
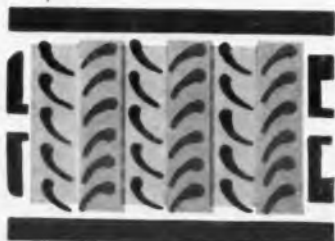


ELECT D



FAN BLADES
IN MULTIPLE STAGES
INCREASE COOLING
IN MINIATURE
BLOWER
... p 48



R O N I C
E S I G N

FEBRUARY 1988



NEW
Revolutionary
TRANSISTOR
FROM STOCK

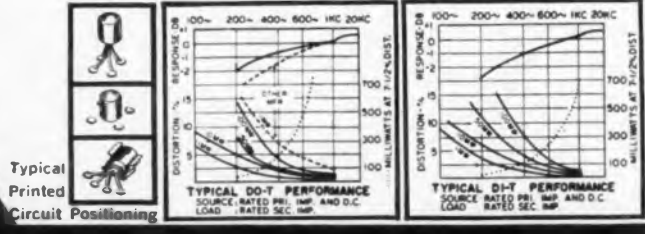


DO-T and DI-T TRANSFORMERS

Sealed to MIL-T-27A Specs.



TRANSFORMERS PICTURED ACTUAL SIZE
DO-T: 3/8" Dia. x 1/2" H., 1/10 Oz.; DI-T: 3/8" Dia. x 1/4" H., 1/20 Oz.



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-T1	20,000 30,000	.5 .5	800 1200	850	815	50	DI-T1
DO-T2	500 600	3 3	50 60	60	65	100	DI-T2
DO-T3	1000 1200	3 3	50 60	115	110	100	DI-T3
DO-T4	800	3	3.2	60		100	
DO-T5	1200	2	3.2	115	110	100	DI-T5
DO-T6	10,000	1	3.2	790		100	
DO-T7	200,000 500	0 0	1000 100,000	8500		25	
Reactor 2.5 Hys./2 Ma., .9 Hy./4 Ma.							
DO-T8	10,000 12,000	1 1	500 CT 600 CT	800	870	100	DI-T8
DO-T9	10,000 12,500	1 1	1200 CT 1500 CT	800	870	100	DI-T9
DO-T10	10,000 12,500	1 1	2000 CT 2500 CT	800	870	100	DI-T10
DO-T11	150 CT 200 CT	10 10	12 16	11		500	
DO-T12	300 CT 400 CT	7 7	12 16	20		500	
DO-T13	600 CT 800 CT	5 5	12 16	43		500	
DO-T14	800 CT 1070 CT	4 4	12 16	51		500	
DO-T15	1000 CT 1330 CT	3.5 3.5	12 16	71		500	
DO-T16	1500 CT 2000 CT	3 3	12 16	108		500	
DO-T17	7500 CT 10,000 CT	1 1	12 16	505		500	
DO-T18	300 CT 500 CT	7 5.5	600 800	19	20	500	DI-T18
DO-T19	900 CT	4	600	53	53	500	DI-T19
DO-T20	1500 CT 600	3 5	600 1500 CT	86	87	500	DI-T20
DO-T21	20,000 CT 30,000 CT	.5 .5	800 CT 1200 CT	850	815	100	DI-T21
DO-T22	200,000 CT 500 CT	0 0	1000 CT 100,000 CT	8500		25	
DO-T23	10,000 CT 12,000 CT	1 1	1500 CT 1800 CT	800	870	100	DI-T23

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-T24	Reactor 4.5 Hys./2 Ma., 6 Hys./2 Ma., 1.5 Hys./5 Ma.	.2 Ma., .5 Ma.	1.2 Hys./4 Ma.	2300			DI-T24	
DO-T25	Reactor .9 Hy./2 Ma., 1.25 Hys./2 Ma., .5 Hy./6 Ma.		.11 Ma.	100			DI-T25	
DO-T26	Reactor .1 Hy./4 Ma., .08 Hy./10 Ma.		.10 Ma.	25			DI-T26	
DO-T27	120 CT 150 CT	10 10	3.2 4	10		500		
DO-T28	320 CT 400 CT	7 7	3.2 4	20		500		
DO-T29	640 CT 800 CT	5 5	3.2 4	43		500		
DO-T30	800 CT 1000 CT	4 4	3.2 4	51		500		
DO-T31	1080 CT 1330 CT	3.5 3.5	3.2 4	71		500		
DO-T32	1600 CT 2000 CT	3 3	3.2 4	109		500		
DO-T33	8000 CT 10,000 CT	1 1	3.2 4	505		100		
DO-T34	10,000 CT 12,000 CT	1 1	10,000 CT 12,000 CT	950	970	100	DI-T34	
DO-T35	2000 CT 2500 CT	3 3	8000 Split 10,000 Split	185		100		
DO-T36	10,000 CT 12,000 CT	1 1	2000 Split 2400 Split	560		100		
DO-T37	20,000 CT 30,000 CT	.5 .5	1000 Split 1500 Split	800		100		
DO-T38	40,000 CT 50,000 CT	.25 .25	400 Split 500 Split	1700		50		
DO-T39	400 CT 500 CT	8 6	400 Split 500 Split	48		500		
DO-T40	400 CT 800 CT	8 8	180 Split 150 Split	48		500		
DO-T41	400 CT 500 CT	8 8	40 Split 50 Split	48		500		
DO-T42	90 CT 100 CT	12 10	32 Split 40 Split	9.8		500		
DO-T43	Drawn Hipermalloy shield and cover 20/30 db							DI-T43

† DCMA shown is for single ended usage (under 5% distortion—100MW—1KC) . . . for push pull, DCMA can be any balanced value taken by .5W transistors (under 5% distortion—500MW—1KC)
† DO-T & DI-T units designed for transistor application only. Pats. Pend.
• DO-T37 thru DO-T44 newly added to series.



COVER: Free-form concentric shapes stress the compressibility and miniaturization aspects of the cooling device represented on the cover. A stylized drawing shows the inner design of the three-stage assembly while progressively darker arrows symbolize heat being carried off. Art critics who may notice similarities between this cover and the paintings on the ceiling of the Sistine Chapel in Rome will be interested to learn that both Michelangelo and ED Art Director Ray Schulze executed their work while lying on their backs. The difference is that Schulze is recovering from a bout of virus hepatitis.

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308	318	328	338	348	358	368	378	388	398	408	418	428	438	448	458	468	478	488	498	508	518	528	538	548	558	568	578	588	598
309	319	329	339	349	359	369	379	389	399	409	419	429	439	449	459	469	479	489	499	509	519	529	539	549	559	569	579	589	599

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602	612	622	632	642	652	662	672	682	692	702	712	722	732	742	752	762	772	782	792	802	812	822	832	842	852	862	872	882	892
603	613	623	633	643	653	663	673	683	693	703	713	723	733	743	753	763	773	783	793	803	813	823	833	843	853	863	873	883	893
604	614	624	634	644	654	664	674	684	694	704	714	724	734	744	754	764	774	784	794	804	814	824	834	844	854	864	874	884	894
605	615	625	635	645	655	665	675	685	695	705	715	725	735	745	755	765	775	785	795	805	815	825	835	845	855	865	875	885	895
606	616	626	636	646	656	666	676	686	696	706	716	726	736	746	756	766	776	786	796	806	816	826	836	846	856	866	876	886	896
607	617	627	637	647	657	667	677	687	697	707	717	727	737	747	757	767	777	787	797	807	817	827	837	847	857	867	877	887	897
608	618	628	638	648	658	668	678	688	698	708	718	728	738	748	758	768	778	788	798	808	818	828	838	848	858	868	878	888	898
609	619	629	639	649	659	669	679	689	699	709	719	729	739	749	759	769	779	789	799	809	819	829	839	849	859	869	879	889	899

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⚡ **202A FUNCTION GENERATOR—Down to 0.008 cps; transient-free!**

Uses: Electrical simulation of mechanical phenomena, vibration studies, servo research and testing, medical research, geophysical problems, subsonic and audio testing.

Advantages: No switching transients, continuously variable 0.008 to 1,200 cps range, 30 v output peak-to-peak constant, hum less than 0.05%, square, triangular or electronically synthesized sine waves, 1% stability, 0.2 db response, less than 1% distortion (sine waves) on all but x 100 range.

Price: \$550.00 (cabinet model), \$535.00 (rack mount).



⚡ **650A TEST OSCILLATOR—Flat within 1 db, 10 cps to 10 MC!**

Uses: Testing TV amplifiers or wide-band systems, measuring filter transmission characteristics and tuned circuit response, determining receiver alignment, making telephone carrier and bridge measurements.

Advantages: No zero set, no adjustments during operation, output voltage range 30 μ v to 3 v, less than 1% distortion, 20 cps to 100 KC; less than 2%, 100 KC to 1 MC; approx. 5% at 10 MC. Hum less than 0.5%, output voltage attenuator, self-contained voltmeter, 2% to 3% stability.

Price: \$550.00 (cabinet model), \$535.00 (rack mount).

**Easy to operate,
highly stable,
wide range**



PRECISION OSCILLATORS

⚡ precision oscillators perform a wide variety of audio, video, and low frequency tests. They offer the outstanding advantages of flexibility and broad usefulness at moderate cost. Employing the ⚡ pioneered RC resistance capacity circuit, the units combine accuracy and reliability with ease of operation and minimum adjustment.



⚡ **205AG AUDIO SIGNAL GENERATOR—Six instruments in one; 20 cps to 20 KC!**

Uses: Measure amplifier gain and network frequency response, measure broadcast transmitter audio and loudspeaker response, drive bridges, use in production testing or as precision source for voltages. Monitors oscillator output, measures output of device under test.

Advantages: Self-contained instrument, no auxiliary equipment needed. 5 watts output, \pm 1 db response, less than 1% distortion, hum more than 60 db down, no zero setting, output and input meters read v and dbm; four output impedances.

Price: \$600.00 (cabinet model), \$585.00 (rack mount).



⚡ **206A AUDIO SIGNAL GENERATOR—Less than 0.1% distortion; 20 cps to 20 KC!**

Uses: Convenient, precision audio voltage source; checks FM transmitter response, makes high quality, high fidelity amplifier tests, transmission measurements.

Advantages: Continuously variable audio frequency voltage, (output 15 dbm) 0.2 db response, hum 75 db down, 2% frequency accuracy, less than 0.1% distortion. 111 db attenuator with 0.1 db steps.

Price: \$800.00 (cabinet model), \$785.00 (rack mount).

Data subject to change without notice. Prices f.o.b. factory.



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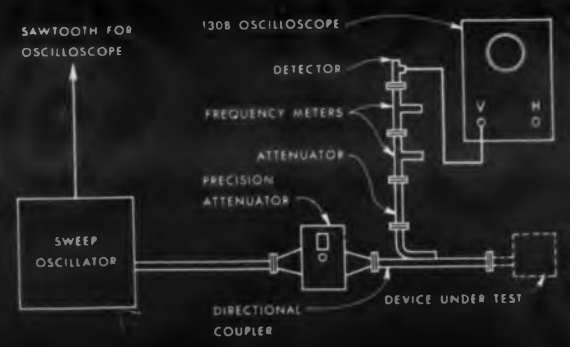
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All electronic; no mechanical

Output level over entire frequency range

Direct reading

Independently adjustable sweep range, sweep rate

Equipment arrangement for automatically displaying magnitude of reflection from device under test

hp Dependable, quality instruments

FOR MORE OSCILLATORS, LIFT PAGE

6956B

ELECTRONIC DESIGN • February 1, 1961

Hewlett-Packard Electronic Sweep Oscillators are precision measuring tools deliberately designed to give you simpler, faster microwave measurements. Five models are provided, covering frequencies 1.0 to 18.0 KMC as follows: Model 682C, 1.0 to 2.0 KMC; Model 683C, 2.0 to 4.0 KMC; Model 684C, 4.0 to 8.1 KMC; Model 686A, 8.2 to 12.4 KMC, and Model 687A, 12.4 to 18.0 KMC.

These instruments make possible microwave investigations and evaluations with a convenience previously associated only with lower frequency measurements. Each oscillator provides a wide range of sweep speeds so that measurements of reflection, attenuation, gain etc., can be displayed on an oscilloscope or recorded in permanent form on X-Y or strip-chart recorders.

Electronic Sweeping

Specifically, the sweep oscillators provide either a CW or swept rf output throughout their individual bands. The instruments employ new backward wave oscillator tubes whose frequency is shifted by varying an applied potential. Thus, troublesome mechanical stops and tuning plungers are eliminated. Sweep range is continuously adjustable and independently variable; sweep rate is selected separately, and either can be changed without interrupting operation. The full band width can be covered in time segments ranging from 140 seconds (very slow for mechanical recorder operation) to 0.014 seconds (high speed for clear, non-flickering oscilloscope presentation).

Linear Frequency Change

The swept rf output from the sweep oscillator is linear with time, and a linear sawtooth voltage is provided concurrent with each rf sweep to supply a linear time base for an oscilloscope or recorder. In addition, for convenience in recording and other operations, rf sweeps can be triggered electrically externally and single sweeps can be triggered by a front panel push button. The rf output can also be internally AM'd from 400 to 1,200 cps and externally AM'd or FM'd over a wide range of frequencies.

Leveled Output

Models 682C, 683C, 684C provide leveled power output over their entire swept frequency ranges. An open-loop leveler is built into each instrument and provides leveled output without external equipment and at no extra cost. The leveler, which controls voltage on the grid of the backward wave oscillator tube, can be switched out of the circuit by means of a front panel control. Power variation over entire range: 682C, 683C $< \pm 1.5$ db; 684C $< \pm 2$ db; 686A (leveler not required) ± 1.5 db; 687A ± 4.5 db.

Rapid Visual Presentation

The variety of sweep rates and band widths available from the sweep oscillators insures convenience and accuracy for reflection and transmission coefficient measurements and many other production line and laboratory tests. For maximum speed, an oscilloscope such as 130B may be used as indicated in the diagram on opposite page. For maximum information and a permanent record, an X-Y or strip-chart recorder may be used.

Complete details of a rapid visual method using an oscilloscope or a maximum-data, permanent record method using a recorder may be obtained from your field engineer. Detailed discussions of these methods are also contained in the Journal, Vol. 8, No. 6, and Vol. 9, No. 1-2, available on request.

8741

TYPICAL SPECIFICATIONS

Below are specifications for 686A Sweep Oscillator, 8.2 to 12.4 KMC. Specifications for 682C, 683C, 684C, and 687A (P band) are similar except for frequency range and other minor variations.

Types of Outputs: Swept Frequency, CW, FM, AM.

Single Frequency Operation

Frequency: Continuously adjustable 8.2 to 12.4 KMC.

Power Output: At least 10 milliwatts into matched waveguide load. Continuously adjustable to zero.

Swept Frequency Operation

Sweep: Recurrent; externally triggered; also manually triggered single sweep. Rf sweep linear with time.

Power Output: At least 10 MW into matched waveguide load. Output variation less than 3 db over entire 8.2-12.4 KMC range.

Sweep Range: Adjustable in 7 steps: 4.4 MC to 4.4 KMC.

Sweep Rate-of-Change: Decade steps from 32 MC/sec. to 320 KMC/sec.

Sweep Time: Determined by sweep range and rate; from 0.0139 to 139 seconds; over full-band.

Sweep Output: Approx. ± 25 -volt-peak sawtooth provided at a front-panel connector; concurrent with each rf sweep.

Modulation

Internal Amplitude: Square wave modulation continuously adjustable from 400 to 1200 cps; peak rf output power equals cw level ± 1 db.

External Amplitude: Direct coupled to 300 KC; 20 volt swing reduces rf output level from rated cw output to zero.

External Pulse: ± 10 volts or more, 5 millisecond maximum duration.

External FM: Approx. 350 v peak to modulate full frequency range.

General

Input Connectors, Impedances: BNC; above 100,000 ohms.

Output Connector: Waveguide cover flange (686A, 687A); Type N, female (682C, 683C, 684C).

Sweep Width: Accuracy, $\pm 10\%$ for full band sweep. $\pm 25\%$ - 15% or ± 3 MC, whichever is greater, for other calibrated sweeps.

Linearity: Half-voltage point of sweep output occurs within 5% of mid-frequency.

Power Requirements: 115/230 volts $\pm 10\%$, 50/60 cps; approximately 540 watts.

Price: ϕ 682C (1.0 to 2.0 KMC)	\$3,090.00
ϕ 683C (2.0 to 4.0 KMC)	3,000.00
ϕ 684C (4.0 to 8.1 KMC)	2,900.00
ϕ 686A (8.2 to 12.4 KMC)	2,900.00
ϕ 687A (12.4 to 18.0 KMC)	3,400.00

(Prices above are f.o.b. factory for cabinet models. Rack mount instruments \$15.00 less.)

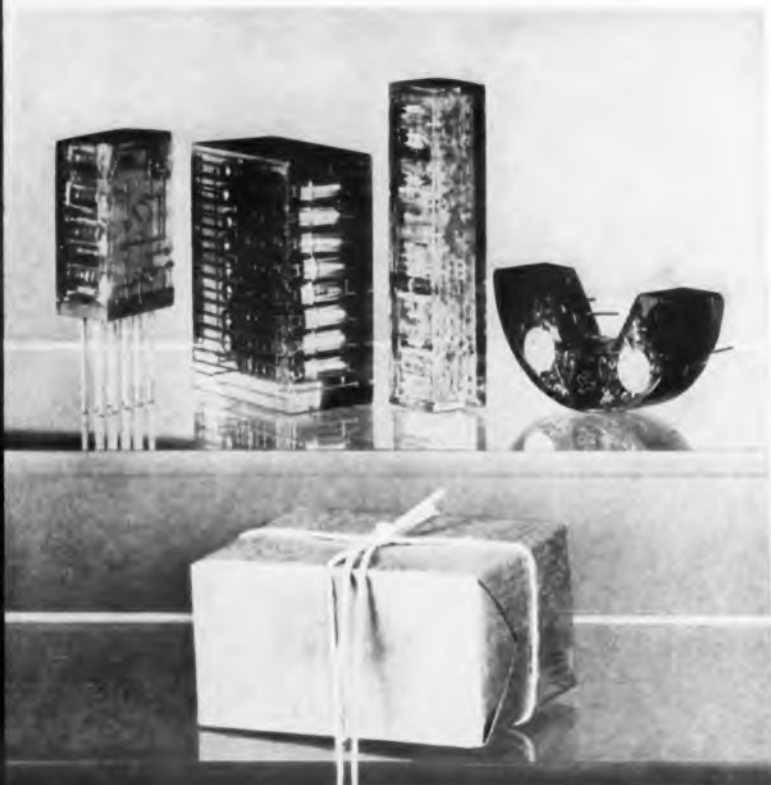
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Coming Next Issue

In the Sept. 28, 1960, issue of **ELECTRONIC DESIGN**, the editors explored the subject of "Converting Heat to Electricity." In that Staff Report, we examined the fields of thermoelectricity, thermionics, and magneto-hydrodynamics (MHD).

In the Feb. 15 issue, in another Staff Report, **ELECTRONIC DESIGN** will analyze in depth three techniques of energy conversion—batteries, fuel cells, and solar cells. This analysis will consist of three articles by engineers well versed in the application of these techniques.

For space and for many ground-based applications, power sources for electronic equipment must possess such characteristics as light weight, compact size, reliable and unattended operation, high energy per unit weight and volume, and long life. Many of these goals can be reached only through efficient use of the techniques which we will describe in the next issue.



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CIRCLE 5 ON READER-SERVICE CARD

Steered Arrays Sought for Communications

Electronically Steered Arrays Held Useful for Communications; Beam-Switching and Phase-Shifting Systems Now in Design.

Alan Corneretto
News Editor

SUCCESSFUL first test of a five-story electronically steerable array radar (ESAR), designed by Bendix Radio Div., Baltimore, for the Air Force and the Advanced Research Projects Agency, has raised hopes that electronic-beam steering techniques may be applicable to communications systems.

Bendix engineers are planning a series of communications tests for ESAR, which was designed as part of a developmental scanning and tracking system for aircraft, missile and space-vehicle surveillance. They believe that the existing system could be used for communications with only slight changes.

At General Electric's Defense Systems Div., Syracuse, N.Y., researchers are planning to add electronic phase shifters to a recently built, 24-



Communications use is planned for ESAR electronically steered L-band array designed for radar surveillance. Array is part of frequency-conversion phase-shifting system controlled by Bendix-designed digital programmer. Sloping, 50-by-50-ft face is fitted with radiating elements arranged in circular aperture of about 50-ft in diameter.

by-24 element, electromechanically steered communications array from which they are getting their first experimental results.

Other companies, notably W. L. Maxson Corp., Avco Electronics and Ordnance Div., Sanders Associates, and Sylvania Electronic Systems Div., are also exploring the use of electronically steered communications arrays.

Two Types of Systems Are Under Consideration

Two of the three general types of electronically scanned antennas are being considered for communications. Bendix, GE, and Sanders are studying phase-shifting systems, in which there is one feed line and each radiating element requires a program-driven phase shifter. Maxson is concentrating on a beam-switching system that is essentially a fixed-phase shifting system. It would cover a sector with a large number of beams that would remain on and be available for communications at all times. In this system, a feed line mated to a directional coupler is provided for each beam.

The general goal of both methods is to achieve the coverage of an omnidirectional dipole with the directivity and gain of array antennas. Maxson studies indicate that a compact, multiple-beam communications array could have at least 10-db gain to as much as 40 db, depending on required beamwidth and range. Such an array, equivalent to a 10-ft dish, would only be about 8 by 6 by 1 ft. It could support a six-way communications net, Maxson engineers suggest.

Electronic Scanning Has Four Main Advantages for Communications

Four important advantages are cited for electronically steered arrays—flexibility, high-power transmission, adaptability to site hardening, and reliability.

Flexibility is largely a result of high scanning speed, possible because of the lack of inertia common in mechanically moving systems. The 50-by-50-ft face of ESAR, which uses a frequency-conversion phasing scheme, can be scanned along its greatest dimension in less than 20 μ sec. In some phased-array systems, inde-

pendent beams can be used to receive signals transmitted from several sources simultaneously.

Maxson is studying many versions of its multi-beam system for potential short-range communications use by a military agency. These systems are adaptations of the 3-D radar system the company has designed for the Federal Aviation Agency. Use of two arrays in a multibeam system would make it possible to receive and transmit simultaneously, the company reports.

Some types of electronically steered communications systems are expected to be versatile enough to track a transmitting source automatically while maintaining communications.

In phased-array systems, like ESAR, that use multiple transmitters independently connected to individual antenna elements, high-voltage breakdown is said to be avoided at extremely high power. Also, the high available power can be used to achieve wide bandwidths, a benefit



L-band log periodic antenna element of ESAR array is one of 8,768 foam-potted units installed in system. Element was chosen for its low mutual coupling—about -25 db—and for its broad bandwidth.

that appears to be growing in importance.

Suitability for hardened sites is another advantage cited for electronically steered arrays. Hardening a conventional communications site is difficult if a moving or a mast antenna is involved. Additional problems can result if a feed horn is included. GE has an Air Force contract to investigate hardened communications antennas of both the electronically and the electro-mechanically steered type. Bendix reports that its studies indicate phased arrays can be hardened economically.

Phased-array systems using independently connected, redundant transmitters are inherently reliable from the system point of view, Bendix reports. Faulty components are not likely to interrupt performance of such a system.

Most Promising Application— Space Communications

The companies investigating electronically steered arrays for communications expect that satellite and other space-probe projects will prove the most advantageous application of such systems. Command and control over space vehicles could be maintained by the tracking system, or conversely, the received message signal could be used for tracking. Maxson, however, is concentrating on short-hand microwave systems, including some suitable for truck mounting. One would be a scatter system.

Wide bandwidth resulting from available high power would make possible easy handling of video and other wideband data. Another application would be in angle-diversity communications systems. Formation of multiple beams with fixed displacement from each other permits introduction of very-high-order angle-diversity systems. Bendix engineers expect orders of angle diversity that cannot be approached reasonably with multiple feeds placed near the focal point of a paraboloid. A cluster of pencil beams having five elevation rows and five azimuth columns can provide 25-order angle diversity, they state.

Problems—Signal Intermodulation, Mw Waves, Simplified Design

Bendix is testing the effects of mutual coupling of antenna elements and the effects of system nonlinearities, which result in signal intermodulation in the ESAR-type system. The company does not expect signal intermodulation to prove a serious disadvantage, however, Bendix says.

The developmental ESAR built near Baltimore is an L-band system. For much higher frequencies—approaching millimeter waves—the logarithmic antenna elements used would become impractically small and numerous. The company is investigating ways of using a printed antenna pattern and an improved feed system. ■ ■

CIRCLE 6 ON READER-SERVICE CARD ►



Actual photograph
of radar display
showing target trails.

Raytheon Recording Storage Tubes Add Greater Capabilities to Your Radar System Designs

The advanced design features of Raytheon Recording Storage Tubes offer designers of radar systems many new application possibilities.

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NEWS

Design Details Outlined
Thermoelectricity Symposium Hears

DESIGN details of a 5-kw thermoelectric generator were revealed by Westinghouse Electric Corp. at the Symposium on Thermoelectric Energy Conversion in Dallas, Tex.

Device design, methods of measuring key parameters, and special problems such as high-temperature operation also drew much attention at the meeting.

The Westinghouse generator, built for the Navy's Bureau of Ships, uses thermocouples made of an improved p-type material, GeBiTe, which was developed for use in the 400- to 550-C range.

Unit Could Be Even Smaller,
According to Project Engineers

Project engineers T. M. Corry, J. C. Kastovich, M. D. Fisher, and W. C. Moreland reported that if a similar generator were built today it could be half the size of the first unit, because of the knowledge gained in the development.

The generator directly converts heat, provided by the burning of kerosene or other fuel, into electric power. Because of heat-flux limitations, two units are required to provide 5 kw. Each of the two subgenerators contains 14 thermoelectric-generator modules placed circumferentially around the central heat source. Each generator module consists of 85 thermocouples.

Thermocouples Joined in Series
Provide 8.5 v, 200 w From Each Module

Thermocouples are connected in series so that each module provides output of about 8.5 v at 200 w into a matched resistance load of about 0.3 ohm. The generator modules can then be connected in series, parallel, or any combination arrangement necessary. Cold water is used to carry heat away from the cold sides of the junctions, according to the description.

Original life tests on the thermocouples are still being monitored, however the tests have indicated a useful life in excess of 3,000 hr under simulated generator conditions.

The focus on devices at the conference was in sharp contrast to the situation at the first industry-wide thermoelectric symposium two years ago. Engineers at the meeting reminisced about the last conference when the state-of-the-art was such that a device paper could not be found on the program. Material characteristics and con-

For Thermoelectric Unit Device Uses Thermocouples to 550 C

tact-resistance problems were the major topics discussed at that time.

Irradiation Effects, Encapsulation Among Subjects Discussed

Among the key problem areas brought up at this year's meeting were irradiation effects on materials, encapsulation techniques, and high-temperature operation. Rare-earth elements, available only in limited quantities until recently, are now being investigated for possible thermoelectric applications.

Sophisticated approaches, involving the use of computers, are being applied in describing the operation of thermoelectric elements, papers indicated. These techniques are also being evolved to achieve optimum design of segmented power generators. Analytical methods are complex, and generally result in inexact approximations. Further refinements in design approaches, such as those discussed, should lead to improved performance of operating equipment.

The commercial availability of thermoelectric generators, in ratings of 5, 10, 50 and 100 w, were announced at the conference by Westinghouse.

Prototype units are now available, with prices ranging from \$1,700 to \$6,000. Life of the devices is estimated at from one to five years. ■ ■



Westinghouse engineer checks over 5-, 10-, 50-, and 100-w thermoelectric generators now commercially available, on a prototype basis, from the company. Price ranges from \$1,700 to \$6,000.



Know ye that we, the corporation of Burnell & Co., upon the recommendation of our customers in the electronics industry do hereby inaugurate the esteemed order of Shrinker Cum Laude.

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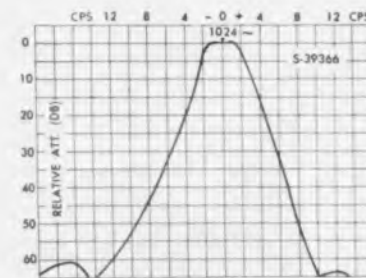
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CIRCLE 8 ON READER-SERVICE CARD

Slow but Steady Growth Seen for Marine Electronics

Japanese Entry Into Market Will Mean Stiff Competition, Electronic Exhibitors at New York Boat Show Predict

STEADY GROWTH in marine electronics sales, rather than a boom, was foreseen by manufacturers exhibiting their wares at the National Motor Boat Show in New York. Thanks to the recession, the much-touted boom in sea-going electronics never made it away from the dock in 1960 according to the final tally.

With all figures now in, the \$20 million market predicted for 1960 shrank to about \$11 million. This market was shared by more than 30 manufacturers, with major slices going to Ray-

theon, Sperry, and Radio Corp. of America.

Mounting Japanese competition will also affect the sales picture. Novel designs and obviously high quality characterized Japanese loran receivers, radio direction finders, and depth sounders on exhibit at the show.

Nevertheless, a number of new sales areas were seen as contributing to future growth. The introduction of alternators in larger outboard motors will mean power aplenty for boats so equipped and a new market for larger items such

as radar and high-powered radiophones.

Another big market may shape up if air and marine navigation systems ever meet on common ground. "Right now there are about a dozen different methods of electronic navigation, including direction finders, loran, Consolan, and the several aviation systems," Raytheon staff planner Columbus Iselin noted. "I believe a common system, probably a form of loran, is certain to be instituted. The resultant combined market will mean lower prices and increased sales." ■ ■



Electronic skipper keeps in touch with Raytheon's 100-w marine radiophone. Watt-power race is shaping up in radiophones as more stations go afloat. Units up to 250 w are now available and salesmen warn that only the bigger sets have a decent chance of being heard. With power going up, the all-transistorized transmitter is further deferred. Designers are continuing their preference for tubes, which have proved to be more reliable, stable, and easier to service in marine gear. Approximately 15,000 radiophones were sold last year for a total market of about \$6 million. The second largest market in marine electronics was in depth sounders—20,000 units for about \$3.5 million.



Hottest items in marine electronics are citizens-band radios such as this miniature unit by Ray Jefferson, Inc. More than 90 manufacturers are now competing for a share of this market, non-existent two years ago. Citizens-band radios are meant to supplement rather than replace conventional radiophones, but customers have not been fully educated on this point, according to some of the more conservative exhibitors queried at the Boat Show. Units have limited power and range, but are proving popular for outboards. FCC licensing is not required, and many transceivers sell for less than \$100.

Exhibitors at show predict shakeout in this field as novelty of handie-talkies wears off. Crowding of the few available channels should also level off sales of citizens-band units.



Radar afloat, such as this Sperry Radar "Five," is proving to be a slow-moving item. Only about 300 sets were sold last year by all manufacturers at about \$2,000 apiece. Some manufacturers predict that unsophisticated, stripped units for less than \$1,000 are on the way.

The industry's broadest line of COMMUNICATIONS TRANSISTORS



Japanese radio direction finders are imported by Bendix. Upper unit is a conventional, transistorized receiver with rotating loop and null meter. Lower instrument is an automatic direction finder with nonrotating loop and crt display selling in the \$1,500 class. Neat, terminal-board-type wiring is used. Both finders are made by Kodin Electronics Co. Bendix spokesmen indicate that the company plans to import other types of gear in the near future.



Loran from Japan features automatic readout on Nixie-type tubes. The receiver is transistorized and uses modular, plug-in units to speed maintenance. Manufacturer is Faruno Electronics Co.; importer is Triton Marine Products. The two companies also market a recording depth finder here. Prices of both units are equal to or higher than U. S. equipment and the distributor is emphasizing quality and design rather than price.

CIRCLE 9 ON READER-SERVICE CARD ▶

PHILCO COMMUNICATIONS TRANSISTORS

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20 KC-2 MC	2N113 2N114 2N115 2N116 2N117 2N118 2N119 2N120	2N121 2N122 2N123 2N124 2N125 2N126 2N127 2N128 2N129 2N130	2N131 2N132 2N133 2N134 2N135 2N136 2N137 2N138 2N139 2N140	2N141 2N142 2N143 2N144 2N145 2N146 2N147 2N148 2N149 2N150	2N151 2N152 2N153 2N154 2N155 2N156 2N157 2N158 2N159 2N160	2N161 2N162 2N163 2N164 2N165 2N166 2N167 2N168 2N169 2N170	2N171 2N172 2N173 2N174 2N175 2N176 2N177 2N178 2N179 2N180
2-10 MC	2N181 2N182 2N183 2N184 2N185 2N186 2N187 2N188 2N189 2N190	2N191 2N192 2N193 2N194 2N195 2N196 2N197 2N198 2N199 2N200	2N201 2N202 2N203 2N204 2N205 2N206 2N207 2N208 2N209 2N210	2N211 2N212 2N213 2N214 2N215 2N216 2N217 2N218 2N219 2N220	2N221 2N222 2N223 2N224 2N225 2N226 2N227 2N228 2N229 2N230	2N231 2N232 2N233 2N234 2N235 2N236 2N237 2N238 2N239 2N240	2N241 2N242 2N243 2N244 2N245 2N246 2N247 2N248 2N249 2N250
10-30 MC	2N251 2N252 2N253 2N254 2N255 2N256 2N257 2N258 2N259 2N260	2N261 2N262 2N263 2N264 2N265 2N266 2N267 2N268 2N269 2N270	2N271 2N272 2N273 2N274 2N275 2N276 2N277 2N278 2N279 2N280	2N281 2N282 2N283 2N284 2N285 2N286 2N287 2N288 2N289 2N290	2N291 2N292 2N293 2N294 2N295 2N296 2N297 2N298 2N299 2N300	2N301 2N302 2N303 2N304 2N305 2N306 2N307 2N308 2N309 2N310	2N311 2N312 2N313 2N314 2N315 2N316 2N317 2N318 2N319 2N320
30-70 MC	2N321 2N322 2N323 2N324 2N325 2N326 2N327 2N328 2N329 2N330	2N331 2N332 2N333 2N334 2N335 2N336 2N337 2N338 2N339 2N340	2N341 2N342 2N343 2N344 2N345 2N346 2N347 2N348 2N349 2N350	2N351 2N352 2N353 2N354 2N355 2N356 2N357 2N358 2N359 2N360	2N361 2N362 2N363 2N364 2N365 2N366 2N367 2N368 2N369 2N370	2N371 2N372 2N373 2N374 2N375 2N376 2N377 2N378 2N379 2N380	2N381 2N382 2N383 2N384 2N385 2N386 2N387 2N388 2N389 2N390



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NEWS

Digital-TV Applications

Slow-Scan, Contour-Free Digital TV May Be Used in Space Applications

A SLOW-SCAN, contour-free digital TV system in development by Ball Bros. Research Corp. may be tabbed for eventual use aboard Mariner and other interplanetary probes.

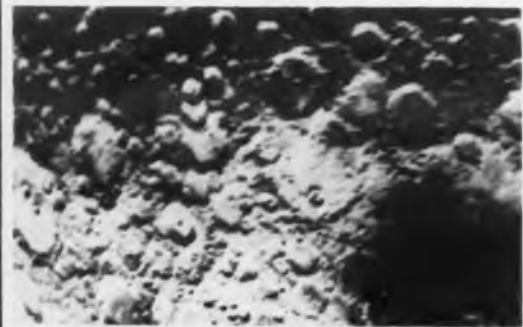
The Boulder, Colo., firm, a relative newcomer to the digital TV game, has been conducting a six-month feasibility study under contract to Jet Propulsion Laboratory and plans to demonstrate an operating breadboard at JPL later this month.

The encoding system designed by Ball Brothers is based essentially on delta-modulation principles, but includes several proprietary innovations. The usual bandwidth-conservation advantages of delta modulation are claimed, but the problems inherent in this design approach, particularly contouring, are said to be minimized.

Contouring, the presence of sharp demarcations between adjacent areas of different tone values, is generally present to some extent in all pulse-code modulation and digital TV systems. In pcm TV, contouring is reduced by employing a large number of quantizing levels. Some pcm systems employ as many as 128 levels; yet, psychological studies have indicated that the human eye can distinguish no more than 8 to 10 different shades of gray on a TV screen.

Delta-modulation TV likewise requires a larger number of quantizing levels than are psychologically necessary to minimize contouring.

The equipment to be demonstrated at JPL will have independently variable scan, clock, and quantizing rates. Scan will be varied from one line to 20 lines per sec and quantizing from 3 to 16 levels. Only motionless, monoscope pictures, as would be transmitted from a space vehicle, will be demonstrated. ■ ■



Ten quantizing levels were used to reproduce this lunar photograph by delta-modulated TV, according to Ball Bros. Research Corp. The presentation (with 525-line scan) appears quite free of contouring and has a fairly good gray scale.

Pushed By Industry

Live Demonstration in Washington Seen Sparking Government Tests

THE NEXT round in a persistent "underground" campaign aimed at obtaining a government-sponsored test of digital TV will begin later this month in Washington, D.C. The occasion will be a live demonstration of digital TV at a meeting of the Washington section of IRE on Feb. 13.

Supporters of the test—primarily the Colorado Research Corp., CRC alumni now at neighboring Ball Bros. Researching Corp., and the National Bureau of Standards—are hoping for a test sponsored by the Federal Communications Commission.

All three organizations will be represented at the Washington session. Ball Brothers will demonstrate live equipment, while Dr. Richard Webb, president of CRC, and William Coombs of NBS will discuss new modulation principles and bandwidth-conservation aspects of digital TV.

Advocates of digital TV point out that elimination of redundant-information transmission, possible through digital coding methods, could result in a significant reduction of bandwidth per TV channel. The uhf TV tests set for New York City would provide a convenient opportunity for definitive tests of digital TV's propagation characteristics and quality, it is said.

At a closed meeting at Massachusetts Institute of Technology last spring, the FCC, NBS, Bell Telephone Laboratories, and other interested organizations discussed the pros and cons of digital telecasting in considerable detail. The outcome was a recommendation to the Commission that the subject deserved further investigation and testing.

The FCC's research branch, however, is still "preparing these findings for submission to the commissioners," according to a spokesman.

Modulation techniques to be discussed at the Washington meeting will emphasize "differential quantizing." This technique, evolved from the better-known delta-modulation scheme, requires a video encoder with nonlinear response characteristics. Amplitude of the encoder pulse varies exponentially with the brightness of the area being scanned.

The differential quantizing technique results in an effectively great number of quantizing steps in the low-frequency (lightly shaded) areas of the picture. Since the eye is most sensitive to contouring in those areas, additional gray levels to minimize contouring are provided only where they are actually needed. ■ ■

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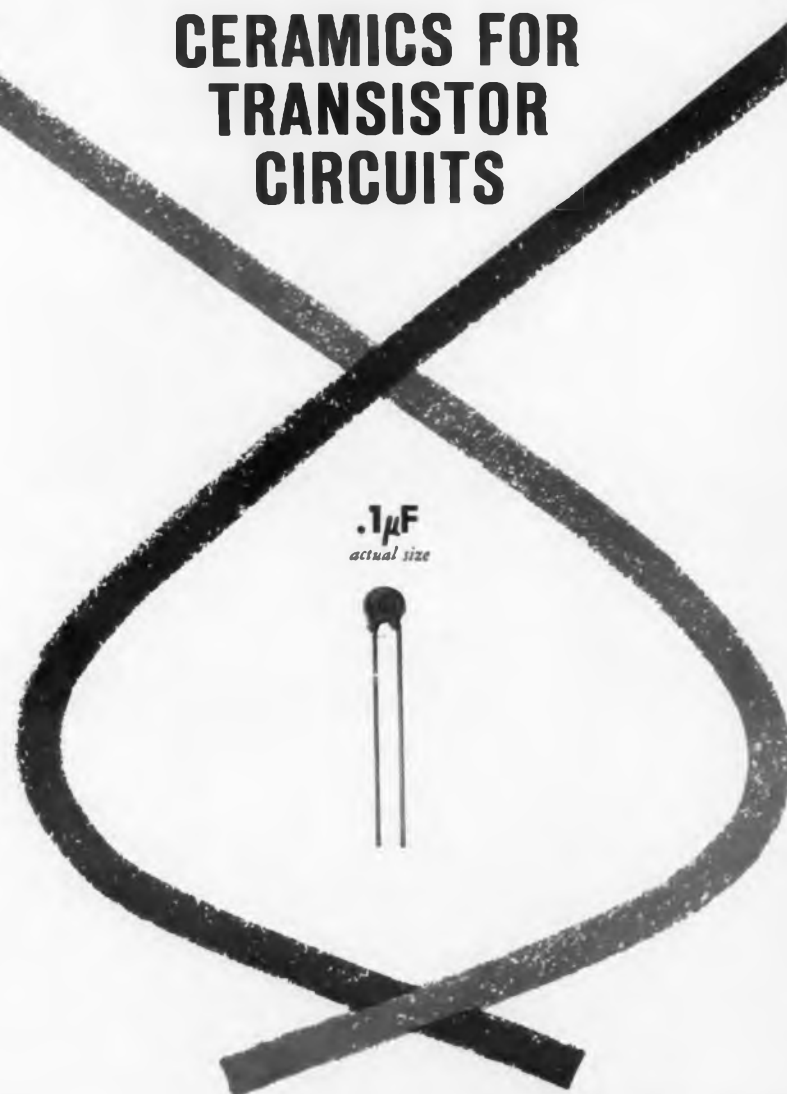
Hypercons have excellent stability, exhibiting no loss in capacitance when operating above room temperature. Their triple-purpose resin coating serves as insulation as well as protection against moisture and mechanical damage.

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.22	.275	.1	.400
.47	.400	.22	.595
1.0	.595	.47	.840
2.2	.840		





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Design Flaws Called Top Unreliability Cause

AGREE Testing Procedures Detect Many Nonrandom Equipment Failures

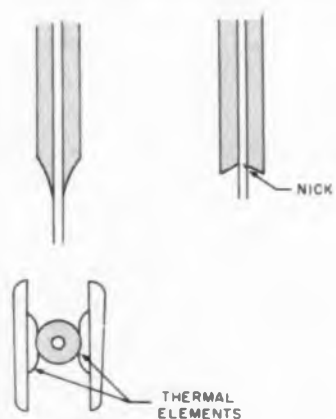
Robert Haavind
News Editor

DESIGN FLAWS have been the most commonly detected reason for unreliability in airborne equipment checked by the Air Force under rigid Advisory Group on Reliability of Electronic Equipment (AGREE) reliability requirements, according to an Air Force spokesman.

This, and other conclusions reached through the applications of AGREE procedures, were presented by Griffith W. Lindsay, staff engineer, Communications and Reconnaissance Div. of the Air Materiel Command's Aeronautical Systems Center, Wright-Patterson AFB, Dayton, Ohio, during the Seventh National Symposium on Reliability and Quality Control in Philadelphia.

The majority of field failures classed as random in operational studies are not actually random, but can be traced to specific correctable causes, it was determined. AGREE testing proved an effective tool for detecting weaknesses in design in time to correct them early in a program, Mr. Lindsay said. Methodical development is necessary to achieve reliable equipment, he commented, but it does not assure reliability.

Failure modes uncovered by the AGREE program, Mr. Lindsay commented, could not have been found by using any other commonly known test method. These failures would have eventually occurred in operating equipment, so that

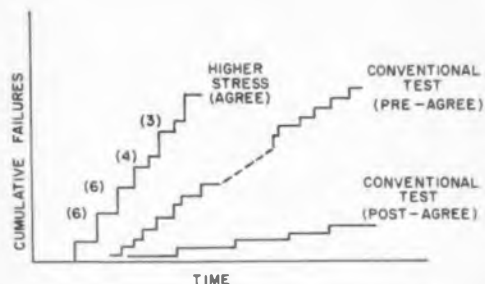


Nicked wire caused by stripping tool, upper right, was a problem uncovered during one AGREE test, engineer Griffith W. Lindsay told **ELECTRONIC DESIGN**. The manufacturer overcame the trouble by designing a thermal stripping tool, lower left, which allows removal of insulation without damaging wire, as shown upper left.

Examples of Reliability Improvements Through Use of AGREE Procedures, Type H

Equipment	Initial MTBF	MTBF After AGREE	Number of Electronic Parts
Time Division Data Link (ARR-60)	50	200	5,890
Time Division Data Link (ARR-61)*	—	250	3,382
Short Range Navigation Equipment (TACAN)	17.5	150	1,010
Airborne Radar	under 13.9	over 55	1,349
Airborne Radar	3.5	over 20	9,000

*Corrective action taken on the basis of the ARR-60 tests was incorporated in the design of the ARR-61, resulting in acceptance on initial tests.



Under ordinary tests the failure rate of debugged equipment tends to be fairly constant, with seemingly "random" failures. With the high-stress tests prescribed by AGREE, however, failures tend to occur in groups, indicating specific failure modes. Corrective action results in a significant decrease in the slope of the failure rate curve.

the cost of AGREE testing is more than covered by future savings in maintenance and supply costs, according to the AMC engineer.

Stresses Exceeding Any Expected in Operation; Special Statistical Methods Necessary

The following recommendations for specifying reliability requirements were developed.

- Statistical acceptance procedures must be made specially for each test.
- Test stresses must exceed any stress that may be encountered by the equipment under operational conditions.
- A few units must be tested for a relatively long time (at least three times the mean time between failures in the case of AGREE). Only after this procedure do statistical samplings of larger numbers of equipment for short periods become valid.
- Contracts containing reliability requirements should be awarded only to contractors having demonstrable reliability competence.

In making this last point, Mr. Lindsay explained that management is a vital factor in achieving reliability. If management does not maintain tight control over every detail of design and production, corrective action becomes difficult, he said.

It was evident at the reliability conference that the Air Force's Aeronautical Systems Center has taken the lead in applying AGREE procedures. The stringent testing requirements involved were recommended by a group composed of representatives from the Department of Defense and industry—the Advisory Group on Reliability of Electronic Equipment—to achieve desired reliability levels. Indications at the conference were that despite the proved effectiveness of the recommended procedures, the Navy, Army, and parts of the Air Force have been lagging in applying the requirements.

Design engineers came under fire during an

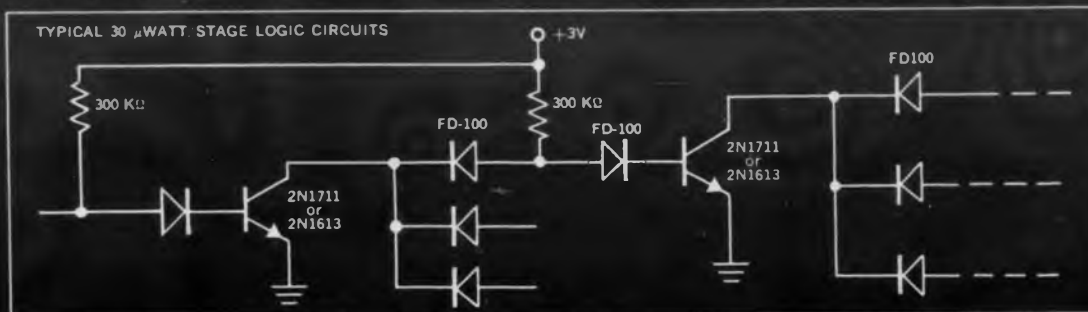
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Total diss.	V_{CBO}	V_{EBO}	h_{FE} ($I_C=150mA$) ($V_{CE}=10V$)	h_{FE} ($I_C=0.1mA$) ($V_{CE}=10V$)	C_{ob} ($I_E=0$) ($V_{CB}=10V$)	I_{CBO}	I_{CBO} ($V_{CB}=60V$) ($T=150^\circ C$)	I_{CBO} ($V_{CB}=50V$) ($T=125^\circ C$)
2N1613	3.0W	75V	7.0V	40-120	20 min.	18pf typ. 25pf max	0.8m μA typ. 10m μA max. ($V_{CB}=60V$)	1.0 μA typ. 10 μA max.
2N1711	3.0W	60V	7.0V	100-300	35 min.	25pf max.	10m μA max. ($V_{CB}=50V$)	10 μA max.
FD100	WIV	P diss.	T_A	T_{stg}	I_R ($V=-50V$)	R_θ (100 mc)		
	50V	250mW	-65° to +175°C	-65° to +200°C	0.1 μA	45%		

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0.001 to 999.9 volts, in 3 automatic or manual ranges, 60 to 1000 cps.

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10 megohms for DC, 1 megohm and 200 μ f for AC.

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NEWS

other session because of their frequent hesitation to change designs based on field data. Failures in operating equipment are too frequently blamed on poor field servicing, according to H. Bayer, Douglas Aircraft Co., Inc., El Segundo, Calif., when design problems are the actual cause of the difficulty.

Mr. Bayer recommended that before design engineers start on an important job, they be given an opportunity to observe operating conditions under which the planned equipment will be used. This would give the designer a better "feel" for the equipment, and would make him more understanding of feedback information when it is received from the field after the equipment goes into operation.

Despite detailed equipment specifications, Mr. Bayer commented, some important design features might be overlooked. On the other hand, some required tests may be too severe for the actual operating conditions to be encountered.

New Statistical Approach Suggested For Accelerated Semiconductor Testing

A new experimental and statistical approach to accelerated aging of semiconductors under high-stress conditions was described by G. A. Dodson and B. T. Howard, Bell Telephone Laboratories. This work is currently being applied to transistors being used in the Nike-Zeus anti-missile missile program, according to sources at the conference.

Temperature was the stress used in accelerated life testing of a pnp diffused-base germanium mesa transistor, type 2N559, used for high-speed switching at low power—about 150 mw. A set of temperature levels was selected for the tests, and a group of transistors was baked at each temperature level for a prescribed time interval. After each interval, the transistors were measured for failures, the temperature in the testing oven was raised to the next level, and the units were replaced for the next test interval. This procedure was repeated until all transistors failed. Then a new time interval was selected, and the procedure was repeated using the same temperature levels.

These tests gave failure distributions of stress with respect to time, and also time with respect to stress. Then an expression was sought for the median failure as a function of stress level, where median failure is defined as the time to fail half of the devices at a specified stress level.

Since this relationship is generally nonlinear, a suitable transformation of the axes was sought to obtain a linear plot. If the actual relationship could be determined in this manner, predictions of life distribution under normal operating

stresses could therefore be made conveniently.

Preliminary experiments indicated that the reciprocal of the absolute temperature was the proper stress transformation, according to Mr. Dodson, and temperature intervals were selected on this basis. The proper time transformation, according to preliminary results, is the logarithm of time. Log-normal plots of test data produced encouraging results.

Although the log-normal distribution has not been statistically proved, results so far indicate that it should prove a valuable tool in accelerated life tests.

Sequential Redundancy Appears Likely For Many Future Satellite Designs

Advantages cited for sequential rather than parallel redundancy may lead to this approach in many future satellite designs.

If it can be assumed that a particular device does not deteriorate appreciably with age, according to Dr. A. L. Aroian, Space Technology Laboratories, maximum reliability can be achieved through sequential redundancy, rather than with the usual parallel approach.

In a sequential system, redundant devices remain off until they are needed to replace devices that fail. In the usual parallel system, redundant units are turned on, and in stand-by condition, until they are needed. With the sequential approach, Dr. Aroian pointed out, each device is used for its full life, while in the parallel approach all devices wear out simultaneously.

Mathematical methods for dealing with problems such as gradual deterioration were developed by Dr. Aroian. R. H. Myers, Hughes Aircraft Co., presented advantages and disadvantages of each of the approaches from the standpoint of particular design requirements.

Neither approach is always best, they concluded, but the many advantages of sequential design should lead to greater use of it in future satellite and space-vehicle systems. ■ ■

Powder Metallurgists Organize New Section in New York Area

A new national organization for powder metallurgists, the American Powder Metallurgy Institute, has established a section of the Institute in the New York metropolitan area for engineers, metallurgists, and others interested in powder metallurgy.

Meetings will be held periodically during the fall, winter, and spring to exchange technical information and ideas, to discuss advances in powder metallurgy applications, and to hear speakers describe various aspects of the powder metallurgy industry.



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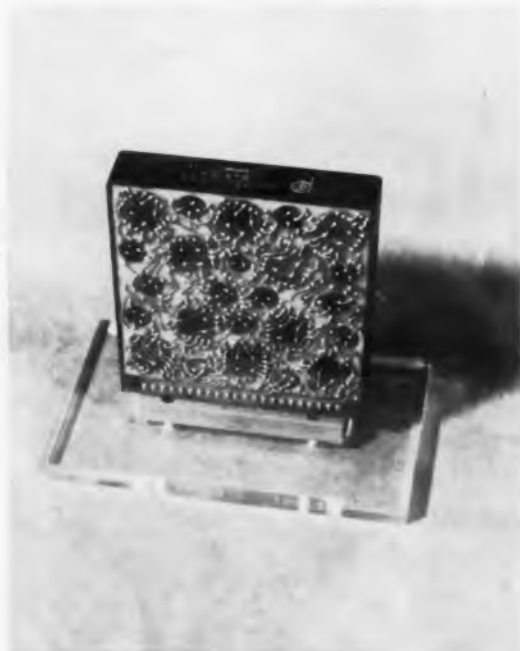
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Maintainable Modular Packages Are Designed

Unicell Packaging Allows Replacement Of Small Cells Containing Few Components, Within Larger Modules



Components in gated counter are contained in small circular cells, shown as dark areas in the module at left. Connections between cells are made on printed board on one side of the module, and connections to pin-type connectors are made on a similar board on the other side, as shown above. This 195-component gated counter measures 4 x 4-in., and is 5/8-in. thick. Heat dissipating components are arranged toward outer portions of the module to aid in heat transfer to the anodized aluminum frame. Precision Circuits, Inc., New Rochelle, N. Y., developed the technique, and is applying it to equipment design.

MAINAINABLE, high reliability modules are the object of the Unicell packaging concept developed by Precision Circuits, Inc., New Rochelle, N.Y.

Many circular cells, each containing only a few components, are inserted into machined holes in a module's foam plastic structure. Epoxy is used as a filler within cells, and also is used to bind circuit boards to the foam structure. A metal frame, with pin-type connectors on one side, surrounds the module.

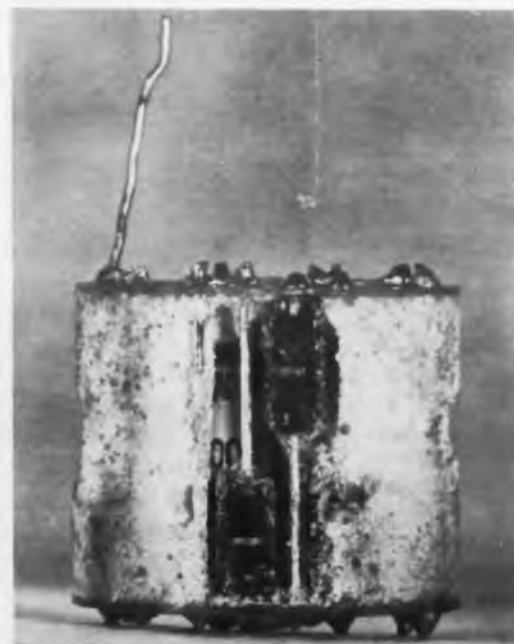
When a part in a module fails, that module is removed and the bad cell located. This cell is taken out of the module by breaking solder joints, and a new cell is soldered in place. Thus, only a small cell containing few components, rather than the full module, is thrown away, lowering maintenance costs.

Low weight, and resistance to shock and vibration are further advantages of the approach.

Precision Circuits adapts equipment to Unicell packaging using schematics prepared by the equipment manufacturer. ■ ■



Unicell is inserted into machined hole in a foam plastic module. When all cells are in place, printed-circuit boards are attached to each side of module and solder joints are made between component leads and printed wiring. A conformal coating of easily cut epoxy is then used over the surface of the boards to protect the solder joints. Techniques for anchoring modules within an equipment package include use of a metal strip, screwed across the top of several plugged-in modules, or use of metal channels around modules to hold them firmly in place.

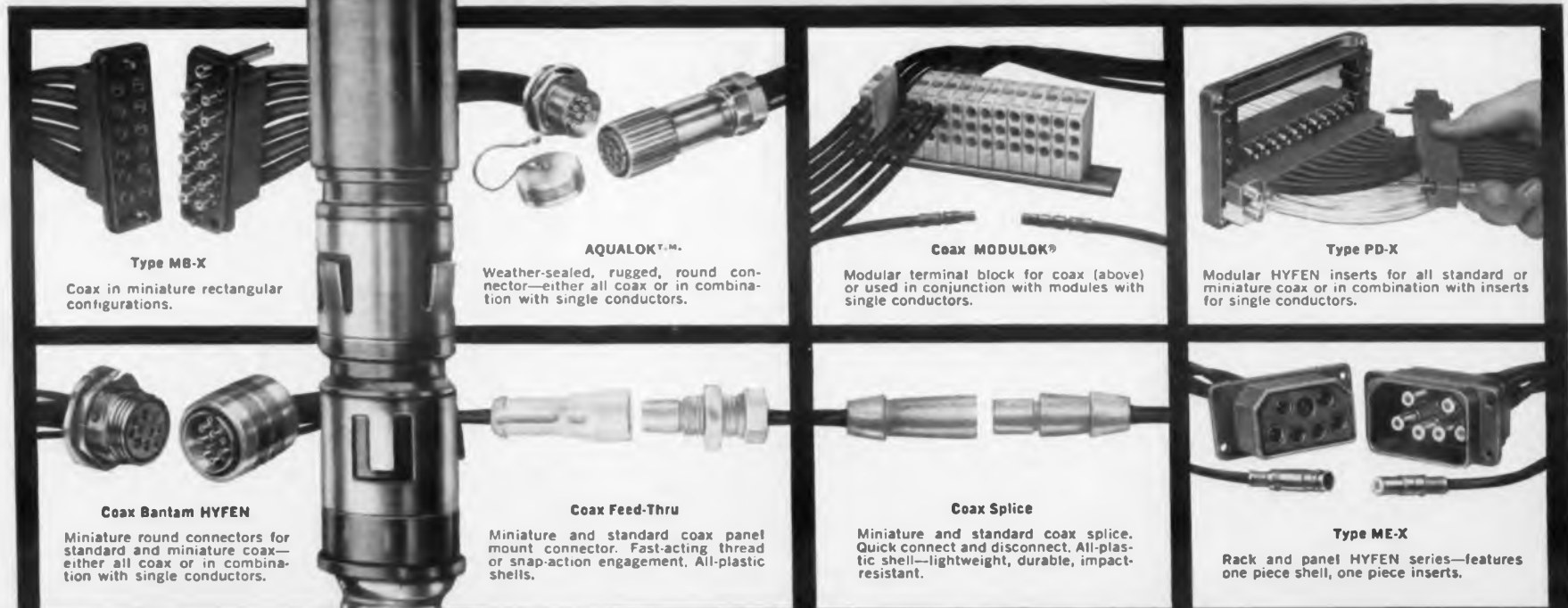


Cutaway cell shows how epoxy holds components rigidly in place (some epoxy has been removed so that components are easily seen). Component cavities machined in each Unicell are purposefully left somewhat larger than component dimensions, according to Stephan Gulyas, vice-president in charge of research and engineering for Precision Circuits, so that the remaining space can be filled with epoxy. This approach holds components tightly in place, while retaining resiliency because of the surrounding foam plastic. Since only a cell, rather than a full module, is thrown away when a failure occurs, low maintenance costs are expected with Unicell packaging. Replacement cells can be stocked at repair points for use when a cell fails.

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0-7	0-10	*TO7-10	7	19	15	
0-7	0-5	*TO7-5	5¼	19	15	
0-7	0-3	*TO7-3	3½	19	12½	
0-14	0-20	*TO14-20	15¼	19	16	
0-14	0-10	*TO14-10	8¾	19	15	
0-14	0-7.5	*TO14-7.5	7	19	15	
0-14	0-5	*TO14-5	5¼	19	15	
0-14	0-3	*TO14-3	3½	19	12½	
0-32	0-30	TO32-30	15¼	19	16	
0-32	0-15	TO32-15	8¾	19	15	
0-32	0-10	TO32-10	7	19	15	
0-32	0-5	TO32-5	5¼	19	15	
0-32	0-3	TO32-3	3½	19	12½	
0-36	0-30	TO36-30	15¼	19	16	
0-36	0-15	TO36-15	8¾	19	15	
0-36	0-10	TO36-10	7	19	15	
0-36	0-5	TO36-5	5¼	19	15	
0-36	0-3	TO36-3	3½	19	12½	
0-60	0-15	TO60-15	15¼	19	16	
0-60	0-7.5	TO60-7.5	8¾	19	15	
0-60	0-5	TO60-5	7	19	15	
0-60	0-2.5	TO60-2.5	5¼	19	15	
0-60	0-1.5	TO60-1.5	3½	19	12½	

*MODELS MARKED WITH AN ASTERISK ARE PROGRAMMABLE.

D-C OUTPUT			MODEL NUMBER	DIMENSIONS IN INCHES		
VOLTS	AMPS	H		W	D	
5-7.5	0-30	T6-30	15¼	19	16	
5-7.5	0-15	T6-15	8¾	19	15	
5-7.5	0-10	T6-10	7	19	15	
5-7.5	0-5	T6-5	5¼	19	15	
5-7.5	0-3	T6-3	3½	19	12½	
7-11	0-15	T9-15	8¾	19	15	
7-11	0-10	T9-10	7	19	15	
7-11	0-5	T9-5	5¼	19	15	
11-14	0-30	T12-30	15¼	19	16	
11-14	0-15	T12-15	8¾	19	15	
11-14	0-10	T12-10	7	19	15	
11-14	0-5	T12-5	5¼	19	15	
11-14	0-3	T12-3	3½	19	12½	
14-17	0-15	T16-15	8¾	19	15	
14-17	0-10	T16-10	7	19	15	
14-17	0-5	T16-5	5¼	19	15	
17-20	0-15	T19-15	8¾	19	15	
17-20	0-10	T19-10	7	19	15	
17-20	0-5	T19-5	5¼	19	15	
20-23	0-15	T22-15	8¾	19	15	
20-23	0-10	T22-10	7	19	15	
20-23	0-5	T22-5	5¼	19	15	
22.5-27	0-30	T25-30	15¼	19	16	
22.5-27	0-12	T25-12	8¾	19	15	
22.5-27	0-10	T25-10	7	19	15	
22.5-27	0-5	T25-5	5¼	19	15	
22.5-27	0-3	T25-3	3½	19	12½	
25-31	0-30	T28-30	15¼	19	16	
25-31	0-12	T28-12	8¾	19	15	
25-31	0-10	T28-10	7	19	15	
25-31	0-4.5	T28-4.5	5¼	19	15	
25-31	0-3	T28-3	3½	19	12½	
31-33.5	0-30	T32-30	15¼	19	16	
31-33.5	0-12	T32-12	8¾	19	15	
31-33.5	0-10	T32-10	7	19	15	
31-33.5	0-5	T32-5	5¼	19	15	
31-33.5	0-3	T32-3	3½	19	12½	
33.5-36	0-30	T35-30	15¼	19	16	
33.5-36	0-12	T35-12	8¾	19	15	
33.5-36	0-10	T35-10	7	19	15	
33.5-36	0-5	T35-5	5¼	19	15	
33.5-36	0-3	T35-3	3½	19	12½	

†ALL NARROW RANGE MODELS ARE PROGRAMMABLE.



MODEL TO36-5M

REGATRAN[®] SEMICONDUCTOR POWER SUPPLIES

SPECIFICATIONS

*REGULATION: 0.03% or 0.01 V from no load to full load and 105 to 125 V line. (0.1% or 0.01 V for 3-amp models.)

RIPPLE: Less than 1 millivolt rms.

INPUT: 105 V to 125 V, 50 to 60 cps.

CIRCUIT PROTECTION: Four-year field-tested electronic and electrical circuit protection.

MOUNTING: Rack and table.

*0.01% or 0.003 V regulation available on special order.

REQUEST BULLETIN 721A.



®Reg. U.S. Pat. Off. Patents Issued and Pending.

NEWS

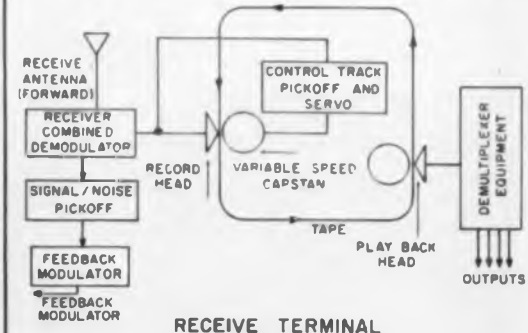
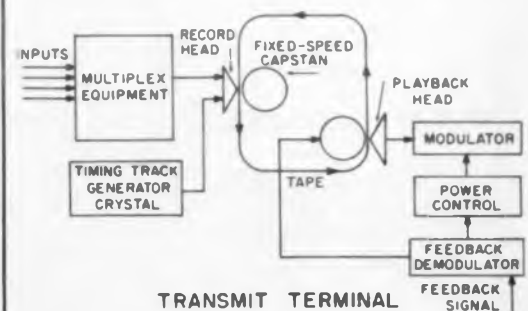
Com System Would Use

*Efficient Use of Channels Foreseen
When Received Power Varies Widely*

A COMMUNICATIONS system has been proposed in which the data rate would be varied by varying the bandwidth used in accordance with changes in interference, changing conditions of multipath reception, weather conditions and other factors. The chief advantage would be efficient use of communications channels. The technique would permit a system to be designed for conditions better than the worst expected.

The variable-data-rate or variable-bandwidth technique has been proposed by J. E. Palmer, Radio Corp. of America, Camden, N.J., who suggests that it would be especially useful in systems where the received signal power varies over a wide range. A variable-bandwidth system, he reports, could be used to maintain a constant signal-to-noise ratio at the input of a detector.

In system operation, down-fades in received signal level would be compensated for by transmission with reduced bandwidth (lower data



Transmit and receive terminals of proposed variable-data-rate communications system show how tape loop is used to store traffic. Speed of tape past record and playback heads is proportional to signal-to-noise conditions in which the system is momentarily operating.

BREAKTHROUGH!

Variable Data Rate

rate), and up-fades would allow transmissions with expanded bandwidth.

Fixed Bandwidth Detectors Employed in RCA System

Mr. Palmer has developed on paper a system that makes use of variable-bandwidth transmission and that employs fixed-bandwidth detectors.

In this system, the transmit terminal is designed around a tape loop that moves at a speed (at the recording head) determined by the bandwidth of the output of an associated multiplexer. The circuit also contains a modulator and feedback receiver.

Fixed-bandwidth multiplexed data are recorded on the loop when they appear at the output of the multiplexer. The recorded data are played back after a delay at a rate determined by a signal from the feedback receiver. The output of the receiver is the signal-to-noise ratio at the main receive terminal relative to its long-term average.

The signal out of the playback head goes to the modulator where it serves as the modulating signal. Because data are put on the tape at a fixed rate and taken off at a variable rate, there will be a variable delay between recording and playback. When the playback speed is less than the record speed, tape will pile up until playback speed exceeds the record speed.

The transmit terminal also contains facilities for truncating the amount of variation in data rate, which will decidedly increase the usefulness of the system.

Demodulated Received Signal Is Transmitter's Modulated Signal

The receive terminal contains a demodulator, a tape loop, a feedback transmitter, and a demultiplexer. The demodulated received signal is the modulating signal generated by the transmitter. Its bandwidth varies in direct proportion to the received signal-to-noise ratio, if transit time is neglected.

Output of the demodulator is recorded on tape, whose rate past the record head varies in direct proportion to the signal-to-noise ratio. After a short delay, the recorded signal is played back at a fixed speed. Therefore, bandwidth of the signal coming off the loop at the receiver terminal is always equal to the original fixed-bandwidth of the transmitter multiplexer and can be fed directly into the fixed-bandwidth receiver demultiplexer. ■ ■



Announcing Eldorado's Model 1050 Solid State Gated Counter — a triple purpose instrument

- 100 Mc/s Direct or Gated Counting of random or continuous events
- Time Interval Measurements with 10 nanosecond resolution*
- Frequency Measurements to 100 Mc/s without heterodyne conversion*



BASIC DATA

Counting and Frequency Measurement
 STORAGE 10⁹ counts (9 digits)
 MAX. COUNTING RATE 100 Mc/s
 DOUBLE PULSE RESOLUTION
 Better than 10 nanoseconds
 TYPICAL INPUT PULSE REQUIREMENT
 +4 volts into 50 ohms
 TYPICAL START/STOP PULSE REQUIREMENT
 -4 volts into 50 ohms

For Time Interval Measurement
 EXTERNAL TIME REFERENCE Trigger requirements same as for input pulse above or will operate on 5 volt peak-to-peak 100 Mc sine wave

APPLICATIONS—The multipurpose Model 1050 is particularly suited for use in weapon or satellite systems, advanced electronic measurements, and nuclear research. Among specific areas of application are studies of missile velocity, acceleration and trajectory; space vehicle tracking; shock wave investigations; radar, telemetering, and communications; frequency stability, phase, and phase shift measurements; pulse width, rise, fall and duty cycle measurements; semiconductor studies; astronomical measurements; nuclear flight time, coincidence, and particle burst studies.

NEW LOGIC — KEY TO 100 Mc/s—The high counting rate of Eldorado's 100 Mc/s instrumentation is made possible by new decimal counting logic developed by Eldorado engineers—specialists in nanosecond pulse techniques.

For details on the new logic, contact your Eldorado engineering representative for Bulletin D-1050, or write us directly. Demonstrations at your convenience.

*When used as a time interval meter, Model 1050 requires an external oscillator for time reference; when used as a frequency meter, it requires an external time base. Eldorado can supply both. The Eldorado Model 1060 Time Interval Meter with same resolution has a built in oscillator for time reference.

Eldorado Electronics

Dept. 36 2821 Tenth Street • Berkeley 10, California • THornwall 1-4613
 CIRCLE 19 ON READER-SERVICE CARD

vernistat[®] design report

Information on Vernistat a.c. potentiometers for design engineers



The Adjustable Function Generator is a programmer consisting of an Interpolating and a Function Adjusting Assembly.

FOR A NON-LINEAR SIGNAL OUTPUT—THE VERNISTAT ADJUSTABLE FUNCTION GENERATOR

See that curve on the panel? You adjust it by hand . . . any shape, real quick! You draw your own $Y = f(X)$ curve and pull out a repeating, non-linear voltage to control the process you require.

Almost any process that can be controlled by a varying voltage can be controlled by the signal from a Vernistat Adjustable Function Generator.

Here's the story:

In the Vernistat, the autotransformer uses equally spaced taps, giving a highly linear output. These taps can be crowded or spread apart, in which case you get a permanent, nonlinear output related to their spacing. In the Function Generator, the autotransformer has 101 equally spaced taps which you can select to form the nonlinear function you desire. Using 34 sliders, you set your voltage up and down the Y-axis, graphing the Y-values against X. The X-axis represents angular position of the shaft over a range of 10 shaft turns.

Actually, the entire Function Adjustable Assembly is nothing more than a switch for pulling the proper curve out of the Vernistat. Once the curve is set an Interpolating Vernistat provides for

a smooth voltage output between taps. The steel case of the Assembly is 3 x 7 x 8 inches, which shows you how compact the mechanism is.

APPLICATIONS

You can use the Function Generator both as a lab instrument and a system component. Some important uses are:

1. Rapid Empirical Determination of Functions: Eliminates time-consuming mathematical calculations and the production and wiring of a large number of special padding resistors. Once a curve is determined, a nonlinear Vernistat can easily be constructed to provide a simplified, permanent, function-generating unit.

2. Linearization: The Function Generator can be used to compensate for nonlinearities in electronic systems. It can be placed in series with the signal to be corrected or used as a nonlinear feedback element in a servo loop.

3. Input to Analog Computer: It converts nonlinear data to an electrical input.

4. Control and Programming: Used in chemical, petrochemical and other continuous processes to control a variety of functions. If the shaft is rotated at constant speed, control will be a function of time.

Several series of Vernistats are available for use with the Function Generator. For a complete description drop us a line.

"CARPE DIEM" — "Seize the Day" — ought to be the motto of every original equipment designer who runs in analog computer or servo circles. One of the opportunities you can seize is Vernistat in any of its varieties. We will gladly send you literature to help you get a good grasp of the subject.

CIRCLE 20 ON READER-SERVICE CARD

DOES THE BURDEN CHANGE THE NATURE OF THE BEAST?

The subject is **LOADING ERROR**. Consider, for example, the Vernistat a.c. potentiometer—a highly linear device, which . . . be the load heavy or light . . . retains high efficiency. This is a direct result of its low output impedance which brings unique benefits to forward-looking designers:

1. Loading error is extremely low. For instance, the loading error on a Model 2B3 Vernistat operating into a 500K load is .026% or less. A d.c. potentiometer with the same input impedance (65K) and the same load has a maximum loading error of about 2%. Our Model 3B with a Z_{in} of 50K and Z_{out} of 40 ohms takes the loading error down to .008%.

2. Several loads can be driven from a single Vernistat without excessive loading error. (And Vernistats can drive other Vernistats in cascade.)

3. Stray pickup from electrostatic fields is cut to practically nil.

4. Phase shift due to stray capacitance is greatly reduced.

Where the specs call for high resolution plus high accuracy, the high resolution pots are thoroughly baffled. To attain high resolution, the wirewound pot requires many turns of fine wire with a resultant increase in output impedance, loading error and quadrature. Thus, accuracy goes to pot. With Vernistat both specs are attainable.

When specifying accuracies many designers tend to separate linearity and loading error requirements. Why not think in terms of **loaded linearity**; that is, linearity plus loading error? That's the way to tie down total error at once. If you can afford to be a happy-go-lucky on this point, you may end up with isolation amplifiers supporting very accurate pots in your electronic system—where a single Vernistat could do the job better and perhaps more cheaply.

The finer details have been written up on 6 coarse sheets of paper headed: "Loading Error—A Review." If you deal with data transmission in analog equipment (for Doppler radars, navigation systems, fire control computers, etc.)—you'll be more than diverted. Write for your copy today.

vernistat division
PERKIN-ELMER CORPORATION
768 Main Avenue, Norwalk, Connecticut

NEWS

New LFE Display System

High-Density Storage Drums
Can Hold up to 52.8 Million Bits

INITIAL acceptance tests by the Army Corps of Engineers on its first RD-900 Random Access Storage and Display System have been completed satisfactorily.

The RD-900, developed by Laboratory For Electronics, Inc. of Boston, is able to select at random any desired information from its memory and immediately display it on a view screen. Since this can include page, tabular, graph, chart, map or any other form of display, all elements required for a complete and accurate interpretation of a given situation are immediately available for decision making.

Data On Drums Retrieved Upon Request In 1 Sec

In operation, the system performs three functions: (1) writing data on high-density storage drums, each of which will hold 1.6 million characters; (2) reading data back when requested; (3) displaying data at the requesting viewing station at a rate of up to 12,800 characters a page. Any data on the drums are retrieved upon request in approximately 1 sec.

The system can be used with any computer, or operate independently. If used with a computer,



RD-900 monitor displays a map of the U. S. Additional information can be overlaid on the map. The system will also display charts, graphs, and pictures, as well as alphanumeric characters. As many monitors as desired can be used with the central RD-900 system.

ELECTRONIC DESIGN • February 1, 1961

Passes Initial Tests

processed information is automatically stored and updated in the RD-900 files.

Supplementary Equipment Includes High-Speed Buffer

Displays planned for the system include a 21-in. square crt, a large wall display which can present images from the display console when desired, and a random-access slide-projector system. A high-speed buffer is now under development under an add-on contract. This buffer will be used between the RD-900 and a computer to speed up data transfer.

An RD-900 system can consist of from one to 33 high-density magnetic file drums, plus electronic controls and a master viewing console. As many additional viewers as are required can be added for a particular installation. Only one console with supervisor's controls is necessary for any RD-900 system, no matter how many viewers or file drums are used.

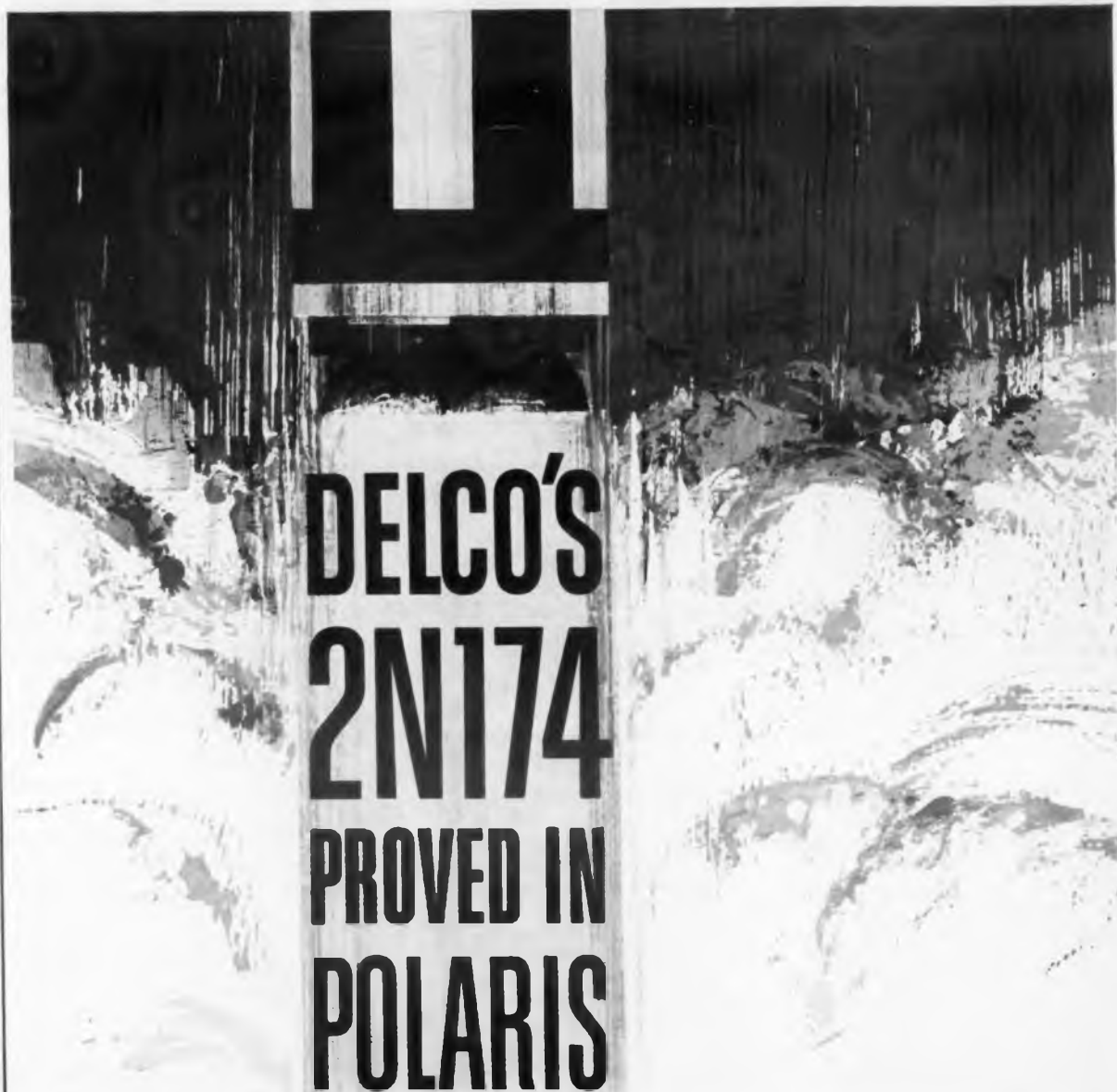
Additionally, no matter how many file drums or viewers are used in any particular application, only one each of the file control, information control, and power is necessary.

The RD-900 is expected to be used in high-level command and control situations where vital decisions would have to be made quickly on the basis of information retrieved from the system's massive storage files. It can free computers for the vital computation tasks that would be necessary in fast-changing tactical situations. ■ ■



Up to 33 file drums, each having a storage capacity of 1.6 million alphanumeric characters, can be used in RD-900. This model shows three file drums (small units on left); the master console with status indicator panel (front center); and, to the rear, a file control, viewer control, information control, and power supply.

ELECTRONIC DESIGN • February 1, 1961



... and Minuteman and Talos and Atlas and Jupiter and Thor and Titan and Bomarc and Zeus and Pershing and hundreds of other military and industrial applications.

For Delco Radio's highly versatile family of 2N174 power transistors meet or exceed the most rigid electrical and extreme environmental requirements.

Over the past five years since Delco first designed its 2N174, no transistor has undergone a more intensive testing program both in the laboratory and in use, in applications from mockups for commercial use to missiles for the military. And today, as always, no Delco 2N174 leaves our laboratories without passing at least a dozen electrical tests and as many environmental tests before and after aging.

This 200 per cent testing, combined with five years of refinements in the manufacturing process, enables us to mass produce these highly reliable PNP germanium transistors with consistent uniformity. And we can supply them to you quickly in any quantity at a low price.

For complete information or applications assistance on the Military and Industrial 2N174's or other application-proved Delco transistors, just write or call our nearest sales office.

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Mitchell 2-8165

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726 Santa Monica Blvd.
UPton 0-8807

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CIRCLE 21 ON READER-SERVICE CARD

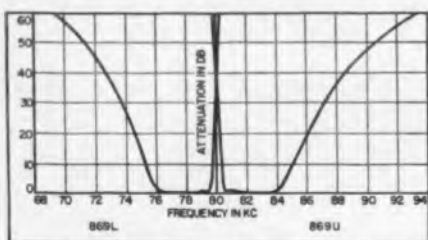


DELCO
DEPENDABILITY
RADIO
RELIABILITY

FIRST SSB Receiver completely designed to Navy specifications for shipboard installations uses HERMES CRYSTAL FILTERS



Single-Sideband Receiver, Model AN/WRR-2, developed by National Company, Inc. for U. S. Navy installations, used Hermes SSB Crystal Filters, Models 869U and 869L.



Attenuation Characteristics, Hermes SSB Crystal Filters, Models 869U and 869L.



Hermes SSB Crystal Filters, Models 869U and 869L. Shown approx. $\frac{1}{4}$ size.

The AN/WRR-2 Single-Sideband Receiver, developed by National Company, Inc., has been adopted by the Navy as standard communications receiving equipment for installation aboard Submarines, Cruisers, and Aircraft Carriers.

The National Company selected Hermes SSB Crystal Filters, Models 869U and 869L for the AN/WRR-2 for their ability to reproduce a high quality SSB signal under adverse environmental conditions encountered in submarine and aircraft carrier operations. Months of service testing verified the quality and performance built into these filters by Hermes engineers. Specifications for these SSB Crystal Filters are:

	Model 869U	Model 869L
Carrier Frequency	80 kc	80 kc
Frequencies at 3 db	80.3 kc max. 84.0 kc min.	76.0 kc max. 79.7 kc min.
Passband Response Variation	± 1.5 db max.	± 1.5 db max.
Environmental Requirements (MIL-F-18327A)	Operating Temperature Range Non-operating Temperature Range	-28°C to $+75^{\circ}\text{C}$ -62°C to $+75^{\circ}\text{C}$

National Company's AN/WRR-2 Single-Sideband Receiver is a companion unit to Westinghouse Electric's AN/WRT-2 Single-Sideband Transmitter, now standard Navy equipment, which also uses Hermes SSB Crystal Filters. Hermes has supplied SSB Filters from 100 kc to 16 mc.

If you have a filtering problem, call on Hermes engineering specialists to assist you in the design of your circuitry and in the selection of filter characteristics best suited to your needs.

Write for Crystal Filter Bulletin.

Itek Electro-Products Co.

75 CAMBRIDGE PARKWAY, CAMBRIDGE 42, MASSACHUSETTS

A DIVISION OF

Itek

CIRCLE 22 ON READER-SERVICE CARD

WASHINGTON REPORT



John J. Christie

EXPENDITURES FOR MILITARY ELECTRONICS will continue upward under provisions of the Eisenhower budget. Spending in fiscal 1962 would appear to be on the order of \$500 million over the current fiscal year. On the basis of new obligational authority, however, the new budget definitely implies a leveling-off of the military market, unless the Kennedy Administration makes sharp upward revisions for major weapons and space systems.

Missile spending in the next fiscal year will amount to just over \$4 billion, as compared to an estimated \$3.8 billion in the current fiscal year. Expenditures in electronics and communications will remain at just over \$1 billion.

Although the level of procurement expenditures will not be much higher than current spending, increased funds will be available for a number of systems emerging from the development stage. This is because funding for SAGE, DEW, and BMEWS was substantially completed out of 1961 and prior funds. Also, the funding of several large weapons systems is nearly completed.

Under the Eisenhower budget, fiscal 1962 expenditures for missile research, development, test, and evaluation will run at about the same \$1.6 billion level estimated for the current fiscal year. The emphasis, however, will shift to tactical missiles, both offensive and defensive, as R&D, test, and evaluation associated with strategic missile systems begin to wane.

The Army's Nike-Zeus anti-missile-missile system is allocated a whopping \$225 million for R&D and test and evaluation, but procurement funds were withheld pending full-scale tests in the summer of 1962.

R&D, test, and evaluation expenditures for the Defense Dept.'s space program will be up nearly \$100 million in fiscal 1962. This will mean stepped-up development work on the Midas, Samos, Advent, and Transit satellites.

All phases of the Navy's anti-marine-warfare program are stepped up under the Eisenhower budget, and a variety of R&D programs involving the electronics industry got higher allocations, including reliability, materials research, and oceanography.

NASA DEVELOPMENT OF AN ACTIVE SATELLITE for commercial use will begin this year out of a supplemental appropriation of \$50 million. The budget provides substantial funding for the program in fiscal 1962, but also assumes that part of the cost will be met by contributions from commercial communications firms. Eisenhower mentioned \$10 million as the expected contribution in 1962. NASA's increased budget also provides additional funds to permit further experiments with the advanced Redbound passive communications satellite and the Nimbus meteorological satellites. In the field of scientific space exploration, NASA will be able to

proceed with development of a large orbiting astronomical observatory and orbiting geophysical observatories.

THE 1960 FOREIGN TRADE LEDGER of the electronics industry will show an alarming increase in imports but also a substantial gain in exports. Imports in the traditional Department of Commerce classifications, relating mainly to entertainment goods, are estimated to have reached \$103 million for a 25 per cent increase over 1959. Moreover, there were an estimated \$33 million in additional electronic imports not previously classified in Department of Commerce reports. The new classification embraces testing and recording instruments, radar equipment, and several miscellaneous product lines.

On the bright side, the electronics industry's 1960 exports are estimated to have hit \$450 million for a 10 per cent gain. Increases were pretty much across the board.

Sustaining the momentum in exports will require an intensive search for new markets. The Commerce Department is off to a good start with a quick 70-country survey of marketing possibilities for radar and for microwave and other communications equipment. Officials feel that the improved fiscal position of foreign governments and industry, and urgent needs for modernizing communications and transport, make these fields particularly promising at this time.

Hopes are also expressed that Western Europe's stepped-up interest in automation, a result of highly favorable business conditions and severe labor shortages, will open a market for U.S. manufacturers of system components.

A further increase in imports this year is inevitable. But, the increase is likely to be sideways rather than vertical. It may be a case of whistling in the dark but some government officials are predicting that imports of Japanese consumer goods reached their peak last year. Imports of British consumer items began a decline in 1960.

Imports of components, however, increased sharply last year and are expected to continue upward. Manufacturers of test instruments, radar, and communications equipment can expect more foreign competition on the basis of trends that became evident in 1960.

THE FUTURE OF ENGINEER UNIONIZATION now depends entirely upon what organized labor can accomplish in this field. Engineers and Scientists of America has closed up shop, turning its affiliates loose as independent unions. With ESA throwing in the sponge, a never really successful attempt to blend professionalism and unionism has finally fizzled out.

Up to now the AFL-CIO unions also have made a poor showing in their efforts to organize engineers and technicians. However, the AFL-CIO has made a searching analysis of its failures and is ready to offer new appeals and to try new organizing methods.

Several new approaches were recommended in a recent study by Everett M. Kassalow, research director of the AFL-CIO's Industrial Union Dept. The demise of ESA serves to underscore the main premise of this report, which is that attempts to play up professionalism and play down unionism have made engineer unions ineffective hybrids. ESA, of course, accentuated professionalism even more by refusing to admit technicians as dues-paying members (although it was willing to bargain for them during the last couple of years).



semiconductor products news

Silicon Performance at Germanium Prices

General Electric unijunction transistors have been simplifying circuits and providing significant savings in overall circuit costs for a couple of years now. Because of their unique characteristics (stable negative resistance, extremely low trigger current, stable trigger voltage, high pulse current capability), one unijunction transistor can often replace two conventional transistors in a circuit. Again keeping your pocketbook in mind, and the reliability of your circuits, G-E has added the 2N1671 Series to the line, giving you silicon performance at germanium prices. And just take a look at the saving possible in a couple of typical circuits.

Typical Circuit Comparisons

Transistor Time Delay Circuit	Unijunction Circuit Equivalent
3 transistors*	1 unijunction transistor
1 diode	1 Zener diode
1 Zener diode	1 relay
1 relay	1 capacitor
2 capacitors	4 resistors
8 resistors	
SAVINGS:	\$3.30 (*germanium transistors) \$16.50 (*silicon transistors)

Transistor Voltage Detector	Unijunction Circuit Equivalent
2 transistors*	1 unijunction transistor
1 potentiometer	1 potentiometer
2 capacitors	1 capacitor
5 resistors	3 resistors
SAVINGS:	\$0.40 (*germanium transistors) \$9.20 (*silicon transistors)

Incidentally, price reductions have also been made on the standard unijunction types 2N489 through 2N494. Your Semiconductor District Sales Manager has complete information, or write to Section 23B88.

Are you one of the thousands who read the print off the page any time you get hold of information on the Tunnel Diode? Well, with just a little patience you can feast on the most comprehensive reference work available on Tunnel Diode theory and applications. The G-E Tunnel Diode Manual is coming soon. Watch for it!

How Stable Can a PNP Low Be?

Series 2N1414 and 2N525 low-frequency germanium alloy transistors are an interesting example of the value of the extensive life testing that General Electric has conducted for years (we have test data on every transistor we've made since 1954, and some even earlier). You know they are the industry's most stable because parameters are completely spelled

out, including "minimum", "typical", and "maximum" values. And we can spell out these parameters because they are backed up by 10,000 hour life tests (to date) on 138 units.

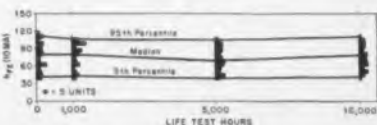
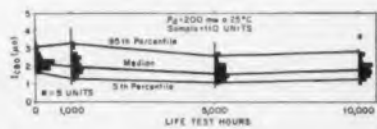


We continue the testing, too. In fact, 300 new units start life test each week. On an average, more than 30,000 General Electric transistors are on cycled life-test racks day in and day out. And it sure pays off in reliability!

If you can't wait for the new Tunnel Diode Manual (and we can't blame you for that), how about the new Fifth edition of the General Electric Transistor Manual? It includes Tunnel Diode switching circuits and amplifiers, and much, much more in 320 fact-filled pages. Ask your G-E Semiconductor Distributor.

Guaranteed High and Low Temp. for JAN 2N526

Speaking of the value of 10,000 hour tests (the only thing more valuable is 30,000 or 40,000 hour tests, and we do that too), our JAN 2N526 transistor features guaranteed maximum high temperature I_{co} and minimum low temperature h_{re} , backed up by the stability proved by the 10,000 hour life test charts shown.

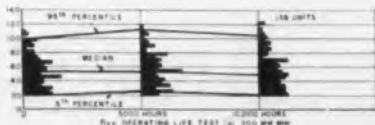


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THE BERYLLIUM CORPORATION

Reading, Pennsylvania

CIRCLE 24 ON READER-SERVICE CARD

NEWS

Microsecond Card Reader at IBM Employs Capacitive-Coupling System

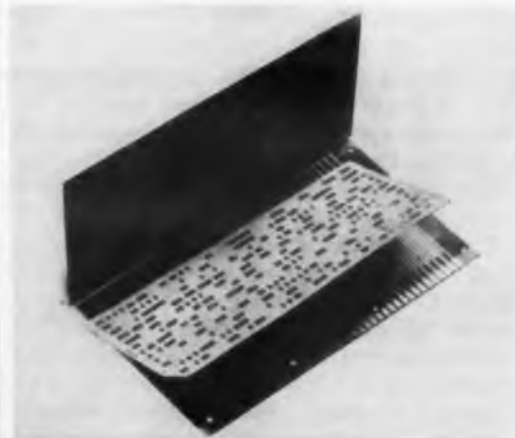
Punched-card hole sensing at microsecond speeds is believed attainable by a capacitance-type system in development at the IBM Research Laboratories, Yorktown Heights, N.Y. Known as the card capacitor, the device employs two printed-circuit boards with parallel conductors arranged on each board and a metalized card.

The conductors are so arranged that when the boards are placed with the conductor sides facing each other, orthogonal crossings are located at each of the 960 possible hole positions in an IBM card. The card itself consists of a metal layer sandwiched between two sheets of ordinary card stock. When the card is inserted into the reader, the foil is grounded and there is a capacitance between the boards at the punched holes.

The card is read by applying voltage pulses to conductors on one of the printed-circuit boards. At a hole, this pulse is capacitively coupled to the orthogonal conductor on the second board.

Many such units could be paralleled by connecting the sense lines. Thus, 500 cards would require only 80 sensing amplifiers for 80-bit words as in a standard IBM format.

With this arrangement, 100-v input pulses to a 500-card memory would generate 1-mv output pulses at each hole. IBM researchers believe a memory block of this size is about the maximum possible without utilizing special compensation techniques to reduce output capacity. Modules of up to 5,000-card size could be feasible with compensating circuits, but drive considerations may become limiting beyond that.



Card capacitor employs orthogonally oriented printed-circuit arrays and metalized cards to sense holes by capacitive coupling. Device is said to be capable of microsecond reading times and should be quite rugged. Memory modules of up to 5,000 cards could be built, according to IBM.

Cw Infrared Maser Developed; Gas Unit Uses Helium and Neon

Development of a continuously operating infrared maser has been announced by the Bell Telephone Laboratories. The device is a gas maser of the helium-neon type, with a continuous output of several hundredths of a watt at one micron.

The cw operation of the maser was demonstrated this week by voice transmission for a distance of several feet over the IR beam. Modulation was accomplished by a Kerr cell. Information bandwidths of up to 300 mc can be impressed on the beam, according to BTL scientists.

Pumping is by gas discharge through the helium-neon mixture, with neon as the active element. Helium atoms accelerated by the discharge excite the neon atoms by collision. It was found that several modes of maser action occur in the neon, and that the device emits several different IR frequencies simultaneously. The two principal IR frequencies differ by about 30 mc and have been experimentally heterodyned to produce an rf signal of that frequency. This provides additional confirmation of the maser's coherence and cw operation.

The device was developed under the direction of Ali Javan, BTL scientist. Additional details will appear in the Feb. 15 issue of *ELECTRONIC DESIGN*.

B-52H Equipped To Carry Douglas Skybolt Missiles

The new "H" version of the B-52 Stratofortress will be modified to carry four Skybolt missiles.

When it reaches operational status, the solid-fuel Douglas Skybolt will be launched from the "H" as far as 1,000 miles from multiple targets. Once launched from the aircraft, the Skybolt will be able to follow a ballistic path to its target, traveling at hypersonic speeds.

Deliveries of the eight-jet B-52H to the Strategic Air Command are scheduled to begin later this year. Present orders for the bomber will extend production to mid-1962.

Accuracy Is Our Policy . . .

In the article, "Designing Low-Pass Filters from Lossy Helical Coaxial Line," in the Dec. 7, 1960, issue, omissions were made in the graphs on p 30. In Fig. 3a, indicating loss vs. length of filter helix, the middle curve was the basic 3-in. helix. The curve on the left was 6 in. and the one on the right, 1.5 in. In Fig. 3c, the curves were placed too far to the right on the graph.



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115-325 volts DC out
at 1.5 amp maximum

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Two new lines of power supplies — one high and one low voltage line — are available now from POWER SOURCES, INC. Both lines feature the exclusive POWER SOURCES regulator circuit that provides full protection for the transistors *without* DC fuses. Both lines are warranted for *five full years*. Warranty includes all semi-conductor components. Cooling systems of advanced design insure long life and trouble-free operation.

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AC Input	105-125 volts, 50-60 cps*, all models		
Regulation (line)	Better than 0.1% or 0.2 volts over entire input range (whichever is greater)		
Regulation (load)	Better than 0.1% or 0.2 volts for no-load to full load (whichever is greater)		
Transient Response	Output remains within regulation limits for step-function change of ± 10 volts in 105-125 volt input range Output remains within regulation limits for changes from no-load to full-load or full-load to no-load		

Low Voltage Supply Specifications

	PS4305	PS4315	PS4330
DC Output Range	0-36 volts 0-5 amps	0-36 volts 0-15 amps	0-36 volts 0-30 amps
AC Input	105-125 volts, 50-60 cps*, all models		
Regulation (line)	Better than 0.025% or 3 mv over input range (whichever is greater)		
Regulation (load)	Better than 0.05% or 5 mv, no-load to full-load variation (whichever is greater)		
Transient Response	Output remains within regulation limits for line voltage steps of ± 10 volts within input range Output recovers in 100 usec for no-load to full-load or full-load to 50% load step changes.		

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RADAC I combines Radiation's Radicon analog/digital converter, Radiplex low-level electronic commutator, and an Ampex tape recorder (with the necessary logic circuitry and power supplies) into a single mobile unit. The system handles up to 48 analog inputs from resistive or thermocouple sources (as low as ± 5 mv full scale) with a resolution of ± 10 μ v. After digital conversion, the information is recorded in computer format on magnetic tape. Data formats are available which are directly compatible with most large and medium scale digital computers.

For more complete data on RADAC I, write to Dept. ED-2R, Radiation Incorporated, Products Division, Melbourne, Florida.

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



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CIRCLE 26 ON READER-SERVICE CARD

NEWS

NBS Device Helps Scientists Study Electromagnetic Waves

A VERSATILE tool for the investigation of electromagnetic waves which originate from sferics or electrical discharges in the atmosphere has been developed by the National Bureau of Standards at Boulder, Colo.

"Ephi," the name for this new system which locates and analyzes sferics, is reported capable of appreciably greater accuracy than direction-finding systems which have been used in the past.

The experimental equipment for the Ephi system has been installed near Brighton, Colo. (about 20 miles northeast of Denver's Stapleton Airfield) by a group of NBS scientists. Three 125-ft vertical antenna towers are spaced about 4 miles apart, forming the vertices of an equilateral triangle. Except for the rare case when a storm is occurring at the exact center of this triangle, a sferic radio signal will reach each antenna at a slightly different time.

Signals Received by Antennas Go to Central Control Station

The signals received at each antenna are fed over coaxial cables to the central control station of the system. Here electronic equipment determines the relative difference in time of arrival of the sferic signal from each antenna, and, from this, the direction from the station to the lightning source is automatically determined.


Since sferics travel with the speed of light and the antennas are so closely spaced, the differences in time of arrival at the three antennas are so small that they are measured in microseconds. The maximum difference in arrival time between the antennas at Brighton is only about 21 μ sec. The Ephi equipment is able to make such measurements of time difference with an accuracy of small fraction of a microsecond.

In addition to determining the direction of arrival of sferic signals, the equipment at the central station at Brighton counts the total number of sferics occurring in any desired time interval, and can count the number of sferics arriving from several different directions at the same time. The sferic waveform can also be photographed, either with still or motion-picture cameras, and retained for further detailed studies aimed at a better understanding of radio-wave propagation as well as the nature of the lightning itself.

In addition to its value as a research tool, Ephi is reported potentially of value in tracking such severe weather phenomena as tornados and hurricanes. ■ ■

CIRCLE 27 ON READER-SERVICE CARD ►

ELECTRONIC DESIGN • February 1, 1961



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CLEVITE TRANSISTOR

WALTHAM, MASSACHUSETTS

How to establish rating values for power transistors

by **RICHARD F. MOREY, JR.**

Manager, Applications Engineering, Clevite Transistor
Division of Clevite Corporation

Every manufacturer of power transistors provides information on the various circuit valves within which a given transistor will satisfactorily perform. These valves or "ratings" are established on the absolute maximum system and are defined so that "the rating values, if exceeded, will cause permanent impairment of the device." Since permanent damage can occur as a result of exceeding rating limits or as a result of an unqualified rating, Clevite Transistor exercises great care in the development of ratings and the proof of their validity.

Clevite places particular emphasis on ratings for junction temperature, power dissipation, collector current, and collector voltage. Each of these ratings is independent and it is not generally possible to approach more than one rating simultaneously. Therefore, specific tests are performed such as "thermal resistance" to establish maximum power dissipation and collector diode leakage current I_{CBO} at both room temperature and high operating temperature to establish maximum rated collector to base voltage. Figure 1 is a diagram of the Thermal resistance test, while Figure 2 indicates the testing configuration for establishing essential collector to emitter voltage ratings.

Other tests are performed to determine collector current and junction temperature. High-temperature-storage life tests to establish maximum junction temperature are further supplemented by Clevite's process of aging transistors at temperatures in excess of the eventual maximum rating.

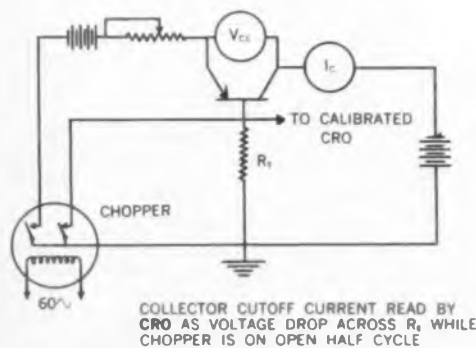


Fig. 1. Thermal resistance test

Perhaps the most important tests are the collector to emitter breakdown tests ($V_{CE(sat)}$ and $V_{CE(sat)}$) which are used to determine the maximum collector to emitter voltage. Figure 3 indicates a typical germanium power transistor operating in breakdown region. Observe that the bias applied between emitter and base differs for each of the seven curves. This bias differential causes the

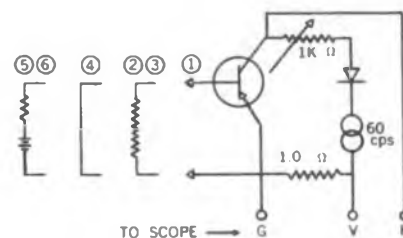


Fig. 2. Collector to emitter voltage test

curves to differ significantly. Curve 1 breaks down sharply at 45 volts, while curve 6 breaks down initially at 118 volts, but upon transverseing the curve, the voltage drops and another breakdown occurs at a point slightly greater than 60 volts. Curves 2, 3, 4, and 5 are somewhere between.

Curve 7 is simply the curve of the collector to base diode and is shown here for reference purposes.

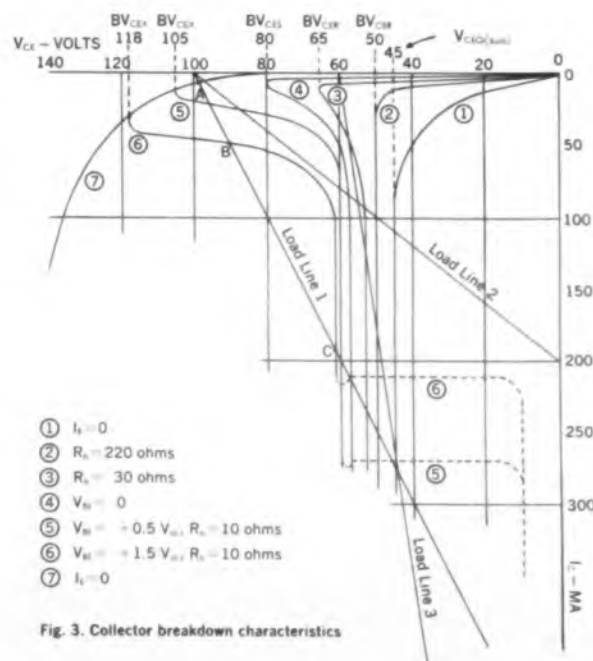


Fig. 3. Collector breakdown characteristics

It may be noted in a particular instance, such as curve 1, that at some voltage (in this case 45 volts) collector current increases without limit. This is the voltage at which collector multiplication causes the overall current gain (α) to equal unity.

The remaining curves serve to indicate the effect of a change in bias at different voltage and current conditions.

The tests and data shown here are only a segment of the total program undertaken by Clevite Transistor to assure a continuous high standard of product quality . . . "reliability in volume."

Detailed Technical Data Bulletins are available on all Clevite's Power Transistors and Diodes. To obtain technical information, please request Application Bulletins 1 & 2.



CLEVITE TRANSISTOR • Waltham, Massachusetts

RCA Scrambling Device for Banks Foins Savings Passbook Forgeries

A scrambling device which makes it virtually impossible to forge passbook signatures in the withdrawal of savings-bank deposits and, at the same time, substantially reduces customer waiting time at tellers' windows has been developed by the Radio Corp. of America.

Known as Signaguard, the device reproduces a passbook signature as an unrecognizable mass of broken lines. When the passbook is presented at the teller's window, the device returns the signature to its original appearance for comparison with the customer's signature.

The new protection system makes use of fiber optics—glass tubes that carry light and images around bends and corners. Signaguard may be likened to cable or telephone wires, with each individual with being a glass tube.

Each tube picks up a small segment of the signature and transmits it to the other end of the tube via a devious route. This scatters signature segments throughout the unintelligible mass that is imprinted on sensitized paper.

In the bank the fiber optics tube is re-reversed to bring the scrambled signature back to its original form for comparison with the signature.

Banks are expected to use the device in conjunction with electronic data-processing systems situated in their main offices. This would eliminate the need for duplicate records of signature and account status in each branch office and also would do away with time-consuming withdrawal checking procedures.

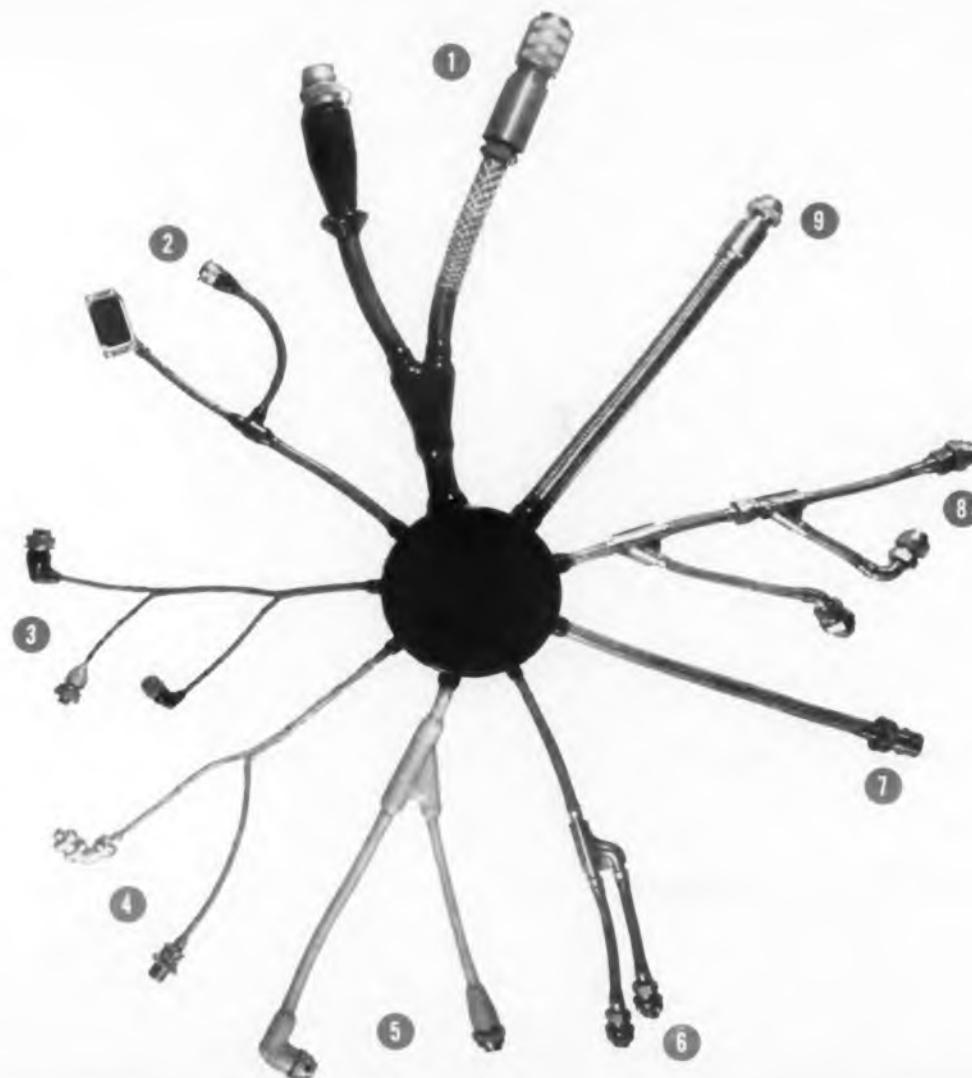
From Maine, Not Fort Sumter



Indiscriminate knob twiddlers are foiled by giant variometer rotor for Navy's vlf transmitter being constructed near Cutler, Maine, for underwater communications. Variometers are made by Permali, Inc., Mount Pleasant, Pa., of plastic laminated wood veneer. Each of two tuners will carry 4,000 lb of 3/4-in. cable. Stators, even larger, will be wound with 5,000 lb of wire.

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ELECTRONIC DESIGN • February 1, 1961



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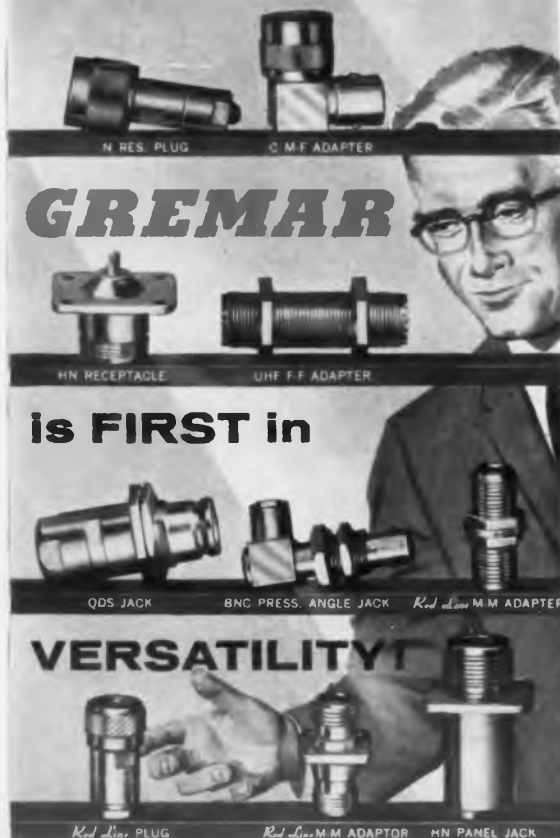
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NEWS

Measurement Snarls Maintainability Drive

Analysis and Definition Difficulties, Lack of Techniques Dominate Third Maintainability Conference in Texas

DESPITE increasing military pressure on industry to improve maintainability of electronic equipment, industry still lacks clearly adequate standards of measurement and is plagued by problems of definition and analysis. Until these difficulties are overcome, a system of describing equipment maintainability in numbers will probably not be evolved for general use.

This was emphasized time and again at the Third Conference on Maintainability of Electronic Equipment sponsored by the EIA and held at San Antonio, Tex.

Typical of the problems still requiring solutions were those posed by Col. W. B. Latta of the Army's logistics office, who said the Army was faced with:

- "The need to know how much it costs to have a repair part in the system.
- "The need to know how much it costs to provide a maintenance technician to accomplish the repair.

- "The need to know when it is more economical to 'throw away' modules rather than repair them.

- "The necessity to provide the contracting officer with a meaningful basis on which to accept or reject contractual proposals that would improve maintainability. In this area, a need is felt for providing contractual incentive which will impel the contractor to simplify the maintenance of Army equipment."

Solution of these problems is expected to lead to new design procedures and new electronic developments. The Navy is actively pursuing maintenance innovations. As reported by Capt. T. W. Murphy of the BuShips shipbuilding office, one of the Navy's serious problems is to keep sufficient numbers of experienced electronic technicians. The Navy, therefore, is searching for techniques, built-in test equipment, and fault locators that will make servicing of the basic equipment easier, he said. Another problem, that of the

Central Structure for Maintainability

1.	Cost of Obtaining Higher Maintainability (Development and Production)	Savings in Support Costs (Including Spares)	Savings Due To Increased Availability (Fewer Systems Procured for a Given Job)	
2.	Preventive Maintenance		Corrective Maintenance	
3.	In-Service Preventive Maintenance	Out-of-Service Preventive Maintenance	In-Service Corrective Maintenance	Out-of-Service Corrective Maintenance
4.	Procrastination Maintenance	Throw-Away Maintenance	Redundancy Maintenance	Preventive Maintenance Instead of Corrective Maintenance
5.	Malfunction Detection	Malfunction Isolation	Access	Maintenance Information
			Maintenance Equipment	
6.	Detailed Engineering Design and Maintenance Planning Decisions			

Maintainability factors described in six levels of abstraction are arranged to interrelate the factors that remain invariant from one hardware system to another. This arrangement was designed at IBM to "put the maintainability problem in perspective," and was part of a paper delivered at the EIA's third maintainability conference.

growing size and complexity of electronic gear, is being experimentally approached by a concept of integrated electronics compartments in which the equipment is not housed in the traditional individual cabinets. In answer to a question on this concept, Captain Murphy said that a production line is currently being adapted to this approach and that installation of an integrated compartment is expected in six months. These compartments will be completely air-conditioned and may ultimately be completely built and assembled at a contractor's plant and "dropped" into the ship during construction.

Eliminating the 'Monsters' From Automatic Test Equipment

The Navy is looking for answers to the problem of creating "monsters" out of automatic test equipment. They are very aware of the drop-off in mean time between failures that occur with the addition of component test capability, self-indicating circuitry, and the like.

No answer was available to the problem of how to deal with changes in philosophy between original and final designs of equipment produced by different contractors, or subcontractors, for a basic equipment, or when personnel changes during production. This is another area in which the Navy would like some answers, Captain Murphy said.

A Dept. of Defense maintainability specialist, Sidney Hirshon, presented the Air Force's hopes for design innovations.

"We visualize," he said, "completely automatic sensing devices which, when coupled with built-in redundant circuits, will rapidly detect the faulty unit and revert to the additional operating mode for safe operation."

"We visualize automatic self-calibrating and self-regulating equipment to insure constant intolerance operation coupled with warning devices to indicate when out-of-tolerances cannot be self-corrected. We visualize built-in marginal stressing circuits which will predict incipient failures and indicate the need for preventive maintenance. We visualize all low- and medium-power and most high-power electronic circuitry handled by solid-state modules 1/20th or 1/50th the size of present-day conventional units performing the same functions."

"We therefore visualize extensive use of disposal-at-failure maintenance rather than repair-type maintenance," he said.

In reply to a question concerning the current status of MIL-M-26512, Mr. Hirshon said that it is undergoing revision to put more "teeth" in it and that the revised issue will be available shortly.

A panel of military maintainability specialists made these points in speaking for the services:



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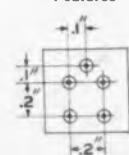
INTRODUCING the NEW Hi-G *“dice cube” relay

*(Created Specifically for
Printed Circuit Applications)*

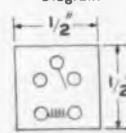
Volume — $\frac{1}{8}$ cubic inch max.
Package Density — 8 per cubic inch,
13,824 per cubic foot.

- Type:** Model C Relay.
Contacts: SPDT, dry circuit to 1 amp resistive.
Temperature: -65°C to $+125^{\circ}\text{C}$.
Insulation Resistance: 1000 megohms @ 125°C .
Dielectric Strength: 1000 VRMS @ Sea Level.
Convenient Size: $\frac{1}{2}$ " Cube, allowing best compatibility in size to other printed circuit components.
Optional Terminals: Long or short leads for printed circuit applications, or hook type for standard wiring.
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Printed Circuit Features



Diagram



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These high-permeability shields are made from existing tools in a broad variety of single and multiple structures—cylinders, spheres, truncated cones—for applications ranging from dc into the audio range and higher. They can be used with almost all conventional transformer core and coil assemblies to provide any degree of magnetic, electrostatic or RF shielding against undesired signals of

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CIRCLE 31 ON READER-SERVICE CARD

NEWS

- The U. S. can afford to pay any price that will give it positive, effective maintainability.

- The U. S. can build a vast numbers theory, but it will do no good if it loses sight of the goals. Dollars spent on maintainability are a means to an end in effective performance. They are the means to an end to develop, produce, and put in use items that can be maintained. The basic "number" is performance. Reliability and maintainability "numbers" must be oriented to this number. If the U.S. waits for all the "numbers" to be developed, it will never reach any goal.

"Integration of Maintainability Requirements into the Research and Development Phase of Weapon Systems" was the subject of a paper by J. W. Lewis, Aerospace Medical Laboratory, Wright-Patterson Air Force Base, Dayton, Ohio. He noted that what is needed from an Air Force point of view is an adequate and integrated program to implement the requirement that weapon system components be serviceable and repairable. The effort must begin at the time equipment design begins, in fact, even at the time of the development of system requirements.

A controversial subject was raised by a question asked after Mr. Lewis made his presentation. The questioner said: "The establishment of a separate group controlling maintainability is generally advised and will be required by revised MIL-M-26512. What sort of group in terms of education, background, etc., should be established?"

Mr. Lewis replied: "There is no known way by which you can specify this data until you study the functions to be assigned a specific group. This will determine the types and quantities of people a specific organization will need."

Another question—"Can a separate group be financed from contract funds, how stable would it be, what is its relationship with design engineering?"—was answered:

"Design review is a finite aspect of the contract and since it is a contract requirement, it is justified contractual cost item. Research and development aspects of maintainability can be financed partly by study contract effort and partly by company-sponsored programs, including support engineering for commercial product lines. The military is calling more and more for contractor-support systems which again makes financing a proper contractual cost."

Solutions to Problem Suffer From 'Undistributed Middles'

A comment very pertinent to designers was made later in the discussion: "Three things have

come out of this discussion that we should get on the record. First, there is insufficient emphasis applied to defining in a systems requirement specification what the maintainability requirements should be.

"Second, we give and get the impression that maintainability is synonymous with accessibility and repairability—analogue to human engineering design.

"Third, we tend to view design for maintainability as a 'review' feature after the fact of design engineering. Maintainability is a subsystem design problem. How do we get functional performance? How do we get trade-offs? The solution suffers from undistributed middles. We must stop looking at just components, accesses, automatic vs. technician testing, and take a look at the 'middles' in the training aids, manuals, etc."

In Session III of the conference, three papers were presented on the subject of "Design for Improved Maintainability."

Asked at this session was the question: "Do any studies provide data relative to maintenance problems of automatic ground support equipment?" The answer was that there is "no knowledge of any. It should be recognized that automatic equipment is, in effect, a 'tender trap'. The same technicians that are unable to maintain regular equipment are required to maintain exotic automatic equipment."

Dr. M. J. Marcus, IBM Federal Systems Div., proposed a method for putting "The Maintainability Problem in Systematic Perspective." Dr. Marcus recommends structuring maintainability by identifying and interrelating the factors in the problem that remain invariant from one hardware system to the next. If the concept of invariance is applied to maintainability, then the problem can be gradually ordered and brought under control. As the field of invariance in maintainability is expanded, control of the problem will increase.

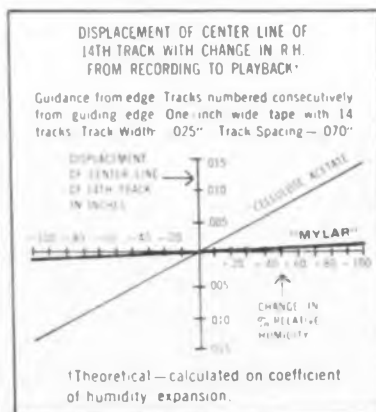
Close to the end of the conference general comment was made relative to the "neglected man"—the prime maintenance tool—the two-legged tool. Engineers were enjoined to take better care of him. In reference to the comment earlier on deemphasis of fundamentals in training, it was suggested that perhaps it should be the other way around with emphasis on standardization of fundamentals. A final challenge was made that design be oriented around one known design parameter, that of the technician classification, such as Airman-5 level, or any other appropriate level.

The papers delivered at this conference have been published by Engineering Publishers, Elizabeth, New Jersey, under the title "Electronic Maintainability, Vol. 3." ■ ■

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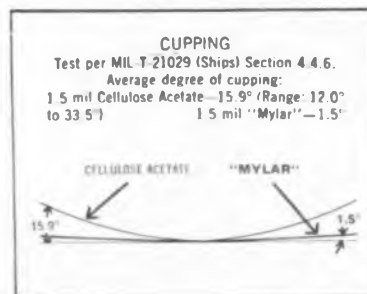


Less track displacement.

Because "Mylar" is virtually unaffected by changes in temperature or humidity, tapes do not shrink or

swell to cause shifting of tracks. Chart 1 compares lateral shifting of track due to dimensional change of "Mylar" and cellulose acetate. Tapes of "Mylar" minimize possibility of garbled or weak signals caused by track displacement.

CHART NO. 2



Fewer signal dropouts.

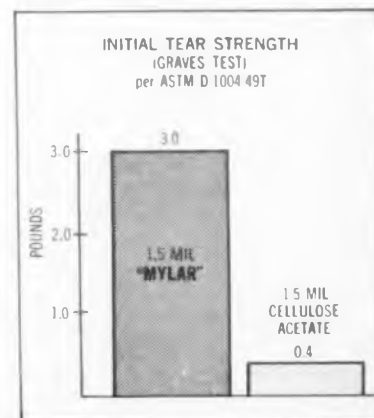
Chart 2 compares "Mylar" with cellulose acetate in cupping due to temperature and humidity change. Insignificant change in "Mylar" minimizes possibility of signal dropout caused by loss of total contact with the recording or playback head.

Less tape breakage.

Since most breaks start as edge nicks, the high initial tear strength of "Mylar" reduces chance of breakage

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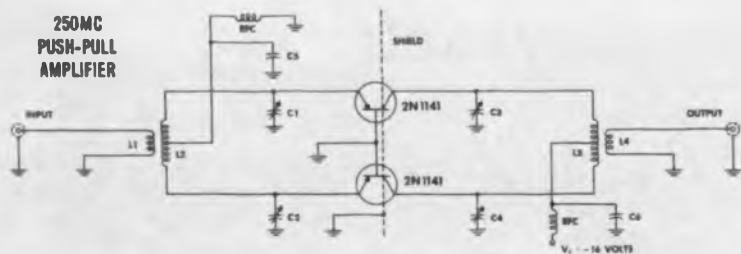
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CIRCLE 32 ON READER-SERVICE CARD



HOW TO SOLVE HIGH GAIN LOW NOISE AMPLIFIER PROBLEMS

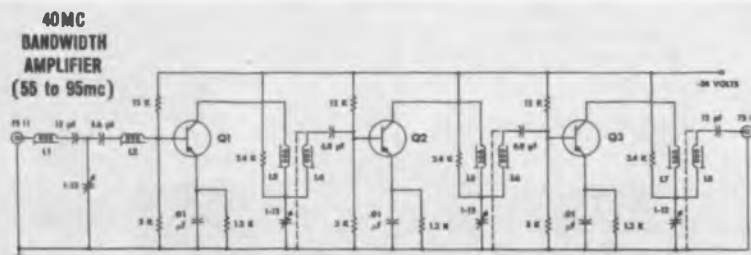
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Use TI 2N1142 transistors if only 330 mw output is required.

Power in - 20 mw
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 $V_{cc} = -25$ v
 $I_c = 35$ ma

C1, C2, C3, C4 = 3-12pf CTC Trimmer Cap.
C5, C6 = 1000 pf Sprague T. V. Bypass Cap.
L1 = 4 turns No. 18 tinned copper wire; $\frac{1}{16}$ " diam; $\frac{1}{8}$ " length
L2 = 6 turns No. 18 tinned copper wire; $\frac{1}{16}$ " diam; $\frac{1}{8}$ " length
L3 = 6 turns No. 18 tinned copper wire; $\frac{1}{16}$ " diam; $\frac{1}{8}$ " length
L4 = 2 turns No. 18 tinned copper wire; $\frac{1}{16}$ " diam; $\frac{1}{8}$ " length



PERFORMANCE CHART

Q1	Q2	Q3	Gain (db)
2N1405	2N1405	2N1405	30
2N1405	2N1406	2N1406	27
2N1405	2N1406	2N1407	23
2N1405	2N1407	2N1407	20

L1, L8 9 TURNS #24 ENAMEL WIRE CLOSEWOUND ON CTC LS9
L2, L4, L6 10 TURNS #32 ENAMEL WIRE CLOSEWOUND ON CTC LS9
L3, L5, L7 20 TURNS #37 GRIPPEZE CLOSEWOUND ON CTC LS9

INPUT 30 v
 V_{cc} 9v
 I_c 4.2 ma



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TYPICAL COMMON-EMITTER SHORT CIRCUIT FORWARD CURRENT TRANSFER RATIO AT 100 mc h_{fe}	13.5 db	11.5 db	9.5 db	10.0 db	10.0 db	7.5 db
TYPICAL NOISE FIGURE AT 200 mc N.F.				5.0 db	6.0 db	7.0 db
TYPICAL MAXIMUM FREQUENCY OF OSCILLATION f_{max}	750 mc	600 mc	500 mc	1100 mc	750 mc	650 mc
TYPICAL COLLECTOR-BASE TIME CONSTANT $r_b' C_c$	30 ohm- μ sec	40 ohm- μ sec	50 ohm- μ sec	12 ohm- μ sec	25 ohm- μ sec	25 ohm- μ sec



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CIRCLE 34 ON READER-SERVICE CARD

EDITORIAL

Some Electronic Chewing Gum Would Come in Handy

Imagineering is generally directed toward solutions of complex problems. Having somewhat of an inverted mind, this engineer has let his fancy focus on a more prosaic problem—finding a replacement for the alligator clip. A basic invention that would facilitate the temporary interconnection of a jumble of hookup wires and component leads without soldering would be welcomed by every circuit designer.

A quick rundown of interconnecting schemes shows the real paucity of ideas: Fahnestock clips, alligator clips, and binding posts are about all. There have been several modifications of clips, particularly those used on test probes, which are improvements. A small tip, easy to attach and detach, grips the lead firmly. This same idea has been used to produce handy jumpers but additional jumpers are needed for every additional lead introduced. Component holders with clips similarly accommodate one component at a time.

Some breadboard connecting schemes, such as coil springs, permit multiple connections to be made by slipping leads between helices but the experimenter has to bring all of his leads to the breadboard. Furthermore, the coils take up a lot of space.

Soldering has to be eliminated, as it is not at all satisfactory. Who among us can solder three leads together without first twisting them all together? And welders aren't flexible enough.

What might the solution be? The ideal interconnecting device ought to be small and light and conform to any contour made with any number of crossed wires that are full of kinks. It ought to be applied without heat or a special tool. The connection should stay firm under the strain of the weight of a component but it should otherwise be broken easily. Of course the resistivity should be extremely low. I believe that the nearest thing would be chewing gum with a conductive filler. Ideas on the flavor, anyone?

James G. Kipp

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Calculating the Performance of RF Amplifiers, Doublers and Triplers



Rather lengthy numerical effort is necessary to complete the Fourier analysis associated with class B and C rf amplifiers and frequency multipliers. A handy "Computa-Guide" has been prepared to simplify calculations and shorten design time.

A. Katz

Section Head
Transmitting and Comm. Tube Applications
Amperex Electronic Corp.
Hicksville, L. I., N. Y.

TO SIMPLIFY the tedious mathematics involved in evaluating the performance of rf amplifiers and frequency multipliers, a "shorthand" sine-wave guide can be used for graphical calculations.

One of the most accurate numerical techniques for the calculation of harmonic components in a complex waveform is the 13-point analysis.¹ The analysis can be applied first, when a variable Y is a single valued function of X , and second, when variable X changes sinusoidally with time.

In an rf amplifier, a sinusoidal voltage is applied to the control grid of the tube, a sinusoidal plate voltage would be expected at the output. The plate current pulse is the complex waveform, or variable Y , which must be analyzed in order to compute the over-all performance of the amplifier.

A non-sinusoidal periodic symmetrical waveform, similar to the plate-current pulse of an rf amplifier, is shown in Fig. 1. One-half of the cycle has been divided into 15-deg increments resulting in 13 points of various amplitudes, A, B, C, D, E, F, G, etc. These amplitudes, used in the first four equations on Table I, can be

used to determine the dc and any of the harmonic components contained in the pulse.

Fig. 2 illustrates the constant current curve of a typical triode working as a tripler. Both the grid-input voltage and the plate output voltage have been drawn and the points A, B, C, D, E, F, and G projected from both sinusoids to the constant current curves. The points of mutual intersection when joined, make up the line called the operating line. In this particular case the operating line is known as the tripler "S" curve. At this time, a very good replica of the plate-current pulse could be drawn. However, it is unnecessary to do this since the amplitudes A, B, C, D, E, F, and G can be substituted in the equations to find the components needed for further calculations.



Fig. 1. A periodic symmetrical waveform, typical of an rf amplifier plate current pulse, is divided into thirteen 15-deg segments for harmonic analysis.

It is also unnecessary to draw the grid sine wave and the plate sine wave each time computations have to be made because the Computa-Guide is in a reality a "shorthand" sine wave. This becomes obvious upon examination of Fig. 3, showing the construction of the Computa-Guide and its various scales.

The use of the Computa-Guide in determining the points A, B, C, D, E, F, and G on the constant current curve for the straight-through amplifier and multipliers is shown in Figs. 4, 5, 6.

Fig. 5 details the step-by-step procedure for establishing the doubler operating line.

In Fig. 5a, points 1 and 2 have been arbitrarily established on the constant current curves. Point 2 is the intersection of the grid bias, E_{cb} , and the plate battery voltage, E_{pb} . The location of point 1 is based upon experience and trial and error. A good choice is the intersection of peak current line of six times the average ammeter current for a multiplier and a plate voltage line of 20 to 30 per cent of E_{pb} . Using the fundamental sine-guide scale, horizontal lines parallel to each other are drawn from point 1 on the Computa-Guide to point 1 on the constant current curves, and from point 2 on the sine guide to point 2 on the constant current curves. Lines B, C, D, E and F are then drawn.

Using the second harmonic sine guide, parallel vertical lines are then drawn between point 1 on

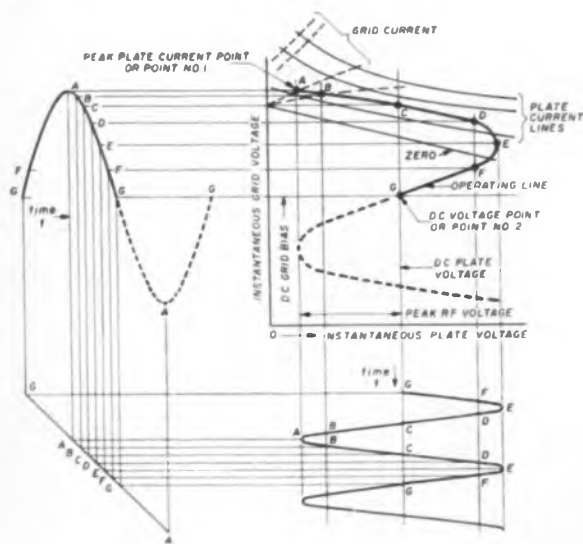


Fig. 2. The operating line, or S curve, of a frequency tripler, developed on the constant current curve of a triode tube.

the sine guide to point 1 on the constant current curves, and from point 2 on the sine guide to point 2 on the constant current curves (See Fig. 5b). Lines B and C are then completed.

In order to draw lines E, F, and G, point 3 must be established. This is located so that the horizontal distance between points 2 and 3 on the constant current curves equals the horizontal distance between points 1 and 2. Now, using the Computa-Guide, vertical and parallel lines are drawn from point 2 (D) on the Computa-Guide to point 2 on the constant current curves, and from point 3 (G) on the Computa-Guide to point 3 on the constant-current curves. The lines E and F may now be drawn (See Fig. 5c).

Fig. 5d shows the intersection of the respective lettered horizontal and vertical lines joined to establish the doubler operating line.

The same technique above may be used in drawing the operating line for the tripler. (See Fig. 6.)

Example Cited For Tetrode Performance

The following design example will demonstrate how the Computa-Guide is used to compute the performance of the 6360 dual tetrode. Assume that the tube will be used in cascade and that it

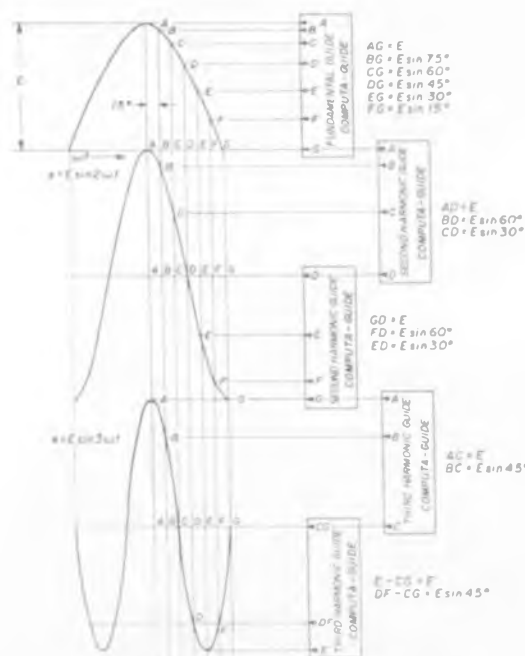


Fig. 3. The construction process for the "Computa-Guide" illustrates why the device is considered a "short-hand" sine wave aid for simplifying calculations.

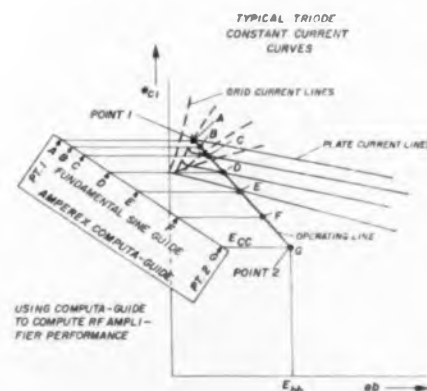


Fig. 4. Typical triode constant current curve with graphical procedure for rf amplifier design.

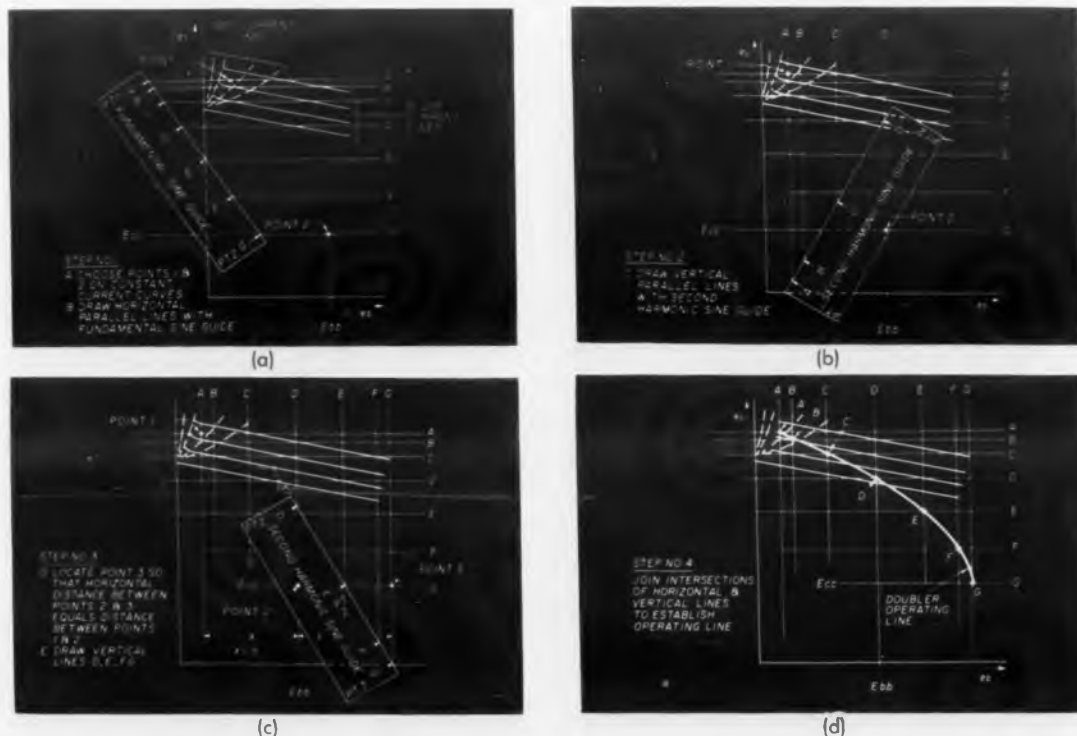


Fig. 5. Procedure for determining fundamental and second harmonic components of a frequency doubler.

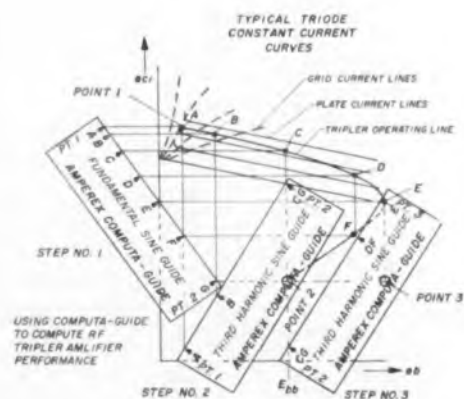


Fig. 6. The fundamental and third harmonic components of a frequency tripler are graphically determined

is necessary to know the performance of one section used as a doubler. (See Fig. 7.)

The following assumptions are made:

- The available dc supply voltage is 200 v. Therefore let $E_{bb} = 200$ v. and let $E_{cc} = 200$ v.
- The dc plate current is 35 ma. Therefore $I_b = 35$ ma dc
- The peak plate current will be about six times this amount or approximately 210 ma. Therefore $i_b = 210$ ma.
- The proper bias for a multiplier should be approximately three times the cut-off. There $E_{cc1} = 90$ v.
- That the peak-plate swing will be about 120 v.

Therefore $E_p = 120$ v and $e_b \text{ min} = 80$ v.

The previous assumptions have established two points on the constant current curves of Fig. 7, point 1 in the low plate voltage area and point 2 of the intersection of bias and dc plate voltage. Using the fundamental sine guide scale, draw horizontal and parallel lines from point 1 on the Computa-Guide to point 1 on the constant current curves, and from point 2 on the Computa-Guide to point 2 on the constant current curves. Now draw horizontal lines A,B,C,D,E,F and G. Note that if this were a straight-through amplifier, the intersection of these lettered lines with a straight operating line drawn between point 1 and point 2 on the constant current curve, would be sufficient to determine the respective amplitudes needed for further computation.

For the doubler operating line, repeat the pre-

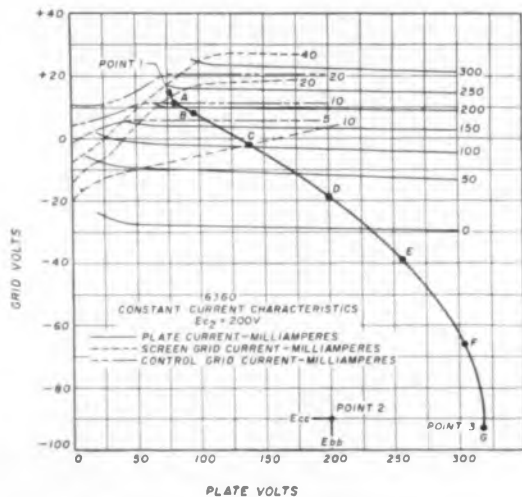


Fig. 7. The constant current characteristics of a 6360 dual tetrode, used in the design example.

vious procedure only this time drawing vertical parallel lines from points 1 and points 2, and of course this time using the second harmonic sine guide. Again, complete the vertical lines A,B,C,D,E,F and G. To determine points D,E,F, and G, it is necessary to use the folded scale of the second harmonic sine guide aligning points 2 and 3 on the Computa-Guide respectively with points 2 and 3 on the constant current curves. Point 3 is established on the constant current curves as $E_{bb} + E_p$ (horizontal distance between point 1 and 2). In this case, $200 + 120 = 320$ v. (See Figs. 5 and 6.)

By designating the intersection of the A vertical with A horizontal lines as point A, and B vertical with B horizontal lines as point B, etc., and joining these intersections the selected doubler operating line can be observed. The amplitudes of the intersections are tabulated in Table II.

The dc currents for meter readings may now be determined using dc current = $1/12 (A/2 + B + C + D + E + F)$. Therefore: dc plate current = $1/12 (105 + 180 + 100 + 30) = 34.6$ ma; dc control grid current = $1/12 (5 + 7 + 2.5) = 1.21$ ma; dc screen grid current = $1/12 (9.5 + 16 + 9) = 2.88$ ma.

The rf power output may now be determined. First, calculate the second harmonic plate peak current (I_{p2}).

$$I_{p2} = 1/12 (A + 1.73B + C - E - 1.73F)$$

$$I_{p2} = 1/12 (210 + 1.73 \times 180 + 100) = 52 \text{ ma.}$$

Therefore:

$$\text{Power output} = \frac{E_{p2} \times I_{p2}}{2} = 120 \times 0.052/2 = 3.12 \text{ w}$$

Table I. Equations relating the values obtained from graphical analysis to the harmonic current components of a complex waveform.

$$\text{DC Current (Meter Reading)} I_b = 1/12 (0.5A + B + C + D + E + F)$$

$$\text{Peak Fundamental RF Current } I_{p1} = 1/12 (A + 1.93B + 1.73C + 1.41D + E + 0.52F)$$

$$\text{Peak Second Harmonic RF Current } I_{p2} = 1/12 (A + 1.73B + C - E - 1.73F)$$

$$\text{Peak Third Harmonic RF Current } I_{p3} = 1/12 (A + 1.41B - 1.41D - 2E - 1.41F)$$

Table II. Instantaneous values of current obtained by graphical procedures for solution of the design example.

Letter	Plate (ma)	Control Grid (ma)	Screen Grid (ma)
A	210	10	19
B	180	7	16
C	100	2.5	9
D	30	0	0
E	0	0	0
F	0	0	0
G	0	0	0

$$\text{Input power} = E_{bb} \times I_b = 200 \times 0.0346 = 6.92 \text{ w}$$

$$\text{Plate dissipation} = \text{dc input} - \text{power output} = 6.92 - 3.12 = 3.80 \text{ w}$$

$$\text{Efficiency} = \frac{\text{input power}}{\text{output power}} = 3.12/6.92 = +45\%$$

$$\text{Driving power} = e_g I_c = 103.5 / 1.21 \times 10^{-3} = 0.125 \text{ w}$$

$$\text{Control grid dissipation} = e_g \times I_{c1} = 13.5 \times 1.21 \times 10^{-3} = 0.0164 \text{ w}$$

$$\text{Grid leak resistance } R_{g1} = E_{cc1} / I_{c1} = 90 / 1.21 \times 10^{-3} = 74 \text{ K}$$

$$\text{Screen grid dissipation} = E_{cc2} \times I_{c2} = 200 \times 2.88 \times 10^{-3} = 0.576 \text{ w}$$

$$\text{Plate effective rf impedance} = E_{p2} / I_{p2} = 120 / 0.052 = 2,300 \text{ ohms}$$

Special Aids and Short Cuts In Using the Computa-Guide

It is not unusual to find a good deal of size variation in the constant current curves from tube to tube. Also the nature of the particular characteristics make it sometimes impossible for the manufacturer to include any room on the graph for very high bias. Examination of the operating lines already discussed above, and the equations used for determining the dc and peak rf currents can provide a better understanding of how to overcome the limitations of various sizes of graph paper. Also, the number of trial computations can be reduced by establishing a few general rules.

The object in most cases of computation will be to achieve the highest possible efficiency, such

as $\frac{\text{power output}}{\text{dc input}}$, Examining the equations in Table I helps to determine what the best efficiency will be for a straight-through amplifier. The object in the first two equations is to get the highest ratio of the individual letter in the rf equation to that which it has in the dc current equation. Notice then, that a high value of A and B and C and D would tend to yield high efficiency. Any values of E and F , however, tend to lower efficiency. Consequently, the designer should establish E on the constant current curves so that it coincides approximately with the zero current plate line. Taking this one step further, E bisects the straight-through operating line. Therefore the operating line can be plotted from A to E instead of from A to G and still yield sufficient information. The letter E may be used as point 2 and the following procedure and equations used to determine E_{bb} and E_{cc1} :

(a) Locate E horizontally so that it equals $e_b \text{ min} + 1/2 (E_{bb} - e_b \text{ min})$

$e_b \text{ min}$ is the horizontal distance on the abscissa measured from zero plate voltage to point A .

(b) In the same manner, the vertical location of E may be determined by locating point E so that it equals $e'g - 1/2 [e'g - (-E_{cc1})]$; $e'g$ represents the vertical distance from zero bias to point A . This method allows the designer to use constant current curves plotted on graph paper where the normal point 2 (G) would have to be located off the bottom of the paper.

(c) For the doubler, locate E so that it equals $E_{bb} + 1/2 (E_{bb} - e_b \text{ min})$

And for the vertical position locate E so that it is equal to $e'g - 1/2 [e''g - (-E_{cc1})]$. For the doubler, point E should be located approximately on the zero plate current line for the best efficiency.

The same system may be used for the tripler computations, but this time the letter C should be located at or about the zero plate current line. Its location can be determined as follows:

(a) Locate C horizontally so that it is equal to E_{bb}

(b) Locate C vertically so that it is equal to $e'g - 0.134 e'g - (-E_{cc1})$

With a little practice, the designer, with the aid of the locating devices given above and the Computa-Guide may shorten the computation time considerably. ■ ■

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2. Brown, Robert H., "Harmonic Amplifier Design", Proceedings of the IRE, Volume 35 (Aug. 1947), pp. 771-777.
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4. Amperex Application Bulletin "6360."

Electronic Products **NEWS**

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Arc suppression in CLARE Stepping Switches Improved with GLOBAR® Varistors

Laboratory report shows up to 4 to 1 reduction in peak voltage compared with standard condenser-resistor networks

C. P. Clare & Co., Chicago, Ill., manufacture a line of precision stepping switches, offering as many as 480 contact points in a single unit. Arc suppression at the relay contact in these switches is vital to long life and dependable operation.

An extensive series of laboratory tests by Clare has established the

superior arc suppression capabilities of GLOBAR varistors. Tests were made in comparison with standard resistor-capacitor networks, using various stepping switches having coil ratings of 6 volts up to 110 volts. Results were based on visual observation of arc suppression, peak voltage and speed as shown on 'scope. and heating of the body of the varistor, as recorded by a pyrometer. In some cases, tests with the varistor showed a 4 to 1 reduction in peak



Typical CLARE stepping switch. Type 20, is shown above. This switch offers up to 480 contact points in twelve 40-point levels, or 320 in sixteen 20-point levels.

application in contact arc suppression, protection against voltage surges and similar problems. Response to short duration impulses is instantaneous.

All GLOBAR varistors are made to individual customer specifications. Inquiries concerning specific applications are welcomed. If your interest is in experimenting with possible uses, it is suggested that you investigate the GLOBAR Varistor Test Kit. Write to Global Plant, Refractories Division, Dept. EDV-21, The Carborundum Company, Niagara Falls, New York.

CIRCLE 201 ON READER-SERVICE CARD

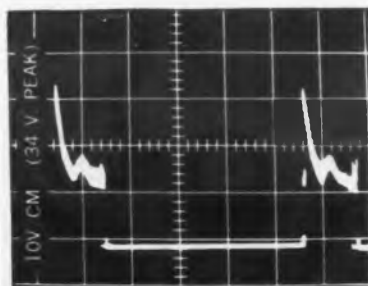
BOOKLET AVAILABLE ON GLOBAR Type BNR VARISTORS



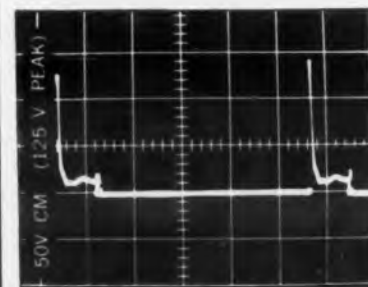
Full information on the physical and electrical characteristics of GLOBAR Type BNR varistors is contained in Technical Bulletin GR-2, which will be mailed on request. For your copy, write

Global Plant, Refractories Div., Dept. EDV-21, The Carborundum Co., Niagara Falls, N. Y.

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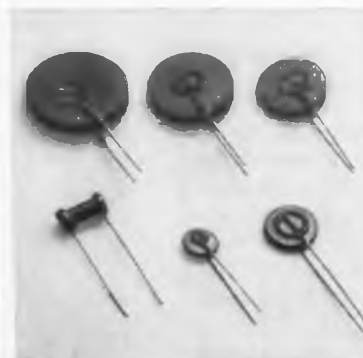


5MS/CM (39 S.P.S.)



5MS/CM (39 S.P.S.)

Reduction of peak voltage is shown in these comparative oscilloscope traces. Upper trace, showing 34 v. peak, was obtained with varistor across coil. Lower trace shows 125 v. peak with .5 mfd. capacitor and 10 ohm resistor across contacts.



Disc and rod type GLOBAR varistors are shown above. Wide variation in voltage coefficients may be obtained through changes in length-diameter ratios.

voltage. Temperature readings revealed more than adequate safety factors under all anticipated voltages and duty cycles.

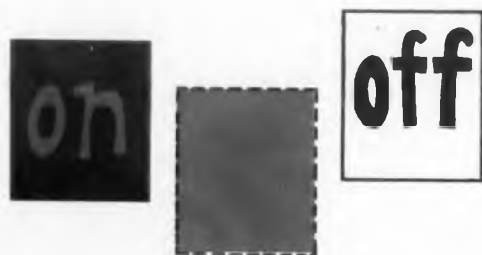
GLOBAR Type BNR varistors are non-linear, voltage-sensitive resistors made from electrical grade silicon carbide. Their negative voltage coefficient of resistance (resistance decreasing with an increase of voltage) offers wide possibilities for

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The "Tri-Stable" Flip-Flop Circuit:

How It Works, How To Design It



In eight steps, the author shows how to rapidly and accurately arrive at a preliminary design of the "Tri-Stable" flip-flop—a circuit especially useful where a three-state logic condition exists, such as "on," "off" and "neutral."

C. K. Beagle
Systems Engineer
Fenske, Frederick & Miller, Inc.,
Los Angeles, Calif.

THE "TRI-STABLE" flip-flop circuit can be used in many cases to greatly simplify "logical" design and provide considerable savings in components. The circuit is especially useful where a three-state "logic" condition exists, such as "on," "off," and "neutral." The flip-flop considered here is a special-purpose design; but the techniques are readily expandable to many other general design configurations.

The function of the "Tri-Stable" flip-flop is analogous to the conventional "Bi-Stable" flip-flop, with the addition of one more stable state. Circuit analysis is also based on this operational philosophy.

The schematic diagram describes a "Tri-Stable" switch of a saturation design, using solid-state devices. Type 2N388 germanium transistors are used. The design is also valid for other germanium and silicon, npn and pnp units. Considerations for using pnp transistors are given in the design steps.

Each transistor has a Zener diode in its collector circuit to set the dc logic levels; these Zener diodes act (1) as a clamp diode when the transistor is conducting, and (2) as a reference voltage when the transistor is cut off. Assuming transistor 1 is conducting, collector voltage will equal E_1 , due to the clamp action of the forward-biased Zener diode. The collector voltages of cut-off transistors 2 and 3 will equal E_1 plus the voltage drop across the back-biased Zener diode. This gives a two-level dc logic derived from one reference voltage E_1 .

The emitter voltage of transistor 1 will equal E_1 less the collector-to-emitter voltage drop. As

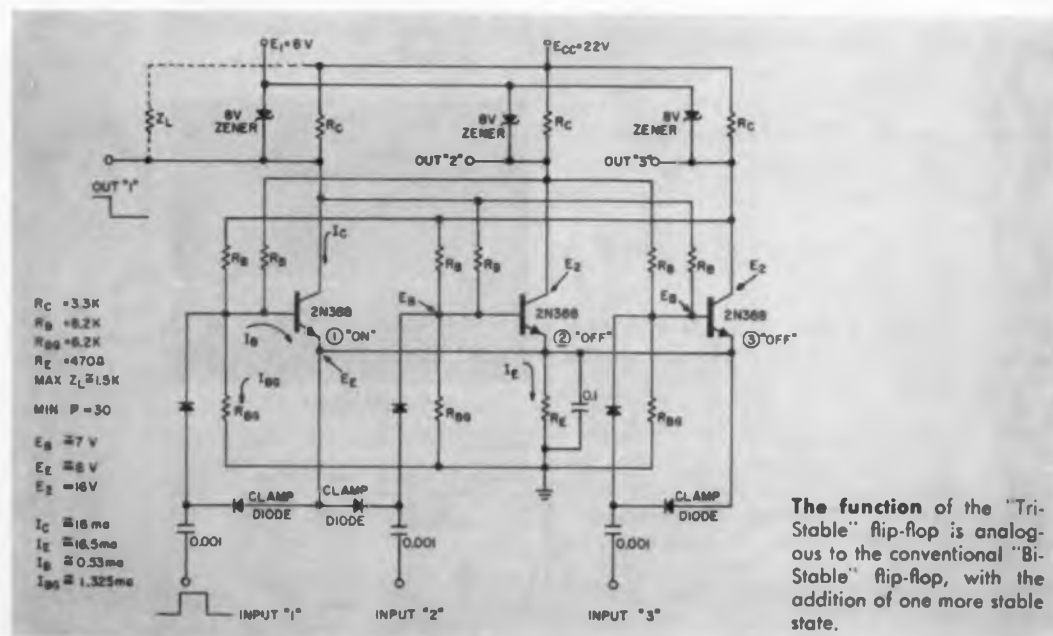
all three emitters have a common resistor, the emitter voltage will remain at the approximate value of E_1 at all times. The emitter-bypass capacitor will hold this voltage at the proper value during transition from one state to another.

The base voltages are determined by the collector voltages and the cross-coupling resistors R_N and R_{Ng} . Each base is fed by the collectors of the other two stages; the voltages are summed at this point.

With the collector of transistor 1 at a potential E_1 and the emitter at a slightly lower potential, the cross-coupling effects of this collector may be discounted. The voltages of collectors 2 and 3 will effectively cut off stages 2 and 3 and

keep transistor 1 turned "on", thus allowing only one stable state to exist. The clamp diodes will prevent this cut-off bias from exceeding 1 v, allowing an input pulse with an amplitude in excess of 1 v to turn the associated transistor on. The clamp diodes also permit the use of many silicon devices with a maximum V_{EBO} of 1 v.

To switch the "Tri-Stable" circuit to another stable state, a trigger pulse is applied to the base circuit of the stage to be turned "on." Due to cross-coupling action, the transistor being turned "on" will, at the same time, bias "off" the other two stages. As the other two stages turn "off," the effect is regenerative, causing the "on" transistor to be driven into saturation. Thus the "Tri-



The function of the "Tri-Stable" flip-flop is analogous to the conventional "Bi-Stable" flip-flop, with the addition of one more stable state.

Stable" circuit can be switched to any of three stable states and acts as a true flip-flop, as opposed to a ring counter.

The design problems involved in determining the proper base drive currents and output loads can involve lengthy network analysis. The following techniques were derived from network solutions, in terms of voltage ratios, and yield a very rapid and accurate preliminary design.

Assuming transistor 1 "on" and transistors 2 and 3 "off," follow these design steps:

1. The choice of the Zener diodes and/or logic levels to be used in the collector circuits is determined by the logic input and output requirements. In the example used, the output logic levels will be between 8 and 16 v. An 8-v Zener diode is used, and a reference voltage of 8 v is required.

2. The transistor to be used should be chosen with reference to minimum beta and maximum I_c encountered to allow the circuit maximum current output capacity. The choice of a 2N388 was made because of its high beta and large current-carrying capacity. Transistors with a beta of less than 10 are generally not suitable for this circuit. The supply voltage, E_{cc} , may be determined at this point and is usually limited by the transistor used. All resistance values shall be chosen within ± 5 per cent of derived values. (Nearest EIA value within ± 5 per cent.)

3. A preliminary check of load requirements can now be made. The following equations give the required transistor characteristics for a given load. The maximum load required for the example used will be 1.5 K. (The load referred to is a resistive load from the transistor collector to E_{cc} .)

$$Z_L = \frac{(E_{cc} - E_1)(E_{cc} - E_2)}{I_B \beta (E_{cc} - E_2) - (E_{cc} - E_1)(I_B + I_{BG})}$$

$$\text{where: } I_B = \frac{I_c}{\beta} \text{ and: } I_{BG} = 2.5 I_B$$

Assigning the following values:

$$I_c = 16 \text{ ma, } \beta = 30, E_{cc} = 22, E_1 = 8 \text{ and } E_2 = 16$$

$$\text{Solving: } I_B = \frac{0.016}{30} = 0.53 \text{ ma}$$

$$\text{Then: } I_{BG} = (2.5)(0.00053) \cong 1.325 \text{ ma}$$

$$Z_L = \frac{(22-8)(22-16)}{(0.00053)(30)(22-16) - (22-8)(0.00053+0.00135)} = 1.2 \text{ K}$$

By solving these equations, it is apparent the "Tri-Stable" circuit will drive a 1.5-K load with the previously assigned values.

4. With transistor parameters and Z_L (max) established, other circuit component values may now be defined. The value of R_E is determined

from the values of E_1 and $I_c + I_B$ (from step 3)

$$R_E = \frac{E_1}{I_c + I_B} = \frac{8}{0.01653} = 484 \text{ ohms}$$

The nearest EIA value of 470 ohms is chosen as the emitter resistor value to be used.

5. An optimum value of R_B in series with R_{BG} is determined by the value of R_E .

$$R_B + R_{BG} = R_E \beta = (470)(30) = 14.1 \text{ K}$$

6. The ratio of R_B/R_{BG} is the same as the ratio of the logic levels involved. To allow a 1-v cut-off bias, the ratio of R_B/R_{BG} is:

$$R_B = \frac{(E_2 - E_1) + 1}{E_1 - 1} = \frac{9}{7}$$

The optimum series resistance derived from step 5 is now split into this ratio:

$$\frac{14,100}{16} = 881 \text{ ohms}$$

$$\frac{9(881)}{7(881)} = \frac{7,929 \text{ ohms}}{6,167 \text{ ohms}} = \frac{R_B}{R_{BG}}$$

Choosing the nearest EIA value, $R_B = 8.2 \text{ K}$ ohms and $R_{BG} = 6.2 \text{ K}$.

7. The value of R_c is found by the equation:

$$R_c = \frac{E_{cc} - E_2}{I_c + I_{BG} + 2(I_{CBO})} = \frac{6}{0.00053 + 0.001325 + 0.00001} \cong 3,210 \text{ ohms}$$

Choosing the nearest EIA value, $R_c = 3.3 \text{ K}$.

8. The maximum load impedance the circuit will drive may be checked against the value determined from step 3 by the expression:

$$I_c - \frac{E_{cc} - E_1}{R_c} \geq \frac{E_{cc} - E_1}{R_L} \\ 0.016 - \frac{(22-8)}{3,300} \geq \frac{22-8}{1,500} \\ 0.012 \geq 0.00933$$

This completes the design steps for the circuit under consideration.

If pnp transistors are used, the following revisions must be made to the design steps:

- The supply voltage E_{cc} and the reference voltage E_1 have must reverse polarity.
- All diodes, including the Zeners, must be reversed.
- Step 6 equation must be changed from

$$\frac{(E_2 - E_1)}{E_1 - 1} + 1 = \frac{R_B}{R_{BG}} \\ \text{to } \frac{(E_2 - E_1) + 1}{E_1 - 1} = \frac{R_{BG}}{R_B}$$

These steps provide a very rapid design of a usable circuit. If a more precise analysis is required (due to extremes of ambient temperature, for example) this very accurate "ball-park" configuration will serve as a starting point. ■

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High-Voltage Testing: It Can Be Nondestructive

In his article, "High-Potential Testing . . . A Semidestructive Process?" (ED, April 27, 1960), author Ben Sachs reviewed the two opposing points of view on high-potential testing, as applied to rotating components. One point of view is that each successive hi-potting weakens all units; Sachs introduced data to prove the claim. Rebutting that view, the author of this article provides test data showing that, "properly conducted, high-voltage tests can be nondestructive." The discussion in this article is general, however, and rotating components are not specifically covered.

Harold N. Miller

Vice President and Chief Engineer
Associated Research, Inc.
Chicago, Ill.

IS HIGH-VOLTAGE testing destructive or non-destructive? Both sides of that question are amply covered in published articles; the answer would seem to lie, in any individual case, in the material being tested and the method of testing.

Intelligent appraisal of the subject first requires understanding breakdown mechanism, or at least the main causes of insulation failures. Insulation breakdown is usually described as: a destructive discharge through the insulation, characterized by a disproportionately large change in test current as test voltage is increased. This surge is often referred to as an avalanche current. After a breakdown failure, it is usually impossible to

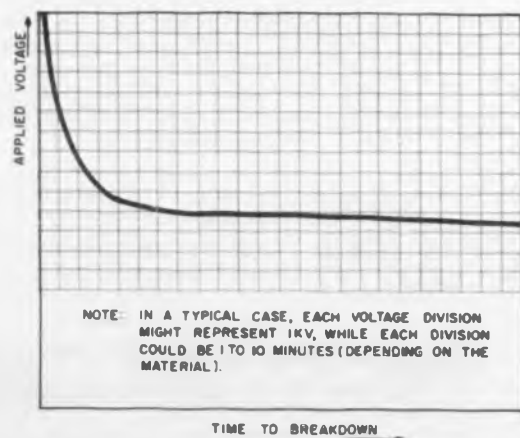


Fig. 1. Applied test voltage versus length of time to breakdown.

restore voltage to the previous point. Breakdown may also be defined as: a rupture of the insulation that results in increased leakage current at a specified test voltage.

Causes of Insulation Breakdown: Three Are Cited

Three main causes of failure are usually identified as:

1. **Mechanical breakdown**, caused by stresses set up by the applied voltage. This type of failure is much more likely to be prevalent with ac testing than with dc; it is often associated with impulse testing.
2. **Thermal failure**, due to insulation deterioration caused by internal generation of heat. This heat may be due to high leakage current, but more often is caused by conductors or other current-carrying parts operating hot. Thermal damage is cumulative with time.
3. **Ionization failure**, due to chemical deterioration of the insulation. This is usually caused by oxygen released during ionization of air in insulation voids or around the insulation. Deterioration caused by this chemical action is cumulative with time.

Since two of the three main causes of insulation damage show a cumulative effect, indiscriminate testing can eventually cause failure. Testing, properly done, however, would not be carried to levels that would result in any significant damage to sound insulation.

Voltage Endurance Can Serve As A Function Of Test Time

The voltage a piece of equipment can stand depends, to a great extent, on the length of time

that voltage is applied. This relationship is not linear, but has the general characteristics shown in Fig. 1. The exact shape of the curve (applied voltage vs length of time to breakdown) depends on the specific material under test, if the applied voltage is ac or dc, the shape of the test electrodes, etc. In all cases, however, the curve shows that, if the voltage is lowered slightly, the withstand time is increased greatly.

If the equipment is originally designed so the insulation can stand 120-130 per cent of the final test voltage for a reasonable length of time (several minutes to an hour), almost indefinite testing at the lower voltages can be done without damage. Recognizing this characteristic of insulation leads many specifying agencies and manufacturers to call for in-service test voltages of 60 per cent to 80 per cent of the factory test values. This voltage-vs-time condition is also specified or implied in many specifications that permit tests at a given voltage for 1 min or, alternatively, a 25 per cent higher voltage test for 5 sec. In the case of equipment already designed or in production, the test voltage the insulation can stand for the long time period can be experimentally determined. Then, running production or maintenance tests at 60 per cent to 80 per cent of this voltage would be safe.

With the present state of the art (where even thin films of insulation may stand many hundreds of volts per mil), it is almost mechanically impossible to have a sound insulation structure with a breakdown strength of less than a few thousand volts. Consequently, most test codes call for high-potential testing values of twice-rated voltage plus a 1,000-v for a period of 1 min. If the equipment is originally designed to stand a slightly

higher voltage than this for a longer length of time, the damage that might be done at the test voltage is minute, and sound insulation would not be harmed even after hundreds of tests. If the test value is chosen too low, the test may as well not be made, for it will give a false sense of security.

Minimizing Destructiveness By Current Limiting

When the voltage-withstand strength of equipment under test is not known or inconvenient to determine, current-limited high-voltage test equipment can be used to insure nondestructiveness of the dielectric strength test. The current limiting may either be in the form of (1) a fast-acting circuit breaker in the output of the test set (set to trip at a few milliamperes or less), or (2) a collapsing-field type high-voltage transformer that automatically lowers output voltage as load current increases.

With equipment of this type, the test voltage is lowered or removed before the insulation can rupture. Thousands of test sets of this type are in continuous use today, testing all types of consumer items without any evidence of causing equipment damage.

Internal Corona Develops Due to Voids in Insulation

Often, in running a high-potential test, internal corona develops due to voids in the insulation, at voltages far below the breakdown voltage of the insulation itself. Unfortunately, the presence of this corona won't show up with most test sets in common use.

Corona produced during testing may rapidly deteriorate the insulation; since the effect of this deterioration is cumulative, subsequent high-voltage tests are usually blamed for failure. Note, however, the production of corona actually indicates a defect (usually a void) in the insulation; thus, the insulation could not be considered sound. When corona damage is significant in the equipment being tested, a high-potential test should be made, using modern corona detection equipment that displays the presence of even minute amounts of corona. Using this type of equipment, the high-voltage test could be stopped at the point of inception of corona, thus preventing harm to the insulation.

DC High-Potential Testing Is an Important Consideration

Another very important consideration in the destructive or nondestructive aspect of high-potential tests is the relative results obtained with ac or dc. Ac testing is usually considered a go/no-go type of proposition. In other words, voltage is run up to a specified value; if the sample



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High-Voltage Testing (continued)

breaks down, it is no good; if it does not break down, it is assumed good.

Unless proper precautions are taken, there is no way of knowing how close the sample approaches the breakdown point. On the other hand, with dc testing, the procedure is somewhat different; leakage current is measured as voltage is raised. As long as current varies approximately linearly with test voltage, the equipment is in good condition. In most cases (this depends on the particular insulation materials involved) there will be a knee in the curve of voltage-vs-current, prior to breakdown. In other words, as the breakdown point is approached, the leakage current starts increasing at a higher rate; soon the avalanche current referred to above appears. On certain newer materials, this knee is almost a right-angle bend; breakdown is reached at about the same time the first sign of the knee appears. In many cases, however, the knee is gradual enough so that the change-of-slope of the current vs voltage curve is apparent; if the test is stopped at that point, no harm is done and the test may be repeated almost indefinitely. Here we have a truly nondestructive test, because, regardless at what voltage deterioration starts to take place, the careful operator (in many cases) can end a test prior to any damage. Careful observation of the slope of the curve of leakage current-vs-applied voltage will yield valuable information about the adequacy, condition, and even expected life of the insulation.

Rate of Application of Voltage Will Affect Breakdown Point

The method of voltage application will have some effect on the breakdown point. Most pub-

lished data indicates that the slower the application of voltage, the more apt the failure to occur at a lower value. Note that in impulse testing of high-voltage insulators and transmission line equipment, voltages many times the normal high-potential test values are used. ASTM Specification D-149, Parag. 3, says, "In general, the dielectric strength decreases with time of exposure to the electrical stress." Appendix I to that same specification says, "The more rapid the increase in voltage, the higher will be the breakdown voltage."

Typical Results Are Described

Despite the massive amount of data supporting the above explanation, additional tests were run at our firm under semicontrolled conditions (to simulate production testing rather than laboratory testing). Ac tests were run, using our model 4501 35-kv oil tester and a model 4505 35-kv materials tester. Dc tests were run using our Model 5265 15 30 45 kv dc Hypot. Various samples were tested, including transformer insulating oils, cellulose acetate film, polyethylene sheets, insulated wire, and simple subassemblies. Results of these test (three are summarized below) amply bear out this fact: properly conducted, high voltage test can be nondestructive.

Test 1: Tests were made on identical samples of transformer grade insulating oil, following the procedure in ASTM D866-49, "Test for Dielectric Strength of Insulating Oil." Fifteen samples of oil, used as a control group, were tested to determine the breakdown voltage. All fifteen broke down between 25 and 28 kv; average for the group was 26 kv. Sample No. 16 was tested

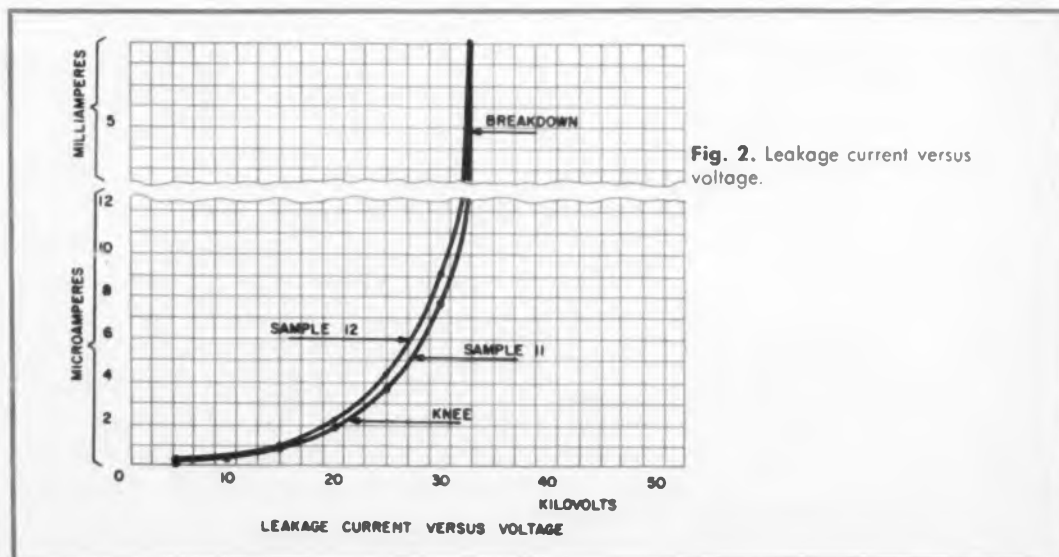


Fig. 2. Leakage current versus voltage.

by raising the voltage at 3 kv per sec up to 20 kv and rapidly dropping the voltage to zero for 100 times, at 2-min intervals. That sample was then tested to breakdown, which occurred at 28 kv; the sample finally broke down on the 88th test (at 25 kv). Sample No. 17 was tested at 22.5 kv for 150 times without failure. The test voltage was raised to 25 kv; the sample finally broke down on the 88th test (at 25 kv). Sample No. 18 was raised to 25 kv and held at that voltage for 1 min before returning to zero. This was repeated until breakdown occurred on the 21st test. Ten more samples were tested to determine the breakdown point. Breakdown in each case fell between 25 and 29 kv.

Test 2: Samples of 0.008-in. cellulose acetate tape were tested in accordance with ASTM Specification D1202-52T, "Cellulose Acetate Sheet and Film." Several control samples were tested to determine the average breakdown value (15 kv). Additional samples of the same material (taken from the same piece) were then given repetitive high-voltage tests, running up to 10,000 v at the rate of 500 v per sec, with rapid return to zero. These tests were repeated 50 times for each sample without failure. The test voltage was then raised until the samples actually broke down, which occurred between 16 and 17.5 kv for this group. Another sample of the same material was raised to 10 kv and the voltage left for 1 hr. The voltage was raised to 12.5 kv; breakdown occurred after 35 min.

Test 3: Samples of insulated cable were tested with dc. In each case, the voltage was raised to 20 kv; the leakage current was recorded. The control samples showed leakage currents between 1.5 and 2 μ a at 20 kv. The voltage of sample No. 11 was increased until breakdown occurred at 32.5 kv. The voltage on sample No. 11 was increased until breakdown occurred at 32.5 kv. The voltage on sample No. 12 was raised to 25 kv and maintained for 2 hr before lowering. The cable showed no sign of damage, nor was there any measurable increase of leakage current during that period. The same sample was then tested 25 times at 20 kv, allowing suitable intervals between tests to permit complete discharge. On the 25th time, leakage current at 20 kv was still identical with the value recorded the first time. The voltage on the same sample was then raised to breakdown, which occurred at 32.5 kv. As shown in Fig. 2, the curve of leakage current-voltage for sample No. 12 (which received a 2-hr test and 25 short tests) is almost identical to the curve of the control sample No. 11, which was raised to breakdown voltage on its first test trial. ■ ■

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CIRCLE 47 ON READER-SERVICE CARD



Soviet engineers designing loop receivers. Square transmitting loop and signal generator are at right. Large, table-model radio on shelf is manufactured at Riga plant. All laboratory equipment is Soviet made.

The Soviet Engineer:

HOW HE LEARNS • HOW HE TRAINS • HOW HE WORKS •

Karl V. Amatneek

Design Consultant
8603 Hull Drive
Philadelphia, Pa.

Here is a personal, worm's-eye view of the Soviet engineer. It differs from the usual bird's-eye portrayal by formal delegations. Author Karl V. Amatneek gathered the material for this article in direct conversations with Soviet engineers in their native language.

Karl V. Amatneek is a design consultant and lecturer on transistor circuitry who recently spent three weeks in the Soviet Union. He lectured on transistor circuits in Riga, at the Latvian Academy of Sciences, and at two factories—the Riga Radio Factory (RRR), where many of the Soviet Union's radios and phonographs are produced, and the State Electrical Factory, the telephone manufacturer of the Soviet Union.

During his stay, Mr. Amatneek made friends with a number of Soviet electronics engineers and visited the RRR laboratories and production floors.



THE SOVIET ENGINEER starts his education at the age of 7 or 8. He attends a public school for 10 or 11 years depending on the requirements in his particular republic. He must attend for the first eight years. Then, if he is to become an engineer, he must attend a high school* for three years.

When he is graduated from high school, a student receives the traditional "Certificate of Maturity." This entitles him to participate in competitive examinations for admission to a university or a polytechnic institute. However, in engineering and several other disciplines, only 20 per cent of the capacity of the freshman class is allotted to new high-school graduates. The other 80 per cent is reserved for those who have spent two years in industry since their graduation.

This is a rather new procedure, first propounded by Nikita S. Khrushchev in 1958. In a conversation with the author, the rector of the Latvian University expressed satisfaction with the enhanced maturity of students admitted on the two-year-deferred basis. "At the same time,"

*An indication of the growth of education in the USSR—in 1928, there were four city high schools in Riga; now there are more than 40.

he commented with enthusiasm, "the brilliant students who come directly from high school are not delayed in developing their natural interests."

Five-Year University Training Includes Summers in Industry

The normal engineering course is five years long. The polytechnic institute or university signs a contract with a factory for furnishing a certain number of students for summer employment. In the course of summer work, the student passes in rotation through production and other departments. During his last summer he works in engineering. Occasionally, some foremen are reluctant to putting up with green students, but on the whole, the system works well.

After studies at the institute (no degree is received at this time), graduates used to be assigned to a factory or other place of employment. Various places had priorities. A federal government organization, for example, had a higher priority than a state organization. Since the decentralization of industry, however, (about two years ago), all factories were given equal priority.

Some Choice of Jobs Now Open to Graduates

Since January, 1960, there has been a new labor law, and now a graduate gets some measure of choice as to where he will work. Still, he hasn't the complete freedom that engineers enjoy

in the United States. On the other hand, the other side of the coin may be even more important to the young Soviet engineer—he knows the government is eager to use his talents fully.

The pay scale for engineers is the same in all factories except in supervisory jobs. There the pay is higher in the larger factories, supposedly on the theory that they involve higher responsibility. Thus, since salary scale and hours are quite fixed, factories may vie with one another for good engineers. As incentives, they offer the engineer the chance of working with school friends and "being closer to home."

Once a graduate has accepted a job, he is expected to work at it for three years. If he changes his job during this interval, it causes bitterness, especially at the institute. But he is really called to task only if he changes to a job for which he was not trained. The theory involved is that the government has made an investment in him and it is entitled to collect for a reasonable length of time. There is some pirating of engineers and this contributes to some early job changes. (In the U. S., engineers tend, on the average, to change jobs every three years.)

When a newly graduated engineer is assigned to a factory, it may not be the factory where he has spent his summers. Thus, the management may not know him, and breaking him in may be difficult. But with some of the rough edges chipped off by appropriate summer work, this should certainly be an easier process than it is in the U. S.

Graduates Start Careers In Production Testing or Drafting

Graduates are started in production testing and similar jobs. They stay at such jobs for varying lengths of time depending on their abilities. They may also start work at drafting jobs.

As the new engineer makes his mistakes and learns in the process, management evaluates him and permits him to take on more and more responsibility. According to one senior engineer, his own break-in process was aided by the universal cooperation of older engineers.

One reason for this cooperation may be the job security that Soviet engineers enjoy. Despite much criticism of Soviet labor unions, the one thing that the unions do provide is job security. During the short stay in the Soviet Union, the writer had to listen to two administrators weeping to the effect that there was practically no way to get rid of an undesirable employee.

Young Engineers Get Their Learning From Magazines, Technical Journals, Colleagues

In addition to advice from older men, the engineer has available to him magazines, both foreign and domestic, and technical meetings of

New, tri-dimensional packaging and interconnecting of modern electronic functions.

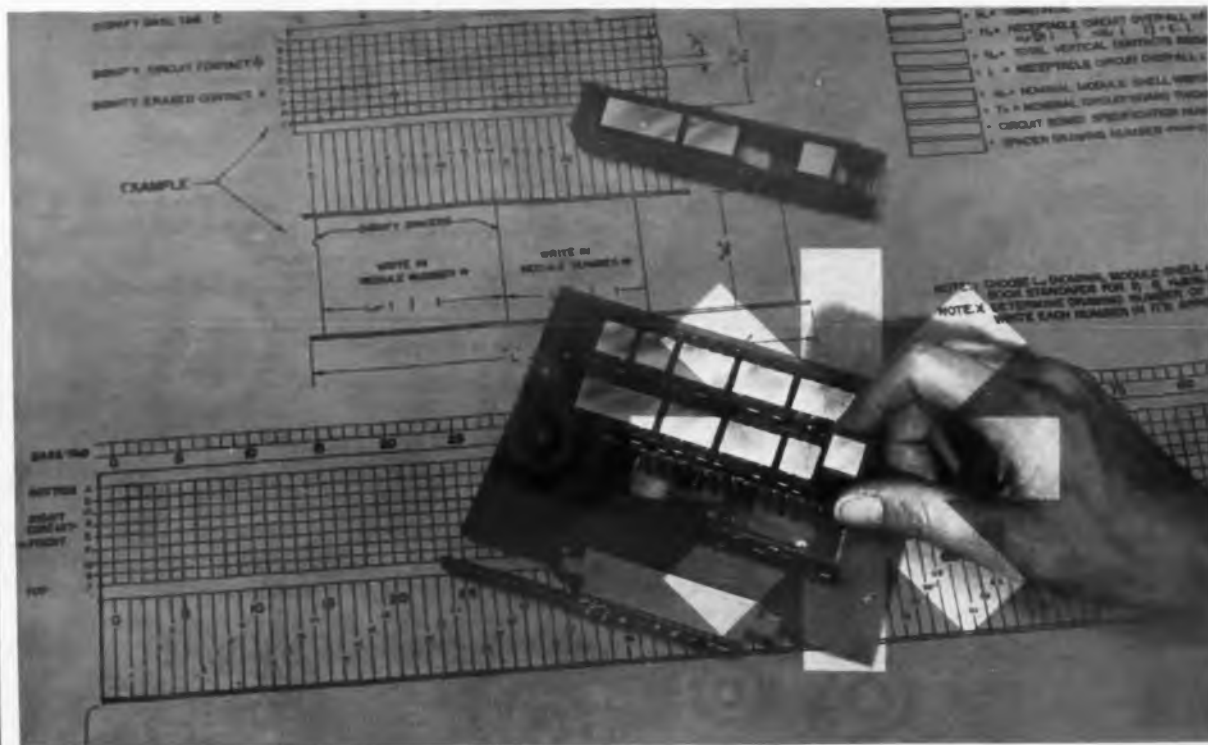
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Soviet Engineer (continued)

various sizes and scopes. Several engineers opined that, among the foreign electronics magazines available to them, they learn most from *Electronics* (U. S.) and *Radio Mentor* (West Germany). A number of foreign magazines, including *Proceedings of the IRE* and *Electronics* are reprinted cover-to-cover (untranslated) and distributed directly to institutions in the Soviet Union.*

As to domestic magazines, they have the amateur-level *Radio*, and the high-level *Radiotekhnika* and *Radiotekhnika i Elektronika*, but nothing between. They have no magazines to give them circuit-design information. Several magazines cover production problems. They are distributed to factories and are not for sale. They do not include electronics sections. The publications in the series carry the common title of "Voprosi Radiotekhniki" (Radio Engineering Topics). They are published by the Government Radio Engineering Committee, Soviet of Ministers, USSR.

Engineers Enjoy Seven-Hour Day, Don't Like Six-Day Week

In discussions of engineers' status in the USSR and in the U.S., invariably Soviet engineers boast of their seven-hour day and their one-month vacation. While there did not seem to be much argument about the vacation, the seven-hour-day claim invariably led to the admission of a six-day week and the agreement that the five-day week is certainly preferable, both from the employee's and management's viewpoint.

Their attitude can be summarized as one that holds the five-day week to be one of their next improvement objectives. Since Saturday is now a short day without a lunch hour, it is inefficient. "The first hour the engineer warms up, and the last hour he prepares for his week-end; thus, much of the day is shot," is the way one management engineer summarized the situation.

In the course of several discussions at the Riga Radio Factory engineers asked about procedures in the U.S.—obviously because they had problems with theirs. Gradually, the following picture of their procedures emerged. It is a fluid picture, not a static one.

Electronics Engineers Design Model, Mechanical Engineers Build Sample

Design of a product at RRR starts when an electronics engineer is assigned to develop a circuit. He works on the schematic and builds a

*ELECTRONIC DESIGN is not available in the Soviet Union.

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CIRCLE 49 ON READER-SERVICE CARD



model. A mechanical engineer then builds a production sample—in cooperation with an artist in the case of a mass-production article.*

The two engineers are then jointly responsible for the design. Usually no separate production redesign takes place. Another department breaks down the design for production. The writer saw a design department of about 30 six-foot drafting desks with a drafting machine on each. Draftsmen used chairs, not stools; tacks, not tape; pencil, not ink; tracing paper, not cloth.

Laboratory Test Equipment Can Be Soviet-Made or Foreign

The electronics laboratory at RRR consisted of two large rooms with a total area of about 1,000 sq ft. These had shelves for instrument storage and desks and benches for development work. Most of the laboratory equipment was Soviet-made; however, there was a number of Bruel and Kjaer (Danish) and Rohde and Schwartz (West German) test instruments. Engineers readily expressed interest in U. S. equipment, but regretted that such equipment was on the U. S. prohibited list. The author was permitted to photograph anything he wished.

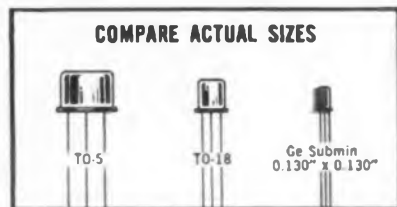
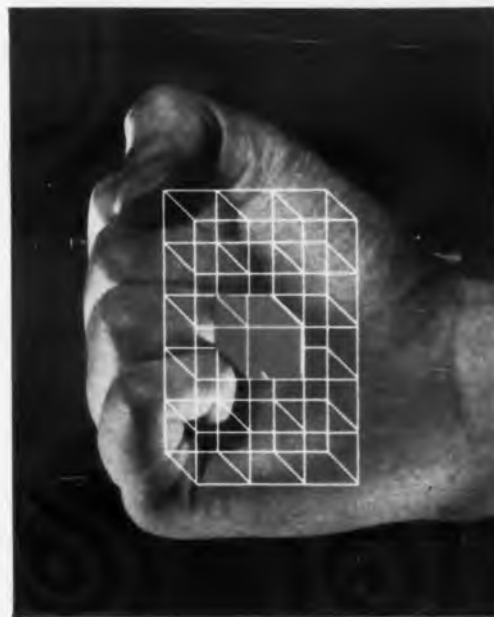
Two production floors were shown, but due to pressure of time the visit there had to be rather hurried. Two lines were running—one for a large, table-model radio in a wooden cabinet and another for a table-phonograph combination. The turn-table as well as the loudspeaker, including cone and magnet are manufactured in the RRR factory. The all-wave-radio front end used printed circuitry; the rest of the single chassis was conventionally wired. No transistors were used in these models, but an advanced laboratory sample of a book-sized transistor radio was shown to the author. An adequate transistor supply for it was assured for 1961.

Soviet production seems to be working within a strict formal paperwork system. They insist on written change notices with no verbal orders. All processes must be described in detail. However, they do manage to find short-cuts. Their foremen, like ours, do not always read specifications, instructions, and prints.

In sum, it was the view of the author that the Soviet engineer is competent. Although his test instruments may not be as sophisticated as some of those recently announced in the U. S., and although they are certainly not as handsome, they are good instruments and the Soviet engineer knows how to use them. ■ ■

*Laboratory instruments are not styled. The writer's remark that a switch knob on one of the Soviet multi-meters felt too heavy drew the rejoinder that "In America your problem is to sell more. Our problem is to buy more."

NEW NPN-PNP GERMANIUM SUBMIN TRANSISTORS



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Where reliability is a must, these submins are tops. Welded package provides truly hermetic seal. Meets MIL-S-19500B: 96-hr. salt spray, 20,000 G centrifuge, 100/2000 cps variable frequency vibration at 20 G, 1/2 ms mechanical shock at 1500 G, 0° to 100°C thermal shock in water, 10-day moisture resistance cycle, tem-

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These new germanium submins are equivalents of standard Raytheon transistors in electrical performance and reliability. Write for data sheets today.

GERMANIUM SUBMIN TYPE	TO-5 EQUIVALENT	V _{CE} Max. volts	f _{ab} typical mc	h _{FE} typical	C _{ob} typical pf	I _{CBO} μA	R _{SA} T typical ohms
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PNP 2N805	2N428	-15	17	80	12	2	1.1
PNP 2N811	2N416	-12	10	80	12	2	65*
PNP 2N813	2N417	-10	20	140	12	2	100*
NPN 2N815	2N388	20	8	110	9	3	3.5
NPN 2N821	2N440	15	10	70	9	3	3

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Now, C & D has expanded facilities of the *AutoReg* plant to provide industry with similar DC sources, which incorporate silicon rectifiers and automatic regulation. Final form of these units can supply power in a range from milliwatts to megawatts, depending upon your requirements.

Companies with a problem in DC power sources should write, giving a general outline of their requirements, to: Vice President in Charge of Engineering

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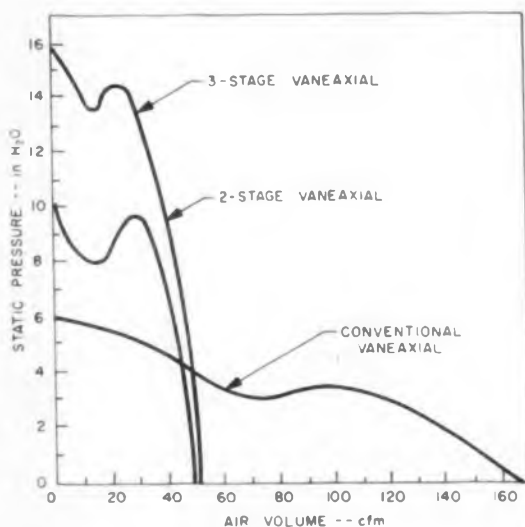


Small, Multistage Blowers Cool Densely Packed Miniature Equipment

EVEN DENSELY packed, miniaturized equipment can now be cooled effectively by small, multistage blowers. Using aircraft-compressor principles, the new blowers can deliver cooling air against extremely high system pressures—more than 0.5 psi.

Manufactured by Globe Industries, Inc., 1784 Stanley Ave., Dayton, Ohio, the 3-in. diam blowers are available with up to three impeller stages. With their high static pressures, they can be used, for example, to deliver cooling air to a central plenum chamber and from there, through tiny ducts, to many individual circuit components. They can also be used to force air through miniature heat exchangers.

The effectiveness of these vaneaxial, multi-



Performance curves of multistage blowers compared with conventional ones show high static pressures developed by the multistage units.

stage blowers against high back pressures becomes apparent when one compares their performance curves (shown in the drawing), with a curve for a conventional, 3-in., vaneaxial blower.

At the peak-efficiency region, slightly to the right of the knees of the curves, the three-stage blower delivers air against a static pressure of almost 14 in. of water. For the same air delivery, 30 cfm, the conventional, 3-in., vaneaxial blower has a static pressure rating of about 5 in. At peak efficiency, the three-stage unit consumes 145 w of input power compared with 140 w for conventional units.

Each stage of the new blowers consists of a rotating propeller and a stationary guide-vane section. The vanes direct air flow in an axial direction when the blower is operating at close to peak output. The guide vanes on the stator are built up in "clamshell" segments, keyed together, and machined.

The 3-in. long blowers are driven by 200-v, three-phase motors and mounted by servo clamps. All the blower parts are precise, aluminum, die castings held to extremely close running clearances.

Limited quantities of the blowers are available for two-week delivery. Production quantities now require from 12 to 14 weeks from date of order. For production quantities of the three-stage blower, the unit price is about \$100. The two-stage units cost slightly less.

For more information on these small, multi-stage blowers, turn to the Reader-Service Card and circle 251.

and now...

UPCC-M2K
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Series UPCC-SLK*
(Knob Screw Lock)
Female chassis connector—
wire solder terminals. Knob
on male card connector—dip
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UPCC-M23
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with AMP 53 terminals.

Still another another "demand" member has joined U.S.C.

family of Printed Card Connectors . . . the new, dual row taper pin Series UPCC . . . FDTP bringing the total of different available types to over 400.

- Conforms to MIL-C-8384 and NAS specs.
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- Screw lock elements—stainless steel—double lead for double speed

UPCC M & -F units available with wire solder, turret type, solderless AMP 37, or dip solder terminals (1/16", 1/8", 1/4" boards).

UPCC FDTP units take AMP 53 taper pins.

Max. Wire Size	218 AWG
Voltage Breakdown (Min.)	2500v, AC, RMS
Insulation Resistance	over 5000 megohms
No. of contacts	7, 11, 15, 19, 23, 32
Current Ratings	7.5 amps

Also custom configurations to meet your specific application requirements.

*Pat. Pend.



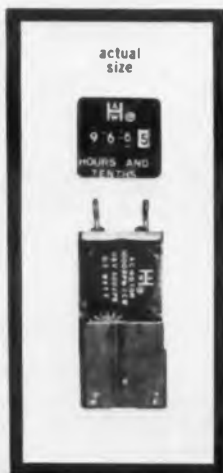
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CIRCLE 52 ON READER-SERVICE CARD



PLEASE DON'T SWALLOW OUR MOTOR

...IT'S HIDING BEHIND THE ASPIRIN. Actually, we set out to build an easy-to-read tiny timer...but we first had to build an aspirin-sized motor to drive it. This assignment might have been a headache for a sorcerer, but A. W. Haydon did it. And there is something magical about these micro-miniature elapsed time indicators and companion events counters. ■ This digital elapsed time indicator has many outstanding features: size is only $\frac{1}{2}$ " square x $1\frac{1}{4}$ " long...weight .75 ounce...

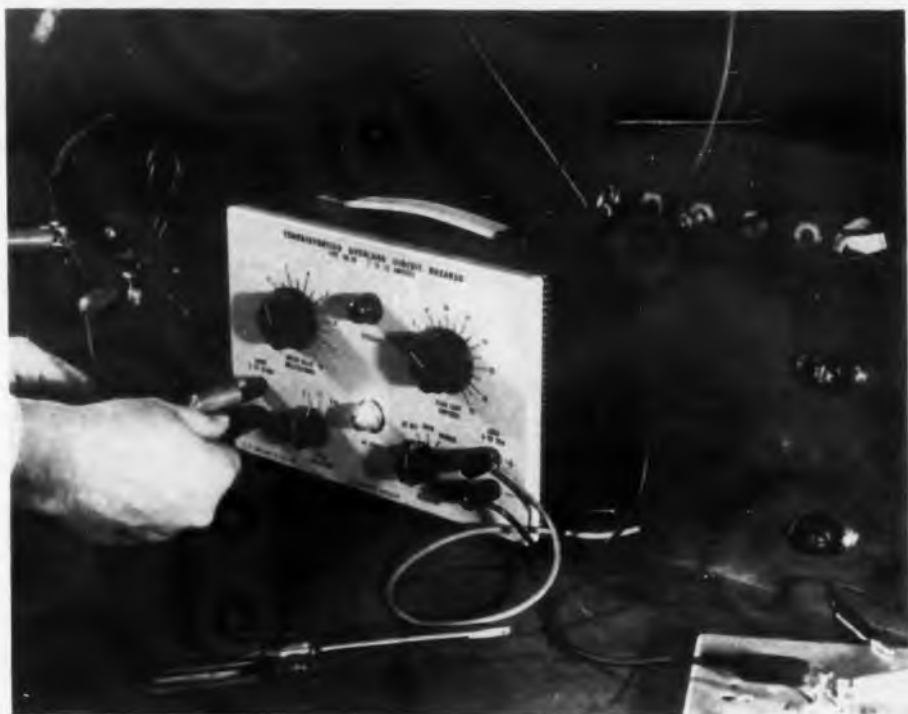


meets all mil specs...temp. range -54 to $+125^{\circ}\text{C}$...vibration to 2000 cps at 20 G...choice of two ranges (hours to 9999, tenths to 999.9)...power input .5 watt, max. In fact, the complete data outweighs the equipment. Send for our heavyweight literature on the 19200 ETI right now. ■ Electrical or electronic, the A. W. Haydon Company works wonders in time. For electronic requirements call Culver City. For electro-mechanical devices call on our wizards in Waterbury.

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CIRCLE 53 ON READER-SERVICE CARD



High-Speed, Adjustable Circuit Breaker Protects Wide Range of Transistor Circuits

FAST ENOUGH to protect even transistor circuits, a new circuit breaker is useful over a wide range of currents, voltages, and break delays. Its cost is not much more than the price of just a few high-quality transistors it might save from premature death.

The circuit breaker, manufactured by the Electronics Div. of P. R. Mallory & Co., Inc., P.O. Box 373, Indianapolis, comes as an answer to a harsh fact of life confronting many circuit designers: Overloaded transistors usually burn out before the fuses that are intended to protect them.

Available in three models that can be inserted between a transistorized load and a power supply, these circuit breakers offer four important features:

- Adjustable load-limit control of 0.04 to 4 amp for the model CB4, 2 to 20 amp for the model CB20, and 5 to 50 amp for the CB50.
- Adjustable break relay (response time) from 100 μ sec to 100 msec.
- Adjustable overvoltage cut-off from 6 to 60 v dc.

■ Selection of either automatic or manual reset.

All these controls, with the exception of the overvoltage cut-off, are accessible on an easy-to-read, calibrated, front panel. The overvoltage cut-off is adjustable through the rear panel.

In addition to its obvious advantage of high-speed overload protection, this breaker serves the engineer in less apparent ways too. Its red "overload" light helps the designer discover circuit faults quickly without having to wait for results of a "smoke" test. It also helps isolate different projects using the same power supply and it permits unattended testing.

The completely transistorized circuit breaker can be represented as a normally closed, spst switch, shunted by large open-circuit resistance, and in series with a small impedance. Transition time between its "on" and "off" positions is less than 1 usec per amp of load current.

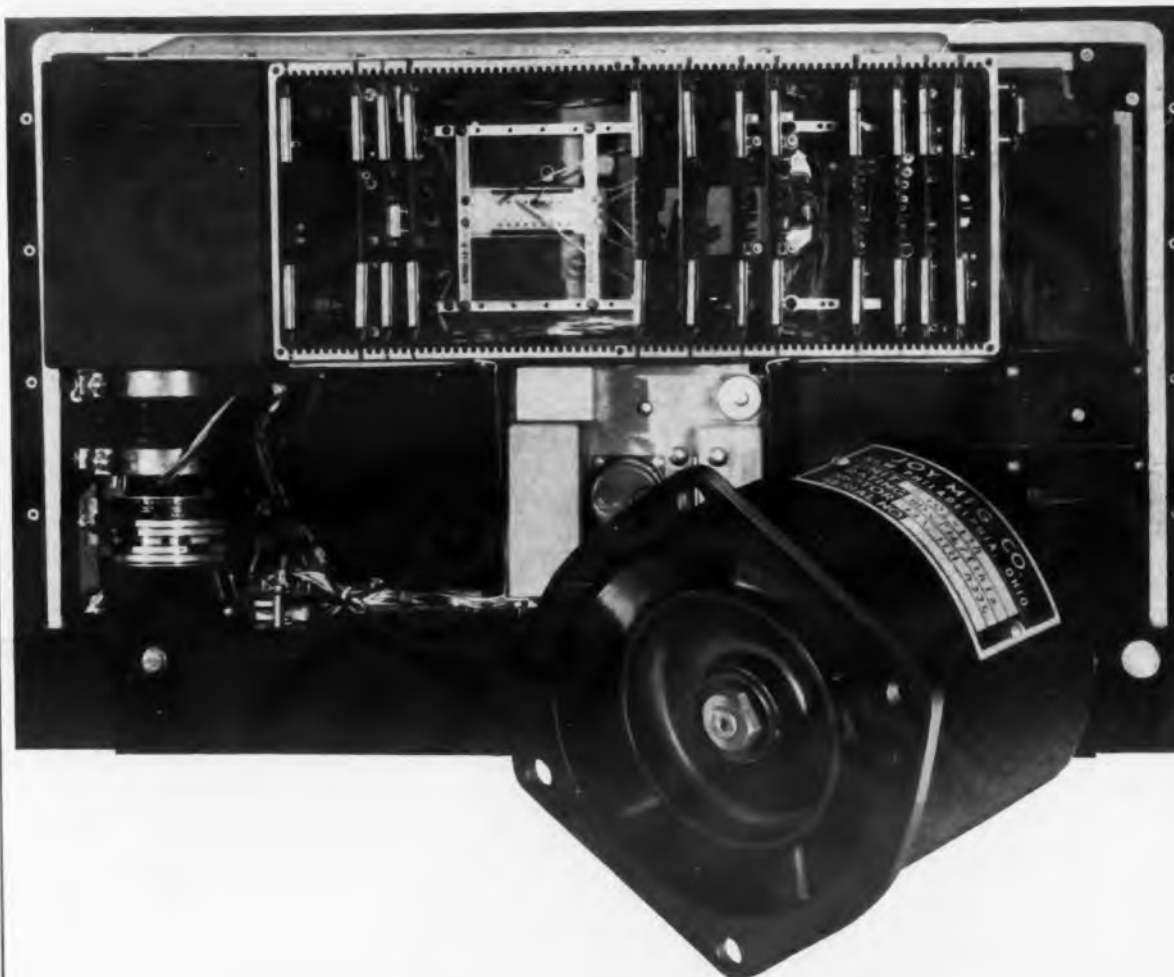
A stable, current-sensing trigger circuit allows the load-limit control to be adjusted to within a few milliamperes of the load's normal operating current. It does not have the power dissipation, instability, and drift normally encountered with devices which may be half "on" and half "off." Hence, it offers optimum protection for loads operating near maximum ratings where thermal runaway can occur.

The response time between sensing an overload and opening the switch is adjustable so that temporary surges of current will not trip the breaker if the operator does not want them to. The break delay also includes a safety feature which limits the delay period if the load exceeds an unsafe current level.

When the circuit breaker has been set for automatic reset, it will interrupt the excessive load current for 2 sec, then re-apply power to the load for the selected break-delay time. It will continue to "test" the load until the overload is cleared. This function allows the breaker to serve as a high-power pulse modulator or as a pulse-width detector.

Available from distributor stock the circuit breakers are priced at about \$350 for the model CB-4, \$390 for the CB-20, and somewhat higher for the CB-50.

For more information on these breakers, turn to the Reader-Service Card and circle 252.



JOY FAN COOLS AMPEX WIDEBAND TAPE RECORDER ... new unit records 4 channels—occupies just 3.5 cu. ft.

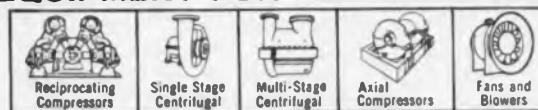
The Ampex Wideband Tape Recorder, with frequency range of 10 cps to 4 mc, displaces only 3.5 cubic feet. With this size limit and rigid internal temperature specs of 104° to 140° F, Ampex designers specified Joy Axivane fans for cooling.

Operating at 23,000 rpm on 400 cycle AC, the Joy blower circulates 60 cfm at 10" static pressure through a built-in heat exchanger system. The straight-through vaneaxial design permits integral mounting directly on

the heat exchanger. The system maintains the internal temperature specified regardless of wide variations in ambient temperature.

With long experience in design problems of this kind, Joy can design small blowers of high pressures or high volumes to suit your exact electronic cooling need. And literally thousands of designs are available off-the-shelf. Let our cooling experts work with you. For more information write for Bulletin 2565-57.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



CIRCLE 54 ON READER-SERVICE CARD

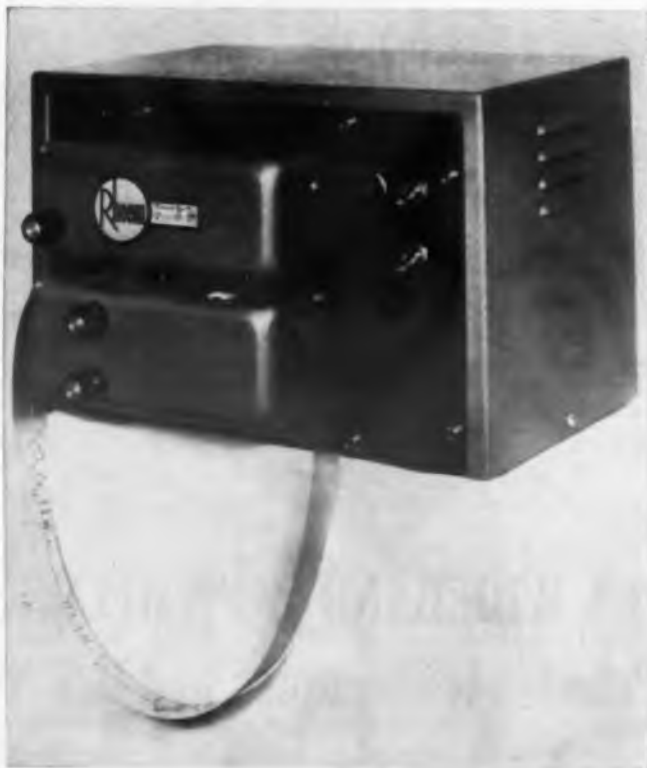
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(Canada) Limited, Galt, Ontario

NEW PRODUCTS

Covering all new products generally specified by engineers designing electronic original equipment. Use the Reader's Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.



**Photocell Reader
Is Completely Transistorized** 521

Model RR-100-D photocell reader is designed to meet requirements of general-purpose punched-tape reading including data processing and process control. It is completely transistorized. The sensing element is one piece of silicon containing eight information- and one timing-track channels. This eliminates focusing problems encountered when each channel has a separate photocell as a sensing element. Specifications include: reading speed, 100 characters per sec, stop on character; tape, 5-, 7-, and 8-channel tapes, paper or aluminum types. All output signals appear simultaneously.

Rheem Manufacturing Co., Electronics Div., Dept. ED, 5200 W. 104 St., Los Angeles, Calif.

Price: \$695.

Availability: 30 days.



**Magnetic Drum
Has Capacity to 150,000 Bits** 522

The MH-5ESC-101 is a complete magnetic drum subsystem, including drum, heads, and associated read-write circuitry. Bit capacity may be as high as 150,000. The basic 5-in. drum weighs less than 22 lb and rotates at 8,000 rpm. Maximum drum capacity is 50 tracks with recirculating registers operating as close as 10 bits. A safety system holds head-to-drum spacing constant and accurate.

General Instrument Corp., Magne-Head Div., Dept. ED, 3216 W. El Segundo Blvd., Hawthorne, Calif.

Price: \$750 to \$1,200.

Availability: 60-day delivery.



**Mica Capacitor Network
Is 0.190 In. Thick** 523

A 5-capacitor bank with 1% tolerance is contained in this disk, 1-3/4 in. in diameter by 0.190 in. thick. The mica network provides 0.125 μ f, in addition to any capacity from 0.125 μ f upward, in 16 steps of 0.0005 μ f, to a total capacity of 0.1325 μ f. Designed for compensation uses, it performs reliably over a temperature range of -55 C to 85 C.

Federal Pacific Electric Co., Cornell-Dubilier Electronics Div., Dept. ED, 55 Cromwell St., Providence, R.I.

Price: \$20 to \$30.

Availability: Immediate delivery.



**DC Vernier Potentiometer
Has Accuracy of $\pm 0.001\%$**

524

Type 9144 dc vernier potentiometer is a 4-dial, 6-figure, dual-range instrument with a total measuring capability of 2.101010 v. It has an accuracy of $\pm 0.001\%$ warranted for a period of 5 yr. Stability is guaranteed to be within $\pm 0.00015\%$ per year or better. Resolution is 0.1 μv and thermal electromotive force is less than 0.1 μv . Primary functions include usage as: a resistance comparator accurate to 2 ppm; a saturated standard cell comparator that will detect differences of 1 μv ; a constant temperature enclosure.

Sensitive Research Instrument Corp., Dept. ED, 310 Main St., New Rochelle, N.Y.

Price: Approximately \$6,000.

Availability: From stock to six months.



**Micro Transistors
In All-Glass Packages**

525

Hermetically sealed in all-glass packages, these 45-v silicon mesa micro-transistors have an operating current range of 50 μa to 20 ma. Saturation resistance is 100 to 200 ohms; cut-off frequency is over 50 mc, and minimum betas are 20 to 80. The package has a thickness of 0.060 in., and a diameter of 0.160 in. max. Power dissipation is 200 mw max at 25 C ambient for amplifier types TMT 839 through 841, and for switching types TMT 842 and TMT 843.

Transitron Electronic Corp., Dept. ED, 168 Albion St., Wakefield, Mass.

Availability: Sample quantities.



**TRANSISTORIZED
DESIGN GROUP**

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
SC 32-0.5	0-32	0-0.5	0.01%
SC 32-1	0-32	0-1	
SC 32-1.5	0-32	0-1.5	
2SC 32-1.5	0-32	0-1.5	
Dual Output	0-32	0-1.5	
SC 32-2.5	0-32	0-2.5	
SC 32-5	0-32	0-5	
SC 32-10A	0-32	0-10	
SC 32-15A	0-32	0-15	
SC 60-2	0-60	0-2	
SC 60-5	0-60	0-5	
2SC 100-0.2	0-100	0-0.2	
Dual Output	0-100	0-0.2	
SC 150-1	0-150	0-1	
SC 300-1	0-300	0-1	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
SC 18-0.5	0-18	0-0.5	0.1%
SC 18-1	0-18	0-1	
SC 18-2	0-18	0-2	
SC 18-4	0-18	0-4	
SC 36-0.5	0-36	0-0.5	
SC 36-1	0-36	0-1	
SC 36-2	0-36	0-2	
SC 3672-0.5	36-72	0-0.5	
SC 3672-1	36-72	0-1	

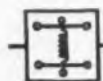
MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
PSC 5-2	0-7.5	0-2	0.02%
PSC 10-2	7.5-12.5	0-2	
PSC 15-2	12.5-17.5	0-2	
PSC 20-2	17.5-22.5	0-2	
PSC 28-1	22.5-32.5	0-1	
PSC 38-1	32.5-42.5	0-1	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
HB-2	0-325	0-200 ma.	0.1%*
HB-4	0-325	0-400 ma.	
HB-6	0-325	0-600 ma.	
HB-8	0-325	0-800 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
SR 12-50	5-13	0-50	0.1%
SR 28-50	24-32	0-50	
SR 48-30	44-52	0-30	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
SM 14-30	0-14	0-30	0.1%*
SM 36-15	0-36	0-15	
SM 75-8	0-75	0-8	
SM 160-4	0-160	0-4	
SM 325-2	0-325	0-2	
SM 14-15	0-14	0-15	
SM 36-10	0-36	0-10	
SM 75-5	0-75	0-5	
SM 160-2	0-160	0-2	
SM 325-1	0-325	0-1	
SM 14-7	0-14	0-7	
SM 36-5	0-36	0-5	
SM 75-2	0-75	0-2	
SM 160-1	0-160	0-1	
SM 325-0.5	0-325	0-0.5	

*0.01% REGULATION AVAILABLE



**MAGNETIC
DESIGN GROUP**

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
KM236-15A	0.1-36	0-15	0.5%
KM236-30	0.1-36	0-30	
KM236-50	0.1-36	0-50	
KM 251	2-14	30A or 240 W.	±1%
KM 252	5-35	12A or 240 W.	
KM 253	20-60	6A or 240 W.	
KM 254	30-90	4A or 240 W.	
KM 255	60-180	2A or 240 W.	

VOLTAGE REGULATED DC POWER SUPPLIES KEPCO



MODEL HB-6M

COMPACTNESS



TWO 4 1/4" SC UNITS
MOUNTED IN RACK ADAPTER RA-2

WIDE VARIETY



MODEL 2SC32-1.5

VERSATILITY



MODEL 400B

FOR DETAILED SPECIFICATIONS
ON MORE THAN 150 STANDARD
MODEL POWER SUPPLIES
SEND FOR KEPCO CATALOG



131-36 SANFORD AVENUE
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CIRCLE 55 ON READER-SERVICE CARD



**VACUUM TUBE
DESIGN GROUP**

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
800B	#1 0-600 #2 0-600 Parallel 1 & 2	0-200 ma. 0-200 ma. 0-400 ma.	TO 0.01%
	Series 1 & 2 0-1200	0-200 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
430D	#1 0-450 #2 0-450 Parallel 1 & 2	0-300 ma. 0-300 ma. 0-600 ma.	TO 0.01%
	Series 1 & 2 0-900	0-300 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
2400B	#1 0-400 #2 0-400 #3 0-150 Bias	0-150 ma. 0-150 ma. 0-5 ma.	unreg- ulated
	Parallel 1 & 2	0-400 0-300 ma.	
	Series 1 & 2 0-800	0-150 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
103	#1 0-300 #2 0-300 #3 -50 to +50 Parallel 1 & 2	0-75 ma. 0-75 ma. 0-5 ma.	unreg- ulated
	0-300	0-150 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
400B	0-400 0-150 Bias	0-150 ma. 0-5 ma.	TO 0.02%
730B	0-350	0-3 Amp.	
720B	0-350	0-2.25 Amp.	
710B	0-350	0-1.5 Amp.	
700B	0-350	0-750 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
780B	0-600	0-3 Amp.	TO 0.01%
770B	0-600	0-2.25 Amp.	
760B	0-600	0-1.5 Amp.	
750B	0-600	0-750 ma.	
605	0-600 0-150 Bias	0-500 ma. 0-5 ma.	
615B	0-600 0-150 Bias	0-300 ma. 0-5 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
2500	0-2500	0-50 ma.	TO 0.004%
1520B	0-1500	0-200 ma.	
1220C	0-1200	0-50 ma.	
1250B	0-1000	0-500 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
KR16	0-150	1.5 Amp.	0.1%
KR17	100-200	1.5 Amp.	
KR18	195-325	1.5 Amp.	
KR19	295-450	1.5 Amp.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
KR8	0-150	600 ma.	0.1%
KR5	100-200	600 ma.	
KR6	195-325	600 ma.	
KR7	295-450	600 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
KR12	0-150	300 ma.	0.1%
KR3	100-200	300 ma.	
KR4	195-325	300 ma.	
KR10	295-450	300 ma.	

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS	REGULATION
KR11	0-150	125 ma.	0.1%
KR1	100-200	125 ma.	
KR2	195-325	125 ma.	
KR9	295-450	125 ma.	



How to make a shrewd increase in recorder efficiency

With twice the performance, the Ampex FR-600 is still compatible with earlier equipment.

Doubles tape utilization and obviates standby equipment

Your FR-600 records 125 kc data at 30 ips instead of 60 — gives twice the recording time per reel. For example, you get 48 minutes recording time on 10½-inch reels, 96 minutes on 14-inch at 30 ips. Not only are tape expenditures cut in half, but standby recorders on long sessions may no longer be needed. And for a broader data spectrum in the future, your FR-600 can accommodate 250 kc at 60 ips or 500 kc at 120 ips.

Multiplies available recording time and eliminates error

Two-hour warmup and adjust sessions are reduced to ten minutes by the FR-600's transistorized circuitry. Final calibration is a one-time-per-use operation. Post-warmup stability — less than 1% drift per 24 hours — precludes time-wasting adjustments and minimizes creeping inaccuracies. Because your FR-600 is ready when needed, it works more hours per day, saving both your time and its own.

Updates performance of older equipment

The FR-600 plays back tapes from most existing data recorders. And because playback heads generally determine overall frequency response, use of an FR-600 for playback can permit earlier equipment (with simple adjustment) to record the same high information density as your FR-600.

The essential data

The Model: FR-600 Laboratory Recorder/Reproducer. Number of tracks: up to 14. Reel sizes and tape widths: 10½- or 14-inch NAB, with ½-inch or 1-inch tape, interchangeably. Frequency response: 300 to 250,000 cps ± 1 db at 60 ips with direct recordings; 0 to 20,000 cps ± 0.25 db at 60 ips in FM-carrier recording — proportionate response at other speeds. Tape speeds: 60, 30, 15, 7½ ips; 120, 3¾, 1½ ips optional. Types of recording: direct, PDM and FM-carrier, by plug-in modules. Compatibility: yes, with Ampex 300 and 800 series; FR-100 and FR-1100 series, and AR-200 and CP-100 series.

Write for full information

AMPEX DATA PRODUCTS COMPANY
Box 5000 • Redwood City, California • EMerson 9-7111



NEW PRODUCTS

Micro-Diodes

507

Hermetically sealed

Increased reliability is claimed for these micro-diodes, hermetically sealed in glass. Their operating and storage temperature range is —55 to 150 C. Maximum power dissipation is 100 mw at 25 C; Zener voltage is between 5.1 v and 10 v at 5 ma.

Transitron Electronic Corp., Dept. ED, 168 Albion St., Wakefield, Mass.

CHANGES IN PRICES & AVAILABILITY

PRICES OF fusion-sealed, fixed-glass capacitors have been reduced 10% by the Corning Electronic Components Div. of the Corning Glass Works. New prices cited were: CYF 10, 91 pf, 10% tolerance, \$0.67 ea; CYF 15, 270 pf, 10% tolerance, \$0.43 ea. The prices are for quantities of 1,000 or more.

SPRAGUE ELECTRIC CO. has announced that their 85-C tubular, wet electrolyte, slug-anode tantalum capacitors, in all ratings at —15%, +20% tolerance, are now priced at the same levels as units rated at —15%, +50%. The wide-tolerance line is being dropped. Large case size type 109D units were dropped from \$4.70 ea to \$3.95 ea in quantities of 1,000 or more. Intermediate case size units were reduced from \$3.75 ea to \$3.25 ea, while the smallest case size type 109D capacitors are now \$1.50 ea instead of the former price of \$1.75 ea.

INTERNATIONAL RESISTANCE CO. has lowered prices on three types of fixed-carbon composition resistors. The fixed-carbon composition resistors in 5% tolerance units rated at 1/2, 1, and 2 w have been reduced in price for volume users. 1/2-w units will cost \$36.70 per 1,000 in quantities of 5,000. In lots of 25,000 there will be a further reduction to \$36.40 per 1,000.

◀ CIRCLE 56 ON READER-SERVICE CARD



"Leadership in
semiconductors"

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CONTACT THE TRANSITRON FIELD OFFICE
NEAREST YOU AS LISTED BELOW.

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Wakefield, Mass. CRYstal 6-5640

CAMDEN, New Jersey
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CHICAGO, Illinois
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Oak Park, Ill. VILLa 8-5556

CLEVELAND, Ohio
14625 Detroit Ave.
Lakewood, Ohio. ACademy 1-9191

DALLAS, Texas
511 Braniff Airways Bldg.
Dallas 35, Texas. FLeeTwood 7-9448

DAYTON, Ohio
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Nissen Building
310 W. Fourth St. PArk 3-0363

Transitron
electronic corporation
wakefield, massachusetts

Sales offices in principal cities throughout the U.S.A. & Europe
cable address: Trelco

CIRCLE 57 ON READER-SERVICE CARD

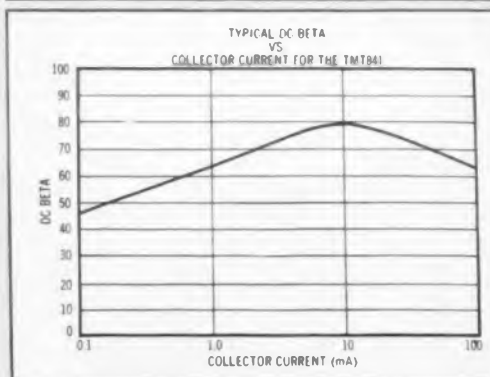
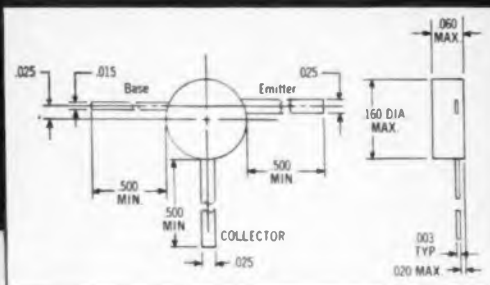
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NEW FROM
Transitron

micro-T

(A MESA MICRO-TRANSISTOR)



AMPLIFIER TYPES					
Type	Maximum Collector Voltage (Volts)	Minimum AC Beta (h _{FE})	Typical Gain-Bandwidth Product (Mc)	Maximum Collector Leakage Current at 25°C (μA)	Maximum Power Dissipation at 25°C Ambient (mW)
TMT 839	45	20	45	1	150
TMT 840	45	40	45	1	150
TMT 841	45	80	65	1	150
SWITCHING TYPES					
Type	Maximum Collector Voltage (Volts)	Minimum DC Beta (h _{FE})	Typical Gain-Bandwidth Product (Mc)	Maximum Saturation Resistance (Ohms)	Maximum Power Dissipation at 25°C Ambient (mW)
TMT 842	45	20	45	120	150
TMT 843	45	45	65	120	150

- SILICON DIFFUSED
- HERMETICALLY-SEALED
- ALL-GLASS PACKAGE

INTRODUCING THE FIRST SERIES IN A COMPLETE LINE OF MICRO-TRANSISTORS

Development of the **MICRO-T** — first silicon diffused mesa micro-transistor in an hermetically sealed all-glass package — represents a major step forward in microminiaturization. As compared with conventional "metal can" configurations, the **MICRO-T's** hard glass packaging embodies a significant improvement in the hermetic seal between leads and package. Reliability is substantially increased; possibility of leakage is sharply reduced.

This new series of 45-volt micro-transistors is the first designed for small-signal low-level applications, with current operating range from 50 microamps to 20 milliamps. Other electrical characteristics include an R_{cs} of 100 to 200 ohms; minimum Betas from 20 to 80; cut-off frequencies of over 50 megacycles. Perfectly compatible with present circuitry, **MICRO-T's** will facilitate microminiaturizing in such critical areas as airborne, space vehicle and missile applications. They are 1/20th the size of the TO-5, and 1/5th that of the TO-18.

The first five types of **MICRO-T's** are available now. For full information, write for Bulletins No. PB-78, (Amplifier types) and PB-79, (Switching types).

**MEET US AT IRE —
BOOTH NOS. 1220-1224**

Transitron

electronic corporation
wakefield, melrose, boston, mass.

SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U.S.A. AND EUROPE • CABLE ADDRESS: TRELCO

NEW PRODUCTS

Miniature Motors

With ball bearings



The DS-105 group of miniature motors, with ball bearings, can be built for dc operation as shunt-series or split field motors or as ac series-type universal motors. At 8,000 rpm, the dc version develops 1/100 hp; ac versions develop 1/200 hp. The 11-oz motors are 2.562 in. long; housing OD is 1.687 in. Shaft diameter is 0.250 in. max. For continuous or intermittent duty, they meet JAN specifications.

Heinz Mueller Engineering Co., Inc., Dept. ED, 4725 W. Iowa St., Chicago 51, Ill.

Batch Counters

Rate is 6,000 per min



These electronic batch counters have a maximum speed of 6,000 counts per min. The model DC-30 divides the counts by 10 for reduced register wear. The model BC-40 counts a preset number from 2 to 16, tripping a relay switch which actuates any electrically controlled function, then automatically resets to 0 for the next count. Model BC-50, basically the same, counts any number from 2 to 256. Model BC-60 counts any number from 2 to 1,024.

Gyra Electronics Corp., Dept. ED, Washington & Elm Sts., P.O. Box 184, La Grange, Ill.
Price: \$99.50 to \$249.50.

501 Magnetic Amplifier 504

Input 5 mv to 5 v dc



A bi-stable magnetic amplifier, the model 1684 is available for signal inputs of less than 5 mv, with up to 5 v overvoltage, and in a high-input version, for signals of less than 5 v dc, with up to 500 v overvoltage. Excitation is 115 v $\pm 5\%$, 400 cps $\pm 1\%$. Input impedance is 1 K or 14 K. Relay coil load is 1 K. Output current is 14 ma dc max in both versions. Weight is about 18 oz.

Lumen, Inc., Dept. ED, P.O. Box 905, Joliet, Ill.

Price: \$200 singly, \$135 ea in quantities of 100.

Availability: 30 days.

606 Differential Amplifier 628

100-meg input impedance



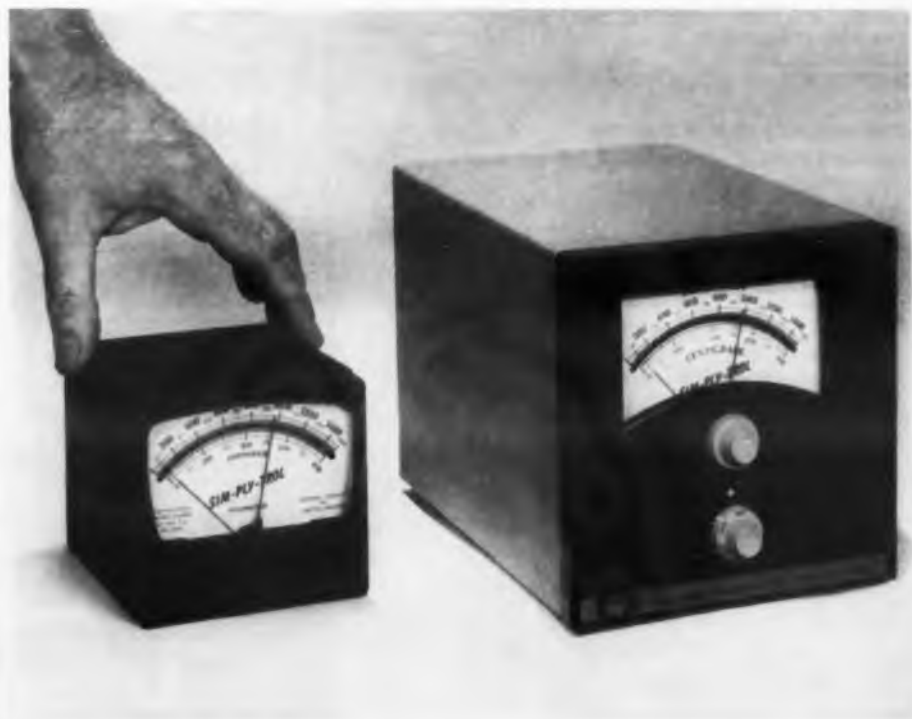
A transistorized differential amplifier, the model TDA-875 has 120-db common mode rejection and 100-meg input impedance. In its differential mode, the amplifier provides 10 v at 10 ma, full-scale output; in single-ended mode, full-scale output is 10 v at 50 ma. User may select among 5 fixed gains. Bandwidth is 5 kc differential, 150 kc single-ended; drift is less than 2 μ v per week and noise is less than 2 μ v peak-to-peak.

Epsco-West, Dept. ED, 240 E. Palais Road, Anaheim, Calif.

Compact, Adjustable Temperature Control Provides Performance of Larger Units

ONE-FIFTH the size of conventional units that do the same work, a new line of automatic temperature controls can monitor and maintain external temperatures to within 1 F or 1.2 per cent of full temperature range. Designated the "Temp-Tendor, Model 450," the units are designed for panel mounting with visual signal indication.

Designed around locking-contact meter relays, the new controls are provided in eight standard ranges from 300 F to 2,500 F. Special ranges may be ordered from the manufacturer, Assembly



Compact temperature control occupies one-fifth the volume of predecessor. Case of small unit can be removed for easy panel mounting.

Products Inc. of Chesterland, Ohio, at higher cost.

As with other meter-relay devices, the set point can be adjusted instantly to any position on the dial. The device itself periodically samples signals from an external thermocouple, usually at a rate of about six times a minute.

When the meter's indicating pointer reaches the set point, the heater power of the controlled device is automatically disconnected.

The unit's rate of interruption can be field-adjusted by simply changing a connection on its rear terminal strip. Faster sampling rates result in more precise control and somewhat shorter contact life.

Because pyrometers are inherently low-torque movements, the model 450 superimposes a small, ac, "dither" signal on the thermocouple signal. This vibrates the moving system of the meter imperceptibly; it overcomes bearing friction; and, as a result, it improves the meter's repeatability substantially.

An adjustable potentiometer and bridge circuit in the 450 allows the user to compensate the pyrometer movement for different thermocouple lengths. Thermocouples with up to 10-ohm resistance can be used without the usual errors encountered in thermocouple break protection.

Small size of the new controls, 4.5-in. wide, 4-in. high, and 5.5-in. deep, results from redesigned circuitry and improved packaging. The device includes, for example, a smaller load relay with the same 5-amp rating of relays used in larger instruments. The load relay turns heat on and off, time-proportioning the "on" period to maintain virtual straightline control.

Delivery of the model 450 takes about 4 weeks. With a single, high, set point, the unit costs \$185. Quantity discounts and OEM prices are available.

For more information on these compact temperature controls, turn to the Reader-Service Card and circle 253.

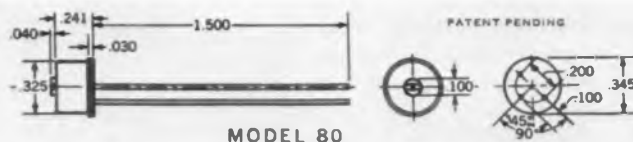
ELECTRONIC DESIGN • February 1, 1961



... It's the new Spectrol ultraminiature trimmer... the smallest trimming potentiometer on the market! Measuring 1/3" in diameter, weighing only 1 gram, and designed specifically for transistor circuits, the Spectrol Model 80 is a remarkable breakthrough in component technology.

Design engineers can now shrink printed circuit packages in all three dimensions. The single turn adjustment is from the top, rather than the side. It is ideal for printed circuit applications. Sealed construction allows complete package encapsulation.

THE MODEL 80 is approximately one-quarter the size of ordinary trimmers, yet it offers greater resolution and resettability because the resistance element is nearly twice as long. These trimmers meet all applicable military and commercial specifications including the most severe humidity cycling and immersion tests.



Available now for immediate delivery. Standard models of Spectrol trimmers and miniature potentiometers, as well as other standard precision potentiometers, are available from your nearby Spectrol distributor. For complete technical information, contact your Spectrol engineering representative or write directly to the factory. Please address Dept. 36.

The Spectrol name,
your assurance of quality.

Spectrol trimmers are produced to the same exacting standards of quality and reliability engineered into the entire Spectrol potentiometer line... the largest selection in the industry.



30

SPECIFICATIONS

DIAMETER 0.345"
STANDARD RESISTANCES (ohms) 50, 100, 200, 500, 1K, 2K, 5K, 10K
RESISTANCE TOLERANCE $\pm 5\%$
NO. TURNS ONE
POWER RATING 1 watt at 70°C
LINEARITY $\pm 1.0\%$
NOISE 100µENR per NAS-710
SHOCK 50 G
VIBRATION 30 G to 2,000 CPS
HUMIDITY MIL-E-5272C, Proced. I (10 days, cycling) and MIL-STD-202A, Method 104, Condition A (immersion in hot water)
SALT SPRAY MIL-STD-202A, Method 101A, Condition A (96 hours)
LOAD LIFE 1000 hours
WEIGHT 1 Gram
PRICE (1-9 units) \$6.00 each

ELECTRONICS CORPORATION

1704 South Del Mar Avenue • San Gabriel, California
Phone: ATLantic 7-9761
1250 Shames Drive • Westbury, L. I., New York
Phone: EDgewood 3-5850

CIRCLE 61 ON READER-SERVICE CARD

if
all you have
for a relay
is a sudden
impulse...



An impulse relay—one that when pulsed will turn something on and leave it on and when identically pulsed again will turn the load off and leave it off—is nothing new. For years you've been able to buy them, complete with ratchets, pawls, escapements, walking beams, lock-in mechanisms, etc., in a regular commercial quality grade. Sequencing and stepping relays are the more educated relatives in the family.

But in the recent trend of getting more things up in the air, and generally getting more and more out of smaller and smaller relays for practically no power and under unpleasant conditions, the standard commercial impulse relay has often gotten dirty looks. Generally, it wouldn't hold together under the vibration or shock levels, and its size and relatively short life further complicated things.

Naturally, Sigma now has an impulse relay with none of the above drawbacks (mostly because it has none of the above mechanical mechanisms). SPDT contacts will switch 2 amp. resistive loads

(28 VDC/120 VAC) 200,000 times; mechanical life with no contact load is 4 million operations. It works on positive DC pulses as short as 1 millisecond, at speeds up to 10 pps. For the space, weight and power pinchers, this new hermetically sealed relay takes up 1" x 1" x 1 1/4", weighs about 2 1/4 ounces and transfers its contacts on as little as 250 microjoules (e.g., 250 mw. for 1 ms.). Vibration immunity is in the order of 30 g's to 2000 cycles, operating temperature -65° to +125°C. About the only caution is that you've got to feed it pulses of the same polarity.

We're building this little marvel and even have a few anxious customers. People who build telemetering equipment, satellites, and perhaps computers as well, are the Sales Dept's. great white hope. If you like binary counting schemes and such, think of the possibilities if you hooked up several in sequence. And with a small roulette wheel and an acquisitive impulse, one might do handsomely, mightn't one?



SIGMA

SIGMA INSTRUMENTS, INC.

91 Pearl Street, So. Braintree 85, Mass.

AN AFFILIATE OF THE FISHER-PIERCE CO

CIRCLE 62 ON READER-SERVICE CARD

NEW PRODUCTS

Power-Supply Kit

For plate, bias, and filament



The model B-12 power-supply kit provides dc plate voltages from 0 to 400 v, at 150 ma max; bias voltages from 0 to 150 v at 2 ma; and three 3-amp ac filament outputs: two at 6.3 v and one at 12 v. Output variation is less than 0.33% or 0.3 v, from no load to full load. Variation from 117-v ac line voltage input of ± 10 v causes less than 0.4% or 0.5-v output change. Ripple is less than 0.003 v rms. The 20-lb unit is 13 in. wide, 8-1/2 in. high and 7 in. deep.

Precision Apparatus Co., Inc., Paco Electronics Co. Div., Dept. ED, 70-31 84th St., Glendale 27, L. I., N. Y.

Price: \$69.95 in kit form, \$99.95 wired.

Thermocouple Reference Junction

For in-flight applications



The thermocouple reference junction series FRJ, for in-flight applications, provides temperature reference for multi-channel thermocouple systems. Junction accuracy matches NBS curves within $\pm 1/5$ F. Units are available with up to 24 channels, and any junction temperature from 25 F above ambient to 250 F. Ambient operating temperature range is -65 F to 165 F with less than 1/2 F reference variation. The 2-lb unit requires 105 to 125 v, 380 to 420 cps, and meets environmental requirements.

Pace Engineering Co., Dept. ED, 13035 Saticoy St., North Hollywood, Calif.

498



ACTUAL SIZE

Amazing, New,
High Inductance

WEE-DUCTOR

The R.F. Choke that's so small
you can pack 200,000
to a cubic foot

Tiny, new, WEE-DUCTOR covers a full range of inductances from 0.10 μ H to 56,000 μ H yet it measures only 0.157" x 0.375".

Unique ferrite sleeve and core construction provides 560,000 to 1 inductance range in a tiny package . . . and yet when assembled side-by-side, exhibit less than 2% coupling.

Essex WEE-DUCTORS are available immediately from stock. WEE-DUCTORS are the latest addition to Essex's broad line of Standard R.F. Choke Coils.

Essex Electronics Standard Line of R.F. Chokes

ESSEX PART NO.	WEE-DUCTOR	RFC-S	RFC-M	RFC-L
L μ H	1-56,000	.1-100	10-1,000	10-10,000
Max. Res. Ω	.035-499	.02-6.0	.04-21	.03-80
I Max. mA	3000-26	4000-220	2700-125	4000-80
Dia.	.157	.188	.250	.310
Length	.375	.440	.600	.900

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ESSEX ELECTRONICS
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550 Springfield Ave., Berkeley Heights, N. J.

CRestview 3-9300

CIRCLE 63 ON READER-SERVICE CARD

Fixed Coaxial Pad 502

Handles 200 w



This fixed coaxial attenuator provides attenuation of 1.5 db \pm 0.1 db in the ulf range. It will accept up to 200 w of cw power. Size is 10 x 1-1/2 x 1-1/2 in.

Merrimac Research & Development, Inc., Dept. ED, 517 Lyons Ave., Irvington, N.J.

Magnetic Core Tester 491

With 40-nsec rise time



A high-speed, multiple output pulse generator, the model 1300 magnetic core tester provides programmed, high-amplitude current or voltage pulses. It has a rise time of 40 nsec, 200-kc stepping rates and 2-1/2-amp current pulses. Primary and secondary pulse widths range from 0.5 to 50 μ sec, and secondary pulse delay from 0 to 5 μ sec. The prf range is from 500 to 200,000 pulses per sec, with maximum average current pulses to 300 ma. Power requirement is 105 to 125 v, 60 cps. The unit is contained in a standard rack cabinet 62 in. high.

Rese Engineering, Inc., Dept. ED, A and Courtland Sts., Philadelphia 20, Pa.

Price: \$4,200.

Availability: 30-day delivery.

ENGINEERING NEWS-#4

BASIC PRECISION SWITCHES

CHECKED

ENGR. *Paul*

CONTROL SWITCH DIVISION

Meet Thousands of Application Needs with these Five Basic Switch Types

STANDARD MODELS in a wide range of dimensional and characteristic designs—from the tiny, powerful sub-subminiature type to the large, general purpose type where size is not important. See each switch series for application suggestions and brief specifications.

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high in-rush
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specifications
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ACTUATORS—toggle, push-button, leaf, roller leaf, lever, roller lever, etc., available.

Choose the Switch Series that meets your basic application needs. Then tell us the specific characteristics you want. Chances are, we have a standard ready for your use. We are fully equipped to make the switch you need in any quantity.

*perfect for
super-sensitive
uses...*

T SERIES



SUB-SUBMINIATURE, SPDT,

$1\frac{1}{2}'' \times \frac{1}{4}'' \times \frac{3}{16}''$
high current capacity in tiny case, excellent shock and vibration resistance, solder terminals, others on request. 25,000 ops. min per MIL-S-6743. 7.5 amps @ 125/250 VAC, 60 cycles Ind. & Res.

*ideal
for compact,
precision control uses...*

E4 SERIES



SUBMINIATURE, SPDT, $\frac{3}{16}'' \times \frac{1}{2}'' \times \frac{3}{16}''$
low movement differential and operating force permit precision control in critical applications. solder: single, double and long double turret terminals. 150,000 ops. @ 125/250 VAC, 2.5 amps.

*for rugged,
low-cost,
easy wiring uses...*

F SERIES



MINIATURE, SPDT, $1\frac{1}{32}'' \times 1\frac{1}{32}'' \times \frac{5}{16}''$
rugged, low-cost design. convenient terminals simplify wiring. solder, screw and spade terminals 150,000 ops. 10 amps @ 125/250 VAC, 28 VDC Res.

*good for
power
circuits,
precision control
uses...*

S SERIES



2-CIRCUIT, SPDT double break, $1\frac{1}{4}'' \times \frac{1}{2}'' \times \frac{1}{4}''$
combines high capacity, moderate size, long life and precision control. tested to 10,000,000 operations. end and side solder. screw and spade terminals. 750,000 ops. @ 125 VAC, 10 amps., U.L. rated.

*for general purpose,
high in-rush
and
repeatability uses...*

S2B SERIES



SPDT, $1\frac{3}{16}'' \times 1\frac{1}{16}'' \times \frac{3}{4}''$
tough, durable, compact. handles high in-rush loads easily. repeats to 10,000,000 cycles min. screw terminals. 20 amps, 125-250/480 VAC, U.L. rated. $\frac{1}{2}$ amp, 125 VDC; $\frac{1}{4}$ amp, 250 VDC.

For more details on these basic precision switch types write for catalog No. 110.

CONTROLS COMPANY OF AMERICA
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Manufacturers of a full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading electronic parts Distributors.



USN 2N705*

FIRST MIL TYPE germanium MESA SWITCHING TRANSISTOR

now available from...
MOTOROLA

ACTUAL SIZE

*
TO MEET
REQUIREMENTS OF
MIL-S-19500/86 (NAVY)

MOTOROLA USN 2N705

ELECTRICAL CHARACTERISTICS at 25°C

PARAMETER	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CB}	15	Vdc
Collector-Emitter Voltage	V_{CE}	15	Vdc
Emitter-Base Voltage	V_{EB}	3.5	Vdc
Collector Dissipation @ 25°C Case Temp	P_c	300	mW
Collector Dissipation @ 25°C Ambient Temp	P_c	150	mW
Forward Current Transfer Ratio	h_{FE}	25 min	—
Base-Emitter Voltage	V_{BE}	0.35 min — 0.44 max	Vdc
Collector Saturation Voltage ($I_a = -4$ mA dc, $I_e = 10$ mA dc)	$V_{CE(sat)}$	0.3 max	Vdc
Storage Time	t_s	100 max	nsec
Fall Time	t_f	100 max	nsec
Delay + Rise Time	$t_d + t_r$	75 max	nsec
Junction Temperature	T_j	100	°C



**FOR COMPLETE
TECHNICAL INFORMATION**
on the Motorola USN 2N705,
write for Data Sheet.
Please address inquiries to
MOTOROLA SEMICONDUCTOR
PRODUCTS INC., Technical Information
Department, 5005 E. McDowell Road,
Phoenix, Arizona.

The USN 2N705 is a PNP germanium high-frequency mesa switching transistor. It is ideal for use wherever high-speed switching is necessary, such as flip-flop, gate and trigger circuits. Reliable operation in switching circuits has been achieved at frequencies in excess of 40 megacycles.

Units are immediately available. Order from your authorized Motorola Semiconductor distributor or your Motorola district office.

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**MOTOROLA SUPPLIES
THE WIDEST RANGE
OF MESA
TRANSISTORS**
for computer, amplifier
and VHF power applications.

FOR COMPUTER APPLICATIONS

2N695 Ultra-high-speed PNP germanium switching transistor. TO-17 package with 4th lead for high-frequency shielding. High-speed performance such as 50 mc flip-flops.

2N705 Germanium PNP. Combine the same high-speed switching as 2N695 with 300 mW device dissipation. TO-18 package.

2N711 Germanium PNP. Lower cost Motorola Mesa switch for less critical switching applications.

2N706B Silicon NPN switching Mesa with lower base resistance, lower saturation voltage and improved high-frequency performance. TO-18 package.

2N706A Silicon NPN switching Mesa. TO-18 package.

2N828 Germanium PNP Epitaxial Mesa. Ultra-high-speed switching, low saturation resistance. High reliability. TO-18 package.

2N834 Silicon NPN Epitaxial Mesa for universal computer and communications applications. TO-18 package.

FOR UHF-VHF AMPLIFIER APPLICATIONS — GERMANIUM PNP

2N700 For 40 to 1000 mc communications applications. TO-17 package with fourth lead providing high-frequency shielding.

2N741 For communications applications up to 100 mc. 300 mW device dissipation. Power gain of 22 db at 30 mc. Excellent video amplifier. TO-18 case.

FOR MEDIUM-POWER VHF TRANSMITTER APPLICATIONS — GERMANIUM PNP

2N1561 Provides 1/2 watt RF power output at 160 mc with 7 db gain. Useful from below 70 mc to 350 mc.

2N1562 Companion driver for 2N1561.

NEW PRODUCTS

DC Power Supply 488

Current regulated to 0.1%



One of a series of solid-state current-regulated power supplies, the model TC200-5 has regulation held to 0.1%. The series converts 110-v, single-phase, 60-cps power to 200 v dc, with maximum current of 5, 10, or 15 amp. Regulation to 0.01% or 0.001% may be obtained. Coarse and fine continuous adjustment of current is provided. The 200-lb unit is 30 in. high, 19-1/2 in. deep, and 24 in. wide.

Spectromagnetic Industries, Dept. ED, P.O. Box 3306, Hayward, Calif.

LC Meter 470

For in situ measurements



The model MM 906 is designed for component checks and in situ measurements of inductance and capacitance, including strays. Minimum ranges, for full-scale deflection on the 4-in. meter, are 0 to 3 μ h and 0 to 3 pf. It provides continuous monitoring from 0 to 300 μ h and 0 to 300 pf, in 5 ranges with $\pm 3\%$ accuracy. Weight is 10 lb.

Solartron Laboratory Instruments Ltd., Dept. ED, Cox Lane, Chessington, Surrey, England.

CIRCLE 66 ON READER-SERVICE CARD ►

ELECTRONIC DESIGN • February 1, 1961



How long will you keep buying obsolete counters when CMC counters with solid state reliability cost so little more?

Announcing the CMC 728A

A SOLID STATE 20 MC UNIVERSAL COUNTER-TIMER

Introduction of the CMC 728A marks another frequency step-up from the company that brought you the first transistorized universal counter-timers. CMC, the leader in truly advanced counting, timing, and frequency measuring equipment offers 100 kc, 250 kc, 1 mc, 10 mc and now 20 mc all solid state instrumentation.

Can You Afford To Settle For Less? If you are considering any counter, will your engineering judgement and sense of real economy dictate purchase of old fashioned equipment? Stop and look at the merits of solid state counters. Did you know that the reliability of all CMC solid state counters is backed with a 2 year warranty—double the guarantee of tube counters? Did you know CMC's solid state 10 mc universal counter timer only costs \$200 more than comparable vacuum tube counters? That's the beginning. Compare the rest of these specifications.

Compare the 20 mc Solid State Universal Counter-Timer—We'd like to, but frankly, there aren't any comparable vacuum tube counters. This might lead the discerning engineer to think that at 10 mc, vacuum tubes are driven "hard", right to their capacity. *And he'd be right.*

More Information—For complete technical information on high reliability solid state counting instrumentation, call your nearby CMC engineering representative, offices in 33 cities throughout the U.S. and Canada, or write directly to Dept. 36.

	Most Popular 10 mc Vacuum Tube Counter	CMC Solid State 10 mc Counter
Base Price	\$2,300	\$2,750
Printer Output	75	n/c
Time Interval Section	175	n/c
Total	\$2,550	\$2,750
Weight	118 lbs.	27 lbs.
Size	21 1/2"H x 20"W x 23 1/2"D	7"H x 17"W x 13"D
Power Requirements	600 watts	46 watts
Accuracy	± 1 count \pm crystal stability	± 1 count \pm crystal stability
Remote Programming	not available	Standard option
Warranty	1 year	2 years
Time Interval Measurements	1 μ sec to 10 ⁷ sec in 1 μ sec increments	0.1 μ sec to 10 ⁷ sec in 0.1 μ sec increments
Period Measurement	0 cps to 10 kc	0 cps to 3 mc
Gate Times	0.001, 0.01, 0.1, 1.0 & 10 sec	0.000001 to 10 sec in decade steps
Time Base	10 to 1 multivibrator type	decade dividers — no adjustment



Computer Measurements Co.

A Division of Pacific Industries

12970 Bradley Avenue, Sylmar, California
Phone: EMpire 7-2161

NEW PRODUCTS

Telemetry Amplifier

496

For use with transducers



This solid-state, modular carrier-amplifier system is designed for use with low-level output transducers. The model MCS-101 provides excitation to the transducer and amplifies the output to 5 v dc. Frequency response is dc to 2,000 cps; combined nonlinearity and hysteresis error is less than 0.2% full scale. The system is powered from unregulated 28 v dc. External dimensions, less connectors, are 1.0 x 1.8 x 2.0 in. Weight is about 4 oz.

Pacific Telemetry Systems, Dept. ED, 10810 W. Washington Blvd., Culver City, Calif.

Price: \$495 ea.

Availability: 4-week delivery.

Waveform Comparator

490

Compares ac or dc to dc



With this oscilloscope accessory, model 212, peak ac may be compared to dc with 0.005% comparison accuracy, or dc to dc at 0.001%. In addition to calibrating ac and dc standards, the device makes possible precise observation of small portions of large waveforms. Frequency range is 0 to 5 kc; inputs are 0 to 20 v peak and dc. Outputs to oscilloscope give presentation of ac peaks versus dc reference, with chopper zero interference, and dc input versus dc reference shown as ac-coupled square wave at chopper frequency.

Rotek Instrument Corp., Dept. ED, 733 Concord Ave., Cambridge, Mass.

Price: \$1,250.

Availability: Delivery from stock to 10 weeks.

TANTALUM CAPACITORS

- . . . "wet slug," high temperature (to 200°C)
- . . . "wet slug," microminiature to miniature
- . . . solid electrolyte, metal case or encapsulated
- . . . foil type, polarized and non-polarized
- . . . Mallory has what you want. Industry's broadest line. 13 types, hundreds of ratings. Write for complete catalog. Mallory Capacitor Company, Indianapolis 6, Indiana.

TAF



TAS



TAP



MTF



TAH



XTL



XTK



HAT



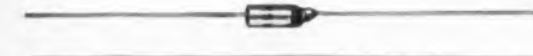
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TAM



Complete line of aluminum and tantalum electrolytics, motor start and run capacitors

CIRCLE 67 ON READER-SERVICE CARD

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Tucson, Ariz.
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Tulsa, Okla.
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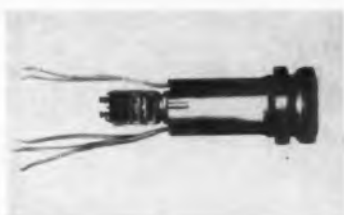
White Plains, N.Y.
Westchester Electric

Winston-Salem, N.C.
Dalton-Hege Radio

Push-Button Panel Switch

463

Is illuminated



This illuminated, push-button panel switch has momentary or alternate action. It is available with double throw switching from two to four poles, and in single or four-color variations. It has independent or switch wiring for lamp circuits.

O & S Research, Inc., Dept. ED, Riverton, N.J.

Precision Potentiometers

461

Resolution is better than 0.01%



These deposited-film, precision potentiometers provide resolution of better than 0.01%. They are designed for use where small increments of shaft rotation must produce proportionally small changes in resistance. They are available in single or ganged types.

Servomechanisms Inc., Mechatrol Div., Dept. ED, 1200 Prospect Ave., Westbury, L.I., N.Y.

Amplifier Rack Module

458

For horizontal mounting



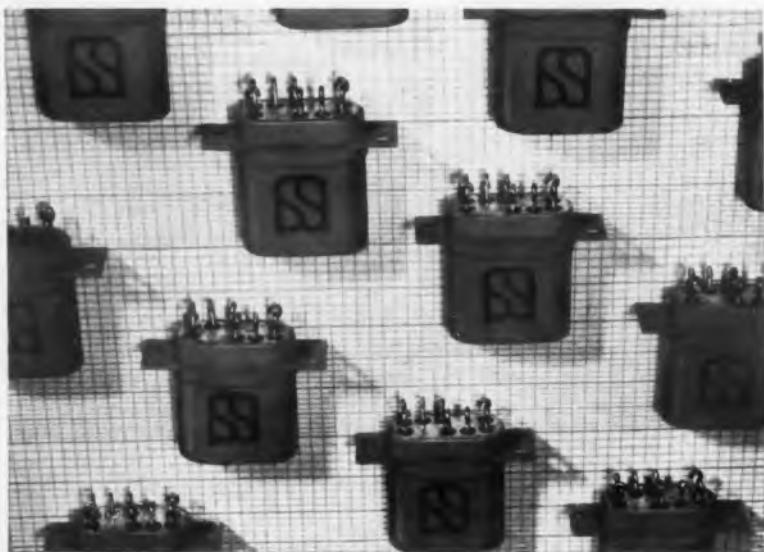
Amplifier rack module model 191A is designed to hold a single amplifier in a horizontal position for mounting in a standard 19-in. rack. It contains an on-off switch, ventilating fan and a fused, 3-wire ac line plug. All ac wiring is complete.

Cohu Electronics, Inc., Kin-Tel Div., Dept. ED, 5725 Kearney Villa Road, San Diego 12, Calif.

Price: \$150 fob San Diego.

Availability: One week.

P. R. MALLORY & CO. Inc.
MALLORY



This is the new Union Crystal Case Relay

The UNION 2-PDT General Purpose Crystal Case Relay is designed to consistently meet the requirements of MS 24250, Mil-R-25018, Mil-R-5757C. Use it where minimum size and *optimum reliability* are essential—in control systems, computers, airborne and guided missile electronic equipment.

To provide vibration immunity, we have incorporated a unique feature in this relay's armature suspension system. A torsion wire is anchored to the armature and backstrap. It acts as a biasing spring; supports the armature and eliminates end play. The relay uses the rotary principle of operation, found in the entire line of extremely reliable Union Switch & Signal miniature relays.

The 2-pole, double throw, bifurcated contact structure increases reliability and efficiency in dry circuit applications. UNION Crystal Case Relays are designed for continuous operations in the -65°C to $+125^{\circ}\text{C}$ range.

Union Switch & Signal's manufacturing capabilities and experience make it possible to provide these quality relays in quantity. Manufacturing techniques make it possible to provide the ultimate in reliability.

The new UNION Crystal Case Relay is available with the 0.2" grid-spaced header or "S" type header, with solder lugs, plug-in terminals, or 3-inch leads, and for various operating voltages.

Contact Union Switch & Signal for additional information about this new Crystal Case Relay. Write for bulletin 1064.

Vibration: 20 G—2,000 cps

Shock: 50 G

Temperature Rating: -65°C to $+125^{\circ}\text{C}$

Contact Rating: Dry circuit to 2 amp., 28-volt DC resistive load.

"Pioneers in Push-Button Science"



UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY —
PITTSBURGH 18, PENNSYLVANIA

CIRCLE 68 ON READER-SERVICE CARD

NEW PRODUCTS

DC Amplifier

480

Occupies less than 4 cu in.



Designed to amplify low-level signals from pressure transducers, thermocouples, etc., to a high-level dc voltage, the model 98 dc amplifier occupies less than 4 cu in. Its output is 0 to ± 5 v dc; bandwidth is 2 kc.

Video Instruments Co., Inc., Dept. ED, 3002 Pennsylvania Ave., Santa Monica, Calif.

Silicon Diode

492

With 0.15- μ sec switching



This silicon diode, type JAN 1N251, provides 0.15- μ sec reverse switching time. It has 0.1- μ a dc reverse current at -10 v, 1.0-v dc forward voltage at 5 ma, and 150-mw power dissipation. Reverse voltage is 30 v.

Rheem Semiconductor Corp., Dept. ED, 350 Ellis St., Mountain View, Calif.

Price: \$3.50 ea, 1 to 99.

Availability: From stock.

Rectifier Tube

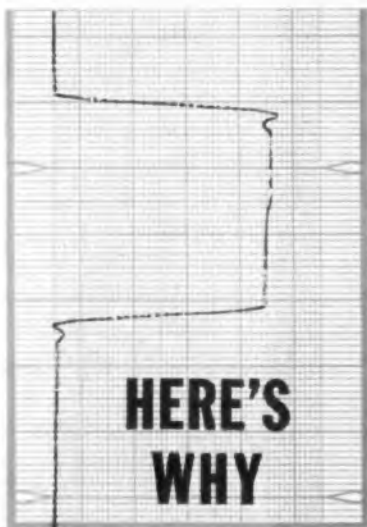
462

Rating is 6.4 amp dc



Model NL-660L/7786 is a 6.4-amp dc rectifier tube designed for industrial power applications where a high commutation factor tube is required. It is available with lug-, 4-pin- and bracket-type bases. Specifications are: filament, 2.5 v; filament current, 21 amp; peak anode current, 80 amp.

National Electronics, Inc., Dept. ED, Geneva, Ill.



AO TRACEMASTER'S CARBON TRANSFER METHOD PRODUCES BETTER RESULTS!

The AO Tracemaster 8 channel recorder uses a direct-carbon-transfer writing method...clearly the best of all methods. The trace above, reproduced from a Tracemaster record, shows why!

Chart speed was 500 mm/sec. (Twice as fast as any other recorder). The trace is a gate pulse out of an Analab oscilloscope. Gate rise time is approximately 2.0 micro seconds. An amazing performance! Note the fine quality of the trace... the consistency of line through the entire band pass.

The direct carbon transfer technique makes this possible... mylar-backed carbon positioned between the stylus and the chart paper acts as an excellent lubricant. Stylus tip radius is smaller to produce a finer trace...yet there's no danger of "plowing". And it permits use of stylus pressure 5 to 7 times higher than with any other recorder (velocity feedback signal out of the pen-motor applied to the linear driver amplifier makes the system much less susceptible to the effects of stylus pressure). This renders the system immune to ordinary shock and vibration stress... there's no ink splatter... little or no skip... no paper-tear.

Learn, in detail, all the advantages of the AO Tracemaster and its direct carbon transfer recording method. Send for complete literature. A request on your company letterhead will bring you an actual sample of an AO Tracemaster record.

American Optical Company

Instrument Division • Buffalo 15, New York

Nuclear Gage 506

For thickness control

The Micro-Meter is a radiation gaging device for non-contacting measurement and control of thickness and density. It operates with a variety of isotopes for industrial applications. Response times can be obtained as low as 10 msec for 0.1% reliability or information. It may also be used for flaw detection and dimension gaging.

Radionics Inc., Dept. ED, Lafayette & Water Streets, Norristown, Pa.

Multiple Relays 473

With 1 to 8 poles



A 2-pole snap switch has been used to extend the number of poles on class 8501 type P relays. Eight normally open and eight normally closed contacts require less than 14 in. of panel. Each pole consists of a snap switch with double-break, double-throw contacts. Contact mechanism is enclosed. Non-inductive rating is 10 amp.

Square D Co., Dept. ED, 4041 N. Richards St., Milwaukee 12, Wis.

Silicon Micro-Diode 505

Used as computer core driver

Designed for use as a computer core driver, the type PD400 micro-miniature silicon diode is characterized by a stored charge of 25×10^{-12} coulomb per ma at 25 deg C, forward voltage drop of 1.5 v at 0.5 amp, and 6- μ sec recovery time.

Pacific Semiconductors, Inc., Dept. ED, 12955 Chadron Ave., Hawthorne, Calif.

Price: \$4.50 ea, 100 to 999.

Availability: Immediate.

CIRCLE 70 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 1, 1961

now in
production
at Reeves
INSTRUMENT CORPORATION



pancake
resolver

with



FUNCTIONAL ACCURACY
AND 2-SECOND REPEATABILITY

integral bearing permits direct gimbal mounting

The new Reeves 10-second Resolver is the ideal instrument for precision stable platform applications. The units are available with either beryllium or aluminum housings for a wide range of operating temperature applications.

Reeves is especially proud of this latest addition to the comprehensive family of high precision resolvers currently in production and ready for inclusion in your systems packages. Whatever your resolver requirements Reeves has the size and design to meet your specifications. Reeves Resolvers are supplied in the 23, 15, and 11 case sizes. For complete specifications, write for data file 202.

REEVES INSTRUMENT CORPORATION

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

Qualified engineers seeking rewarding opportunities in these advanced fields are invited to get in touch with us.



The Leaders Specify ALPHLEX® TUBING & SLEEVING

- made to the highest standards • comprehensive variety of colors and put-ups
- immediate delivery from your local Alpha Wire distributor

For these advantages Alphlex Tubing & Sleeving is used by such leaders as Conair, General Electric, Gulton Industries, Polaroid Corporation & Govt. agencies. Write for Alphlex catalog.

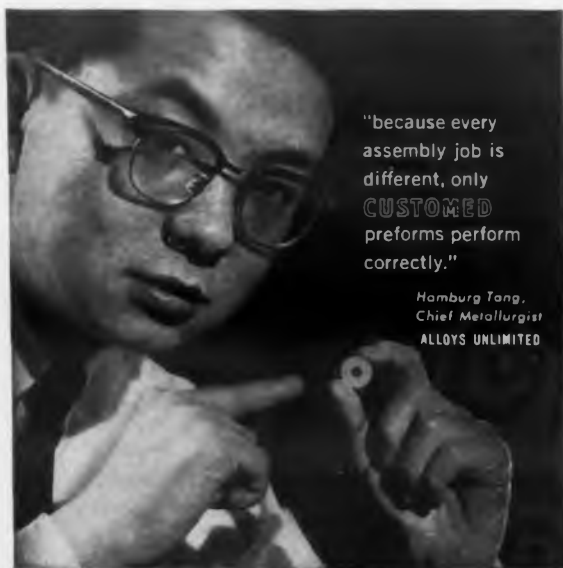


TYPE	DESCRIPTION	GRADE	DIELECTRIC STRENGTH V/MIL	TEMP. RATING	LOW TEMP. FLEX.	OIL RESISTANCE	SIZES & COLORS
PVC-105 PLASTIC TUBING	High resistance to heat, oil, chemicals, corrosion, fungi; no loss in tensile strength or flexibility. Protects irregular objects and snakes well.		800	105°C	-30°C	remains flexible indefinitely	#24-#12 A-1 #11-#2 A, B, C, D, G, H #2½-#1 A, B
PVC-744 PLAST. TUBING	Specifically designed for sub-zero temperatures.		550	70°C	-67°C	Good	#24-#0 A
PIF-130 PLASTIC IMPREGNATED FIBERGLASS SLEEVING	Class B insulation for continuous operation to 130°C. Excellent color retention even on prolonged baking at high altitudes.	A-1 B-1 C-1	8000 4500 2500	130°C 130°C 130°C	-30°C -30°C -30°C	Good Good Good	#24-#2 B, C, D, G #1 and larger C, D
VVB-133 VARNISH IMPREGNATED TUBING & SLEEVING	Class B insulation for general use; high tensile strength, good flexibility, non-peeling cracking, low moisture absorption, acid oil resistant.	A-1 B-1 C-1	7000 4000 2500	135°C 135°C 135°C		Good Good Good	#24-#2 B, C, D, G #2½-#1 B, C
YFT-200 TEFLON EXTRUDED TUBING	Unmatched for electrical application at high temperature frequencies. Thin, flexible, permits miniaturization and compactness.		500-1000	250°C	-90°C	Excellent	#30-#15 B-K #14-#8 B, C, D, F, G, H, I, J #7-#0 J
WRT-250 SILICONE RUBBER EXTRUDED TUBING	Excellent tensile strength, elongation, and tear strength, low water absorption and good oil resistance.		400	200°C	-85°C	Good	#28-#10 H
PVC-80 EXTRUDED PLASTIC TUBING	Excellent snaking, expands to irregular shapes. Dilates under certain conditions and resumes its size if it is the polyvinylchloride type.		800	80°C	-30°C	stiffens slightly	#24-#12 A-1 #11-#2 A, B, C, D, G, H #2½-#1 A, B
PVE-70	(Same as PVC-80)		1200	80°C	-70°C	swells slightly	#24-#7 J
WRF-200 SILICONE RUBBER FIBERGLASS TUBING	Class H insulation, excellent for shock resistance, extreme flexibility and freedom from cracking and crazing at extreme temperatures.	A-1 B-1 C-1	7000 4000 2500	200°C 200°C 200°C	-67°C -67°C -67°C	Good Good Good	#24-#15 B-K #14-#2 B, C, D, G, H, J #1-#½ B, C, H, J
WTF-1200 HI-TEMPERATURE FIBERGLASS SLEEVING	Class H insulation. Tightly braided sleeving for use up to 650°C. Can be colored for coding. Special constructions up to 1/16" wall thickness and double wall thickness available.		Determined by space factor	650°C	-55°C	Good	#24-#½ B, J
WPF-400 SILICONE IMPREGNATED FIBERGLASS TUBING	Class H insulation for high temperature use. Remains flexible and retains its electrical properties to 205°C.	C-1 C-2 C-3	2500 1500 Space factor	205°C 205°C 205°C	-39°C -39°C -39°C	Good Good Good	#24-#½ J

A. CLEAR B. BLACK C. YELLOW D. RED E. BLUE F. BROWN G. GREEN H. WHITE I. ORANGE J. NATURAL K. VIOLET

ALPHA WIRE CORPORATION Subsidiary of LORAL Electronics Corporation
200 Varick Street, New York 14, N. Y.
Pacific Division: 1871 So. Orange Dr., Los Angeles 19, Calif.

CIRCLE 71 ON READER-SERVICE CARD



"because every assembly job is different, only CUSTOMED preforms perform correctly."

Hamburg Tang,
Chief Metallurgist
ALLOYS UNLIMITED

NEW CUSTOMED SOLDER PREFORMS IMPROVE AUTOMATIC SOLDERING

New customed preforms consist of an accurately predetermined amount of a specific alloy. The proper melting temperature and correct volume of solder are assured. Labor costs are lowered. Production increases. Scrap is eliminated. Get the facts today! Write for 8 page Guide to Preform Soldering.

21-01 43rd Ave., Long Island City 1, N. Y.



CIRCLE 72 ON READER-SERVICE CARD

I have a feeling in the pit of my photocell that you are open to this page. Why not have a look at these data while you are here.

Cds-Photoconductive CELLS

Capable of dissipating especially high power up to one watt.

- RUGGED
- ECONOMICAL

Various standard types with different electrical and physical characteristics available to meet your specifications.

WRITE:
NATIONAL SEMICONDUCTORS LTD.
230 AUTHIER ST. Montreal 9, P. Q.
Phone: RI: 4-2946

CIRCLE 73 ON READER-SERVICE CARD

NEW PRODUCTS

Subminiature Capacitors

475

From 0.001 μ f to 1.0 μ f



These subminiature, hermetically sealed ceramic capacitors, for general printed-board use, range in value from 0.001 μ f to 1.0 μ f. Rated at 100 wvdc, operating range is -55 to 125 C. Sizes range from 0.3 in. length at 0.001 μ f to 0.65 in. length at 1.0 μ f.

Statmetics Corp., Dept. ED, 5121 Weeks Ave., San Diego 10, Calif.

Price: Up to \$1.40 ea.

Isolation Mounting Plug

494

For component insertion

The two solder turret terminals of this isolation mounting plug will accommodate small components for insertion or substitution in a circuit. The top terminal is isolated from the banana plug, which fits standard 0.166-in. diameter jacks. The model 1390 has molded plastic insulation.

Pomona Electronics Co., Inc., Dept. ED, 1500 E. 9th St., Pomona, Calif.

Price: From \$0.95 to \$0.78 ea.

Availability: From distributors.

Radiation Survey Meter

460

For beta and gamma energy



Model 440 low-energy survey meter is designed for detecting and measuring beta and gamma radiation over a broad energy range. It has an accuracy of 10% with gamma dependence of $\pm 15\%$ from 6.5×10^4 to 1.2×10^6 electron volts. No zero adjust or other external adjustments are necessary. Full scale sensitivity ranges are from 0.3 to 0.300 milliroentgens per hr.

The Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

ELECTRONIC DESIGN • February 1, 1961

Circuit Breaker

Switches 1,000 amp



Originally developed for plasma research work, these units are capable of switching from 10 to 150 kv at currents up to 1,000 amp. Switching time is less than 6 msec. Reproducibility of the system for current fault detection is better than 1/2 of 1% on all ranges.

Resitron Laboratories, Inc., Dept. ED, 2908 Nebraska Ave., Santa Monica, Calif.

Price: From \$100 to \$750.

Availability: 1 week.

Transmitter-Receiver

Uses telephone lines

The Teledata 8-channel code transmitter-receiver uses the toll message network of long-distance telephone lines in conjunction with the Bell Data-Phone 100. Speeds of 425 codes per min are obtained, and a parity checking feature insures accuracy. The Teledata reads tapes punched on standard data processing machines.

Friden, Inc., Promotion Planning Dept., Dept. ED, 1 Leighton Ave., Rochester 2, N. Y.

Silicon Rectifiers

In compact stacks



This series of single phase, bridge silicon rectifier stacks is mounted on compact, dual-fin heat sinks measuring 3 x 3-3/4 in. overall. They are available with current ratings from 5 to 50 amp, and with peak reverse voltage ratings from 50 to 500 v. Components in the series include 6- and 12-amp rated diffused junction cells and 25-amp rated rectifier cells with low forward voltage drop and low reverse leakage characteristics.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

Price: From \$12 to \$80 ea.

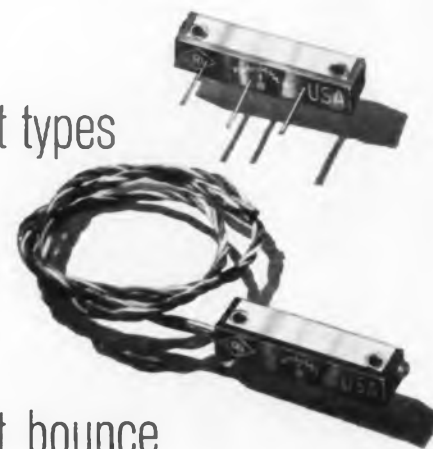
655

Centralab Model



Linear Motion Variable Resistors

different types



contact bounce

No contact bounce when vibration tested, 20-20,000 cps at 30 g's, loaded at 80% rated load, at 80% wiper travel, 3 planes, 10 minutes each. Induced noise less than 10 millivolts.

DESCRIPTION	MODEL	TERMINAL LEADS	RESISTANCE RANGE	POWER RATING (Watts)	MAXIMUM OPERATING TEMP.	ENCAP-SULATED
Gen. Purpose (Composition)	BA-701	Nylon or Teflon	10K to 2.5 Meg	0.25@ 50°C	+125°C	No
Gen. Purpose (Wirewound)	BA-702	Nylon or Teflon	10 ¹¹ to 20K	0.25@ 50°C	+125°C	No
Gen. Purpose (Composition)	BA-703	Printed Circuit	10K to 2.5 Meg	0.25@ 50°C	+125°C	Yes
Gen. Purpose (Wirewound)	BA-704	Printed Circuit	10 ¹¹ to 20K	0.25@ 50°C	+125°C	Yes
Gen. Purpose (Composition)	BA-705	Nylon or Teflon	10K to 2.5 Meg	0.25@ 50°C	+125°C	Yes
Gen. Purpose (Wirewound)	BA-706	Nylon or Teflon	10 ¹¹ to 20K	0.25@ 50°C	+125°C	Yes
Gen. Purpose (Composition)	BA-707	Printed Circuit	10K to 2.5 Meg	0.25@ 50°C	+125°C	No
Gen. Purpose (Wirewound)	BA-708	Printed Circuit	10 ¹¹ to 20K	0.25@ 50°C	+125°C	No
High Temp. (Wirewound)	BA-712	Teflon	10 ¹¹ to 20K	1.0 @ 70°C	+175°C	No
High Temp. (Wirewound)	BA-714	Teflon	10 ¹¹ to 20K	1.0 @ 70°C	+175°C	Yes
High Temp. (Wirewound)	BA-716	Printed Circuit	10 ¹¹ to 20K	1.0 @ 70°C	+175°C	Yes

Maximum end resistance: < 1% of total.

Size:

encapsulated 23/64" x 19/64" x 1-11/32", without encapsulation 5/16" x 1/4" x 1-1/4".

Resistances: Wirewound: 10-20-50-100-200-500-1K-2K-5K-10K-20K ohms. Composition: 10K-20K-50K-100K-500K, 1 Meg, 2.5 Meg.

Standard Tolerances: ±5% Wirewound, ±20% Composition. Closer tolerances available upon request.

Shock: Less than 1% change in resistance with JAN-S-44 apparatus at 100 g, 5 shocks in each of 3 planes, Method 202A.

Meet or exceed all specifications of applicable MIL-STD 202-A, MIL-R-19A and MIL-R-94B tests.

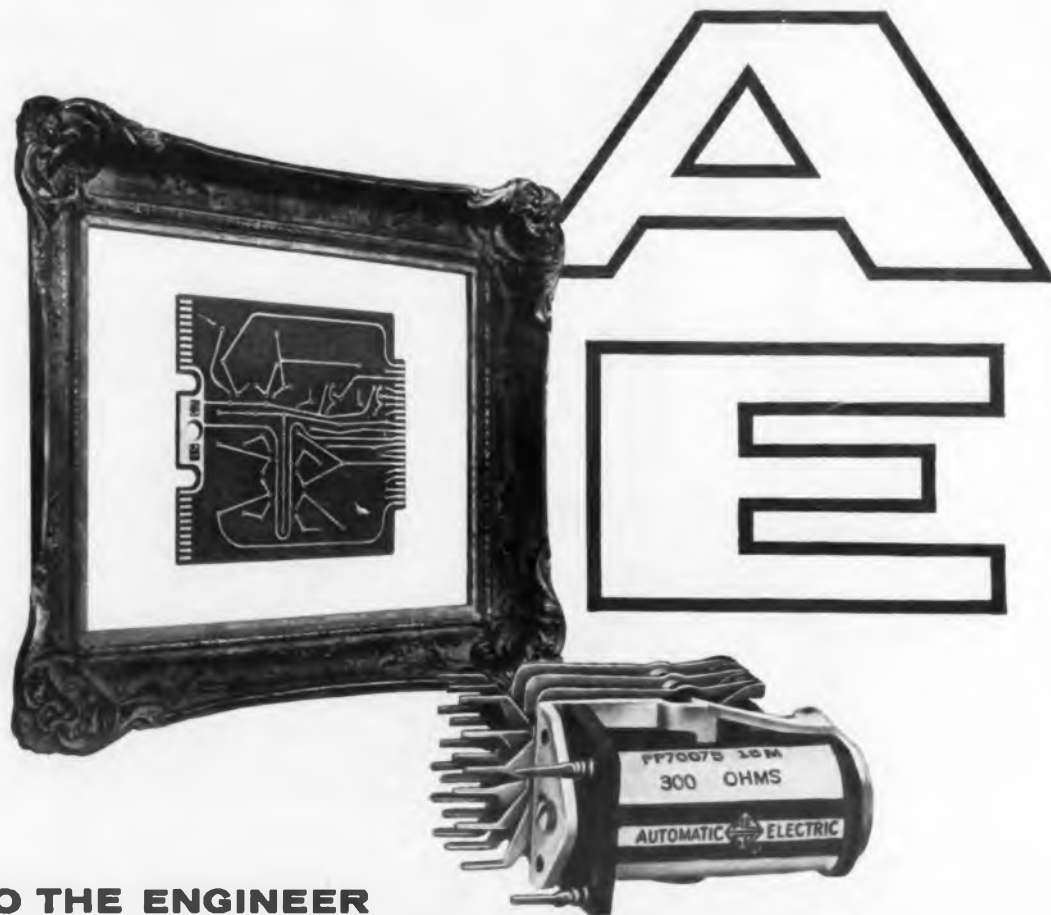
Industrial quantities of the Model 7 are available for immediate delivery at factory prices from your CENTRALAB industrial distributor.

Centralab

B-6039

The Electronics Division of Globe-Union Inc.
960B East Keefe Avenue • Milwaukee 1, Wisconsin
Centralab Canada Limited • Ajax, Ontario

ELECTRONIC SWITCHES • VARIABLE RESISTORS • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS
CIRCLE 74 ON READER-SERVICE CARD



TO THE ENGINEER

who wants to make the most of his etchings

If your printed circuit board designs involve switching, you can count on getting the best results by using AE Class E relays with direct-connect terminals.

Series EQPC relays, with end-mounted printed circuit lugs, occupy a minimum of board space, and furnish dramatic savings in assembly and wiring time.

The AE Series EQPC printed circuit relay is a miniaturized version of the premium-quality Class B telephone-type relay, with many of its

best features. Contact reliability exceeding 200 million operations can be expected.

Automatic Electric also supplies Class E relays with Taper-Tab terminals, and prewired for plug-in, with 8- to 20-prong octal plugs, with or without hermetically sealed containers or dust-tight housings.

Want details? Just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois. Also ask for Circular 1702-E on *Relays for Industry*, and the new *Conversion Factors* booklet.



AUTOMATIC ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS



CIRCLE 75 ON READER-SERVICE CARD

NEW PRODUCTS

Transistor Oscillator

352

Crystal-controlled



The LTO-M3-1 crystal-controlled transistor oscillator has a frequency range of 3 kc to 100 kc with a tolerance of ± 0.02 to 0.03% or, with oven, 0.001%. The unit is available in silicon or germanium. Input voltage is 20 to 28 v dc; output is 2 v into 600 ohms. Total harmonic distortion is less than 5%. It measures 2 x 2-1/2 x 1/2 in.

Monitor Products Co., Dept. ED, 815 Fremont, South Pasadena, Calif.

20-w Resistors

420

Wirewound, ceramic case

These 20-w, wirewound resistors, in ceramic cases, come in 40 stock values ranging from 5 ohms to 30 K. They are rectangular in shape and have axial leads 2 in. long. The manufacturer claims nondrifting during shelf life and very high resistance to humidity for this series 800.

Hamilton-Hall, Inc., Dept. ED, 227 N. Water St., Milwaukee 2, Wis.

Availability: Delivery from stock.

Data-Input Unit

679

Direct entry type



This direct-entry data-input unit is adaptable to any computer or digital instrument. It can be used with tapes both punched and magnetic, or cards. The 10-key keyboard can accommodate from five to 30 control keys. Indicator lights are available for special applications.

Clay Corp., Electronic Div., Dept. ED, 408 Junipero St., San Gabriel, Calif.

Price: \$245.

Availability: 90 days.



A 32-page digest of the industry's most complete lines of single-turn and multi-turn precision pots!

With new sections on A-C . . . Non-linear . . . Liquid-filled . . . and Helitrim® trimming potentiometers. As well as turns-counting dials and delay lines!

Complete technical data, including environmental specs and outline drawings, is at your fingertips. And it's all arranged in a fast-reading format that makes pot picking easier.

Just ask for it.

Beckman / **Helipot**

POTS : MOTORS : METERS

Helipot Division of
Beckman Instruments, Inc.
Fullerton, California

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CIRCLE 151 ON READER-SERVICE CARD
ELECTRONIC DESIGN • February 1, 1961

Servomotor

152

Smallest size 8 is 0.84-in. long

Said to be the smallest size 8, 115 v servomotor sold, the Model 8 SM 461 is 0.840-in. long, weighs 1.1 oz. A precision-control component, it has a rotor inertia of 0.18 gm-cm² coupled with a stall torque of 0.22 oz-in., providing acceleration at stall of 86,500 rad per sec²—three times greater than any equivalent unit, asserts the company. Using stainless-steel and Teflon as insulation throughout permits an ambient temperature rating of -55° to +130° C. Maximum unit operating temperature is 200° C.

Helipot Div. of Beckman Instruments, Dept. ED, Fullerton, Calif.

Precision Potentiometer

153

Has matching 7/8-in. turns-counting dial



Model 7216, 7/8-in. diam. precision pot has standard resistance of 10 to 125,000 ohms and ± 0.5 per cent standard linearity. A 7/8-in. diam. 2600 series turns-counting dial is also offered for users desiring a precision pot-and-dial package, counts full turns and hundredths. The model 7216 is a ten-turn potentiometer with 1/4-in. diam. shaft and 3/8-32 bushing mount. It is rated at two w at 25° C with a minimum operating temperature of -55° C. The pot has a molded diallylphthalate housing, bronze front lid and stainless-steel shaft.

Helipot Div. of Beckman Instruments, Dept. ED, Fullerton, Calif.

Panel Meters

154

Built to MIL specs



Built to exact conformity with MIL-M-10304A, 4-1/2-in. round, sealed panel meters have plug-in terminal construction, easy disassembly and good linearity. All-metal construction and modern appearance make the 92 standard models suitable for a variety of applications. Available as volt-meters, ammeters, milliammeters and microammeters.

Helipot Div. of Beckman Instruments, Dept. ED, Fullerton, Calif.

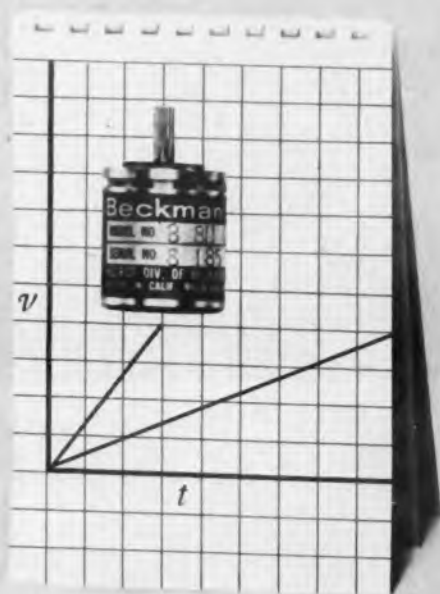
Availability: 30 days.

**NEW SIZE 8 SERVOMOTOR
RESPONDS 3-TIMES FASTER**

These fast response Size 8's have a whopping acceleration of 86,500 rad/sec²...and feature torque at stall of 0.22 oz. in., rotor inertia, 0.18 gm. cm.². That's at least three times faster than any other Size 8's available.

The entire BECKMAN® Size 8 line is available in standard models for 26-volt or 115-volt sources - Servomotors, Inertia-Damps, Velocity Damps, or Servomotor Rate-Generators (special models available for other voltages). For the servosystems man working with 115-volt reference supplies, this can mean an end to accessory gear that so often compounds reliability and cost problems.

At the Breadboard stage? Several BECKMAN® Size 8 and Size 11 Servomotors are available from stock for immediate delivery in prototype quantities. Check with your Helipot rep. write us for the list of stock Servomotors and for the Size 8 and 11 Catalog.



Beckman / **Helipot**

POTS : MOTORS : METERS

Helipot Division of
Beckman Instruments, Inc.
Fullerton, California

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CIRCLE 155 ON READER-SERVICE CARD

The Untouchables

Single Crystal Silicon... the "Pinnacle of Purity"



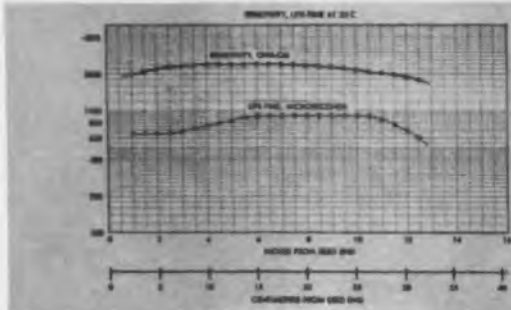
Dow Corning single crystal silicon is produced by vacuum zone refining hyper-pure polycrystalline rod. Result: The purest silicon produced! Typically, impurity content is only 0.15 part per billion of boron for crystals that are consistently above 1000-ohms centimeter resistivity. Boron content is even lower for crystals of 2000-ohms centimeter and above... available on a selective basis.

This highest purity P-type silicon is the result of a completely integrated processing facility that starts with the production of trichlorosilane and ends with the crystals heat-sealed in airtight polyethylene envelopes. Purity and quality control dominate every step — in producing the basic chemicals... in growing polycrystalline rod... in vacuum zone refining... in product evaluation and in packaging.

Purity pays off... in rectifiers and diodes having higher peak inverse voltage ratings — in maximum utilization because of uniform lateral and radial profiles over the entire length of the rod. With Dow Corning single crystal rod, you're assured of maximum yield and minimum waste per rod. Rod diameter variation is controlled to less than 1.4 mm (0.055 inches) — simplifying mechanical preparation for either the diffusion or alloying process.

Hyper-pure silicon for every need is now available from Dow Corning. If you grow your own crystals from polycrystalline chunk using the Czochralski method... if you zone refine polycrystalline rod... if you need 1000-ohm centimeter or better resistivity in single crystal P-type — Dow Corning should be on your preferred source list.

Each Dow Corning single crystal rod is checked for resistivity over its entire length. Resistivity and lifetime profiles, like those shown below, are supplied with each crystal.



Write for "Hyper-Pure Silicon
for Semiconductor Devices."
Address Dept. 3314a.

HYPER-PURE SILICON DIVISION
Address: HEMLOCK, MICHIGAN

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

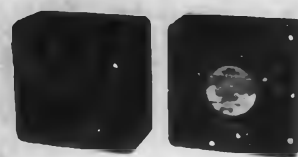
CIRCLE 76 ON READER-SERVICE CARD

NEW PRODUCTS

Phase Generator

381

Shifts phase at power level



Signals may be phase-shifted through 360 deg without amplitude variations and converted to power levels of 7 w with the model PGA phase generator. Designed for servo development, it will drive most synchros, choppers, and related equipment. The solid state unit has a guaranteed life of 10,000 hr. Input is 115 v, output 0 to 180 v adjustable; phase error is 30 min, range is 360 deg continuous.

Theta Instrument Corp., Dept. ED, 520 Victor St., Saddle Brook, N.J.

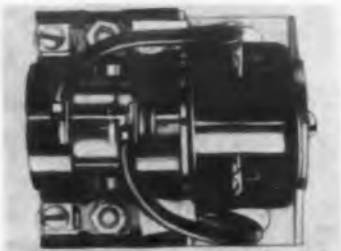
Price: \$425.

Availability: Delivery from stock.

Mercury Relay

663

Plunger type



The plunger-type mercury relay series W-20-3 is silent and chatterless in operation. The normally open contact is hermetically sealed; ratings are: 30 amp at 120 v ac; 20 amp at 240 v ac; 8 amp at 440 v ac; 15 amp at 120 v dc; 10 amp at 240 v dc; and 2 hp on 1 phase 120 to 240 v ac. Noninductive heater load rating is 35 amp at 120 v ac and 25 amp at 240 v ac. Interchangeable coils are available for 24, 120, 240, and 440 v ac.

The Mercoid Corp., Dept. ED, 4201 Belmont Ave., Chicago 41, Ill.

Automatic Analyzer

414

Checks up to 120 circuits

Model 8524 analyzer is for high-voltage, automatic circuit and cable analyses. It will check cables with up to 120 conductors. The following tests can be made with a programed sequence: continuity, 0.5 to 200 ohms, test speed is from

3 sec to 4 min per conductor; ac or dc Hypot, from 0 to 5,000 v, test time is from 1 sec to 15 min per group; insulation resistance, standard 500 v test potential, test time is from 1 sec to 15 min per group. Self-checking circuitry indicates any point of malfunction of the equipment.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

Price: \$10,000 and up.

Availability: 3 to 6 months.

Amplifiers and Attenuators

390

Low cost, light weight



These audio and video amplifiers and logarithmic voltage attenuators are transistorized, powered by batteries with life up to 1,500 hr. High- and low-impedance amplifier models have 30 and 40 db gain respectively; voltage attenuators are in 2 models: dc to 1 kc, and dc to 100 kc, with peak inputs to ± 100 v. Amplifiers are 4-7/8 in. long and weigh 6 oz; attenuators are 3 in. long and weigh 4 oz. Both units are 1-3/4 in. in diameter.

Kane Engineering Laboratories, Dept. ED, 845 Commercial St., Palo Alto, Calif.

Price: \$60 to \$90.

Availability: 10-day delivery

Radar Tube, 12-in.

379

Has low-drive gun



A low-drive electron gun, which permits the use of transistorized video circuitry, is a feature of the 12AMP single-beam, fast-writing cathode-ray tube. Deflection plate connections are made through the tube neck for hf operation. The screen is aluminized.

Fairchild Camera and Instrument Corp., Electronic Tube Div., Allen B. DuMont Laboratories, Dept. ED, Clifton, N.J.

Price: \$375.

Availability: 4 to 6 weeks.

2 NANOSECOND MICROWAVE SWITCHING with SOLID STATE RELIABILITY



MA-3457
S.P.S.T. C Band
Solid State Switch

Microwave Associates' new coaxial switches provide:

- Efficient switching across the microwave spectrum
- Solid-state reliability for military applications
- Lightweight (approx. 5 oz.) ruggedized construction
- Low driving power — from 10 to 100 milliwatts
- Power handling capability $\left\{ \begin{array}{l} 4 \text{ watts CW (S.P.S.T. unit)} \\ 150 \text{ watts peak at 0.001 duty cycle} \end{array} \right.$
- Low insertion loss — as low as 0.2 db

Solid-state switches are as good as the semiconductors they incorporate. All units described use the most advanced microwave silicon diodes available, specifically developed for this function by Microwave Associates Semiconductor Division.

LOW POWER LEVEL COAXIAL SWITCHES

Frequency (Mc)	Insertion Loss (Max)	Isolation (Min)	Switching Power
210-240	0.2 db	20 db	10 mw
260-340	0.2 db	18 db	10 mw
400-500	0.3 db	20 db	10 mw
570-630	0.3 db	20 db	10 mw
900-1000	0.3 db	20 db	10 mw
1250-1350	0.5 db	20 db	10 mw

MEDIUM POWER LEVEL COAXIAL SWITCHES

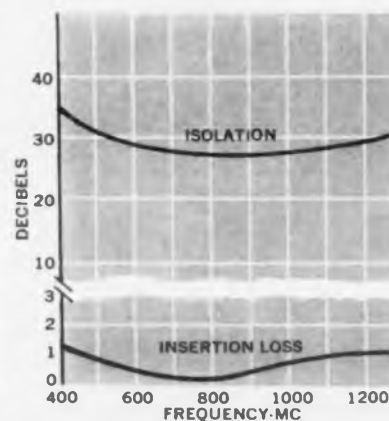
200-1000	1.5 db	22 db	70 mw
1000-2000	1.5 db	20 db	70 mw
2000-4000	2.0 db	16 db	70 mw

LOW POWER LEVEL VOLTAGE VARIABLE ATTENUATORS

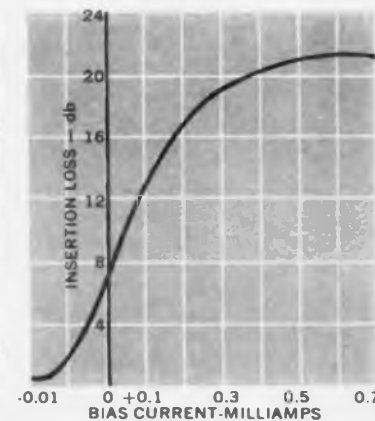
Frequency (Mc)	Attenuation Range
260-340	0.2 db-18 db
400-450	0.3 db-20 db
570-630	0.3 db-20 db
1250-1350	0.5 db-20 db

Narrow-band higher frequency units are available with lower loss and increased isolation.

TYPICAL PERFORMANCE BROADBAND MICROWAVE SWITCH SPST



TYPICAL PERFORMANCE VOLTAGE VARIABLE ATTENUATOR (425 Mc = 25)



Units for handling higher powers are now in development. Microwave Associates has capabilities for meeting your requirements for single-pole multiple-throw and waveguide switching devices. Our switches invite comparison. We invite your inquiries.

A quotation/data sheet will be sent on request.

MICROWAVE ASSOCIATES, INC.
ELECTRON TUBE AND DEVICE DIVISION, Burlington, Mass.



Western Union FAX • TWX: Burlington, Mass., 942 • BRowing 2-3000

CIRCLE 77 ON READER-SERVICE CARD



0 to 100 C

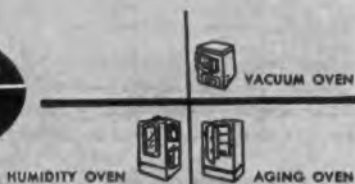
WHAT'S AN ENVIRONMENT WITHOUT PRECISE CONTROL?

Hotpack Humidity Chambers To Meet Jan-Mil Specs

Now you can duplicate actual environments for component stability tests easily . . . with exact control at all times! Hotpack's eight humidity models offer a wide temperature range from 0° to 100°C, and 20% to 98% RH. *And most important*, you can adjust each unit accurately to any point within its range *automatically*, on planned *programmed cycles! Standard controls also include wet and dry bulb recorder-controller for a visual performance record . . . and an exclusive, over-temperature LIMITSTAT which *automatically* prevents product damage!

- Complete stainless steel interiors
- Three heat selector . . . Low, Medium, High
- Rapid refrigeration to 0°C
- Double-wall construction; automatic water inlet and filter; chambers to 31 cubic feet
- Chemical dehumidification available
- program-controller optional

For detailed humidity chamber information and your special requirements, write today:



THE ELECTRIC HOTPACK CO., INC.
5065 COTTMAN AVENUE • PHILA. 35, PA.

CIRCLE 78 ON READER-SERVICE CARD

NEW PRODUCTS

Dual Blower

354

Delivers 150 cfm



The model 8481 dual-outlet blower delivers 150 cfm in free air or 90 cfm at 0.4 static pressure, over an ambient temperature range of -34°C to 93°C . The unit is 6-3/8 in. high by 7-3/4 in. wide. Motors are wound for 115 v or 220 v at 60 cps.

Ripley Co., Inc., Dept. ED, Middletown, Conn.

Test Centrifuges

419

Capacity is 15,000 g-lb

Two centrifuges in the 1200 series have a maximum capacity of 15,000 g-lb. The 1220 will subject a 150-lb, 18-in. cube test specimen to g forces from 0 to 250 g at 24 in. nominal radius. The 1230 will test a 150-lb, 24-in. cube specimen at forces from 0 to 200 g at 42 in. nominal radius. Repeatability and constancy of rotation are within 0.5% for both machines. Boom speeds are infinitely variable.

Genisco, Inc., Dept. ED, 2233 Federal Ave., Los Angeles 64, Calif.

Price: Model 1220, \$9,500; model 1230, \$10,500.

Availability: 45-day delivery.

Flexible Coupling

363

Bore tolerance is 0.0003



A precision flexible instrument coupling, the model 587 BC has bore diameters true to 0.0003, and concentricity to 0.001. Torque rating of the beryllium copper coupling is 10 oz in.; weight is 0.6 oz. Shaft diameters range from 0.1250 in. to 0.2500 in. It is 1.044 in. long by 0.625 in. diameter.

Santa Fe Instruments, Inc., Dept. ED, 2343 Jerome Ave., New York 68, N.Y.

LATEST DATA ON ULTRASONIC DELAY LINES!



THIS NEW CATALOG

gives you up-to-date specs on the industry's most complete line of ultrasonic delay lines for missiles, MTI, radar countermeasures and computer applications. Send for it today.



LABORATORY FOR ELECTRONICS, INC.

Computer Products Division

1079 Commonwealth Avenue

Boston 15, Mass., Dept. E-114

CIRCLE 79 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 1, 1961

Card Reader

437

For 7080 system

The 7502 card reader provides direct card input to the 7080 data processing system. It is designed to handle small-volume card input at moderate cost. Cards are read photoelectrically at speeds up to 60 per min. Each card column is translated automatically into 1 corresponding binary-coded character.

International Business Machines Corp., Data Processing Div., Dept. ED, 112 E. Post Road, White Plains, N.Y.

Price: \$18,750 ea, or \$375 monthly rental.

Availability: IBM 7080 delivery begins Fall 1961.

Capacitor Calculator

Slide-rule type



With one setting, this calculator solves problems of frequency, reactance, power factor, dissipation factor, equivalent series resistance, impedance and phase angle. Capacitance formulae and a comparison chart are provided. The A, B, C, and D slide rule scales are incorporated. Send 25c to Ohmite Manufacturing Co., 3629 Howard St., Skokie, Ill.

Protected Relay

438

With transparent cover

The 200-PC unit is wired and mounted on a standard octal plug and protected with a transparent high-impact plastic cover. Coil may be 6 to 110 v dc or 6 to 220 v ac, with resistance up to 16,000 ohms. Contact ratings are 8 amp at 110 v ac, non-inductive, or 10 amp at 28 v dc, non-inductive. Some forms available with 1, 2 or 3 poles.

F & B Manufacturing Co., Omega Electric Div., Dept. ED, 4248 W. Chicago Ave., Chicago 51, Ill.

CIRCLE 80 ON READER-SERVICE CARD ►

General Electric's Large Electrostatic Deflection Tubes Are Now Available In Production Designs

Here are eight of the many large General Electric electrostatic deflection tubes which are available now to meet your display system requirements. YOU GET PROVED RELIABILITY and known performance—and at less cost—when you specify G-E production-type cathode ray tubes in your design. AND, EACH TUBE can be supplied to meet MIL-E-1 shock and vibration tests to assure reliable operation under severe operating conditions.

PRICE AND DELIVERY OF SAMPLES ON REQUEST. For complete specifications on these G-E production-type tubes—or any cathode ray tube—send requirements and application description to R. E. McBride, Sales Manager, General Electric Co., Cathode Ray Tube Dept., Electronics Park, Syracuse, N. Y.

555-01



1. 12AKP7, radar tube. 2. Z-4760, 2-gun, 12". 3. Z-4718, low drive, 12". 4. Z-4778, 2-gun with integral magnetic shield, 12". 5. Z-4701, minimum deflection defocusing, 12". 6. 12 ANP-14, high performance radar. 7. GL-4623, 16" electrostatic deflection. 8. Z-4652, tetrode tube design, 12".

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GENERAL  ELECTRIC



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IN THE MAIL**

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2. YES NO Please send me also free of charge, any special **MICROWAVES** issues.

3. I do design work I supervise design work I do no design work

4. Address stencil is correct. Please make indicated corrections.

5. Principal Electronic Manufacturing or Service category at this facility.

PLEASE CHECK ONE ONLY

Audio, Communication, Radar, Radio & TV Mfrs

Instruments, Controls, Test Equipment Mfrs.

Analyzer, Computers, Business Machine Mfrs.

Aircraft, Aircraft Accessories, Guided Missile Mfrs.

Component Parts, Sub-Assembly Mfrs.

Material Mfrs

Atomic Energy

Independent Labs, Consultants, Research Orgns

U. S. Government

Mfrs. other than above.

Estimated number of Engineers _____ Total employees _____ at this facility

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27* ISSUES IN '61

*27th issue: **ELECTRONIC DESIGNERS' CATALOG**

NEW PRODUCTS

Cartridge Rectifiers

PIV from 1 kv to 6 kv

373



This series of cartridge rectifiers is rated at piv from 1 kv to 6 kv, and dc current from 100 ma to 200 ma at 25 C ambient; reverse current is 10 μ a, at full rated piv, at 25 C ambient. The units meet military specifications. The series includes JEDEC types 1N1730 through 1N1734, 1N2382, 1N2383 and CEC1734.

Columbus Electronics Corp., Dept. ED, 1000 Saw Mill River Road, Yonkers, N.Y.

Price: On request.

Availability: 5-day delivery.

Servo-Repeater

409

Provides coded output

The SR-115 servo repeater system, when used with appropriate synchro-transmitters, provides digital coded contact closures corresponding to the angular position of a remote shaft. It is an integral package containing two control transformers, a servo-motor, synchro switch, servo-amplifier, two shaft position encoders and inter-connecting gear trains. The coded output is suitable for entry through storage and translation circuitry to recording devices.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

Solid-State Time Generator

Has 0.005% accuracy

384



The model 320 digital time generator uses a 1-ke tuning-fork oscillator to attain time-base accuracy of 50 ppm. Timing markers at 0.001, 0.01, 0.1, and 1 sec intervals are provided. The Nixie display supplements 24-hr real-time outputs. A binary coded output is optional. The rack-mounting unit is 7-in. high and 15-in. deep.

Lockheed Electronics Co., Information Technology Div., Dept. ED, P.O. Box 446, Metuchen, N.J.

Price: \$2,950.

A VERY SPECIAL DELIVERY BY THE MAN FROM MILGRAY

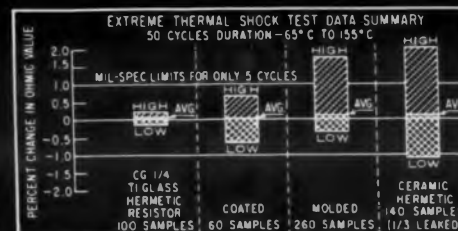


TEXAS INSTRUMENTS HARD GLASS HERMETIC RESISTORS

Texas Instruments Type CG $\frac{1}{4}$ Hard Glass Encapsulated Resistors are new units which represent a notable advance in resistor technology. Hermetically-sealed, these precision carbon film resistors have a guaranteed wattage rating **double** the standard MIL rating for a package this size.

They are immediately available from Milgray/New York in quantities of 1 to 999.

The results of over twelve million unit hours of test data on T1 type CG $\frac{1}{4}$ resistors show conclusively that the hard-glass construction method provides important increases in stability and reliability.



FOR OVERNIGHT DELIVERY CONTACT THE UBIQUITOUS MAN FROM

MILGRAY/NEW YORK

136 Liberty Street/New York 6, New York/REctor 2-4400
Enterprise and Zenith numbers in leading industrial areas
TWX-NY1-4013/FAX-FQF

CIRCLE 81 ON READER-SERVICE CARD

WEIGHT of your system can be cut if you specify components capable of outstanding performance. Example: high output lets *one* Sperry traveling wave tube replace *two* ordinary tubes in Nike-Zeus. If weight reduction is a knotty problem for you, call Gainesville, Florida, FRanklin 2-0411 collect, for full information about Sperry capabilities.

SPERRY

**ELECTRONIC
TUBE
DIVISION**

Gainesville, Florida • A Division of Sperry Rand Corporation



SPERRY'S FAMILY OF TRAVELING WAVE TUBES covers P through X Bands with unusually high output and light weight. These characteristics, combined with the inherent ruggedness of metal-ceramic construction, conduction cooling and wide-range thermal compensation, make Sperry traveling wave tubes particularly suitable for airborne applications.



NEW PRODUCTS

Bead Thermistors 405

General purpose type

These general-purpose bead thermistors are available in three glass-probe types and a variety of sizes from 1/4 to 2 in. in length. Thermal time constants are 25, 2 and 1 sec, when supported by leads in still air, still oil or still water. Dissipation constants are approximately 1, 3.5 and 5 mw per deg C.

Victory Engineering Corp., Dept. ED, 519 Springfield Road, Union, N.J.

Availability: From stock.

Timing Unit 395

Rates from 0.1 to 100 pps



The BEC model 101 timing unit generates crystal-referenced timing pulses for test instrumentation recorders. Pulse rates range from 0.1 to 100 pulses per second, in decade steps. Each rate is pulse-width modulated to allow identification on the recorded output. Reset may be manual or automatic. Packaged, solid state circuitry is used.

Binary Electronics Co., Dept. ED, Bldg. "E," 824 E. Walnut Ave., Fullerton, Calif.

Linear Velocity Meter 440

Accuracy is 0.1%

This linear velocity meter measures the velocity of film, tape and strip or the surface speed of disks, drums and shafts. Accuracies of 0.1% are obtained from 0.15 to 20 in. per sec. Measurements may be taken continuously or intermittently. The output is available in digital or analog form. Measurements are 2-1/2 x 1-1/8 x 1-1/16 in.

Aeroflex Corp., Aeroflex Laboratories Div., Dept. ED, 48-25 36th St., Long Island City 1, N.Y.

Induction Heater Generators 445

15 kw to 50 kw

Six models in this line of induction heater generators provide rf outputs from 15 kw to 50 kw. The 450-ke units are thoroughly tested for noise and radiation. The rf power output is controlled by powerstat or by saturable core reactor. A full complement of safety and protective devices is provided. Line requirements are 220 v ac, 3-phase, 25 to 85 kva.

McDowell Electronics, Inc., Dept. ED, 105 Forrest St., Metuchen, N.J.

Tape Handlers 399

Compatible with 8 computers



The model 906 II digital magnetic tape handler is compatible with any of 8 different computers. Changing the capstan motor and drive, and the tension arm, adjusts the handler to variations in tape speed, width, and pulse density.

Potter Instrument Co., Inc., Dept. ED, Sunnyside Blvd., Plainview, N.Y.

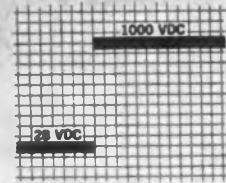
DC Power Supply 402

Transient-free

Elimination of transistor-ruining transients is claimed for the model MTRO36-5A regulated dc power supply. Rated 0 to 36 v at 5 amp, the unit has 15-mv dynamic line regulation, 2-mv maximum rms ripple, and 0.05-ohm maximum dynamic impedance. The dynamic regulation circuit uses transistors, while magnetic amplifiers provide static regulation.

Perkin Electronics Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

Convert Invert — Change



Daven solves your solid-state power supply problems!

Take advantage of Daven's experience in designing extremely compact, light-weight, high temperature units, which can withstand the most severe altitude, shock, and vibration environments. Let us engineer solid-state supplies for your missile-borne, airborne, shipborne, underwater or ground support equipment.

Converters

- DC input voltage from 6 volts to 230 volts
- DC output voltage from 1 volt to 15 kilovolts
- DC output current from microamperes to 100 amps
- Dynamic regulation, ripple, stability as required

Inverters

- DC input voltage from 6 volts to 230 volts
- AC output from 20 VA to 2500 VA
- 60-400-800-1600-2000 cycles per second
- One, two or three phase, any voltage level
- Voltage and frequency regulation 0.1% to 10% as required
- Output waveform — sine or square wave

Frequency Changers

- 20 VA to 2500 VA
- Change to or from any of these frequencies: 60-400-800-1600-2000 cycles per second
- Voltage and frequency regulation 0.1% to 10% as required

Write for complete information, including your application and requirement data.



THE DAVEN CO.



LIVINGSTON, NEW JERSEY

TODAY, MORE THAN EVER, THE DAVEN © STANDS FOR DEPENDABILITY

NEW PRODUCTS

Electronic Generator

Output is 2,000 va



Model M 1435D, an electronic generator, is designed for use where precisely regulated voltage and a broad frequency range are required. It has an output of 2,000 va and can be integrated into two- and three-phase systems. Specifications are: frequency range, 50 to 20,000 cps; frequency stability, $\pm 0.001\%$; voltage regulation, $\pm 1\%$; voltage stability, $\pm 0.25\%$.

Communications Measurements Laboratory, Inc., Dept. ED, 350 Leland Ave., Plainfield, N.J.

Drop Timer

With aneroid blocking



The Series 5379 timer is applicable to pilot escape systems, air cargo drop, and certain arming or recovery systems. A clockwork mechanism provides a fixed time delay between the time an arming pin is pulled and a pressure cartridge is fired. An internal aneroid block senses altitude and prevents other than pre-set operation. The device weighs about 8 oz.

Leesona Corp., Patterson Moos Research Div., Dept. ED, 90-28 Van Wyck Expressway, Jamaica 18, N.Y.

Price: \$525 ea, 100 units; \$330 ea, 300 units; \$250 to \$300, 500 or more units.

Availability: 6 to 8 weeks.

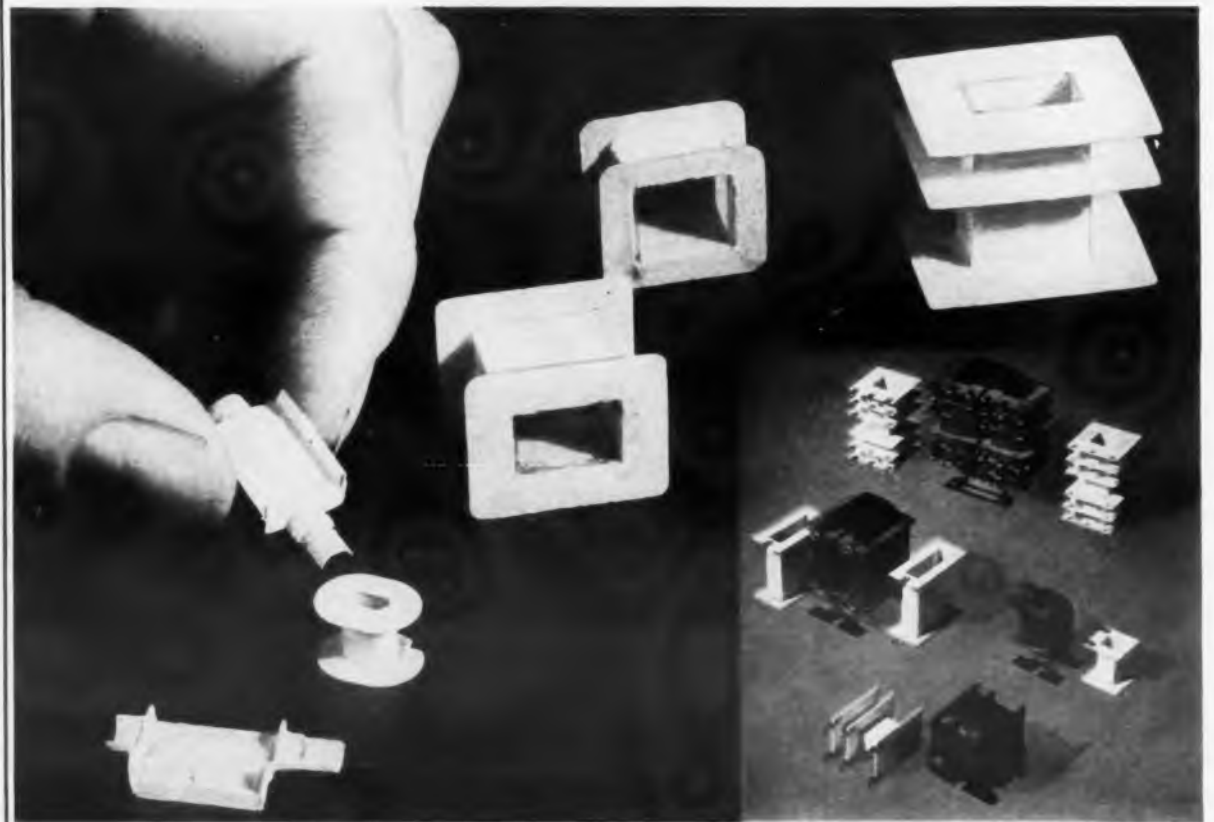
Accuracy Is Our Policy . . .

A photograph depicting an octal socket saver made by Ponona Electronics Co., Inc., was mistakenly printed above a description of the General Radio Co. Type 1557-A vibration calibrator on p 158 of the Dec. 7 issue.

SILICONE NEWS from Dow Corning

683

When Miniaturizing



Design Problems Are Simplified With Silicone-Glass Laminates

Miniaturization means heat. Heat that has to be dissipated from smaller surface areas. Temperatures go up — and materials like Dow Corning Silicones come into their own!

Take silicone-glass laminates, for example. At high temperatures they have dielectric properties that are superior to those of other laminated materials. In addition, silicone-glass laminates have excellent resistance to ozone, arcing, corona, and fungus attack . . . even the formidable combination of high humidity and high voltage.

Mechanical strength is good — permitting thin, rigid coil bobbin walls, more winding space and better resistance to winding pressure. One-piece laminated coil bobbins, like those shown, are used in continuous operation at 250 C, have been tested at 400 C for 1,000 hours. This high temperature resistance means soldering heat doesn't loosen terminals.

These are reasons why the Foster Transformer Company, Cincinnati, Ohio, specifies coil bobbins of silicone-glass laminates for transformers they manufacture. Multi-flange coil bobbins simplify manufacture of computer power transformers. Used in airborne guidance control systems (top of insert), they weigh only .85 pounds each. This transformer, the filter chokes (center) and output transformer (bottom) all have coil bobbins made from silicone-glass laminates . . . are impregnated with Dow Corning silicone varnish to assure reliability of lightweight miniaturized designs.

Glass laminates made with Dow Corning Silicones are available from leading laminators. Write for a list!

CIRCLE 800 ON READER-SERVICE CARD

For "Silicones for the Electronic Engineer", Write Dept. 3314.



Dow Corning

... Specify Silicones

For Constant Capacitance

Dow Corning silicone fluids are, in themselves, excellent dielectrics. In capacitors and RF filters, silicone fluids boost the performance of the paper dielectric . . . substantially increase permissible operating temperatures, decrease electrical losses. Highly stable to changing environments, silicones show little drift in electrical or physical properties over a broad range of temperature and frequency conditions . . . often eliminate costly compensating circuit. To assure an almost constant capacitance vs. temperature relationship for their specialty capacitors . . . and the lowest possible power factor for their RF interference filters . . . The Filtron Co., Inc., of Flushing, N. Y., impregnates their RF interference filters and capacitors with Dow Corning silicone fluid.



CIRCLE 801 ON READER-SERVICE CARD

Silastic RTV Packages . . . Protects

Built by Vitro Laboratories, Silver Spring, Md., this pre-amplifier consists of a vacuum tube and three transistor stages containing a total of twenty-five parts. Design specifications called for a package no larger than 1-7/16" diameter by 5" . . . plus operating requirements of high insulation strength, heat stability, resistance to shock, vibration and moisture. These were met conveniently and easily by mounting the components on a printed circuit board, encapsulating the unit with Silastic® RTV, the Dow Corning room-temperature vulcanizing silicone rubber.

Silastic RTV is poured over the unit until the mold is completely filled. It exerts a firm grip on components, eliminating clamps and brackets . . . soaks up shock and vibration, dissipates heat, locks out moisture.



CIRCLE 802 ON READER-SERVICE CARD

To Save Space . . . Cut Weight

Airborne Accessories Corporation, Hillside, N. J., uses a variety of miniaturization techniques in designing power drives for actuators and other devices. One of their most important tools in making smaller, more reliable drive motors is silicone insulation, including Dow Corning Silicone Varnish impregnation. Its use on these high performance motors assures utmost reliability under almost continuous on-off-reverse operation . . . helped designers provide up to 50% more power per pound.

This 400-cycle silicone insulated actuator motor has a 4.25 inch frame, weighs only 13.2 pounds with brake, is rated 2.5 hp, 11,000 rpm continuous duty; to 6 hp, 9,000 rpm intermittent duty.



CIRCLE 803 ON READER-SERVICE CARD

CORPORATION MIDLAND, MICHIGAN

branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON D.C.
CIRCLE 800, 801, 802, 803 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 1, 1961

Voltage Regulator Tubes

357

Glow discharge type



These glow discharge voltage regulator tubes, Types VX62 and VX64, regulate 95 and 150 v respectively with current ranges from 100 μ a to 50 ma. The tubes, enclosed in standard T-3 glass envelopes, operate from -55 C to 75 C with minimum life said to be over 1,000 hours.

The Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

Price: \$3.50 ea, 1 to 9; \$2.80 ea, 10 to 99.

Availability: 7-day delivery from stock.

Scanner Module

418

Switches 10 signals

The SC-101 scanner module is designed to sequentially switch 10 low-level mv or thermocouple signals and to provide point identification circuitry. It consists of a stepping switch, packaged in a dustproof housing, and necessary controls. The module is 4-1/4 in. wide, 6-3/4 in. high and 4-1/2 in. deep.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

Price: \$250 ea, 1 to 9; \$238 ea, 10 to 24.

Logic Modules

378

On plug-in cards



The FMS-208 dual, medium-speed flip-flop is one in a series of transistorized plug-in logic modules. It has 2 independent flip-flops with set and reset gates, and a maximum count rate of 200 kc. There are 14 other cards in the line, of similar style; among them are gates, drivers, oscillators and operational amplifiers.

General Applied Science Laboratories, Inc., Dept. ED, Merrick & Stewart Aves., Westbury, N.Y.

Price: FMS-208, \$71; others \$48 to \$425.

Availability: 30 to 60 days.

Mono Cord

NO SPLICE RINGS

are better because the principle hazard found in ordinary seal rings and belts has been removed by Western's *Mono Cord* one-piece construction. In addition, dimensional requirements are maintained, quality controlled, and service vastly improved—all at no extra cost.

Don't use a spliced ring for technical seal applications, but profit from nearly 60 years experience—specify *Mono Cord* rings by Western

Write or phone for information, literature or a visit by our sales engineer in your area.



WESTERN RUBBER CO.
GOSHEN 9, INDIANA

*Molded and Lathe-Cut Rubber Parts
for All Industries*

CIRCLE 84 ON READER-SERVICE CARD



Old Fashioned?

See what **Ungar**
does to
soldering
tools
next month!

Davey-Paxman Vertical Boiler • Davey-Paxman & Co. • Circa 1876

CIRCLE 85 ON READER-SERVICE CARD

NEW PRODUCTS

Patching Equipment

For RF and video



These 52 and 72 ohm coaxial jack strips and patch cords are made for low-power rf routing, and the distribution of audio and video signals. Standard and miniature cable systems may be patched. Jacks have BNC fittings, and are protected against climatic extremes. Panels are available with 12, 20, or 48 jacks.

Trompeter Electronic Associates, Dept. ED, 7713 Oakdale Ave., Canoga Park, Calif.

Price: \$123 to 300.

Availability: 30 to 45 days.

Audio Transformers

Primary impedance is 600 500 ohms



These three audio input transformers all have a primary impedance of 600 500 ohms center-tapped. Model A-4778 is a line-to-grid unit with a turns ratio of 1 to 20 and a secondary impedance of 240-K, center-tapped. Model A-4779 is for line-to-single or push-pull grid applications with a turns ratio of 1 to 10 and a secondary impedance of 60-K center-tapped. Model A-4780 is for line to push-pull applications with a turns ratio of 1 to 20 and a secondary impedance of 240-K, center-tapped.

Chicago Standard Transformer Corp., Dept. ED, 3501 W. Addison St., Chicago 18, Ill.

Price: From \$3.84 for the A-4779 to \$6.70 for the A-4780.

Accuracy Is Our Policy . . .

In the New Product description of the Dunco 235 time-delay relay on p 142 of the Jan. 4 issue, the manufacturer was incorrectly identified as The Harry P. Bridge Co. The Dunco 235 is made by Struthers-Dunn, Inc., Pitman, N.J.

380

Give your Products

**MORE RELIABILITY and
BETTER PERFORMANCE with**

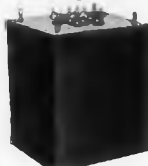
FREED QUALITY

In stock for immediate delivery

CONSTANT VOLTAGE TRANSFORMERS.

Meets Military
Specifications
No Tubes
No Moving Parts

Accurate Regulations
Fast Response
Fully Automatic



MIL Type



Commercial Type

Here at last is a hermetically sealed magnetic voltage regulator that will provide constant output voltage regardless of line and/or load changes.

CAT. #	INPUT VOLT.	EITHER MIL. OR COMMERCIAL LINE FREQ.	OUTPUT VOLT.	OUTPUT VA.
MCV-620L	95-130 v	60 cps.	115	20
MCV-670L	95-130 v	60 cps.	115	70
MCV-6130L	95-130 v	60 cps.	115	130
MCV-670F	95-130 v	60 cps.	6.4	70
MCV-6130F	95-130 v	60 cps.	6.4	130
MCV-420F	95-130 v	400 cps.	6.4	20

MAGNETIC AMPLIFIERS

- Hermetically Sealed To MIL Specifications
- No Tubes
- Direct Operation from Line Voltage
- Fast Response
- Long Life Trouble Free Operation
- Phase Reversible Output

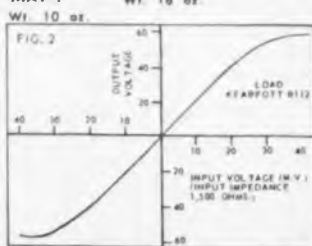
Power Gain 2×10^4



Transistor
Preamp.
MAT-1

Mag. Amp.
MAF-5

Motor



PARTIAL LISTING ONLY
WRITE FOR FURTHER INFORMATION ON THESE
UNITS OR SPECIAL DESIGNS
Send for NEW 48 page transformer catalog. Also ask for
complete laboratory test instrument catalog.

FREED TRANSFORMER CO., INC.

1727 Weirfield St., Brooklyn (Ridgewood) 27, N.Y.

CIRCLE 86 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 1, 1961

ANNOUNCING

ANOTHER **CTI** FIRST!



**The Model 230
TAPE-PROGRAMMED
CABLE HARNESS ANALYZER**

- Automatic Testing by Tape Control
- Search and Fault Print-Out
- Capacity up to 9600 wires

Introducing the most flexible testing unit devised for the analysis of wiring harnesses . . . the CTI Tape-Programmed Cable Harness Analyzer, Model 230. Any number of complex test procedures are programmed with ease. Operation is entirely automatic and unattended. The unique "Search-Out" feature provides a printed record of test failures and the actual location of all circuits associated with each failure. Simultaneously programmable go/no-go continuity and leakage tests. Any combination of branch or standard circuits can be selected. Test capacity of up to 9600 wires in 600 wire increments. Engineering changes in the cable harness tests are quickly handled by paper tape programming. The CTI Tape-Programmed Cable Harness Analyzer is another outstanding breakthrough by CTI.

Write for full information



**CALIFORNIA
TECHNICAL
INDUSTRIES**
DIVISION OF TEXTRON INC.
BELMONT 6, CALIFORNIA

Foremost in Automatic Testing
CIRCLE 87 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 1, 1961

Mounting Cleats

383

For precision components



These mounting cleats are designed for the precise placement of motors, synchros, etc. They are sized to accommodate all Bureau of Ordnance Series rotating components, and are machined from No. 303 stainless steel bar or cast with No. 416 heat-treated stainless steel. The cleats have a clear, passivated finish.

PIC Design Corp., Dept. ED, 477 Atlantic Ave., East Rockaway, L.I., N.Y.

Price: \$45 to \$75.

Availability: 10-day delivery from stock.

Image Intensifier

406

Brightens X-ray image

The 3000X image intensifier produces an image 3,000 times brighter than that available on a conventional fluoroscopic screen. Lower levels of X-radiation are therefore required, and inspection areas need not be darkened. Movie, TV and still cameras can be used in conjunction with direct optical viewing. Brightness is automatically controlled.

Tracerlab Industrial Div., Dept. ED, 1601 Trapelo Road, Waltham, Mass.

Price: \$11,551 ea.

Availability: 60 days.

Cooling Units

374

Dissipates 9,375 w



This cooling unit, one of a line of airborne units modified for use in ground support equipment, has a nominal heat dissipation rate of 9,375 w. Other models in the line of lightweight, compact liquid-to-air heat transfer systems have capacities from 100 to 10,000 w.

Lear, Inc., Lear-Romec Div., Dept. ED, 3171 S. Bundy Drive, Santa Monica, Calif.

10%
ACCURACY

over
ENTIRE METER SCALE!

1 mv - 250 v, 20 cps - 20 kc

22 years of experience in designing and producing laboratory-type Electronic Voltmeters has made possible this Ballantine Model 300-G.

This is the most precise instrument in our entire line of sensitive wide-band Electronic Voltmeters.



Price \$315

BALLANTINE Model 300-G SENSITIVE ELECTRONIC VOLTMETER

- Top accuracy of 1% over entire meter scale from 1 mv to 250 v and over the band of 20 cps to 20 kc. Better than 2% to 1,000 volts and for the wider band of 10 cps to 250 kc.
- High input impedance: 2 megohms shunted by 15 pf, except 25 pf on lowest voltage range.
- Long life: Several thousands of hours of operation without servicing or recalibration.
- Does not require stabilized input voltage. Less than 1/2% change in indication with power supply change from 105 v to 125 v.
- Five inch, mirror-backed, easy-to-read meter. Only two scales with mirror between. One is 1 to 10 for volts, and the second is 0 to 20 for decibels.

Also available in 19 inch relay rack Model 300 G-S2 at \$325.

Write for brochure giving many more details

— Since 1932 —



BALLANTINE LABORATORIES INC.

Boonton, New Jersey

CHECK WITH BALLANTINE FIRST FOR LABORATORY AC VACUUM TUBE VOLTMETERS. REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY, OR WAVEFORM WE HAVE A LARGE LINE WITH ADDITIONS EACH YEAR. ALSO AC DC AND DC AC INVERTERS, CALIBRATED WIDE BAND AF AMPLIFIER, DIRECT-READING CAPACITANCE METER, OTHER ACCESSORIES. ASK ABOUT OUR LABORATORY VOLTAGE STANDARDS TO 1,000 MC.

CIRCLE 88 ON READER-SERVICE CARD

POINT OF NO RETURNS



Desk-eye view of a computer logic circuit utilizing Sperry 2N706 Silicon Mesa Transistors.

SPERRY

SPERRY SEMICONDUCTOR
DIVISION

OF
SPERRY RAND CORPORATION
NORWALK, CONNECTICUT

See Us at Booths 2733-2739
at the IRE Show.

Here's where you put your experience on the line.

Will the vendor you select confirm the confidence of your decision . . . or will the transistors he delivers return to haunt him — and you?

63 QC checks before and during mechanized manufacture.
Our way of trying to make your confidence our **only** return!

SEMICONDUCTOR IS OUR MIDDLE NAME . . . SEMICONDUCTOR INTEGRATED NETWORKS (SEMI-NETS®), TUNNEL DIODES, MESA AND ALLOY SILICON TRANSISTORS AND DIODES. SALES OFFICES: CHICAGO, ILLINOIS; EL SEGUNDO, CALIFORNIA; WESTWOOD, NEW JERSEY; TEWKSBURY, MASSACHUSETTS; STAMFORD, CONNECTICUT; TOWSON, MARYLAND; MASSAPEQUA PARK, NEW YORK. SEMICONDUCTOR OPPORTUNITIES AVAILABLE TO QUALIFIED ENGINEERS

*Trade Mark, Sperry Rand Corporation

NEW PRODUCTS

Decade Counters 397

Up to 8 decades per unit



As many as 8 of these miniature Series F decades may be combined into a single panel-mounting unit. Display is 1 in. high, in-plane, on 1-3/8 in. centers. Operating frequency exceeds 200 kc at less than 2 w per transistorized decade, with electrical reset, and optional 10-line coincidence or 1-2-4-8 binary output.

Robotomics Corp., Dept. ED, 2422 E. Indian School Road, Phoenix, Ariz.

Price: \$108 per decade in quantities of 10.

Availability: 3 to 5 weeks.

Trimming Potentiometers 392

For high-stability uses



The subminiature precision trimming potentiometer type CT-100, shown above, has a tap adjust and a rotation of 320 deg ± 5 deg. The functionally similar type CT-200 is 1/2 x 1/2 in. sq. and is available with printed-circuit terminals or Teflon-coated leads. Stability of the units equals or exceeds military standards. Standard resistance range is 10 ohms to 50 K, tolerance $\pm 5\%$; power rating is 1.0 w at 60 C. Operating temperature ranges are -55 C to 150 C or 225 C.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

Price: CT-100, \$3; CT-200, \$4.

Availability: 4 to 6 weeks.

◀ CIRCLE 89 ON READER-SERVICE CARD

Test Console 401

For electromagnetic interference

The model 101 test console provides rapid interference testing of electronic and electro-mechanical systems. There are 100 channels with corresponding galvanometers, matching networks, and signal detectors. Two oscillograph recorders with 400-ft magazines provide immediate permanent records. Channel isolation is 50 db average. Frequency range is dc to 400 mc; loading is 0.5-meg per v.

Northrop Corp., Norair Div., Dept. ED, 1001 E. Broadway, Hawthorne, Calif.

Cathode-Ray Tube 439

With 2-hr memory span

The CK1362 cathode-ray tube can remember and visually indicate signals up to 2 hr after they are received. It can present the signals for a total read-out time of up to 1 min, or erase at any time with high infrared energy. Designed for true motion indication in radar, the tube is capable of oscilloscope signal comparison. It has magnetic deflection and low-voltage electrostatic focusing.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass.

Price: \$110 ca.

Availability: Immediate.

Vibration Analyzer 442

For on-line analysis

This fully automatic vibration analyzer performs on-line, spectral density analysis of dynamic data. Random or periodic signals are presented for analysis. Spectral energy is distributed over a bandwidth of 5,000 cps with a resolution of 50 cps. It is then encoded at a rate of 5,000 readings per sec, with an accuracy of better than 1%. The entire spectrum is swept and encoded every 20 msec or on command.

Communications Control Corp., Dept. ED, 14707 Keswick St., Van Nuys, Calif.

Availability: 120 days.



You can forget about this tube

... for up to 10,000 hours
in remote and unattended
microwave installations!



Amperex® EC157



This is the new microwave triode developed specifically for exacting common carrier requirements... providing far greater reliability, gain and power, than any other disc-seal, wide-band microwave triode available today!

Expected life, 10,000 hours - guaranteed life, 6000 hours.
When used as a narrow-band CW amplifier... gain is 18 to 19 db,
with a power output of 0.5 watt at 4000 Mc.

As a broadband amplifier... gain is 12 db, with a power output of 0.5 watt at 4000 Mc.
Saturation power output... as high as 2.5 watts.
Required operating voltage... a low 180 volts, to simplify power supply, insulation and safety problems. And it can also be used for telemetering, industrial and test equipment applications... as an amplifier, oscillator, doubler or tripler to over 6000 Mc.



about common carrier and other applications with the EC157

AMPEREX ELECTRONIC CORPORATION

230 Duffy Avenue, Hicksville, L. I., N. Y.

In Canada, Rogers Electronic Tubes & Components, 116 Vanderhoof Ave., Toronto 17, Ont.

NEW PRODUCTS

Variable Load Conductance Box 385

Dissipates 250 w



This flexible, medium-power load box provides an accurate, variable load conductance capable of dissipating about 250 w. The 6-dial conductance decade is designed for the testing of power supplies and power amplifiers. When connected to a source of constant voltage, each step on a given dial yields equal increments of current, making possible accurate linear adjustment of load current. The box can be switched to zero conductance for no-load measurements.

The Daven Co., Dept. ED, Livingston, N.J.

Availability: 6 weeks.

Photo Resist

431

Called Resist-Etch, this photo resist is said to positively block off unwanted electroplate and to permit accurately defined patterns in printed circuits calling for lines 0.005-in. wide, spaced 0.005-in. apart. It is free of pinholes, compatible with all plating solutions, unaffected by plating cycles, easily removable, and non-toxic.

The Meaker Co., Dept. ED, Nutley 10, N. J.

Spring-Driven Gyro

664

Runs 7 to 9 min



This spring-energized gyro, designed to give inertial reference for short durations, has a run-down time of 7 to 9 min. The model 1091 attains its full speed of 3,330 rpm in 100 msec after uncaging. Drift measured after 30 sec is less than 1 deg for the outer gimbal and less than 6 deg for the inner gimbal. There are segmented pickoff commutators on the outer gimbal for roll reference information. The package weighs about 3-3/4 lb and measures 5 in. long by 4.2 in. in diameter.

MEMCOR, Courter Products Div., Dept. ED, Boyne City, Mich.

Free from Thermal Fatigue—the

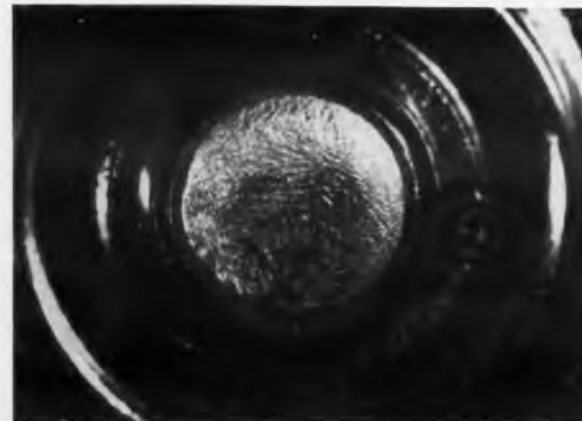
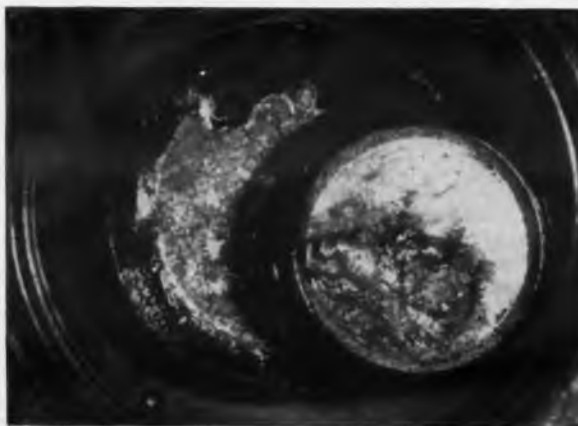


Thermal fatigue of internal soft solder joints has long been a major pitfall in rectifier design. Now, General Electric medium current silicon rectifiers beat the heat and highly cyclical loads with high melting point, hard solder joints that make thermal fatigue failures a thing of the past.

The test units shown (minus housing and top lead) were set up to reach 180°C and drop to 40°C during 3-minute "on" and 1-minute "off" cycles. After 900 thermal cycles the soft solder junction temperature rose to 191°C while the hard solder junction temperature peak remained at 180°C. At 1150 cycles the soft solder junction

temperature reached 201°C, and by 1155 cycles it had skyrocketed to 240°C where the soft solder melted and the junction sandwich separated from the copper stud.

In contrast, the hard solder junction temperature peaks remained constant, unaffected by the highly cyclical load. In fact, General Electric hard solder junction silicon rectifiers have been tested to 70,000 temperature cycles from 35°C to 200°C with absolutely no trace of thermal resistance deterioration. And hard solder joints are only one part of the inside story of G-E medium current silicon rectifiers.



The two test units are shown here. Before the test they were identical in every respect, except that the unit on the left uses conventional tin-lead soft solder, while the unit on the right uses exclusive G-E hard solder joints.

Inside Story of General Electric Medium Current Silicon Rectifiers

DESIGNED FOR THE 2 TO 30 AMPERE RANGE...

General Electric medium current silicon rectifiers offer important extra advantages for your circuit designs:

- high current operation with minimum space requirements
- high junction temperature rating and extremely low voltage drop and thermal impedance
- available with negative polarity (stud is anode)
- transient PRV ratings mean safer application
- may be mounted directly to chassis or fin, or may be electrically insulated from heat sink using mica washer insulating kit provided
- conservative ratings for maximum reliability under all operating conditions
- all of these same rectifiers are available in a wide range of rugged stack assemblies complete with cooling fins, connection terminals and mounting brackets.

For complete information on General Electric thermal-fatigue free medium and high current silicon rectifiers, see your G-E Semiconductor District Sales Manager. For additional technical data, write Section 23B2, Rectifier Components Department, General Electric Company, Auburn, New York. In Canada: Canadian General Electric Company, 189 Dufferin St., Toronto, Ontario. Export: International General Electric Company, 150 East 42nd Street, New York, N. Y.

For fast delivery at factory-low prices in quantities up to 999, see your local G-E Distributor

Progress Is Our Most Important Product

GENERAL  ELECTRIC

CIRCLE 91 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 1, 1961

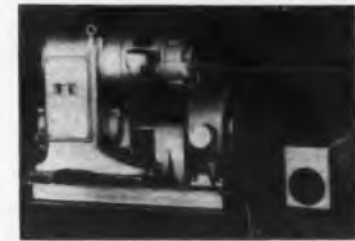
Medium Current Silicon Rectifier Cells						
JEDEC & GE Type Number	Repetitive PRV	Transient PRV	Max. Ioc. @ 145°C Stud Single Phase	Max. Rev. Cur. (Full Cycle Av. @ Full Load)	Max. Full Load Voltage Drop	Max. Oper. °C
1N1341A	50	100	6A	3.0 ma	.64V	200°
1N1342A	100	200	6A	2.5 ma	.64V	200°
1N1343A	150	300	6A	2.25 ma	.64V	200°
1N1344A	200	350	6A	2.0 ma	.64V	200°
1N1345A	300	450	6A	1.75 ma	.64V	200°
1N1346A	400	600	6A	1.5 ma	.64V	200°
1N1347A	500	700	6A	1.25 ma	.64V	200°
1N1348A	600	800	6A	1.0 ma	.64V	200°
1N1199A	50	100	12A	3.0 ma	.55V	200°
1N1200A	100	200	12A	2.5 ma	.55V	200°
1N1201A	150	300	12A	2.25 ma	.55V	200°
1N1202A	200	350	12A	2.0 ma	.55V	200°
1N1203A	300	450	12A	1.75 ma	.55V	200°
1N1204A	400	600	12A	1.5 ma	.55V	200°
1N1205A	500	700	12A	1.25 ma	.55V	200°
1N1206A	600	800	12A	1.0 ma	.55V	200°
1N248	50		10A	5.0 ma	1.5V*	175°
1N249	100		10A	5.0 ma	1.5V*	175°
1N250	200		10A	5.0 ma	1.5V*	175°
1N248A	50		20A	5.0 ma	1.5V**	175°
1N249A†	100		20A	5.0 ma	1.5V**	175°
1N250A†	200		20A	5.0 ma	1.5V**	175°
1N2154	50	100	25A	5.0 ma	0.6V	200°
1N2155	100	200	25A	4.5 ma	0.6V	200°
1N2156	200	350	25A	4.0 ma	0.6V	200°
1N2157	300	450	25A	3.5 ma	0.6V	200°
1N2158†	400	600	25A	3.0 ma	0.6V	200°
1N2159	500	700	25A	2.5 ma	0.6V	200°
1N2160	600	800	25A	2.0 ma	0.6V	200°

*@25A
**@50A
†B types available as SIGNAL CORPS approved units.
††Signal Corps approved units available as USA 1N2135A.

Frequency Source

377

Variable 380 to 420 cps



The series 32 variable frequency source unit is designed for the testing of 400-cps components. Frequency range is 380 to 420 cps. Voltage is variable from 105 to 125 v, 3-phase, line-to-neutral (182 to 217 v, line-to-line). Input is 3-phase, 60-cps; output is 3-phase, 4-wire, 5-kva; ratings between 0.60 kva and 25 kva; frequency to 1 kc, and single-phase or 50-cps input, are also available.

Georator Corp., Dept. ED, Fairview Road and Tudor Lane, Manassas, Va.

Price: \$1,090 to \$5,500.

Availability: 60 to 75 days.

Terminal Block Connectors

432

These terminal block connectors require only 1/4 turn and are positively self-locking. They are available in 15-, 20- or 30-amp ratings and in units of 2 to 20 stations. They meet MIL-T-16784A specifications and have a dielectric strength of 400 v between terminals, 5,000 v terminal to base.

Camblock Corp., Dept. ED, Natick Industrial Center, Natick, Mass.

DC Power Supplies

351

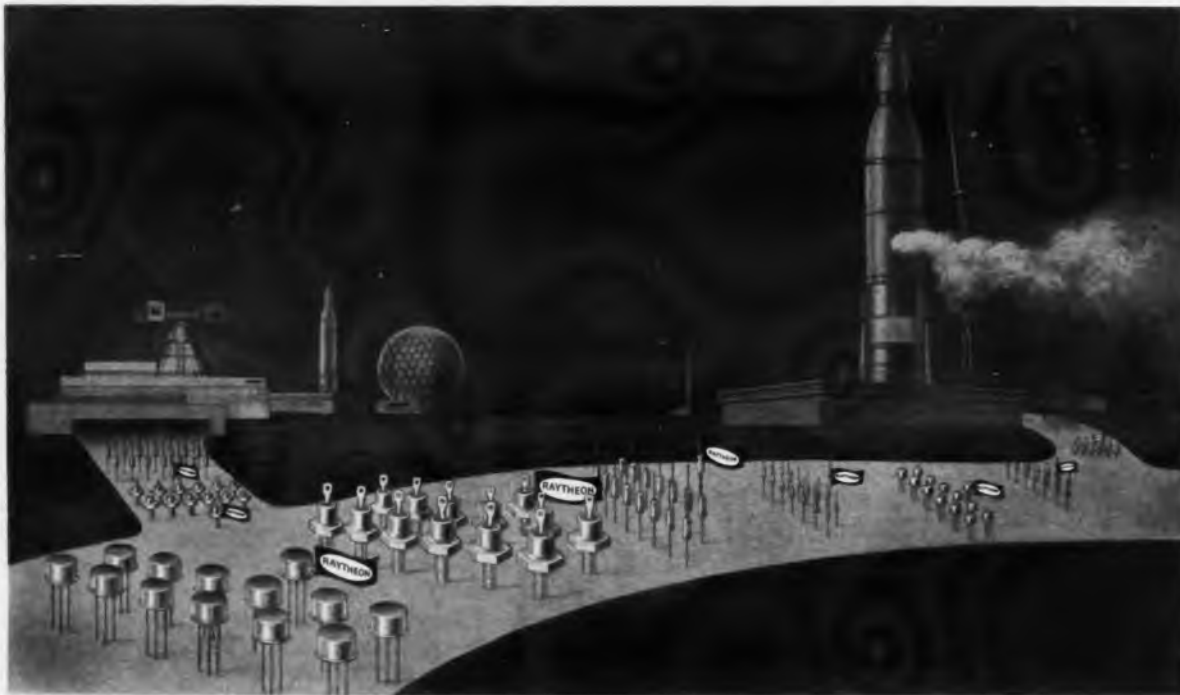
Regulation is 0.1%



Series TR dc power supplies have a regulation of 0.1% or 10 mv with negligible ripple. Three models are available: 0 to 100 v at 100 ma; 0 to 36 v at 200 ma and 0 to 18 v at 1 amp. All models are remotely programmable and have continuously variable current limiting. Specifications are: output impedance, less than 0.03 ohm to 1 kc, less than 0.1 ohm to 50 kc; ambient operating temperature range, from 0 to +45 C; controls, main and vernier voltage controls are wire-wound type.

Electronic Measurements Co., Inc., Dept. ED, Eatontown, N.J.

Price: From \$159 to \$179.



MIL TYPES

... mobilized for reliability!

Two new silicon device groups now stand ready to serve you, as part of Raytheon's military semiconductor selection. Mobilized for reliability, these new devices offer the planar uniformity of Raytheon's diffused junction construction. The new groups are Raytheon's JAN 1N457, 1N458 and 1N459 diffused junction silicon diodes, and NAVY 1N1124A, 1N1126A and 1N1128A diffused junction silicon rectifiers.

Whether your MIL circuit design calls for silicon or germanium, NPN or PNP, diode, rectifier, or transistor, check Raytheon for an increasingly broad selection. Construction techniques and quality controls are continually refined to give you more quality assurance in every MIL type, as well as more MIL types — from Raytheon. To bring your files up-to-date on the growing Raytheon MIL selection, write on your letterhead for Data-Pak #11.

RAYTHEON SEMICONDUCTOR MIL TYPE SELECTION

Consult your local
authorized Raytheon Distributor
for up-to-date information on all
Raytheon semiconductor products.

Service	Type	Specification	Service	Type	Specification
PNP Silicon Transistors					
SIGC	2N328A	MIL-S-19500-110	JAN	1N126A	MIL-E-1-156C
SIGC	2N329A	Amend. I MIL-S-19500-111	JAN	1N127A	MIL-E-1-157C
			JAN	1N128	MIL-E-1-158B
			JAN	1N198	MIL-E-1-170D
Germanium Self-Bonded Diodes					
JAN	1N270	MIL-E-1-992A	JAN	1N253	MIL-E-1-1024A
JAN	1N276	MIL-E-1-1025	JAN	1N254	MIL-E-1-989B
JAN	1N277	MIL-E-1-993A	JAN	1N255	MIL-E-1-990B
JAN	1N281	MIL-E-1-961	JAN	1N256	MIL-E-1-991B
PNP Germanium Transistors					
USAF	2N404	MIL-T-19500-20	JAN	1N540	MIL-E-1-1085A
SIGC	2N416	MIL-T-19500-56A	JAN	1N547	MIL-E-1-1083A
SIGC	2N417	MIL-T-19500-57A	NAVY	1N1124A	MIL-S-19500-104
NAVY	2N422	MIL-T-19500-56A	NAVY	1N1126A	MIL-S-19500-104
SIGC	2N425	MIL-T-19500-41A	NAVY	1N1128A	MIL-S-19500-104
SIGC	2N426	MIL-T-19500-42A	Diffused Junction Silicon Diodes		
SIGC	2N427	MIL-T-19500-43A	JAN	1N457	MIL-E-1-11026
SIGC	2N428	MIL-T-19500-44A	JAN	1N458	MIL-E-1-11027
SIGC	2N464	MIL-T-19500-49B	JAN	1N459	MIL-E-1-11028
SIGC	2N465	MIL-T-19500-50A	USAF	1N645	MIL-E-1-1143
SIGC	2N466	MIL-T-19500-51A	USAF	1N646	MIL-E-1-1143
SIGC	2N466	MIL-T-19500-51B	USAF	1N647	MIL-E-1-1143
JAN	2N466	MIL-T-19500-51B	USAF	1N648	MIL-E-1-1143
SIGC	2N467	MIL-T-19500-52B	USAF	1N649	MIL-E-1-1143

RAYTHEON COMPANY

SEMICONDUCTOR DIVISION

SILICON AND GERMANIUM DIODES AND TRANSISTORS • SILICON RECTIFIERS • CIRCUIT-PAKS
BALTIMORE, MD., Southold 1-0450 • BOSTON, MASS., Hillcrest 4-6700 • CHICAGO, ILL., National 5-4000 • DALLAS, TEXAS, Lakeside 6-7921 • DAYTON, OHIO, Baldwin 3-8128
DETROIT, MICH., Trinity 3-8330 • ENGLEWOOD CLIFFS, N. J., L'Oreal 7-4911 (Manhattan, Wisconsin 7-6400) • LOS ANGELES, CAL., Plymouth 7-3151 • ORLANDO, FLA., Garden 3-0518
PHILADELPHIA, PA., (Haddonfield, N.J.), Hazel 8-1272 • SAN FRANCISCO, CAL., (Redwood City), Emerson 9-5566 • SYRACUSE, N.Y., Howard 3-9141 • CANADA Waterloo, Ont., Sherwood 5-6831
GOVERNMENT RELATIONS Washington, D. C., Metropolitan 8-5205

CIRCLE 92 ON READER-SERVICE CARD

NEW PRODUCTS

Transistorized Inverters

356

Interchangeable regulator



Any unit in this line of 25-, 50-, or 100-v-a inverters can be controlled by the same regulator. The transistorized units produce 115-v, 400-cps current from a 115-v, 60-cps or 28-v dc source. They feature encapsulated transformers, isolated input and output, aluminum construction, and regulation within $\pm 1\%$ into resistive or inductive loads.

Victory Electronics, Inc., Dept. ED, 50 Bond St., Westbury, N.Y.

Price: Regulator \$272.85 to \$283.40, lower unit \$152.40.

Availability: 5-day delivery from stock.

Miniature Markers

433

Self-sticking, miniature markers for electronic components are available in sizes of 0.060 x 0.200 in. and 0.120 x 0.200 in. Characters are printed accurately and legibly. They adhere at temperatures to 300 C. Markers are available in various materials in thicknesses of 0.001 to 0.004 in.

W. H. Brady Co., Dept. ED, 727 W. Glendale Ave., Milwaukee, Wis.

Analog-Digital Converter

360

Has plug-in components



This optical, shaft-position analog-to-digital encoder features modular plug-in components and self-contained spares. Provision is made for remote testing and monitoring of the type RD-13G. The unit provides 8,192 codes per revolution. It is available in separated units, 2 mounting styles and shaft types, both senses of rotation, and positive or negative output pulses from a choice of output circuits.

Wayne/George Corp., Dept. ED, 588 Commonwealth Ave., Boston, Mass.

BOURNS
TRIMPOT®

Schweber

FOR
IMMEDIATE
LARGE
QUANTITY
DELIVERY
AT
FACTORY
PRICES

Yes! Schweber can sell
any model of BOURNS TRIMPOT®
at factory prices.
Sizeable quantities are
available for immediate
shipment from stock from
Schweber's warehouse.

 Schweber
ELECTRONICS

80 HERRICKS ROAD, MINEOLA, L. I., N. Y.

PIONEER 8-6320, TWX 9-CY-NY-580U

CIRCLE 93 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 1, 1961

Bourns Trimpot® Puts the Proof in Humidity-Proof

NUMBER 5—RELIABILITY SERIES

Plunging a potentiometer into near-boiling water is just one of the ways Bourns puts the proof in humidity-proof. Every Trimpot unit made takes this 60-second bath with the water simmering at 90°C. Air expanded by the heat creates four pounds of pressure inside the potentiometer—enough to cause bubbles—if it leaks. Only if the unit is completely leak-free does it pass the test.

Bourns humidity proofing starts at the beginning—with original design and selection of materials. The plastic chosen for Trimpot cases, for example, displays the unusual properties of high insulation resistance and extremely low moisture absorption.

Further protection against humidity results from manufacturing procedures, such as internal potting of the resistance element and sub-components. Finally, Bourns samples all production for compliance to MIL-STD-202A, Method 106 as a routine part of a Reliability Assurance Program. As a result, Trimpot does more than "resist" moisture; it keeps moisture out.

For more information about the industry's largest selection of humidity-proof adjustment potentiometers—wirewound and carbon in a variety of sizes, power ratings, operating temperatures, etc.—write for new Trimpot summary brochure and list of stocking distributors.



 BOURNS
BOURNS, INC., TRIMPOT DIVISION
8135 MAGNOLIA AVE., RIVERSIDE, CALIF.
PLANTS: RIVERSIDE, CALIF. AND AMES, IOWA

Exclusive manufacturers of Trimpot®, Trimit®, and E-Z-Trim®. Pioneers in transducers for position, pressure and acceleration.

CIRCLE 94 ON READER-SERVICE CARD

MACH 5... MACH 10...

and Beyond



STEVENS *Certified* THERMOSTATS

Up where the "wild blue yonder" becomes inky black, you can't afford to gamble on precise, reliable temperature control. And that's the natural domain of Stevens thermostats. They are compact and lightweight . . . withstand high G's . . . are utterly reliable even under wide temperature swings. For Stevens Thermostats are a product of creative engineering . . . coupled with the most stringent environmental testing and quality control programs in the industry. If space is your dimension, take the measure of Stevens thermostats *first*.

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

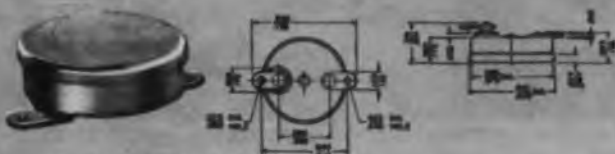
STEMCO

THERMOSTATS

**Type MX shown;
other *Certified* disc types available**

*2° to 6°F Differential Standard
1° to 4°F Differential Special*

**Maximum spread of 6°F
including differential and tolerance*



**6°F is difference between maximum open
and minimum close*

NEW PRODUCTS

Digital Tape Transport 446

Will read from 0.1 to 15 in. per sec

Model DT-10 will read, write, or read after write from 0.1 to 15 in. per sec in selectable speeds or continuously variable speeds, controlled manually or remotely, for any type of computer format. Tape-speed settings are held to within $\pm 1/4\%$ independent of line voltage or frequency. Separate reel servos permit constant tape tension and uni- or bi-directional fast start-stop modes are possible for all types of programs.

Shepherd Industries, Inc., Dept. ED, 103 Park Ave., Nutley 10, N.J.

Metallized Mylar 447 Capacitors

Usable range to 125 C

These metallized Mylar capacitors have a usable temperature range up to 125 C without derating. Capacity tolerances of 1% and better are available. These units have low dielectric absorption and high insulation resistance, and may be used in potting applications.

Film Capacitors, Inc., Dept. ED, 3400 Park Ave., New York 56, N.Y.
Price: \$0.35 to \$2.

Availability: Two weeks.

Contact Element 404

Knitted wire

This dry circuit contact element, called a Fuzz Button, is made of fine-gauge knitted wire mesh. Individual wires in the resilient button exert a high pressure with relatively small total force, breaking through non-conducting films. Contact is unaffected by dust particles, as the button contains only 15% of wire by volume. Normally made with a gold-plated, silver-copper alloy wire, the contact has anti-bounce characteristics.

Tecknit Design Service, Technical Wire Products, Inc., Dept. ED, 48 Brown Ave., Springfield, N.J.

◀ CIRCLE 95 ON READER-SERVICE CARD

Transmitting Tube 403

Has low battery drain

The filament in this beam power tube, the RCA-4604, reaches operating temperature in less than 1 sec. Developed for push-to-talk radio transmitters, this feature conserves battery power during standby. The tube will deliver 30 w in cw or fm service at 175 mc. The 6.3 v filament draws 0.65 amp during transmission periods, no current in standby.

Radio Corp. of America, Electron Tube Div., Dept. ED, Harrison, N.J.

Pentode Tube 393

Medium voltage type



The beam-type NU116 pentode, operating in the 300 to 1,500 v range, is suitable for amplification and voltage regulation. Plate dissipation is 15 w; screen voltage is 200 v, and heater voltage is 6.3 v. Cutoff bias is less than 10 v with currents up to 15 ma. Transconductance is 4,600. Its diameter is 0.875 in. max; length is 2.5 8 in. max.

National Union Electric Corp., Electronics Div., Dept. ED, Bloomington, Ill.

Availability: Immediate in small quantities.

Digit Verifier 441

Eliminates human error

The A570 check digit verifier eliminates human error in encoding account and other reference numbers into punched paper tape. The verifier is actually a solid-state computer. It is designed to operate with the firms' accounting machines that produce tapes for data processing.

Burroughs Corp., Equipment and Systems Div., Dept. ED, Detroit 32, Mich.

CIRCLE 96 ON READER-SERVICE CARD >

ELECTRONIC DESIGN • February 1, 1961



HERE'S WHY P&B TELEPHONE TYPE RELAYS GIVE YOU reliable performance over long life

Armature Pin Bearing shows only .0005" increase in clearance after 300 million operations.



Musky Armature Arm prevents sagging or bending.

BS SERIES TELEPHONE TYPE

Measure the thickness of the BS series armature arm. You will find the cross section area is greater than ordinary relays of this type. Here is the kind of quality that spells dependability.

Observe that the stainless steel hinge pin runs the full width (not just half) of the armature, providing optimum bearing surface. This pin, operating in a stainless steel sleeve, shows only minimal wear during nearly a *third of a billion operations*.

Best of all, P&B quality costs no more. A whole new plant is being devoted to the production of high performance telephone type relays. Your nearest P&B sales engineer will be happy to discuss your relay problems. Call him today.

Heavy Duty Frame maintains dimensional stability, adds to relay's sensitivity.

BS SERIES ENGINEERING DATA

GENERAL:

Breakdown Voltage: 1000 volts rms 60 cy. min. between all elements.

Ambient Temperature: -55° to +85° C. +125° C available on special order.

Weight: 9 to 16 ozs.

Terminals: Pierced solder lugs;

Coil: One #16 AWG wire

Contacts: Two #18 AWG wires

Enclosures: Dust covered or sealed

CONTACTS:

Arrangement: DC—up to 28 springs

AC—up to 24 springs

Material: 1/4" dia. twin palladium.

Up to 1/4" dia. single silver.

Other materials on special order.

Load: 4 amps at 115 volts, 60 cycle resistive

Pressure: 15 grams minimum

COILS:

Resistance: 100,000 ohms maximum

Current: 10 amps maximum

Power: DC—50 Milliwatts per movable arm.

Greater sensitivity on special order.

AC—17.9 volt-amps.

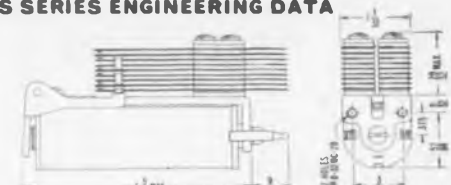
Duty: Continuous

Treatment: Centrifugal impregnation

Voltages: DC—up to 300 volts with series resistor. AC—up to 250 volts, 60 cy.

MOUNTING: Two #8-32 tapped holes 3/4" o.c.

Other mountings on special order.



GS SERIES—Excellent sensitivity: 50 mw per movable arm minimum (DC). For applications requiring many switching elements in small space.



LS SERIES—Medium coil relay with short springs and light weight armature for fast action, reliability and long life.



TS SERIES—Short coil relay is available in AC and DC versions. Long life construction. Can be supplied (DC) with up to 20 springs (10 per stack).

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

AWARD
of
MERIT



SILVER SEALED
(switch-type)

HOT ROD
(turret-type)

HI FI
(FM) Tuner

Throughout the industry, the trouble-free TARZIAN TUNERS are winning praise for meritorious achievement.

No other commercial unit possesses so many of the desirable features found in the TARZIAN TUNER which is recognized as "the world's finest tuner for the world's finest sets."

Today, TARZIAN is the only commercial manufacturer offering the HOT ROD (turret-type) and SILVER SEALED (switch-type) . . . as well as the Hi Fi FM Tuner. All with built-in HIGH QUALITY . . . DEPENDABILITY . . . and EXCELLENT PERFORMANCE at LOW COST.

For more information, write to: Sales Department, Tuner Division



SARKES TARZIAN INC

east hillside drive • bloomington, indiana

Manufacturers of TV and FM Tuners • Closed Circuit TV Systems
• Broadcast Equipment • Air Trimmers • Magnetic Tape • Semiconductors

CIRCLE 97 ON READER-SERVICE CARD

NEW PRODUCTS

Power Transformer

For control use

684



This line of automation control power transformers is designed for use with relays, control valves, small motors and other control devices. They are for 115/230-v 60-cps operation and are available with outputs from 6 v at 2 amp to 24 v at 8 amp.

Chicago Standard Transformer Corp., Dept. ED, 3501 W. Addison St., Chicago, Ill.

Price: From \$5.56 to \$22.21.

Availability: Immediate.

Crystal Can Relay

434

This 4pdt crystal can relay is equipped with stud chassis mounts. This permits the relay to be placed in a 0.32-sq in. of chassis space.

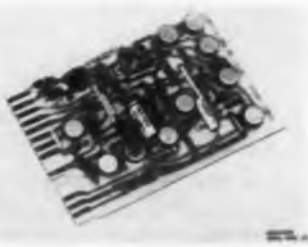
Branson Corp., Dept. ED, 41 S. Jefferson Road, Whippany, N. J.

Availability: From stock.

Solid-State Amplifier

677

Operates from 0 to +55 C



In standard form the model 3801 solid-state amplifier will operate over a temperature range from 0 to +55 C. It will stand shock of 30 g and meet specifications to an altitude of 50,000 ft. Specifications are: input drift, 1 mv per 30 C change; output, ± 10 v at 4 ma load, ± 20 v at 2 ma load; total dc gain, in excess of 250,000; frequency response, dc to 200 kc; dimensions, 3-3/4 x 2-1/4 x 1-2 in.

Donner Scientific Co., Dept. ED, 888 Galindo St., Concord, Calif.

Price: \$400.

Availability: 45 days.

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FAST DELIVERY FROM STOCK
HUNDREDS OF MODELS
CUSTOM DESIGNING

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of fractional horsepower motors

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TWX Princeton, New Jersey 636

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Temperature Sensors 443

Positive-slope

This semiconductor positive-slope temperature sensor has a coefficient of 0.8% per deg C. Called the Semi-temp, it has an effective range of -60 F to 150 C. The sensing element is a silicon crystal; the entire unit is encapsulated in epoxy. There are 9 standard resistances in the 100- to 2,000-ohm range, with tolerances of $\pm 10\%$.

Kulite Semiconductor Products, Inc., Dept. ED, 1030 Hoyt Ave., Ridgefield, N.J.

Delay Line 394

For computer use



Developed for coding applications in a commercial computer, this lumped constant delay line has a total delay of 2.4 μ sec, with maximum output noise of 0.2 v, or 4%. Output rise time is 0.165 μ sec, max; attenuation is 15% max, and impedance is 300 ohms $\pm 5\%$. Two intermediate taps are provided.

Nytronics, Inc., Essex Electronics Div., Dept. ED, 550 Springfield Ave., Berkeley Heights, N.J.

Motor-Generators 444

Brushless inductor type

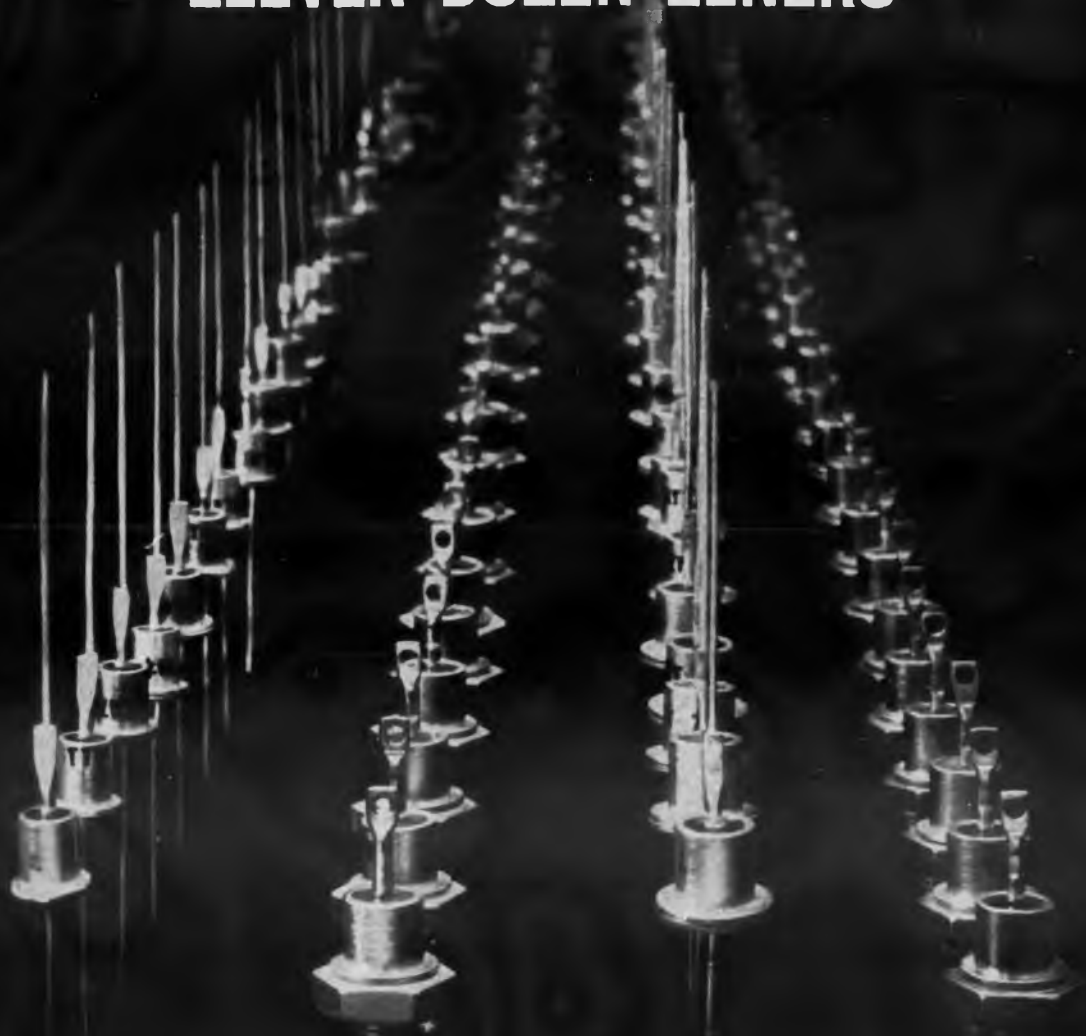
These brushless inductor motor-generators are rated at 2 to 15 kva, 3 phase, or 1 to 7-1/2 kva, 1 phase, 0.8 pf. Output voltage is 120/208 v, 400 cps, 3-phase, or 120 v, 400 cps, single-phase. Input voltage may be 440 v, 60 cps, 3-phase or 220/380 v, 60 cps. Voltage regulation is $\pm 1/2\%$ from no load to full load. Units are available in 3 classes of frequency regulation, no load to full load.

Leach Corp., Dept. ED, 18435 Susana Road, Compton, Calif.

CIRCLE 99 ON READER-SERVICE CARD >

ELECTRONIC DESIGN • February 1, 1961

ELEVEN DOZEN ZENERS



132 BASIC ITT TYPES COVER 33 VOLTAGES IN 4 POWER RATINGS

The complete ITT "Gold Crown" line of zener voltage regulator diodes offers all the most widely used power ratings in a very extensive range of zener voltages. Backed by the world-wide research, development and production facilities of the great ITT System, these outstandingly reliable diodes

feature sharp zener characteristics, low dynamic impedance and conservative power ratings. Welded cases with hermetic glass-to-metal sealing assure total environmental protection for the most critical commercial and military applications. Write for Bulletin No. 230, containing complete data.



SEMICONDUCTOR DEPARTMENT ■ COMPONENTS DIVISION
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION, CLIFTON, NEW JERSEY

ITT COMPONENTS DIVISION PRODUCTS: SELENIUM RECTIFIERS • SILICON DIODES AND RECTIFIERS • TANTALUM CAPACITORS • POWER TUBES • IATRON STORAGE TUBES • HYDROGEN THYRATRONS • TRAVELING WAVE TUBES

- 4 power ratings: 3/4, 1, 3 1/2 and 10 watts
- 33 zener voltages (nominal): 3.9 to 100 volts
- standard tolerances: $\pm 20\%$, $\pm 10\%$, $\pm 5\%$
- temperature range: -65° to 175° C.

NEW PRODUCTS

Trace Plotter

366

Detects 1-micron deflections



The model 860 trace plotter detects, amplifies and plots trace deflections as small as 1 micron. It is capable of using time resolutions in the sub-nanosecond region. The tube trace is reproduced on a pre-scaled sheet of graph paper in 1.5 to 3 min. Sensibility is increased about 15 times. X and Y settings are independent; magnification of the axes is arbitrarily adjustable. Although designed specifically for the traveling wave deflection tube, the unit may be used with any oscilloscope.

Edgerton, Germeshausen & Grier, Inc., Dept. ED, 170 Brookline Ave., Boston, Mass.

Doped Silicon

430

Single crystal silicon is available doped to the specific requirements of device manufacturers. Impurities are held to a very low level. It is produced in diameters up to 26 mm and in lengths to 360 mm.

Dow-Corning Corp., Dept. CS-143, Dept. ED, Midland, Mich.

Synchro Transmitters

355

For pressure sensing



The TL Series of synchro transmitters, in ranges from 0-10 and 0-350 psi, are available in 115-v and 26-v designs for use at 400 cps and 60 cps. The pressure medium is contained within the encapsulated dual aneroid element. The similar TR series, available in ranges from 0 to 600 through 0 to 20,000 psi, uses a helical Bourdon tube element. Both series are oil-damped to withstand 25-g vibration. Linearity is said to be $\pm 0.5\%$.

Servonic Instruments, Dept. ED, 640 Terminal Way, Costa Mesa, Calif.



ANOTHER LING FIRST! NEW 5000 LB. SHAKER —PROVIDES BUILT-IN PIGGY-BACK CHAMBER CAPABILITY

Ling offers you another design first with its new Model 300 Shaker. This new 5,000-pound-force shaker features Ling's unique closed-loop water-cooling system, a hermetically sealed system which is specifically designed to eliminate coolant contamination of an environmental chamber. Without any special shaker accessories, it operates with a piggy-back chamber, permitting testing to unlimited altitudes and humidity, and at temperatures from -100° to $+300^{\circ}$ F. The specially designed lightweight armature weighs only 41.5 lbs. Ling's unique low-voltage armature and field design eliminates corona problems when operating at altitudes, and the temperature range can be readily expanded above 300° F with the addition of an external thermal barrier. For details on Model 300, write Department ED-261 at the address below.



LING-TEMCO ELECTRONICS, INC.

LING ELECTRONICS DIVISION

1515 SOUTH MANCHESTER, ANAHEIM, CALIFORNIA • PROspect 4-2900

The design of the Model 300 Shaker is an extension of an environmental shaker concept pioneered by Ling. This revolutionary concept, using a closed-loop cooling system for direct cooling of the armature, field coils and for compensation conductors, has greatly improved the efficiency of shaker performance.

In Model 300, Ling hermetically seals the system—so the standard shaker can be used freely in an evacuated chamber without special shaker accessories. Model 300 is particularly suited for mounting with the piggy-back chamber—the technique in which the shaker body acts as one wall of the chamber, and only the table rides into the chamber.

In addition, Model 300 offers Ling's new velocity signal generator for displacement monitoring. Loop-type flexures offer maximum lateral restraint and linear spring constant.



SPECIFICATIONS FOR LING'S MODEL 300 SHAKER INCLUDE:

Force Rating, vector	5,000 lbs.
Frequency range	5-3,000 cps.
Stroke, continuous duty	1 inch, peak to peak
Flexure Stiffness	1,000 lbs. per inch
Table Diameter	13 $\frac{3}{8}$ inches
Max. Acceleration	100 G
Stray Field	less than 6 gauss, 3 inches above the table



LING-TEMCO ELECTRONICS, INC.
LING ELECTRONICS DIVISION

HIGH POWER ELECTRONICS FOR
VIBRATION TESTING • ACOUSTICS • SONAR
CIRCLE 101 ON READER-SERVICE CARD
ELECTRONIC DESIGN • February 1, 1961

Contact Set

359

Of magnetic reed type



The GA-53738 I.I magnetic reed contact set is composed of 2 overlapping reeds sealed in a glass envelope 7/8-in. long. The set closes at 34-amp turns and releases at 18-amp turns in a standardized test coil. Initial contact resistance is 0.2 ohms at 0.1 amp in a 1.5 v circuit. Resistance load rating is 0.125 amp maximum in 28 v circuit. Life expectancy of the unit is 3 million operations at maximum load. Over-all length is 1.53 in., with a diameter of 0.16 in.

Western Electric Co., Defense Activities Div., Dept. ED, 195 Broadway, New York 7, N.Y.

Brazing Compound

429

Capable of withstanding temperatures up to 1,800 C, this molybdenum brazing compound is suitable for joining porous, refractory metals such as tungsten, molybdenum, or tantalum to solid materials without infiltration of the permeable material.

Electro-Optical Systems, Inc., Dept. ED, 125 N. Vinedo Ave., Pasadena, Calif.

Door Interlocks

386

Eliminate jumper wiring



A maintained-contact actuator position on these 3-door interlocks allows checking of hazardous equipment without the use of cheaters or jumpers. The actuator is manually pulled to the maintained-contact position. When the door is closed, it automatically returns to its normal position. The 22AC and 23AC single series, and the 24AC dual model, have thermoplastic actuating rods. The switches are rated for 10 amp at 125 or 250 v ac; 1/2 amp at 125 v dc and 1/4 amp at 250 v dc, and 1/2 hp at 250 v ac.

Minneapolis-Honeywell Regulator Co., Micro Switch Div., Dept. ED, Freeport, Ill.

Price: \$2.88 to \$7.10 ea.

What is your need for exactitude?... "over there at 3pm" or "5000 yards/212° azimuth/70° elevation/15 hours, 22 minutes, 12.033 seconds PST."

The Canoga Model 8476 Radar Telemetry Data Tie-In System provides digital radar determination of range, elevation and azimuth of an object in space with reference to time. A choice of signals generated internally are recorded at from one to 100 per second, stored in binary memory devices and are available as an input to computers, magnetic tape recorders, punched paper tape recorders, printers and other devices. Data printed out from computer processing give time of occurrence; polar and cartesian coordinates of one or more targets corrected for refraction, parallax and earth curvature; dX, dY and dZ of the targets relative to each other; 23 words, 14 bits each, of telemetered data; and more. With the Canoga Model 8476 it is possible to reconstruct a complete trajectory of a given target providing digital evaluation at any time. **canoga**



5000/212°/70°/1522 PST

Canoga Electronics Corporation • Van Nuys, California • Fort Walton Beach, Florida

CIRCLE 102 ON READER-SERVICE CARD

WRIGHT **MOTORS** / *Size 8 Servos*



The Industry's Widest Variety

When weight and space are critical and it becomes essential to use the smallest and lightest production servos available, Sperry Rand's Wright Division offers you the industry's widest variety of advance components.

Typical of this variety are Wright Size 8 Servos, a few of which are shown above. Normal Torque or High Torque. High Acceleration or Exceptional Acceleration. Normal Torque to Power or High Torque to Power. You name it, Wright has it. And 200°C operation is standard!

Telephone Durham (919) 682-8161 or write for get-acquainted literature and name of our nearest representative.

Servo Motors, Motor Tachometers, Geared Servos, Synchros, Servo Packages, and Spin Motors in frame sizes from Size 8 through 30.

WRIGHT

DIVISION OF SPERRY RAND
Durham, North Carolina

CIRCLE 103 ON READER-SERVICE CARD

NEW PRODUCTS

VHF Antenna

590

For tracking and telemetry



The model 420A, a dual-polarized vhf tracking and telemetry antenna, operates in the 215- to 260-mc range. Collapsible for air transport, it measures 8-ft square by 6-ft deep in operation and weighs 250 lb. Gain is 18 db min; vswr is 1.4 max. Other features include unambiguous acquisition mode, simultaneous 2,000-mc tracking, 125-mph wind operation.

Avien, Inc., Antenna Dept., Dept. ED, 58-15 Northern Blvd., Woodside 77, N.Y.

Price: Less than \$3,000.

Availability: From stock.

Survey Meter

398

For radiation detection



The model 440 survey meter will detect and measure beta and gamma radiation of less than 1 milliroentgen per hour. An air ionization chamber with a mylar window is used to cover an energy range of 6,500 electron v to 1.2 million electron v. Its read-out dial can be set for 5 sensitivity ranges which encompass from 0 to 300 milliroentgens per hour. Battery power supply is 4 "D" cells, with 100 hr life. The unit weighs 5-1/2 lb.

The Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland, Ohio.

For that



NEW IDEA

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IRE SHOW

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New York

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Age limit—over 18

CIRCLE 104 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 1, 1961

Transmissibility Plotter

400

Plots voltage ratios



The model 200A transmissibility plotting system automatically records the ratio of rms value of 2 varying ac voltages with respect to a third varying voltage. Ratios of non-sinusoidal voltages from 5 cps to 5 kc, or of sinusoidal voltages to 20 kc, appear on a built-in X-Y recorder. The system covers a 20-db dynamic range.

F. L. Moseley Co., Dept. ED,
409 N. Fair Oaks Ave., Pasadena,
Calif.

Limit Switches

396

Heavy-duty, metal-cased



Designed for use in metal-conduit wiring systems, the KL series of heavy-duty limit switches provide for right-hand or left-hand mounting, in a variety of actuation modes. The switch, removable for connection outside the case, is sealed against oil and moisture. It is rated for spdt operation at 2 hp, 250 v ac; 1 hp, 125 v ac; and 20 amp at 125 v ac. Switch mounting is independent of case mounting.

W. L. Maxson Corp., Unimax
Switch Div., Dept. ED, Ives Road,
Wallingford, Conn.

Nose Cones Plated with Sel-Rex Bright Gold* Recovered From Space Orbits



President Eisenhower holds American flag which was in recovered capsule during its flight through space. Capsule shown was electroplated with patented Sel-Rex Bright Gold Process.



*finding the golden needle in
the haystack...*

Space capsule Discoverer XIV was plated with Sel-Rex Bright Gold. So was its predecessor, Discoverer XIII, which had been rescued earlier from the Pacific Ocean.

This patented plating process was applied by Philadelphia Rust-Proof Co., Inc. to provide maximum heat reflectivity and emissivity, under sub-contract from General Electric Company Missile and Space Vehicle Department. Sel-Rex precious metal plating processes, in fact, are included in the original specifications of many advanced Space Age projects.

Sel-Rex sales and service technicians throughout the Free World are ready to serve you with unmatched professional precious metal plating services. Technical literature free on request.

* Patented



SEL-REX CORPORATION

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World's largest selling Precious Metals Plating Processes

CIRCLE 105 ON READER-SERVICE CARD

CHOPPERS

*You relax when Airpax is
your source for the very best
in "quality-proven" choppers.*



"The Smallest Chopper in the World." The Model 30, a diminutive electro-mechanical chopper, is a natural for low noise requirements. Weight is 9 grams. Dimensions are 21/64" x 21/32" x 3/16".

RELIABILITY



The design of the Model 33 electro-mechanical chopper is such that the noise level has been brought to an irreducible minimum. Even at high impedances, the noise is down in the random noise level.

UNIFORMITY



Type 6020-3, a molded transistor chopper for printed circuit use, operates over a DC to 100 KC chopping range. Drive voltage may be 2 to 20 volts peak square wave or 5 to 20 volts peak sine wave.

VERSATILITY



Series 175 choppers, industry standards for 60 CPS operation, provide highly reliable, trouble-free performance. 5,000 hours of continuous rated operation will not alter characteristics.

STABILITY



These 400 CPS miniature choppers, Series 300, are widely used as modulators and demodulators in stabilized DC amplifiers for analog computers and in servo-mechanisms for automatic controls.

DURABILITY





DECISION MAKER

for simplified monitoring,
controlling, high-precision switching

Normal/abnormal . . . high/low . . . go/no-go: these are important decisions being made by A.P.I. Very High Sensitivity Measuring Relays.

Direct from sensory elements or circuits, the A.P.I. measuring relay makes a decisive "yes or no" decision on the basis of very close-tolerance voltage or current changes. In typical, critical applications, this measuring relay is saying "yes or no" on a change of ± 1 microamp; or in a 400- to 500-volt circuit, on a variation of only a few percent.

Moreover, the relay is capable of actuating on very tiny currents: for example, total inputs as small as 0.2 microampere or 0.1 DC millivolt. It does so without signal amplification, amplifier costs or the signal distortion problems that often go along.

Performance stability is inherent; reliability is exceptional due to the A.P.I. locking-coil design. On "make", contact is firm with substantial contact pressure; contact resistance is low. On "break", separation is clean and quick without contact teasing.

10,000,000 perfect operations is not an all-time record; it's a reasonable expectation of service life.

Widely used for precision switching in computer, control and alarm circuits, VHS measuring relays are practically unlimited in scope of application.

For more information, send for Bulletin 104-D.



ASSEMBLY PRODUCTS, INC.

Chesterland 17, Ohio

CIRCLE 107 ON READER-SERVICE CARD

NEW PRODUCTS

Infrared Detector

686

For industrial use



Type FR-E47 is a general-purpose, lead-sulfide detector designed expressly for industrial applications. It may be used for counting, scanning, sorting and switching. Specifications are: mean time constant, 375 μ sec; dark resistance range, 5 K to 1.5 meg; sensitivity, 0.7 to 2.7 microns. The cell is housed in a dual-prong plastic housing.

Tupper Trent Co., Inc., Dept. ED, 207 Carter St., Chelsea 50, Mass.

Price: \$6.15 ea.

Availability: Immediate.

Braided Shieldings

436

This braided shielding is available in three forms. Flat braid is woven of tinned-copper strands and flattened at the time of manufacture. Oval commercial braid is similar but not flattened. Tubular braid is constructed to MIL-QQ-B-575, with internal supports to maintain a circular cross-section.

Alpha Wire Corp., Dept. ED, 200 Varick St., New York, N. Y.

RF Power Meters

673

Measure from 0.2 to 700 mc



These rf power meters measure from 0.2 to 700 mc. They include model PM-4, 150 and 600 mw full scale; model PM-5, 500 and 1,500 mw full scale; and model PM-6, 1.5 to 6 w full scale. Of the absorption type, they are completely shielded and non-radiating, permitting transmitter testing and adjustment without interference. No correction curve is necessary to cover the frequency range. Accuracy is $\pm 5\%$.

Electro Impulse Laboratory, Inc., Dept. ED, 208 River St., Red Bank, N.J.

Price: \$95 ea.



how to see high impedance ac signals

The Keithley Model 102B Amplifier combines a 400-megohm input with high gain and low noise. It sharply reduces circuit loading errors when measuring outputs from accelerometers and other piezo-electric devices. It also has many uses in studies on hearing aids, phonograph pick-ups, and microphones.

Features of the Model 102B are: decade gains from 0.1 to 1000, selectable bandwidths of 2 cps to 150 kc and 2 cps to 1.7 mc, and a 5-volt, 50-ohm output for scopes and recorders. Other features include:

- **input impedance** of 400 megohms, shunted by 3 μ f.
- **low noise level**, below 10 μ v from 10 cps to 150 kc at maximum gain.
- **gain accuracy** of 1% at midband for all gain settings.
- **rise time** of 0.3 μ sec at highest gain.
- **two accessory** low capacitance probes available.
- **Price** — \$335.00

For full details write:



**KEITHLEY
INSTRUMENTS**

12415 EUCLID AVENUE
CLEVELAND 6, OHIO

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ELECTRONIC DESIGN • February 1, 1961



a **spot** is a **spot**
is a high
resolution **spot**
with
CELCO YOKES

- **Celco YOKES**
keep spots **smallest**
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keep spots **roundest**
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keep spots **sharpest**



Use a **CELCO DEFLECTION YOKE** for
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• Pacific Division - Cucamonga, Calif. - YUkon 2-2688

CIRCLE 109 ON READER-SERVICE CARD
ELECTRONIC DESIGN • February 1, 1961

Rectifier Analyzer

685

For ratings from 100 ma to 20 amp



This analyzer, model 170, is designed to test any semiconductor rectifier at any combination of ratings from 100 ma to 20 amp and from 0 to 1,000 v. Flexibility is made possible by independently adjustable forward current and reverse voltage. Mirror-scaled 1% meters include: 1/3/25 amp dc full scale to measure average forward current; 250/1,000 v peak to measure reverse voltage; 0 to 1.5 v to measure forward voltage drop.

Wallson Associates, Inc., Dept. ED, 912-914 Westfield Ave., Elizabeth, N.J.

Price: \$855.

Availability: From stock in 2 to 3 weeks.

Servo Mount Clamps

435

The Rota-Way servo mount clamps can be attached to test or other types of fixtures to hold any standard servo mount component securely in place. Operating handles are in various lengths depending on the device to be tested.

Angler Industries, Dept. ED, Metuchen, N. J.

Price: \$12.50 ea.

Availability: One week.

VHF Microvoltmeter

364

Has automatic tuning



This selective vhf microvoltmeter, the model USWV, automatically tracks an unknown signal, measuring its amplitude and frequency. Waveform analysis is carried out by manual tuning. The frequency range is from 30 mc to 400 mc. Logarithmic voltage indication, over an 80-db range, and linear indication are provided. Minimum input is 10 μ v rms; frequency response is 0.2% per mc \pm 1 db, and input attenuation is 0 to 60 db. Bandwidth is 125 kc, 3 db down, to 1 mc, 80 db down.

Rohde & Schwarz Sales Co., Inc., Dept. ED, 111 Lexington Ave., Passaic, N.J.

COMPACT, 3-OUNCE TIME DELAY RELAY

with silicone-controlled
delay from 1/4 to 120 seconds



Worth a closer look . . . the Heinemann Type A Silic-O-Netic Relay. Despite its small overall size, the relay offers many big performance features.

For example, double-pole, double-throw switching . . . at fast snap-action contact speed.

The relay is a load carrier in itself: it may be energized continuously . . . does not require auxiliary lock-in circuits.

And it has a hermetically sealed time element that is forever free from the effects of aging or fatigue. The Type A Relay has proven itself in countless applications; it will give you reliable service over a long, long operational life.

For full details, refer to Bulletin T-5002. A copy will be sent on request.

BRIEF SPECS

Time Delays: from 1/4 to 120 seconds

Overall Dimensions: 2-1/16" x 2" x 1-9/16"

Contact Capacity: 3 amps at 120V AC, 1.5 amps at 240V AC (non-inductive load), 1 amp at 50V DC, 0.5 amp at 125V DC.

HEINEMANN

ELECTRIC COMPANY

156 Plum St., Trenton 2, N. J.

CIRCLE 110 ON READER-SERVICE CARD



S.A. 1678

ALL Digits Can Be Read from Any Angle

IN-LINE DIGITAL READOUT

featuring
ONE-PLANE PRESENTATION



Series
10000

PRICE **\$18⁰⁰**
COMPLETE

Over 1000
firms throughout
the world in just a
few years prove
unprecedented
acceptance of
IEE digital
readouts.

The IEE digital readout puts the digit right up front, visible from any angle. Vision is unimpaired by stacked characters and sharp, clear-white digits provide high-contrast, error-proof reading. Use of words, color, and multiple projections offer utmost versatility.

QUANTITY PRICES
ON REQUEST

WRITE TODAY
FOR COMPLETE
SPECIFICATIONS.

Binary-To-Decimal
Decoders Available.

Representatives
in
Principal Cities



INDUSTRIAL ELECTRONIC ENGINEERS, INC.

Engineers and Manufacturers of Fully Automatic Systems and Digital Readouts
5528 Vineland Avenue, North Hollywood, California

CIRCLE 111 ON READER-SERVICE CARD

NEW PRODUCTS



Indicator Light

448

The model 855S-DS panel indicator light has a black shroud which excludes light emission from the sides. It is available in a bi-colored version which is colored when lit, and white when unlit. It mounts in a 3/8 in. diameter hole. The Sloan Co., Dept. ED, 7704 San Fernando Road, Sun Valley, Calif.



Audio Triode-Pentode

449

A high-gain triode-pentode, the ECL86/6GW8 was designed for audio applications. Voltamperes are 250, each section; g_m is 10,000, pentode section; μ is 21, pentode section, and 100, triode section. The heater draws 7 amp at 6.3 v. International Electronics Corp., Dept. ED, 81 Spring St., New York, N. Y.



Insulating Adapter

450

This adapter, for use with TNC and TM connectors, provides insulation from the mounting panel. Body is nylon, dielectric is Teflon; all metal parts are silver-plated. Voltage rating is 500 v rms, 60 cps. General RF Fittings, Inc., Dept. ED, 702 Beacon St., Boston 15, Mass.

NEW! GENISCO SERIES 1200 G-ACCELERATORS



FOR BOTH ENVIRONMENTAL AND PRODUCTION TESTING.

- 0.25% accuracy at any setting over full range
- Accommodate test objects up to 18" or 24" cube and weighing 150 lbs.
- G range of 0 to 200 or 0 to 250 gs. 15,000 g-pounds, maximum.
- Extremely simple and flexible design; many optional accessories.
- Low tub silhouettes provide easy access to test object
- Rapid speed changing with programmed servo control capabilities.
- On-off repeatability within 0.33%

G-Accelerators in the new 1200 Series possess the ruggedness, simple operation, fast response and flexibility required for routine production or environmental testing, and the accuracy demanded for laboratory calibration programs. These features together with low cost easily make them your best centrifuge values. For complete information write for brochure.

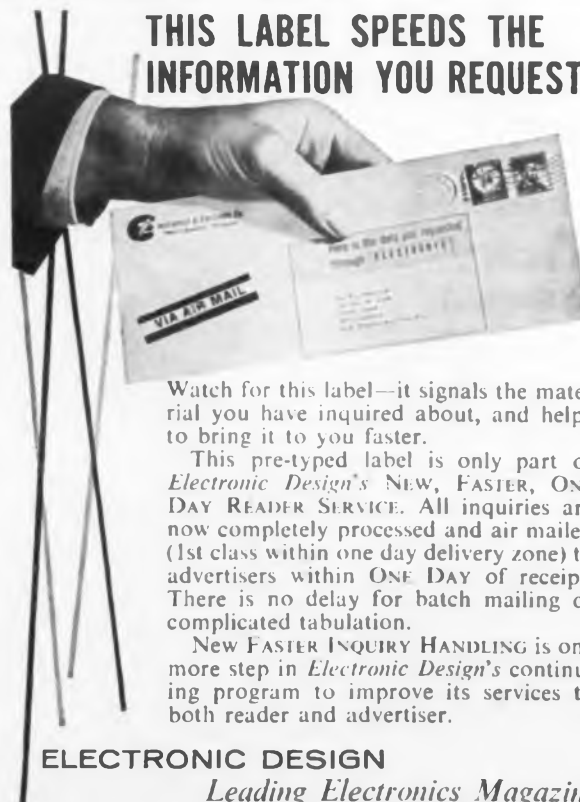
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Neon-Glow Indicators

451

Operating on standard line voltage, the models 116 and 117 neon-glow indicator assemblies are simple and practical for mounting. Available with nut or snap-plug in a variety of lens styles and colors. Drake Manufacturing Co., Dept. ED, 4626 N. Olcott Ave., Chicago 31, Ill.

Price: From 37 cents to 61 cents each.



High-Voltage Resistors

452

Designed for high-pulse currents at very high voltages, these resistors have corona-free operation up to several hundred kv. A typical 38-ohm unit will handle 12.3 kw, 18 amp, with 1,000 cfm of cooling air required. Inductance is less than 50 μ h. Franklin Engineering Design Co., Dept. ED, 977 Commercial St., Palo Alto, Calif.



Wiring Terminals

453

Feed-through and stand-off terminals Nos. 1041 through 1043 have shank diameters of 0.090 in. and heights from 0.082 and 0.281. They are designed to withstand heavier wiring. Material is lacquered and silver-plated brass. Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

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416-PAGE

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CIRCLE 911 ON CAREER INQUIRY FORM, PAGE 111



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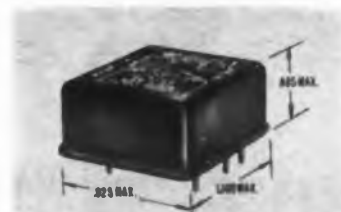
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NEW PRODUCTS

Latching Relay

353

Lies flat on circuit board



The FL, a dual-coil latching relay, has a maximum height of 0.485 in. Base size is 1.100 in. x 0.925 in. Its dpdt contacts are rated 3 amp at 30 v dc or 2 amp at 115-v, 60-cps resistive. Designed to operate in severe environments, the relay will remain firmly latched in either position without applied coil power.

Potter & Brumfield, Dept. ED, Princeton, Ind.

Potentiometers

416

Single turn, wirewound

Series 1500, 1600, 1700 and 1800 potentiometers are single turn, wirewound precision units. They are all available in servo and panel models. Series 1500 is 1-7/16 in. in diameter, rated at 3 w; series 1600 is 1-3/4 in. in diameter, rated at 4 w; series 1700 is 2 in. in diameter, rated at 5 w; series 1800 is 3 in. in diameter rated at 7 w. All have maximum equivalent noise factors of less than 100 ohms.

Duncan Electronics, Dept. ED, 1305 Wakeham Ave., Santa Ana, Calif.

Price: From \$12 to \$19 ea, 1 to 9.

Availability: Standard, from stock, custom, 30 days.

Miniature Potentiometer

365

Has 1/2 w rating



Small, light, and rugged, the model D miniature potentiometer is rated at 1/2 w. It has a voltage rating of 350 v rms and an ambient temperature range from -55 C to 120 C. The unit is said to have a life of 100,000 cycles and an ability to sustain heat overloads of 500 F. Specification MIL-R-94B is met.

Reon Resistor Corp., Dept. ED, Yonkers, N.Y.

ELECTRONIC DESIGN • February 1, 1961

Rate Gyro

Features improved damping



Damping in the series 7601 rate gyro is held at from 0.5 to 0.9 times critical over a temperature range of -54 C to 84 C. Response time therefore remains uniform over the environmental range. The spin motor of this 6.5-oz unit uses 1-1/2 w of 26-v, 400-cps power in 1, 2 or 3-phase versions. No external choke is required. An isolated motor rotation detector is available.

Lear, Inc., Instrument Div., Dept. ED, Box 688, Grand Rapids, Mich.

Price: \$800 per unit in production quantities.

Availability: 180 days

Ceramic Magnet

Residual is 3,770 gauss

This oriented barium ferrite permanent ceramic magnetic material, designated F-510, has a residual induction of 3,770 gauss and a coercive force of 2,700 oersteds. Intrinsic coercive force is 2,800 oersteds; maximum energy product is 3.3×10^6 gauss-oersteds.

D. M. Steward Manufacturing Co., Dept. ED, 3660 Jerome Ave., Chattanooga, Tenn.

Price: On request.

Availability: 4 to 5 weeks.

Power Supplies

Response time is 10 μ sec



The solid state TPS series of power supplies cover a range of 0 to 150 v at up to 30 amp. The units, said to be transient-free, have a response time of 10 μ sec. They are designed to eliminate drift due to transistor aging and temperature, and to provide an amplifier current gain of 1 million and a voltage gain of 10,000. Load and line regulation are held to 100 ppm. Life is warranted to be 5,000 hr.

Power Devices Inc., Dept. ED, 10709 Venice Blvd., Los Angeles 34, Calif.

368

Which of These 4 Major Improvements Is Most Important To Your Business?



The Avnet System

is based on New Concepts, Major Improvements in Service

The Avnet System IS a system of improvement, newness, change for the better. That's how progress is made. That's how—and why—Avnet is America's major source of supply in electronic components. Of the many new practical concepts Avnet has introduced, four are symbolized above. Which of them are important in your business?

- 1 A NEW CONCEPT OF PLACING the Right Line—in the Right Place—at the Right Time. The Avnet System supplies not only the components themselves but a wealth of application information, saving the user hours of costly research time.
- 2 A NEW CONCEPT OF SUPPLY—an available supply that is overwhelming in its size. Avnet's supply of electronic components is vast—in breadth and in depth. It is also carefully anticipated to meet your demands of tomorrow, next month, next season.
- 3 A NEW CONCEPT OF TIME Avnet ships your orders about $\frac{1}{3}$ faster than any other major source of supply, hence $\frac{1}{3}$ of the hours can be cut from your waiting time. Although the 8 hour clock is symbolic, it is symbolic of a fact.
- 4 A NEW CONCEPT OF SCHEDULING. Once your order is given to Avnet, it knows no "weak-ends." Within a given period, Avnet ships more orders than any other source for electronic components, giving your specific order quicker delivery, faster use.



5 THE CONCEPT OF NEW CHALLENGE. Avnet doesn't know what the next decade will bring. But Avnet is very ready, willing and able to meet the challenge with more improvement in service, more newness, more changes for the better. For this is the very basis of The Avnet System.

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Width	90mμsec to 105m sec	Output	50V 1000Ω, 5V 75Ω
Delay	90mμsec to 105m sec	Also pre-pulse and sawtooth sweep	

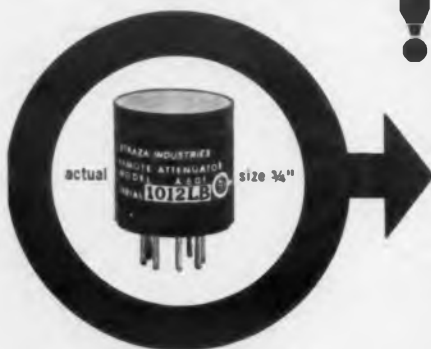
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... **VERSATILE!** With minimum interaction between control wires and signal, unit permits unlimited length of unshielded control wire. Control voltage, 0 to 28 volts ac or dc, attenuates high or low-impedance ac or dc signals. Can be used for phase shifting, variable filter, AGC control, etc.

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CIRCLE 118 ON READER-SERVICE CARD

NEW PRODUCTS

Phase-Angle Voltmeter

693

Laboratory features in portable unit



The model VM-233 phase-angle voltmeter functions as an ac voltmeter, phase meter, phase-sensitive null indicator, power-factor meter, and provides separate measurement of the in-phase and quadrature components of a signal. Standard models have reference levels from 3 v to 300 v with 100-K reference input impedance, and may be used at 400 or 800 cps. The 12 ranges cover 1 mv to 300 v. Accuracy as a phase-angle voltmeter is $\pm 3\%$ of full scale, and $\pm 2\%$ as an ac voltmeter. Null sensitivity is 2 μ v and harmonic rejection is greater than 55 db. The unit measures 3-3/4 x 10-1/4 x 8-1/8 in.

North Atlantic Industries, Inc., Dept. ED, Terminal Drive, Plainview, L.I., N.Y.

DC Power Supplies

358

Up to 85% efficiency



Four dc power supplies, designed for ground support, aircraft, or missile applications, are available in compact form. The model AU-0192, operating at an efficiency of 80 to 85%, produces 550 w with 6 voltage outputs from a 22-v to 32-v input. This silicon device holds 0.5% regulation from -55° C to 100° C. The model AU-0291 gives ac to dc isolated outputs at 60 cps. Large amounts of power are handled by the model AU-0109, a dc to dc converter. The model AU-0241, a regulated silicon unit, weighs 3 oz and provides 28 v at 50 ma.

Victoreen Instrument Co., Jordan Electronics Div., Dept. ED, 3025 W. Mission Road, Alhambra, Calif.

Price: On request.

Availability: 2 weeks to 3 months.

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ELECTRONIC DESIGN • February 1, 1961

55

temperature & millivolt ranges



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Yes, a single Speedomax H Recorder enables you to measure practically any temperature or millivoltage encountered in research activities. Simply pick the stocked range card and scale you need from 50 thermocouple or 5 millivolt ranges . . . substitute them in your Speedomax H Recorder . . . insert matching chart paper . . . and you're ready to record.

The specifications listed below are for the Speedomax H Strip Chart Recorder with a widely used range of 0 to 10 millivolts. For information on other ranges, contact your nearest L&N Office, or write to address below.

List No.—3-32-000-044-6-120-5 Speedomax H Model S Recorder, available for delivery in less than four weeks.

Record—Single-point continuous line.

Measuring Circuit—D-c potentiometer.

Electrical Range—0 to 10 millivolts.

Accuracy Rating— $\pm 0.3\%$ of span.

Dead Band—0.2% of span.

Chart Number—600006: 50 uniform divisions in 6 $\frac{1}{2}$ ". Chart tear-off included.

Chart Speed—120 inches per hour.

Span Step Response Time Rating—1 second nominal.

External Circuit Resistance Rating—Up to 2500 ohms for normal performance.

Current Standardization—Automatic, every 48 minutes.

Power Supply—Operates on 120v, 60~.

Optional Feature—Carrying handle and feet available. Add (-9) to List No.

Price—\$585.00 f.o.b. Philadelphia or North Wales, Pa. (subject to change without notice). Add \$12.00 to price for (-9) suffix if desired. Use List No. 3-32-000-044-6-120-5 when ordering from L&N, 4908 Stenton Ave., Phila. 44, Pa.

LEEDS **NORTHROP**
Instruments Automatic Controls • Furnaces

CIRCLE 120 ON READER-SERVICE CARD
ELECTRONIC DESIGN • February 1, 1961

3-Phase Transformer

376

Uses Y cores



Each core in this circular transformer is a 120-deg sector, wound and lap jointed. Coils are placed over a pair of adjacent cores. Thermic interchange is minimized. Magnetic paths in any core are always symmetrical with respect to the other two, giving magnetic, electrical, and physical balance on all phases from no load to full load.

Culow Transformer Co., Inc., Dept. ED, Carlstadt, N.J.

Digital Modules

411

Are plug-in type

The 3C-PAC series H plug-in digital modules measure 5 x 3-5/16 x 7/16 in. Operating ambient temperature range is 0 to 50 C. Standard models are available at either 10- or 16-mc clock frequencies. Typical rise and fall times are 8 to 10 nsec. Features include glass-impregnated epoxy cards, etched circuits and dip-soldered connections.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

Time Delay Relay

362

For extreme environments



The model 700 thermal time delay relay switch, a linear expansion type, will operate in ambient temperatures of -65 C to 125 C. It withstands shocks of 50 g and vibration levels of 55 to 500 cps. Contact arrangement is spst normally open or normally closed, rated at 3 amp, 115 v ac resistive.

Thermal Controls, Inc., Dept. ED, 41 River Road, N. Arlington, N.J.

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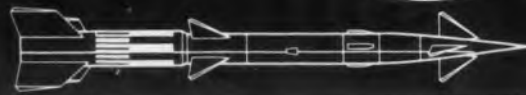
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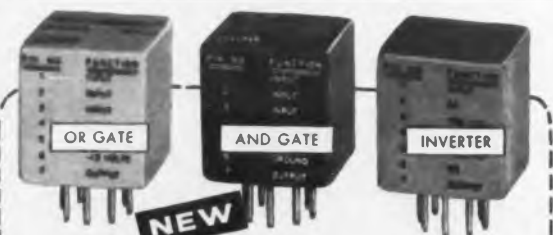


is kept on the alert with the help of an Eastern pressurizer dehydrator system. This compact unit feeds a flow of controlled, dry air to the wave guide of the powerful acquisition radar — at pressures higher than the atmosphere, so that the ambient can't sift in through leaks. As a result, moisture can't condense on high-voltage elements; dangerous arc-overs are eliminated. The dehydrating pressurization pack is completely self-contained, circulates air through alternate, self regenerating capsules of silica gel which need never be replaced. For additional information, write for Bulletin 370.

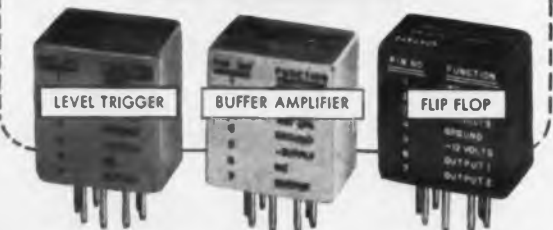


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NEW PRODUCTS

Trace Camera

646

Polaroid or standard



With interchangeable backs, the C-12 oscilloscope trace camera accepts Polaroid or any conventional film. There are 8 interchangeable lenses, down to $f/1.5$, housed in keyed, calibrated mounts. The camera may be used horizontally or vertically. The unit mounts simply and can be swung away when not in use.

Tektronix, Inc., Dept. ED, P. O. Box 500, Beaverton, Ore.

Price: \$500 with $f/1.9$ lens and accessories.

Availability: From stock by 1st quarter of 1961.

Molding Compound

428

This fiber glass reinforced polyester molding compound, Grade 1506, is said to have high impact strength and good moldability in deep-draw parts. The UL-recognized material has an ignition time and extinguishing time of 85 sec. It is rated for sole support of current-carrying members up to 150 C.

The Glastic Corp., Molding Materials Div., Dept. ED, 4521 Glenridge Road, Cleveland 21, Ohio.

Pressure Transducers

367

Withstand 600 F



Operation from -100 F to 600 F during 11-msec shocks in excess of 100 g is claimed for these pressure transducers. Model 538B has a flush-mounting diaphragm; model 539B, a 1/4-in. threaded fitting. The bonded strain-gage type units measure absolute or gage full-scale pressures in ranges from 200 to 2,000 psi. Excitation voltage is 10 v, ac or dc. Repeatability is 0.1%; combined error is 0.5% of full scale. The 3.5 oz units measure 2-5/8 in. by 1-1/8 in. diameter.

Electro-Mechanical Research, Inc., Dept. ED, Sarasota, Fla.

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In **H-32** core solder for the first time, **HYDRAZINE FLUX** offers more advantages than ever. When flux is normally applied, far more than is actually needed is used. Now, the exact ratio of flux to solder provides for proper wetting. Thereafter the flux decomposes and is eliminated. Cleaning and production time are saved.

TEST HYDRAZINE FLUX AND CORE SOLDER in your own plant. Write for samples of either H-Series Fluxes or H-32 core-solder form and technical literature.

[®]U.S. Patent No. 2,612,459

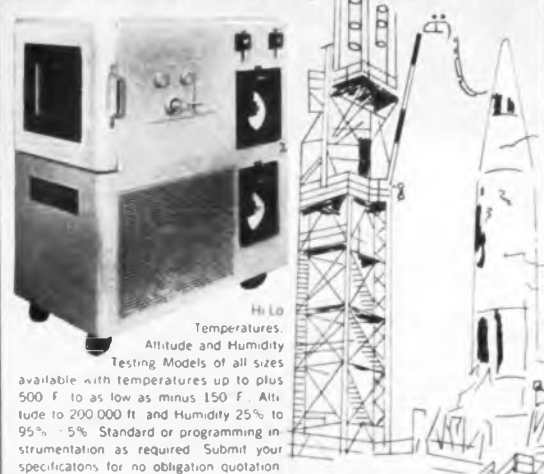
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is the **FIRST** to have a fully transistorized inline digital "read-out" counter!



Model S with New Counter and IC-601 Inductance Comparator.

The Model S is the first of its type to have this new counter which operates on a simple photocell principle minimizing maintenance, since the pick-up consists of a simple photo-diode and photocell. The number of turns applied to the coil flash onto the screen shown above.

The Model S toroidally winds ± 16 — ± 50 wire and down to $\pm .065$ " finished I.D. ± 16 wire tightly wound down to $\frac{1}{4}$ " fin. I.D. An attachable comparator allows winding directly to desired inductance. Interchangeable heads include 2", 3", 4", 6" and 7" heads for RANDOM winding and 2", 4" and 6" heads for precise LAYER winding.

Send for further information,
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The most COMPLETE line of TOROIDAL equipment in the world.

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Snap-Action Switch

Provides positive feel



This snap-action switch provides a positive feel of switch operation with almost simultaneous switching action. The miniature, push-button switch, for panel mounting, conforms to MIL-S-6743, Military Part 25085-1. Its electrical rating is 5.0 amp at 120 or 240 v ac, 3 amp at 30 v dc inductive at sea level, and 4 amp at 30 v dc resistive at sea level. Higher ratings are available. The switch weighs 6 oz and requires an operating force of 21 oz.

P. R. Mallory & Co., Inc., Milli-Switch Corp., Dept. ED, Gladwyne, Pa.

Transistor Heat Sinks

421

Model 2502 natural convection heat sink offers a thermal resistance of 1.3 C per w. The unit has a weight of 0.4 lb and measures 4 x 3 x 1.28 in. Model 2501 measures 4 x 3 x 0.687 in. and provides thermal resistance of 2 C per w.

Astro Dynamics, Inc., Dept. ED, 98 Osborne Path, Newton Centre, Mass.

Availability: From stock.
Price: From \$3.85 to \$0.87 ea.

Telemetry Unit

389

For temperature measurement



The model 1751/(D) amplifier unit is designed for measuring temperature and amplifying thermocouple signals to telemetering levels. Output is unidirectional, 0 to 5 v across 500,000 ohms, from a 0- to 20-mv input at 8-ohms impedance. Linearity is $\pm 1\%$, ripple 0.3%; operating temperature range is -45 F to 160 F. The companion model 1751/(E) reference unit, with a chromel-alumel thermocouple, completes the system.

Lumen, Inc., Dept. ED, P.O. Box 905, Joliet, Ill.

Price: \$850, complete system.
Availability: 5-week delivery.

667

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Torrington Manufacturing Co., Specialty Blower Div., Dept. ED, Torrington, Conn.

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427

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Cutting Your Reading Time in Half



Part 3

How many times have you read pages of material only to realize you have merely been reading words while your mind wandered elsewhere? Here are some proven methods to make your reading material more meaningful through improved comprehension.

Myron Q. Herrick
Developmental Research Institute
New York, N.Y.

YOUR reading concentration can be improved if you will learn to apply several important techniques. One of the techniques is phrase reading. Earlier in this reading-improvement series, we saw that phrase reading could develop better reading concentration. This is because the word-by-word reader, the person who stops his eyes on each word of print, can think more rapidly than he can read. Therefore, it is easy for his mind to wander.

Pre-reading is another important technique. It improves your concentration and comprehension because your mind picks up information so quickly you don't think of other things. Pre-reading helps you decide whether what you're reading is necessary and important—whether you should give a thorough reading to all of it, or just certain parts.

If you have no particularly pressing outside worry, but still find it difficult to concentrate—as you probably do when the material doesn't vitally interest you—it is a sign that you are allowing yourself to be a passive reader. You are

not involved in your reading. You sit passively, your eyes traveling over the print, expecting your eyes to do the work while your mind is either miles away or busy complaining about the dullness of reading. Your mind must be actively working. You must become wholly involved, active and thinking! How can you accomplish this?

Read with a purpose. Before you even begin, go over with yourself the advantages to be gained from reading the article. Never read without being consciously aware of some purpose. You may, for example, read an article in *ELECTRONIC DESIGN* about new drafting methods. Before reading this article many questions will automatically pop into your mind, and you will speculate about what the article can tell you. As you read, this preliminary thinking may be

forgotten, and when the purpose vanishes, the interest goes also. Always keep your purpose in mind, and you won't find yourself reading aimlessly and without attention. You will read intensively in order to achieve that purpose.

Ask questions. In order to involve yourself more completely with the writing, in order to read with a purpose, read with questions in mind. These questions may be of two kinds: (1) those formulated between pre-reading and thorough reading, and, (2) those formulated during thorough reading.

Between pre-reading and thorough reading, ask yourself:

1. What am I looking for? What is my purpose in reading this article? If you should find no purpose, don't bother with it! If you have a purpose, read intensively with that purpose in mind.
2. What is the author's stated theme or purpose? Keeping this question in mind will help you to distinguish between main ideas and supporting details.
3. What is the author's real purpose? Is he trying to convince me of anything he doesn't state outright? These questions will help to identify the author's hidden purpose.

Why is the author presenting the information on this occasion?

What seems to be the author's own sentiments on his subject?

What conclusion does he want the reader to draw? And for what reason?

During a thorough reading, turn the first sentence of every paragraph into a question. In factual writing, this is usually the topic sentence—that is, one which expresses the main idea of the paragraph. The rest of the paragraph usually supports this main idea with evidence or elaborates it in more detail.

Anticipate. Your eyes may not be able to pick up ideas as fast as your mind can assimilate them. Your mind will race ahead, and if you're not careful, you soon find yourself thinking of other things. Nip this situation in the bud by turning the left-over mind power into the reading—anticipate what points the author is going to make; weigh his effectiveness in leading up to them; try to stay one step ahead of the writer. You will find that this keeps you busy, with little mental room for distraction.

In any kind of reading you must involve yourself completely, just as you would if you were in earnest conversation. Always keep your purpose in mind as a goal. Like someone learning to swim, you must not be afraid to plunge in completely, keeping only your head above the water to maintain a purposeful direction.

Because you are questioning and anticipating the author's thoughts, you will be able to grasp the organization of the facts and ideas. You must think while you read, cooperate with the author by thinking with him, as you would if you were talking with him. Remember, the marks on the printed page are merely symbols for the author's thoughts. Get the meaning behind the words. Is he making his points effectively? You'll find that this will keep you busy, active in the material, less prone to distraction. You'll also find it easier to be completely interested.

By now your speed will be increasing rapidly if you have followed the directions in phrase reading. Push yourself at maximum speeds and don't be afraid that comprehension is going to drop. Quite to the contrary, you will find reading far more pleasurable and your mind will be actively involved in absorbing the material. The next article will show you ways to evaluate what you read, thus sharpening your skill as a critical reader. ■ ■

Parts 1 and 2 of this series dealt with phrase-reading and pre-reading. The next, and last, article of the series will discuss methods of being a critic while being a reader and will also summarize the earlier articles.

A 64-page book, giving the how, what, and why of reading improvement, is available to individuals. Send \$2 to Developmental Research Institute, Dept. E-61, 500 Fifth Ave., New York, 36, N.Y.

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$$E = S(1+i)^x$$

Where E = Annual Earnings
 S = Starting salary out of college
 i = Percentage improvement in use-value per year
 x = Number of years of experience

Obviously then, the formula for total earnings over a period of n years would be:

$$\int_0^n S(1+i)^x = S \left(\frac{(1+i)^n}{\log(1+i)} - \frac{(1+i)^0}{\log(1+i)} \right)$$

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Electronics Personnel Consultants

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*Manufacturers' catalog appears in 1960-1961 ELECTRONIC DESIGNERS' CATALOG

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1 hp 120 V a-c, 2 hp 240 V a-c
25 amp resistive 28 V d-c

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DIMENSIONS: 1½ x 1¼ x 11½ inches.

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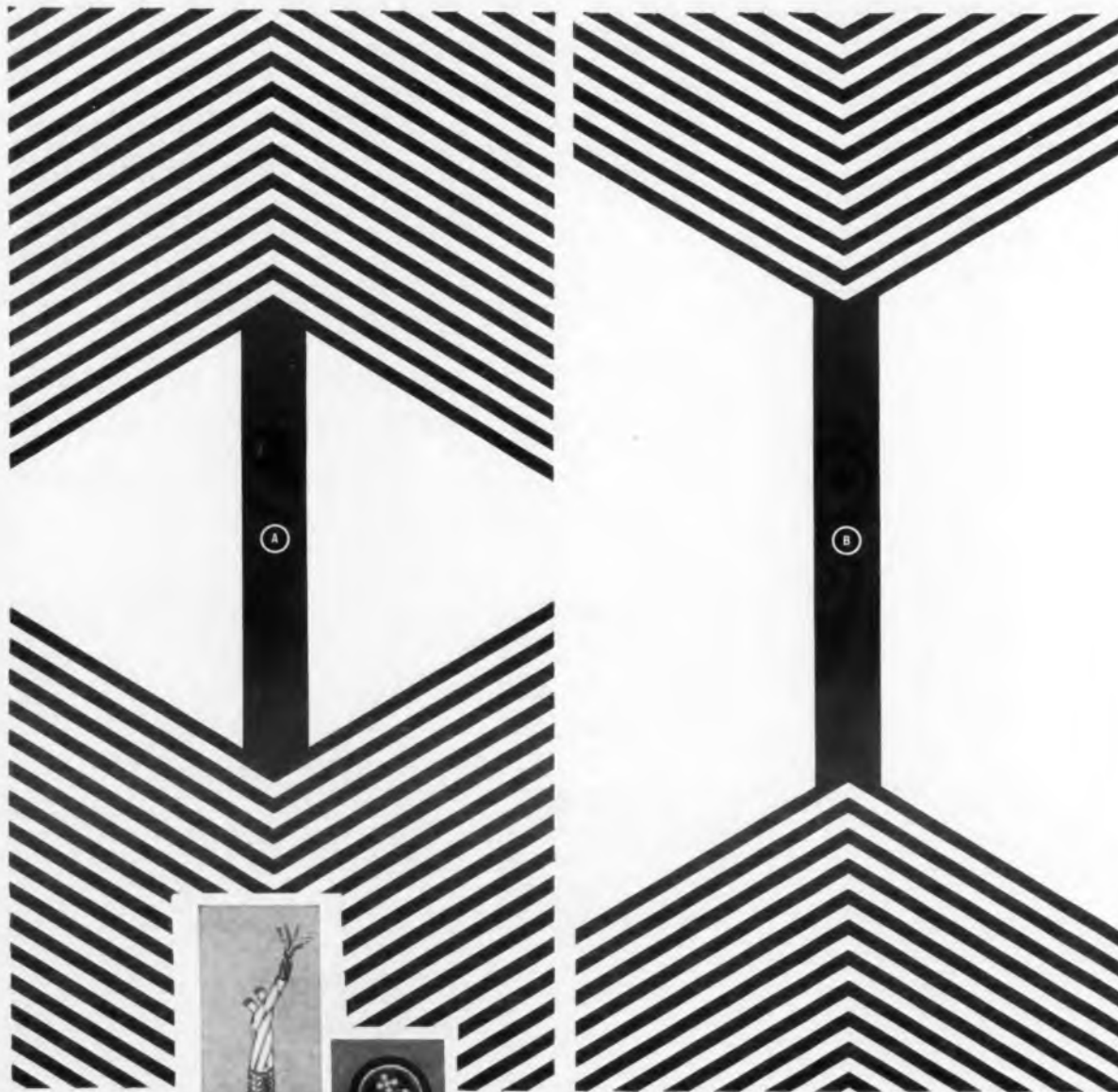
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