE USED TO SEND DATA

Recognizing that one pair of wires of a 4-wire telephone channel are unused half of the time during a phone message, scientists at a British subsidiary of International Telephone and Telegraph Corp. in London propose to use them for transmitting data during idle intervals.

Measurements made at ITT's Standard Telecommunication Laboratories indicated that one or the other of the two pairs making up a 4-wire circuit are idle for 65% of the time of a conversation. They have developed a system that uses this idle time for data transmission up to the full modulation rate of the channel.

Speech is delayed by a magnetic drum with spaced record and replay heads to obtain advance knowledge of the presence of pauses. When a pause exceeds 100 to 200 milliseconds, a control unit switches the circuit to data. On resuming speech, the control unit reverts the circuit.

A major problem overcome was prevention of speech loss during switchover. ITT scientists say the system allows better than 95% use of circuit time.

LICENSE PROGRAM OFFERED TO PRINTED CIRCUIT FIRMS

The G. T. Schjeldahl Company, Northfield, Minn., has initiated a selective licensing program for their new roll-to-roll system for processing and production of flexible circuitry.

The licensing arrangement will cover the processing equipment as well as rights to Schjeldahl's technical aid and its processing techniques.

OOPS! WE GOOFED

Last month, on page 98, we discussed a new, truly portable laboratory accuracy dual-trace oscilloscope. But we called it by the wrong number. The correct description is Tektronix Type 422. Sorry for any confusion we may have caused.

PROCEEDINGS OF THE ISSCC

Proceedings of the International Solid State Circuits Conference, held in Philadelphia February 17-19, may be obtained by writing Mr. Harry G. Sparks, Moore School of Electrical Engineering, 200 S. 33rd St., Philadelphia, Pa. 19104. Cost is $6.00. Make check payable to the Solid State Circuits Conference.

MULTI-USE TV CAMERA

New TV camera, made exclusively with silicon transistors by Diamond Electronics, a unit of Babcock & Wilcox can now make practical use of closed-circuit TV in many regular applications, and also in many potentially hazardous operations. Picture degradation will not exceed 10% with voltage changes as high as 30v. and temperature variations as high as 100°F. Camera, less lens and vidicon, costs less than $1,000 and weighs only 12 lb.

3-D INTERFEROMETER RADAR SMALLER, WEIGHS LESS

A new light-weight 3-D radar has been disclosed by Radio Corporation of America.

Developed at RCA's Missile and Surface Radar Division, Moorestown, N. J., the device is much smaller and lighter than current systems, according to Louis Swartz, project manager.

He said that use of the interferometer principle can produce helicopter-transportable 3-D radars of less than 6,000 lbs. Current systems weigh as much as 40,000 lbs. The interferometer radar, using an antenna of only 350 lbs., has an elevation accuracy of plus or minus 1,000 feet at 100 miles.

Mr. Swartz said the interferometer principle is basically the interaction in space between beams emitted from a pair of elements in the antenna. The radar sends out a "giant hand" with many fingers in a vertical plane. When an aircraft crosses one of the fingers, the position and elevation of the craft is known instantly.

NEW SYLVANIA MIXER DIODE INCREASES RADAR RANGE

Sylvania's new microwave mixer diodes increase the range of radar and other communication equipment by approximately 5%.

The new microwave diodes, for use in the S and X bands, have noise figures of 5.5 and 6.5 db, one-half a decibel lower than obtainable in other currently available microwave diodes.

LASER SYSTEM MEASURES MACHINING WITH PRECISION

The first successful application of the laser as part of a commercially available measuring system has been disclosed by Airborne Instruments Laboratory (AIL) Division of Cutler-Hammer, Deer Park, N. Y.

The system, called the Absolute Interferometric Laser Calibrator, is the first of a line by AIL that uses a laser for the ultra-precise linear length measurements required by sophisticated machining methods.

The combination of the laser with recent advances in optics and specially designed computers is the first application in industry that will produce linear measurements to accuracies previously unheard of in machining, according to AIL engineers.

The company reports that the AIL Calibrator is particularly suited for calibration and checkout of numerically controlled machine tools and measuring machines.

UNITED TELECONTROL BUYS MEMORY SYSTEMS FIRM

Manufacturing rights, specialized tooling, and equipment to produce the memory systems, formerly produced under the name Indiana General, Keasbey, N. J., have been purchased by United Telecontrol Electronics, Inc.

The Memory Systems Divisions produces basic memories for computers, and format control systems used to transpose raw data into a computer-compatible format. Harold T. Sher, President of United Telecontrol, Farmingdale, N. J., said that some key technical personnel from Indiana General have joined United Telecontrol.

Major products of United Telecontrol are transponders and radar beacon systems, telephone and telegraph equipment, test equipment and instruments.

R&QC PROCEEDINGS

The Eleventh National Symposium on Reliability and Quality Control attracted nearly 1,000 scientists, engineers and executives from around the world to its January meeting in Miami, Fla. Thirty-six states and nine other nations were represented.

Proceeds of the Symposium, containing some 60 papers, are available at $5.00 per copy from: IEEE, Box A, Lenox Hill Station, New York, N. Y.

NEW PRODUCTS

At I.E.E.E.

VARIABLE ATTENUATOR

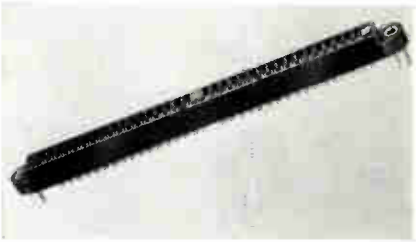
This miniature X-band continuously variable attenuator is for the 8400-9250MC range. It is adaptable for other freq. ranges. The attenuation variation is less than ±0.5db. VSWR is 1.5db; insertion loss is 2db. Arra Inc. Booths 1110-11.

Circle 295 on Inquiry Card

PC CONNECTOR

Series 600-132 are available with 34 or 16 contacts and accept a 3/32 in. PC board. Bifurcated contact construction provides reliability under the most adverse operating conditions. Continental Connector Corp. Booths 2307-09.

Circle 296 on Inquiry Card



RESIN DISPENSER

The Model 26 PDM Blendmaster dispenser meters relatively small quantities of casting resins, and insures accurate proportioning and thorough mixing. Uses include the production of electrolytic capacitors, small modules, and encapsulation. Hull Corp. Booth 1918.

Circle 297 on Inquiry Card

NEW PRODUCTS

At I.E.E.E.

INDICATOR LIGHT

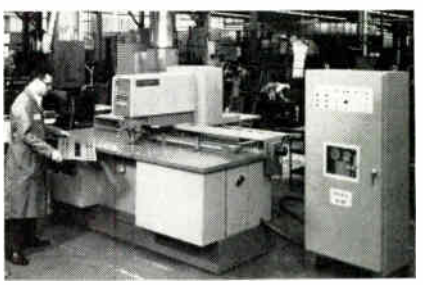
This series of 120v. miniature incandescent indicator lights are available in bayonet Deluxe Molded or midget Bi-Pin Cartridge. They are available in both military and industrial types. Drake Mfg. Co. Booth 2225.

Circle 319 on Inquiry Card

PUNCHING MACHINE

With the Fabramatic Model 15 numerically controlled punching and notching machine, short run and prototype production can be profitable. It handles pieces 15 x 30 in. and punches ¼ in. mild steel. Wales Strippit Co. Booths 1811-13.

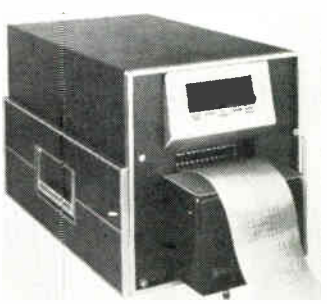
Circle 320 on Inquiry Card



INSTRUMENTATION PRINTER

Model 410A prints more than 10 lines/sec., yet is competitive in price with machines limited to a printout of 3 to 5 lines/sec. It also offers 8-digit column printing, with up to 4 additional columns optional. Computer Measurements Co. Booths 3710-12.

Circle 321 on Inquiry Card



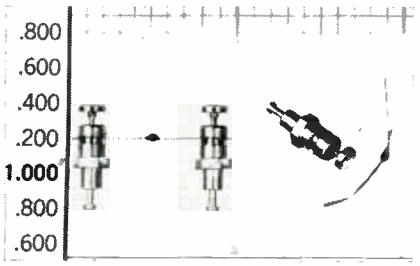
NEW PRODUCTS

At I.E.E.E.

COMPONENT CLIP

Cambion Part No. 3864 will hold ribbon lead diodes as thin as 0.001 in., and is also adaptable for any component using fine wire leads up to 0.032 in. dia. Push-button plunger facilitates diode insertion and removal. Cambridge Thermionic. Booth 2219.

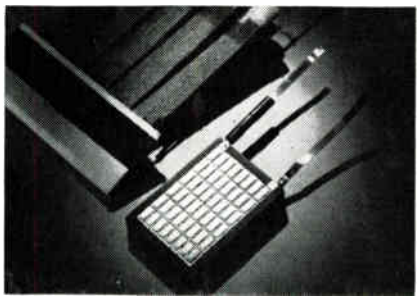
Circle 298 on Inquiry Card



HEAT PUMP MODULE

This closely-packed 48 couple heat pump module is for small temp. control needs. The TRI module consists of 96 alternate N & P bismuth telluride elements with copper links attached to produce 48 couples electrically in series, and thermally in parallel. American Smelting & Refining Co. Booth 4005.

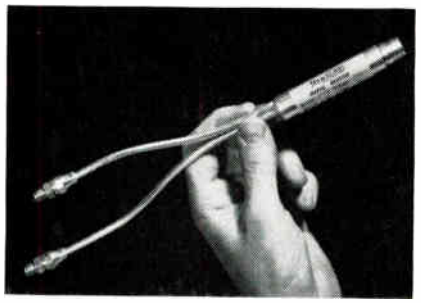
Circle 299 on Inquiry Card



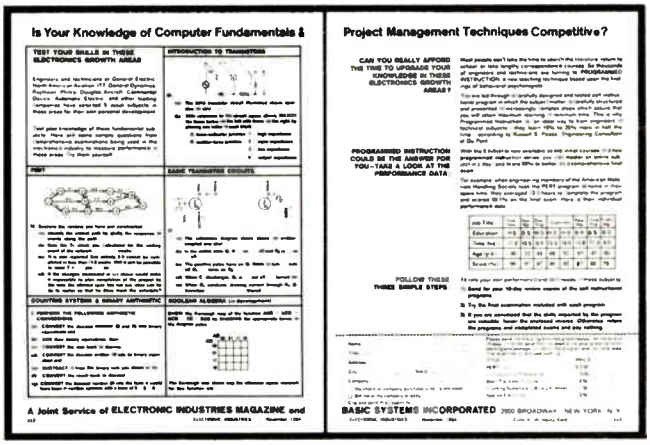
LOAD RESISTOR

The Termaline® Model 8710 1kw r-f load resistor runs cool to the touch and weighs 5 oz. For reflection-free termination of 50Ω coaxial systems, these non-magnetic miniature hi-power loads can be mounted inside focussing coils. Freq. range is dc to 4gc. Bird Electronic Corp. Booths 3213-17.

Circle 300 on Inquiry Card



Why did Engineers from over 600 Companies answer this Ad?



They decided to keep their skills competitive by teaching themselves PERT, Transistors and Transistor Circuits, Binary Arithmetic, and Applied Electricity. They did it with these Programmed Instruction* courses and then they started to write us . . .

Compare your answer with theirs...

"I have recently received your programmed instruction course. The method which you employ is excellent, I cannot see how anyone could help learning the subject matter."

". . . I believe it is the best instructional method I have encountered . . ."

". . . it seemed to motivate me to learn . . ."

". . . I consider this an ideal instructional form . . ."

". . . feeling of accomplishment throughout the course . . ."

"I feel I really learned."

*The "teaching machine" technology.

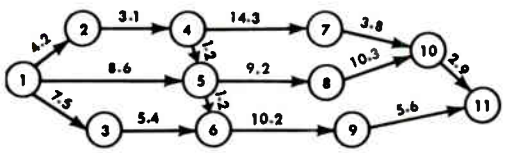
A Joint Service of ELECTRONIC INDUSTRIES MAGAZINE and

Test your Knowledge

of these fundamental subjects. Here are some sample questions from comprehensive examinations being used in the electronics industry to measure performance in 2 of these 5 areas.

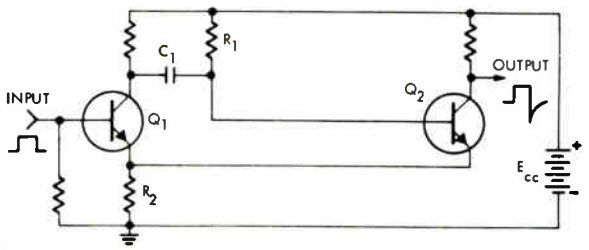
Try them yourself . . .

PERT



12. Examine the network you have just constructed.
   (a) Identify the critical path by giving the sequence of events along the path: _____.
   (b) Give the T_E which you calculated for the ending event of the network _____ weeks
   (c) It is now reported that activity 6-9 cannot be completed in less than 11.8 weeks. Will it still be possible to meet T_L? ☐ yes ☐ no
   (d) If the changes mentioned in (c) above would make it impossible to plan completion of the project by the time the allotted span has run out, what can he do to replan so that he does meet the schedule?

BASIC TRANSISTOR CIRCUITS



27.
   (a) The schematic diagram above shows an emitter-coupled one-shot _____.
   (b) In the stable state Q_1 is ☐ on ☐ off and Q_2 is ☐ on ☐ off.
   (c) The positive pulse turns on Q_1 which in turn: ☐ cuts off Q_2 ☐ turns on Q_2.
   (d) When C_1 discharges, Q_2 is: ☐ cut off ☐ turned on.
   (e) When Q_2 conducts, drawing current through R_2, Q_1 becomes _____ biased.

To rate your own performance and skill needs in these 5 subjects:

1) **Send for your 10-day review copies of all 5 self-instructional programs.**
2) **Try the final examination included with each program.**
3) **Only if you are convinced that the skills imparted by the program are valuable to you should you keep the programs. Otherwise, return them with completed exams and pay nothing.**

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TITLE	PRICE	
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BASIC SYSTEMS INCORPORATED 880 THIRD AVENUE/NEW YORK, N.Y.

NEW PRODUCTS

At I.E.E.E.

PHOTOCELLS

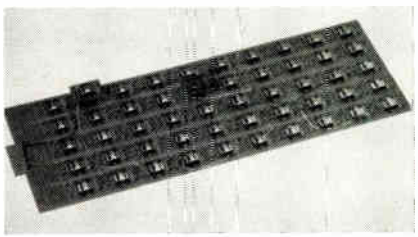
The CL705HL, CL905HL and CL905-HLL series use a substance which combines cadmium sulfide and cadmium selenide to realize the best features of both materials. The resulting photocells have the high response speeds of CdSe and the stable memory and temp. characteristics of CdS. Clairex Corp. Booth 1725.

Circle 301 on Inquiry Card

INTEGRATED CIRCUIT BOARD

The 8089 series is used for reliability testing and breadboarding. It accommodates 50 integrated circuit flat packs. Snap-action covers design eliminates soldering and welding. Augat Inc. Booth 2227.

Circle 302 on Inquiry Card



CURVE TRACER

Model 438 permits an instantaneous oscilloscope display of full dynamic range of capacitance vs. voltage for various semiconductor devices. Diodes can be swept from a slightly forward bias condition to a reverse voltage of 100v. American Electronic Laboratories, Inc. Booth 1103.

Circle 303 on Inquiry Card

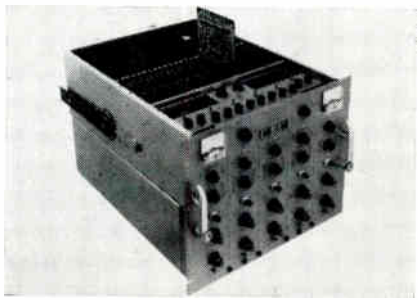
NEW PRODUCTS

At I.E.E.E.

TELEMETRY EQUIPMENT

This 5-channel bit synchronizer and signal conditioner locks the clock to within ±5° for the entire tracking range. The system building blocks are part of a general-purpose PCM ground station which provides effective bit synchronization even with signal-to-noise ratios of —10db. The Roback Corp. Booth 3826.

Circle 316 on Inquiry Card



RESISTANCE STANDARD

Model SR 1050 transfers resistance measurements from a single 10 kilohm resistance standard to values up to 110 megohms. Eleven precise wirewound resistors can be switched in series, parallel and series-parallel configurations. Electro Scientific Industries, Inc. Booths 3015-19.

Circle 317 on Inquiry Card

GENERAL PURPOSE COMPUTER

The DDP-116 performs up to 294,000 computations/sec. Basic memory cycle is 1.7μsec. Add time is 3.4μec. The memory is expandable up to 32,768 words. Computer Control Co., Inc. Booths 3410-14.

Circle 318 on Inquiry Card

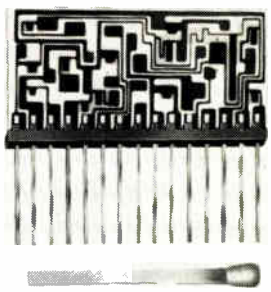
NEW PRODUCTS

At I.E.E.E.

MICROELECTRONIC PACKAGING

Several new microelectronic packaging techniques and connector applications will be shown by Elco Corp. One such approach will be a substrate connector which makes substrates pluggable. See these units at Booths 1420-22.

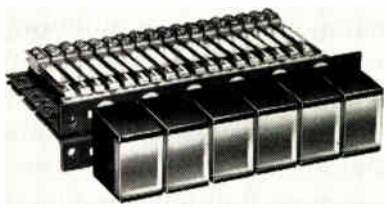
Circle 304 on Inquiry Card



ILLUMINATED SWITCHES

The 37000 and 38000 Series littel multiswitches feature 1 or 2 lamp lighting, plus full or split-face illumination in an unlimited choice of color combinations. Easily insertable color filters are available. Switchcraft Inc. Booths 2825-27.

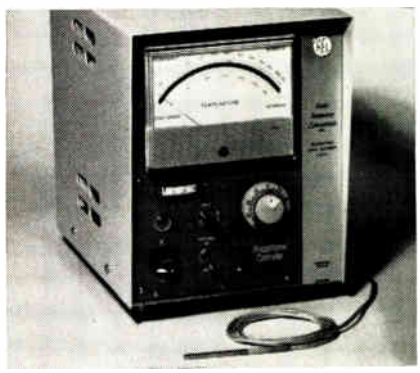
Circle 305 on Inquiry Card



PROPORTIONAL CONTROLLER

Model 50 controls power up to 60kw. It is particularly suited for temp. control uses. No operator is needed to continuously monitor the process when changing the control point. Radio Frequency Laboratories. Booth 3125.

Circle 306 on Inquiry Card



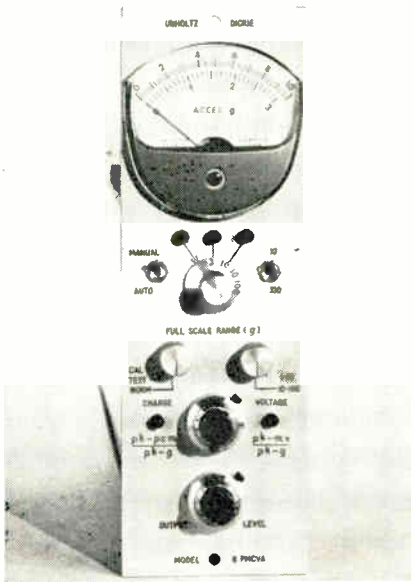
NEW PRODUCTS

At I.E.E.E.

RECORDER PREAMPLIFIER

Automatic ranging feature of Model 8 PMCVA signal conditioning amplifier makes possible multi-channel tape or galvanometer recordings without the loss of data due to recorder saturation. Typical recorders have a usable dynamic range of 10 to 20db. Unholtz-Dickie Corp. Booth 3944.

Circle 307 on Inquiry Card



CIRCUIT BREAKER

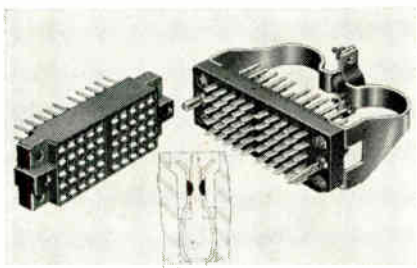
The Series JA hydraulic-magnetic circuit breakers are available in 1-, 2-, and 3-pole models. They come in integral or fractional current from 0.100 to 20a., and in standard voltage ratings up to 250vac. Single-pole models measure 2.00 x 0.75 x 2.09 in. Heinemann Electric. Booths 2841-43.

Circle 308 on Inquiry Card

CONNECTOR

This multiple contact connector uses a welded gold button on the contact surface of the female receptacle. This reduces the gold coverage area 95%. Cinch Mfg. Co. Booth 2538.

Circle 309 on Inquiry Card



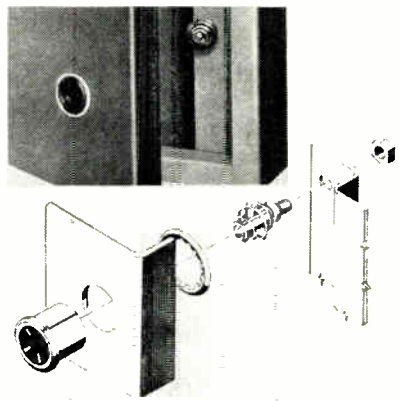
NEW PRODUCTS

At I.E.E.E.

DOOR FASTENER

This door fastener automatically unlocks door and kicks it open when a push-button is pressed. Automatic-ejection feature eliminates need for door handles. Southco. Booths 1818-20.

Circle 310 on Inquiry Card



STRETCHABLE CABLE

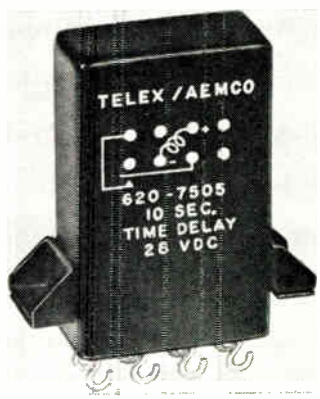
This line of stretchable wire and cable will elongate from 10% to over 200%, with shielded coaxial constructions and silicone rubber or plastic jackets. They are designed for use as lead wire, communications (including coaxial type) and for power uses. Sizes are from 14 AWG to 34 AWG. Birnbach Radio Co. Booth 4416.

Circle 311 on Inquiry Card

TIME-DELAY RELAY

Type MD microminiature dc time-delay relay offers isolated load switching by glass reed relays. Switching circuits are sealed in glass. Delay period is adjustable. Fixed delay is 0.1 to 60 sec. Telex/Aemco. Booths 1729-31.

Circle 312 on Inquiry Card



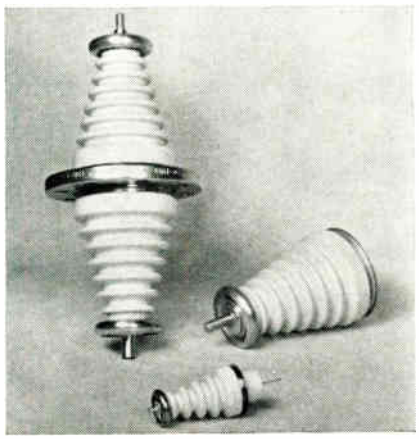
NEW PRODUCTS

At I.E.E.E.

PORCELAIN BUSHINGS

These corona-free porcelain bushings have active alloy porcelain-metal bonds. No gasket, paste or epoxy seals are used. Six sizes are available with ratings of 10, 15, 25, 50, 75, and 100kv RMS, respectively. Ceramaseal Inc. Booth 1622.

Circle 313 on Inquiry Card



DATA PRINTER

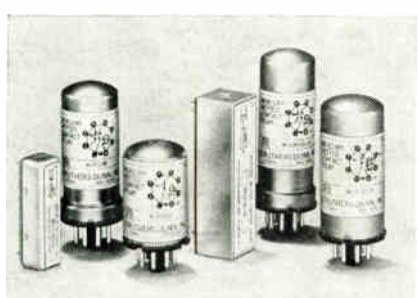
The Series N Lister printer produces 2400, 32-column lines/min. It is expandable to a 32-column printer. Speeds can be changed to 1200 lines/min. in alphanumeric version and 2400 lines/min. in numeric model. Di/An Controls, Inc. Booth 3945.

Circle 314 on Inquiry Card

WETTED CONTACT RELAYS

These plug-in and PC type mercury-wetted contact relays are available with 1 or 2 switches. Life is on the order of 1 billion operations and more. They have zero contact bounce. Available in 5a., Form D bridging and 2a. Form C non-bridging (break before make) contacts. Struthers-Dunn, Inc. Booth M14.

Circle 315 on Inquiry Card



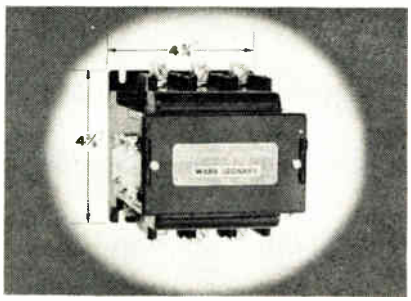
NEW PRODUCTS

At I.E.E.E.

AC CONTACTOR

The Series 5000 NEMA Size 2 ac magnetic contactor is rated at 50a. It is intended for automatic input power supply switching. The basic 3-pole contactor occupies 20.8 sq. in. Ward Leonard Electric Co. Booths 2229-31.

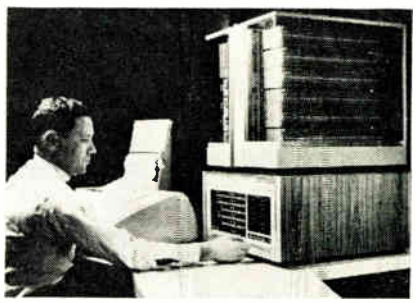
Circle 232 on Inquiry Card



DIGITAL COMPUTER

Programmed Data Processor-8 is an integrated circuit computer. Core memory consists of 4096 words. Memory cycle is 1.6μsec.; it adds in 3.2μsec., and transfers data at rates up to 625K words/sec. Digital Equipment Corp. Booths 3927-29.

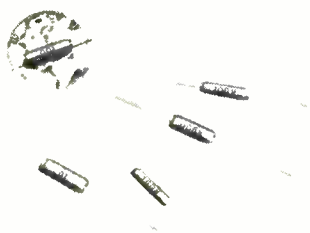
Circle 235 on Inquiry Card



POLYCARBONATE CAPACITORS

The 463 UW fills the gap between Mylar and Polystyrene. Temp coefficient is less than 1%, and insulation resistance is greater than 75,000 megohms. It is fully rated from —45° to +125°C. TRW Capacitor Div. Booth 2833-35.

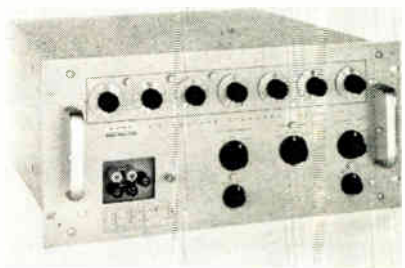
Circle 233 on Inquiry Card



VOLTAGE STANDARD

With the Model 304 dc voltage standard, output voltage is set using a 3-position range switch, and seven 12-position rotary switches. Ranges are 0-1222.2221v.; steps are as small as 1μv. Output current to 50ma. Cohu Electronics. Booth 3602.

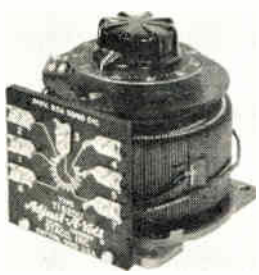
Circle 236 on Inquiry Card



VARIABLE TRANSFORMERS

The T1520U Adjust-A-Volt® operates from a 240v. line with 9.5a. output. Available in 2 or 3 gang assemblies for 3-phase operation. Terminals are provided for over voltage, line voltage, and voltage doubler connections. Staco, Inc. Booth 2834.

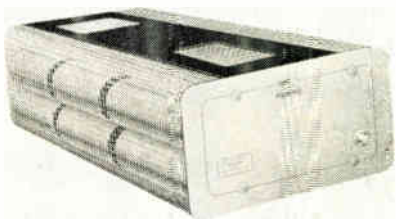
Circle 234 on Inquiry Card



POWER SUPPLY

The HS (half-rack system) and FS (full-rack system) modules cover the voltage range between 5.5vdc and 51.0vdc in 26 slot-type units. Currents range from 8.0a. to 46.0a. Wattages are from 104.5 to 816 in standard rack and half-rack sizes. Consolidated Avionics Inc. Booth 1324.

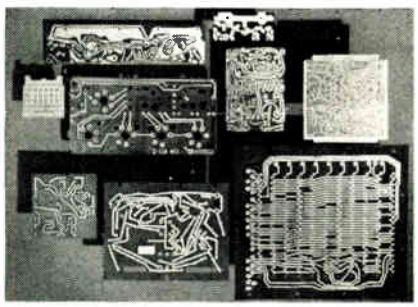
Circle 237 on Inquiry Card



PRINTED CIRCUITS

The CC-4™ series use a process which allows reduced PC costs and great flexibility. One of the boards exhibited has printed wiring on epoxy coated steel base materials. Photocircuits Corp. Booths 2602-04.

Circle 238 on Inquiry Card



WIREWOUND TRIMMER

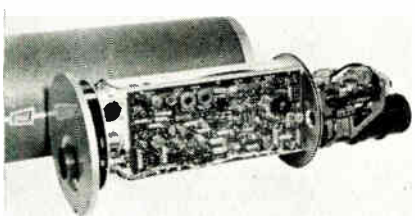
Series 160 is a miniature, ¾w., 15 turn, wirewound rectilinear trimmer. It is enclosed in an insulated and sealed 1 x 0.320 x 0.180 in. diallyl phthalate housing. The resistance range is 100Ω to 20KΩ. CTS of Berne Inc. Booths 2907-09.

Circle 239 on Inquiry Card

CAMERA SYSTEM

The type RGS-11 camera system features 800-line horizontal resolution at 10MC bandwidth, automatic light level adjustment of 4000:1, and high gauss focus field for improved resolution and corner focus. It is available with 2:1 interface. Dage Television Co. Booth 3101.

Circle 240 on Inquiry Card



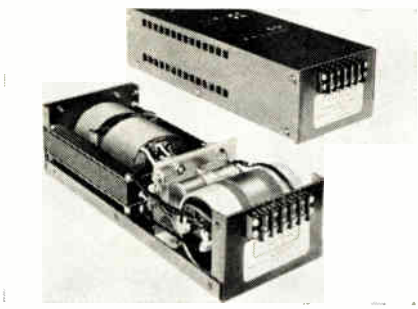
NEW PRODUCTS

At I.E.E.E.

POWER SUPPLIES

Line voltage variations are said to be reduced by a factor of over 10 to 1 by the input transformer used in the PRM power modules. They are available at fixed dc output voltages from 6.3 to 120; power ratings to 120w. Kepco Inc. Booths 2636-38.

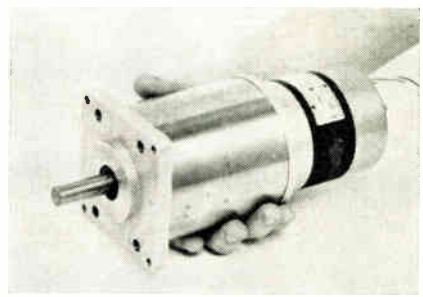
Circle 223 on Inquiry Card



PLANETARY GEARMOTOR

The CLC in line planetary gearmotor delivers up to 200 lb.-in. continuous duty and to 600 lb.-in. intermittent duty. Unit is 3½ in. dia. max. with overall length to 8 in. It operates from 115 and 230vac, 50/60 or 400 cps, 1 or 3 phase. Globe Industries, Inc. Booths 1100-01.

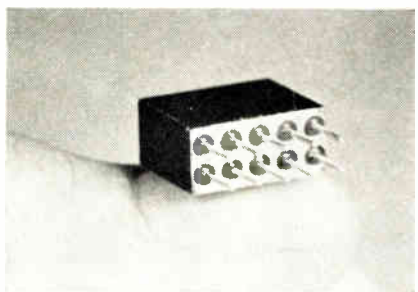
Circle 226 on Inquiry Card



LATCHING RELAY

The type LJ 1/6 size latching relay has a contact arrangement of 2 Form C DPDT. Contacts are rated at 1a. (dry circuit) 28 vdc. Max. operating time at rated coil voltage is 4msec. Its volume is 0.04 cu. in. Branson Corp. Booth 2311.

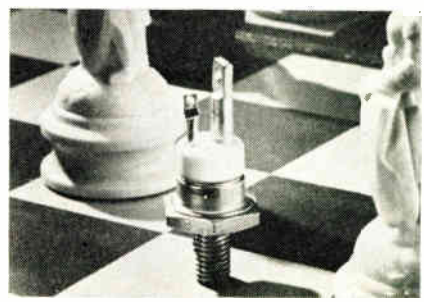
Circle 224 on Inquiry Card



ALL-DIFFUSED SCR

The C145 high-power SCR is rated @ 1300v. (VBO and PRV) and 55a. RMS. Minimum parameters include a dv/dt rating of 200v./μsec. and a minimum di/dt rating of 50-100a./μsec. General Electric Co. Booth 2906.

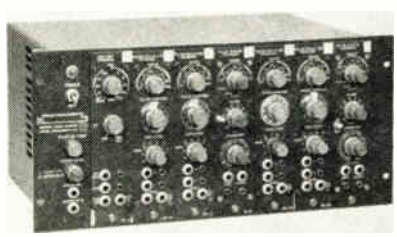
Circle 227 on Inquiry Card



PULSE GENERATOR

The Type 1395-A accommodates up to 7 plug-in modules in various combinations to simulate radar, telemetry, and digital-data pulse signals. Modules now available include PRF unit (2.5 cps to 1.2mc), delay unit, shaper, amplifier, and word generator. General Radio. Booth 3201.

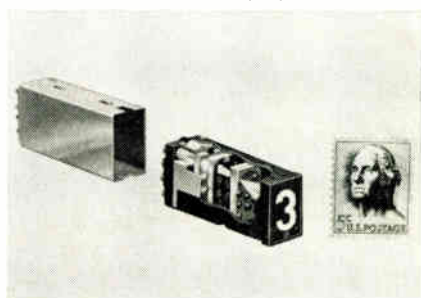
Circle 225 on Inquiry Card



REAR-PROJECTION READOUT

Microminiature Series 340 contains 11 miniature incandescent lamps at its back, a piece of film with 11 message displays, a series of lenses and a front viewing screen. Messages are rear-projected individually or in combination. Industrial Electronic Engineers, Inc. Booth 1433.

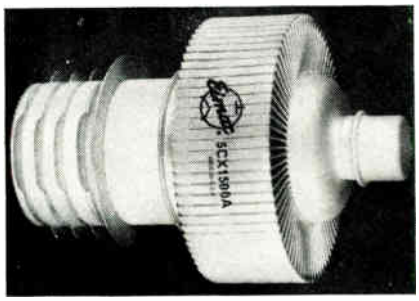
Circle 228 on Inquiry Card



POWER PENTODE

The 5CX1500A amplifier pentode is rated at 1500w. plate dissipation. It is intended for the 1000 to 1500w. peak envelope power range. Uses include Class C amplifier or a driver in variable freq. power supplies. Eitel-McCullough, Inc. Booth 2415-19.

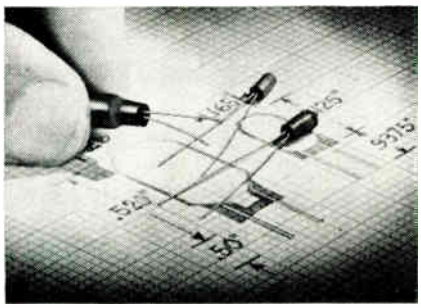
Circle 229 on Inquiry Card



MINIATURE LAMPS

These miniature, imbedded lamps are data display devices. They eliminate color dilution and give shock-mount protection to glass envelopes. Available in T-¼, T-1, and T-1¾ types. Master Dynamics. Booth 2226.

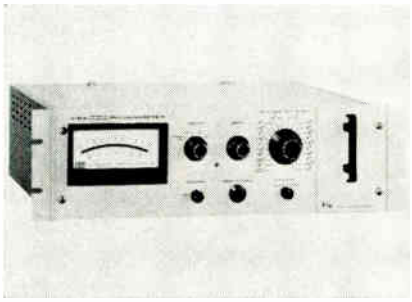
Circle 230 on Inquiry Card



PICOAMMETER

Model 418A has 21 ranges from 10^{-2}a. full scale to 10^{-12}a. Accuracy is ±2% of full scale from 10^{-2} to 10^{-8}; ±3% of full scale on the other ranges. It has reed relays that can be used with external programming to control range selection. Keithley Instruments Inc. Booths 3704-06.

Circle 231 on Inquiry Card

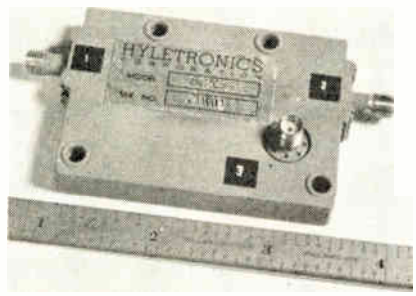


Circle 123 on Inquiry Card

NEW PRODUCTS

NANOSECOND SWITCH

SPST nsec. diode switch covers the full freq. band from 2.5 to 11KMC.



Model SCX-3 has a max. insertion loss of 3db and a minimum isolation of 30db. The actual insertion loss is less than 1.5db and isolation is well above 40db over most of the freq. band. Switching time is less than 3nsec. Modulating freqs. in excess of 30MC have been applied to this switch to achieve 100% modulation of r-f signals. Bias may be as low as 5mw. Hyletronics Corp., 185 Cambridge St. Burlington, Mass.

Circle 241 on Inquiry Card

PULSED MAGNETRON

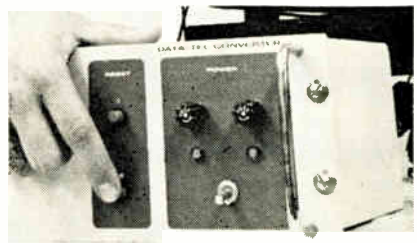
Tunable freq. from 2700MC to 2900MC. It has a 450kw min. peak power output.

The DX276 pulsed magnetron is a direct plug-in replacement for the 5586. It is warranted for 1000 hours. The tube's reliability is due, in part, to a continuous gettering action made possible by a newly developed sputter pump (internal ion pump). The resulting decrease in gas also helps to improve MTI cancellation by reducing phase jitter. It also improves efficiency, increases tolerance to excessive and prolonged overloads, and reduces burn-in time to 3 min. The tube's duty factor is 0.001. Amperex Electronic Corp., Hicksville, L. I., N. Y.

Circle 242 on Inquiry Card

DATA CONVERTER

Converts low-level computer data to high-level, lower-speed telegraph signals.

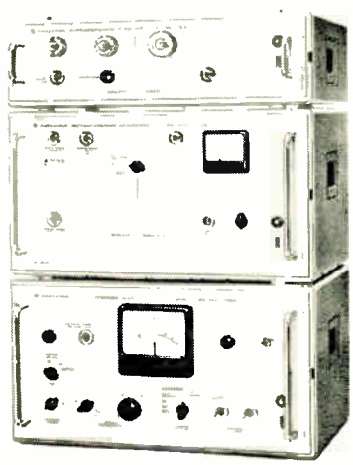


The Data/Tel Converter accepts output signals of 150 bit/sec. and divides them into 2 isolated signals for transmission on standard, 75 bit/sec. telegraph lines. The "split" signal is unintelligible until recombined in the receiver section of a companion Data/Tel unit. The garbled characteristic affords a degree of message security during transmissions. The new unit ends the slow, manual conversion methods now used. Radiation Inc., Melbourne, Fla.

Circle 243 on Inquiry Card

PHASE DELAY TESTER

Determines the group and phase delay of active and passive 4-terminal networks.



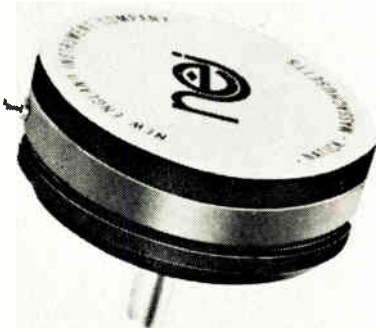
The Type LFM group delay test assembly has a delay measurement range of ±10 to ±1000nsec. A crystal-stabilized 20KC split freq. generated by the measuring section modulates carrier waves of 100KC to 10MC in the video modular/demodulator unit, and carrier waves of 25MC to 250MC in the r-f modulator/demodulator. The measured phase difference is displayed on a meter calibrated in nsec., or the equipment can be freq. swept and group display vs. freq. displayed on a CRO. Rohde & Schwarz Sales Co., Inc., 111 Lexington Ave., Passaic, N. J.

Circle 244 on Inquiry Card

NEW PRODUCTS

CONDUCTIVE PLASTIC POT

Resolution is essentially infinite, and life is 10 million revolutions.



The Waferpot™ is a basic single-cup unit 0.5 in. deep. Each additional cup adds 0.180 in. in depth. It meets the 100Ω noise spec. now written for wirewound potentiometers, and withstands 10-day Mil-R-12934 humidity cycling tests with a resistance change of less than 2%. Temp. coefficient is ±200 parts/million /°C for most resistance values. Resistance values from 1K to 20K are standard. New England Instrument Co., Kendall Lane, Natick, Mass.

Circle 245 on Inquiry Card

LOW-NOISE CONVERTER

Translates signals in the 400 to 402MC band to 136 to 138MC range.

Model SC-742 is a self contained low-noise converter. Two identical channels are provided for use in polarization diversity receiving systems. Completely solid state in design, it consists of 2 identical and separate amplifier-mixer channels using a common local oscillator signal. Each channel has a gain adjustable from 10 to 14db. The noise figure is less than 5.5db. General Dynamics / Electronics, 1400 N. Goodman St., Rochester, N. Y.

Circle 246 on Inquiry Card

TRANSPONDER DELAY LINES

Delays of 20.3μsec. and 24.65μsec. Each occupy 4 x 4 x ⅜ in. of PC board space

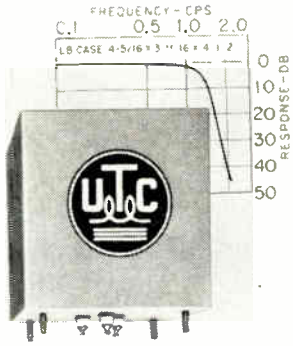
Models 53-89 and 53-92 can be supplied as separate PC mounting components or together with associated circuitry. Impedance is 400Ω for the Model 53-89 and 470Ω for the Model 53-92. The delay to rise time ratio is better than 50:1; attenuation is less than 0.12db/μsec. and temp. coefficient less than 50 ppm/°C over a temp. range of −55°C to +85°C. Taps are provided at 1.45μsec. intervals to a ±0.05μsec. tolerance. ESC Electronics Corp., 534 Bergen Blvd., Palisades Park, N. J.

Circle 247 on Inquiry Card

NEW PRODUCTS

LOW PASS FILTER

Passes signals from dc to 1 CPS; response is flat within 1db for signals to 0.75 CPS.



These stable units perform with an unvarying freq. response over extended periods of time and usage. At freqs. above 2 CPS, the filter has an attenuation of at least 40db. The source and load impedances are 10KΩ. It is manufactured and guaranteed to Mil-F-18327B. The size is 4 5/16 x 3 11/16 x 4½ in., and weight is 6 lbs. United Transformer Corp., 150 Varick St., New York, N. Y.

Circle 248 on Inquiry Card

METAL-CERAMIC TUBES

Pulse output 2kw; plate dissipation 100w. Used in phased array radar.

Tube type 7815R meets applicable Army-Navy military specs. The 100w plate dissipation rating is specified with forced air cooling. Less than 2.5 in. long and under 1.3-in. in dia. at its widest point, this high-mu planar triode can be used as oscillator, multiplier or power amplifier at freqs. up to 3GC. It can be operated in any position. At 6 vac or dc, the heater current is 1.0a. Absolute max. ratings include: peak pulse plate supply voltage, 3500v.; pulse length, 6μsec. General Electric Co., Tube Dept., Owensboro, Ky.

Circle 249 on Inquiry Card

MOLDED JACKET INDUCTORS

Designed to meet requirements of Mil-C-15305 and Mil-C-39010.

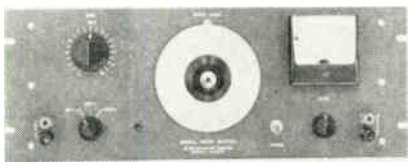
Type 15 molded jacket inductors have inductances through 1800μh. They have 0.156 in. dia. and 0.375 in. length. Through the use of an open magnetic circuit and more efficient use of coil winding space, miniaturization is obtained without sacrificing stability. Axial leads are of oxygen free copper, with 60/40 solder coating. For increased copper weldability, a pure tin coating can be supplied. Standard tolerances available from stock are 5%, with other available tolerances from 1% through 20%. Speer Carbon Co., div. of Air Reduction Co., Inc., Theresia St., St. Marys, Pa.

Circle 250 on Inquiry Card

NEW PRODUCTS

SIGNAL PHASE SHIFTER

Accepts high Z input signals and delivers low Z output signals.



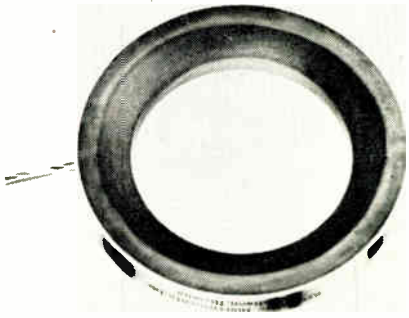
Type 107 signal phase shifter is for servo amplifiers. It permits independent adjustment of phase and gain of carrier signals passing through a developmental system. Unit saves time over temporary or makeshift methods. The device is inserted anywhere in the amplifier chain of a servo system. It provides gain or attenuation and phase shift of 60-, 400-, and 800-cycle servo carrier signals. Gain is nominally zero, adjustable in calibrated 2db steps to provide gain or loss of 20db. Servo Products Co., 40 N. Daisy Ave., Pasadena, Calif.

Circle 251 on Inquiry Card

NEW PRODUCTS

ANTI-PINCUSHION DEVICE

Eliminates CRT geometrical distortion. Mounts on standard yokes.



Type P8 compact electromagnetic anti-pincushion device is encapsulated. It has precision construction and permits convenient front panel or remote control, eliminating mechanical adjustment. Each corner is corrected independently by using optional individual coil leads. For the most precise, highest resolution displays, corner focus of anti-pincushion device and yoke combination can be improved by matching yoke. Syntronic Instruments, Inc., 100 Industrial Rd., Addison, Ill.

Circle 252 on Inquiry Card

GaAs DIODES

Min. continuous output at room temp. of 100μw with a 300μw typical output.

The output of the LED-10 is achieved with an input of 100ma at a wavelength of 9000 Å. Spectral bandwidth is 210 Å. It has a h-f modulation capability above 10MC. This makes the diode well suited for data and communication systems, where large amounts of data are put on light beam. General Electric Co., Electronics Park, Syracuse, N. Y.

Circle 253 on Inquiry Card

PLUG-IN RELAY

Available with silver alloy contacts in SPDT, DPDT and 3PDT.

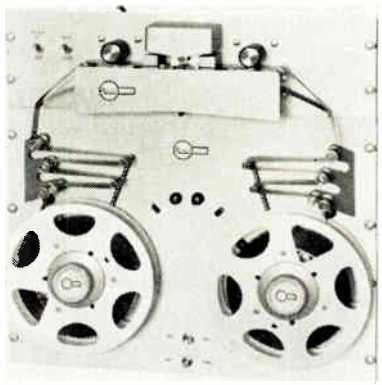
This ruggedly constructed relay is equipped with precision-built hinge-pin armature bearings. These bearings provide friction-free operation and adjustment stability. They are interchangeable with conventional relays that have similar plug-in mounting. For ac or dc voltage actuation of 6, 12, 24 and 115v. and for dc current actuation. Dust cover combines transparency of glass with toughness of metal. Magnecraft Electric Co., 5577 N. Lynch, Chicago, Ill.

Circle 254 on Inquiry Card

NEW PRODUCTS

TAPE READER

Has high-speed bidirectional rewind at 200 in./sec. and self adjusting brakes.



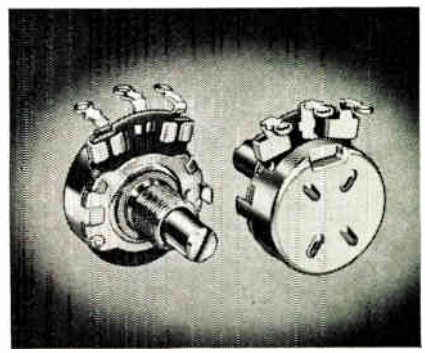
Models RR-702 photocell punched tape reader and the RS-702 tape spooler operate at reading speeds up to 700 characters/sec. They are available in unidirectional and bidirectional models. Units have hardened steel tape guides, no-tape and broken tape sensing, and electronic noise suppression. Rheem Electronics, 5250 W. El Segundo Blvd., Hawthorne, Calif.

Circle 255 on Inquiry Card

NEW PRODUCTS

VARIABLE RESISTORS

Resistance range covered can vary from 200Ω to 10 megohms.



This line of variable resistors are suitable for use as resistance switching devices. By means of an internal detent mechanism, as many as 6 different resistance positions can be located on the unit. The device is 15/16-in. in dia. and is rated at ½w. Centralab, The Electronics Div. of Globe-Union Inc., P. O. Box 591, Milwaukee, Wisc.

Circle 256 on Inquiry Card

PHASE SHIFTER

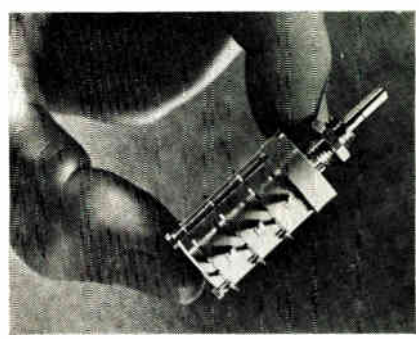
Electrostatic unit for freqs. between 50MC and 150MC. Input impedance, 50Ω.

The series 60 Variogon is an electrostatic type, continuous rotary (0° thru 360°) phase shifter. Applications are: Doppler simulators, phase lock instruments, freq. offset generators, etc. Nilsen Mfg. Co., 606 Highway 27 N., P. O. Box 127, Haines City, Fla.

Circle 257 on Inquiry Card

ROTARY SWITCH

Features 30° indexing with 2 to 12 positions, and continuous rotation or stops.



Series 2500 is a totally enclosed, explosion-proof micro-miniature rotary switch. It measures ½ in. in dia., with a max. overall switch dimension of 0.62. Unit has 1 to 12 decks. It carries 8a. continuous, makes and breaks ½a. 115vac resistive, ¼a. 28vdc resistive and 1.8a. 28vdc inductive. Janco Corp., 3111 Winona Ave., Burbank, Calif.

Circle 258 on Inquiry Card

ELECTRONIC INDUSTRIES

Advertisers — March 1965

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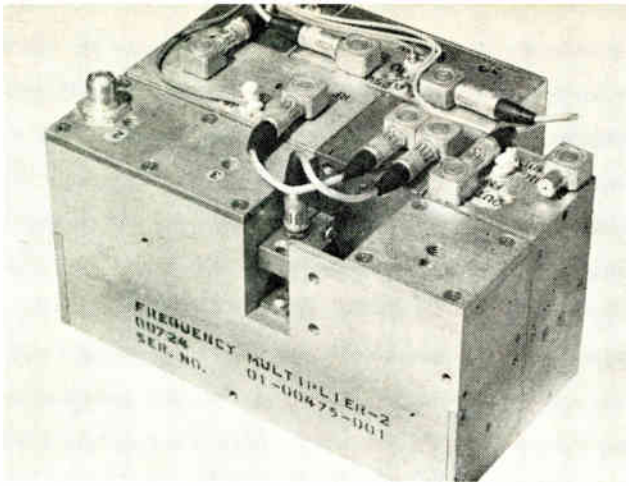


Fig. 2: An example of the modular approach to telemetry equipment. Unit is an all-solid state experimental transmitter.

NAVY TELEMETERING (Concluded)

(*Continued from page* 81)

patible or become obsolete when other units are added.

All circuitry is being developed first in the form of wired circuit cards. These are replaced by printed circuit cards as the circuit designs are proven. Also, where possible, circuit operating levels and module interfaces are chosen to be compatible with microcircuits. Provisions are being made to accommodate improved ancillary equipment such as high-speed electrostatic printers, digital-data display boards and automatic alarm equipment, as these become available. The present and future systems are shown in Fig. 1.

Possibilities for the Future

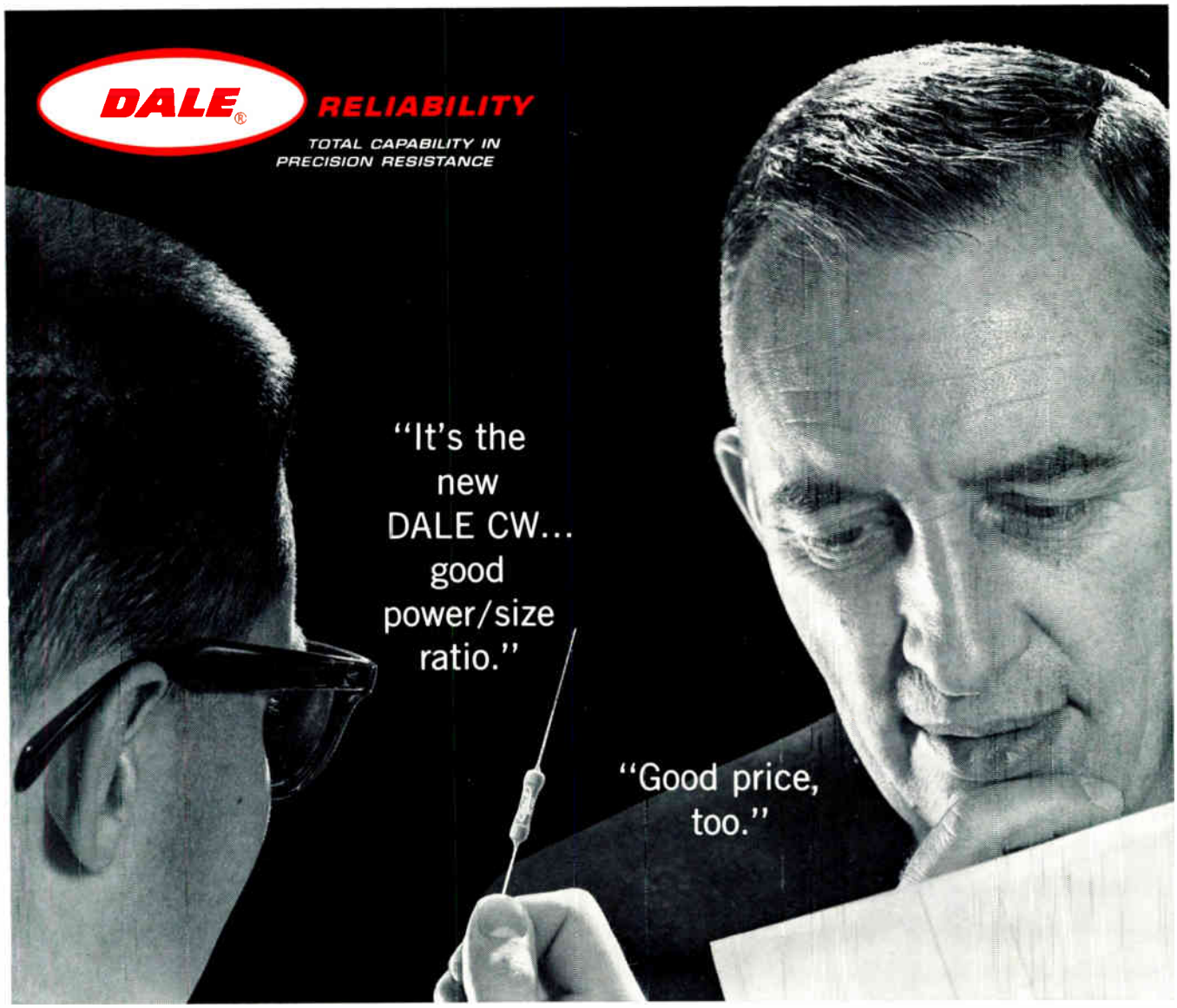
Although it is difficult to predict advances in technology, the progress made in laboratories indicates that by 1970 it should be possible to build a complete 1 watt UHF telemetry transmitter for operation from a 28 vdc source in a space not exceeding two cubic inches. This need already exists. It is also likely that it will become possible to build an all solid-state r-f power amplifier for the UHF telemetry band which will provide 10 to 20 watts of output power with an efficiency of at least 60%.

Finally, a rather sophisticated data reduction system, excluding the ancillary equipment, may be built in less than a cubic foot of volume by the use of micromodular methods. It will then be possible to provide fully reduced data aboard a combat ship or plane as readily as it is now done in large land based facilities.

The use of standardized telemetry building blocks or modules, for both airborne and ground installations, will help to keep the costs under control and at the same time provide a high degree of flexibility in the choice of data transmission formats. It will allow for updating system performance without obsoleting large quantities of equipment.

Reference

"Design Objectives for Telemetry R-F Transmission Links for the Period 1960-1970" by T. B. Jackson; NAVWEPS Report 7202, October 1961. (Second Revision, NAVWEPS Report 8146, 15 March, 1963 is available from OTS, Dept. of Commerce, Washington, D. C. $.75 each.)



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CW SPECIFICATIONS

DALE TYPE	POWER RATING	RESISTANCE RANGE	BODY LENGTH (←.062)	BODY DIA. (←.032)	LEAD LENGTH (→.125)	LEAD DIA.
CW-2	4.25 W	1 Ω to 47.1K	.625	.250	2	.040
CW-2A	3 W	1 Ω to 42.1K	.812	.188	1.5	.032
CW-2B	3.75 W	1 Ω to 24.5K	.562	.188	1.5	.032
CW-2C	3.25 W	1 Ω to 32.3K	.500	.250	1.5	.040
CW-5	6.5 W	1 Ω to 95.2K	.875	.312	2	.040
CW-7	9.0 W	1 Ω to 154K	1.218	.312	2	.040
CW-10	13 W	1 Ω to 273K	1.781	.375	2	.040

Tolerance: Standard tolerance is ±5%
Temperature Coefficient: ±260 PPM/°C
Lead Material: Tinned copperweld, standard
Operating Temp. Range: −55 C to +350 C

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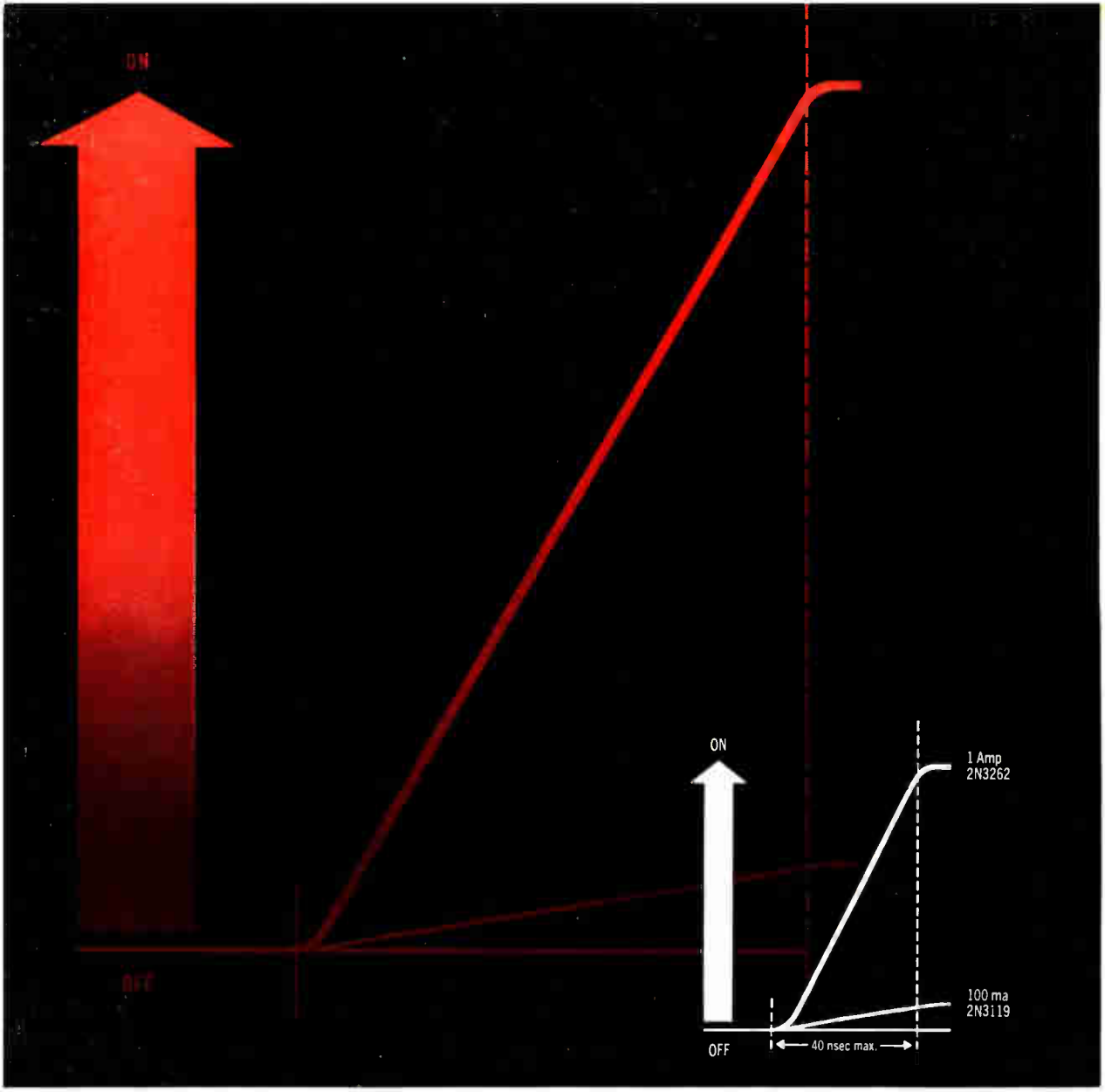

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Maximum Ratings	2N3119	2N3262
V_{CEX}	100V	100V
V_{CEO} (sus)	80V	80V
I_C	0.5A	1.5A
V_{EBO}	4V	4V
t_{on} (max.)	40 nsec	40 nsec
P_t	4 watts @ 25° C Case	8.75 watts @ 25°C Case

Characteristics	2N3119	2N3262
h_{FE} @ 100 ma	50-200	
@ 500 ma		40 (min.)
f_T	250 Mc (min.)	
		150 Mc (min.)

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