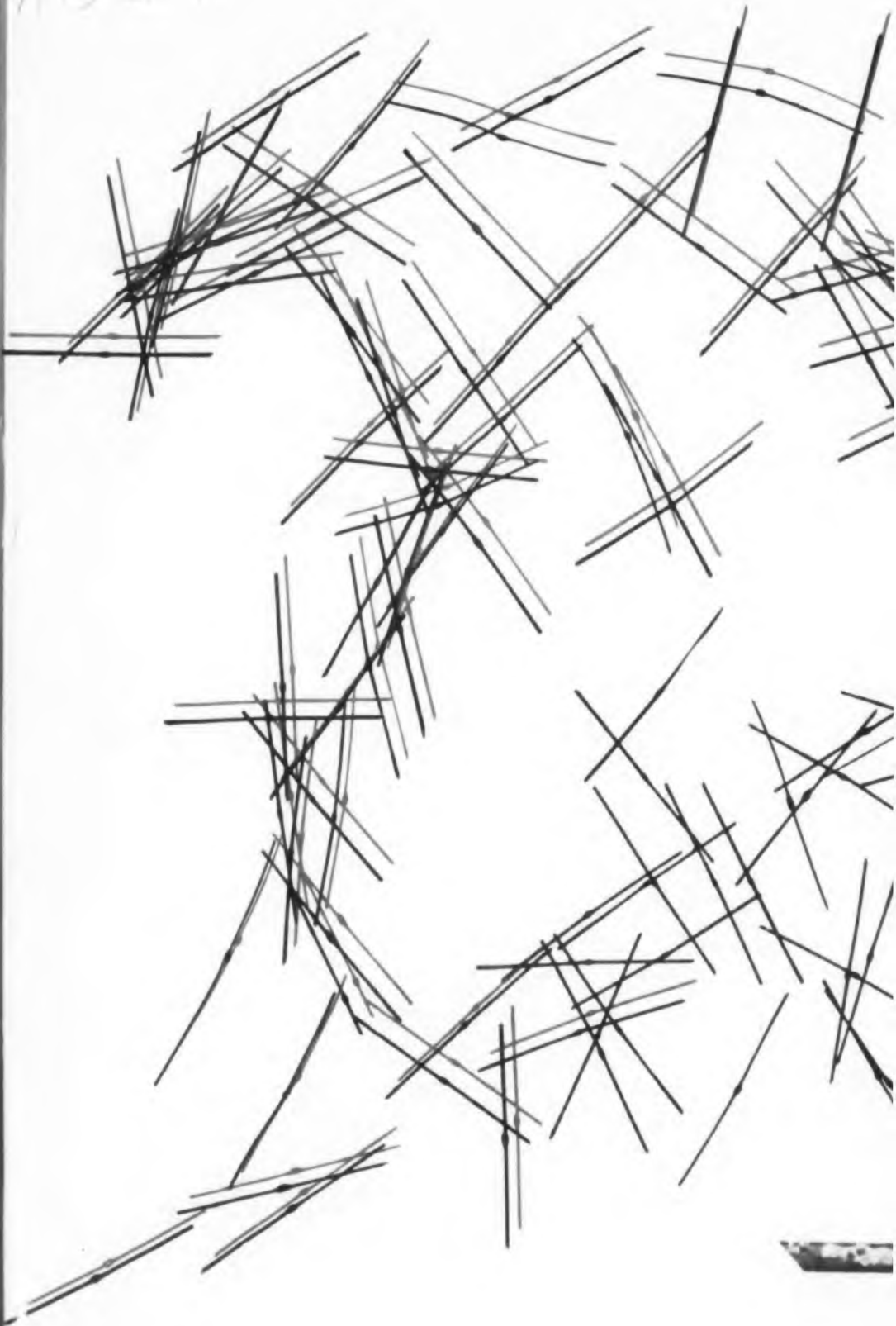


ELECT D

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A. D. ...



RONIC ESIGN

NOVEMBER 11, 1960

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Flyspeck Diode
Stands 20,000 g
... p. 74

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MINIATURE PULSE TRANSFORMERS



- Meets all requirements of MIL-T-27A
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CATALOG #	APPLICATION	TURNS RATIO
EPT-1		1:1
EPT-2	Impedance Matching	2:1
EPT-3		3:1
EPT-4		4:1
EPT-5	and	4:1
EPT-6		5:1
EPT-7	Interstage Coupling	7:1-1
EPT-8		5:1
EPT-9		3:1
EPT-10		1:1
EPT-11		1:1
EPT-12	Blocking Oscillator	1:1
EPT-13		2:1
EPT-14		1:1.4
EPT-15	Memory core &	5.5:1PP
EPT-16	Current driver	3.3:3.1PP
EPT-17	Current driver	6:1
EPT-18	Current Transformer	11:1
EPT-19	Pulse Inversion	6:1:1

*Supplied both molded and cased

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Primary 105/115/125 V 50-60~

Cat. No.	Appl.	MIL Std.	MIL Type
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MGP 2	Plate & Fil.	90027	TF4RX03JB002
MGP 3	Plate & Fil.	90028	TF4RX03KB006
MGP 4	Plate & Fil.	90029	TF4RX03LB003
MGP 5	Plate & Fil.	90030	TF4RX03MB004
MGP 6	Plate	90031	TF4RX02KB001
MGP 7	Plate	90032	TF4RX02LB002
MGP 8	Plate	90036	TF4RX02NB003

Cat. No.	Appl.	MIL Std.	MIL Type
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MGF 2	Filament	90017	TF4RX01GB003
MGF 3	Filament	90018	TF4RX01FB004
MGF 4	Filament	90019	TF4RX01HB005
MGF 5	Filament	90020	TF4RX01FB006
MGF 6	Filament	90021	TF4RX01GB007
MGF 7	Filament	90022	TF4RX01JB008
MGF 8	Filament	90023	TF4RX01KB009
MGF 9	Filament	90024	TF4RX01JB012
MGF 10	Filament	90025	TF4RX01KB013

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MGA 2	Pri. 600 Split Sec. 4, 8, 16	Matching	90001	TF4RX16AJ002
MGA 3	Pri. 600 Split Sec. 135,000 C.T.	Input	90002	TF4RX10AJ001
MGA 4	Pri. 600 Split Sec. 600 Split	Matching	90003	TF4RX16AJ001
MGA 5	Pri. 7,600 Tap @ 4,800 Sec. 600 Split	Output	90004	TF4RX13AJ001
MGA 6	Pri. 7,600 Tap @ 4,800 Sec. 4, 8, 16	Output	90005	TF4RX13AJ002
MGA 7	Pri. 15,000 C.T. Sec. 600 Split	Output	90006	TF4RX13AJ003
MGA 8	Pri. 24,000 C.T. Sec. 600 Split	Output	90007	TF4RX13AJ004
MGA 9	Pri. 60,000 C.T. Sec. 600 Split	Output	90008	TF4RX13AJ005

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- Variable DC test voltage: 50 to 1000 volts
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NEW MINIATURE VARIABLE HIGH FREQUENCY INDUCTORS

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- High Self Resonant Frequency



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VHI-1	1.1 1.75	95	2.2
VHI-2	1.7 2.5	95	1.9
VHI-3	2.3 3.7	95	1.6
VHI-4	3. 4.5	100	1.4
VHI-5	4. 5.7	100	1.3
VHI-6	5.5 7.5	100	1.
VHI-7	7. 10.5	100	.9
VHI-8	10. 15.	100	.85
VHI-9	14.5 20.5	100	.6
VHI-10	20. 30.	100	.55

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Here at last is a hermetically sealed magnetic voltage regulator that will provide constant output voltage regardless of line and/or load changes.

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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

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HIGHLIGHTS OF THIS ISSUE



Flyspeck Diode Stands
20,000 g (Cover) 74

Said to be the smallest commercial-type computer diodes available, the units in the PD-100 series can withstand 20,000 g. Some of their claimed uses are "hand-sized computers," and pocket-sized space instrumentation systems." One cubic foot can hold 20,400,000 of the diodes. An array of the diodes forms our art director's cover design. A photogram was made with the diodes (actual size) along with a diode (lower right) magnified several times.

How to Design a Sure-Starting Multi and Couple it to a load 46

Here is graphical information which can help a reader to quickly determine the optimum load coupling for a transistorized multivibrator.

Calibrating Frequency Standards 50

Seven methods of calibrating frequency standards are outlined. Types of equipment required and comparison of results are described to evaluate the various techniques.

Voltage Controls This Variable Bandwidth Amplifier ... 64

A simple vacuum tube device varies bandwidth in accordance with a control voltage. The circuit is useful at both audio and radio frequencies. It can be used to vary the bandwidth of a nonlinear servo system with respect to a derivative of the output.

◀ CIRCLE 1 ON READER-SERVICE CARD

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Directly interchangeable with all other octal-size relays.



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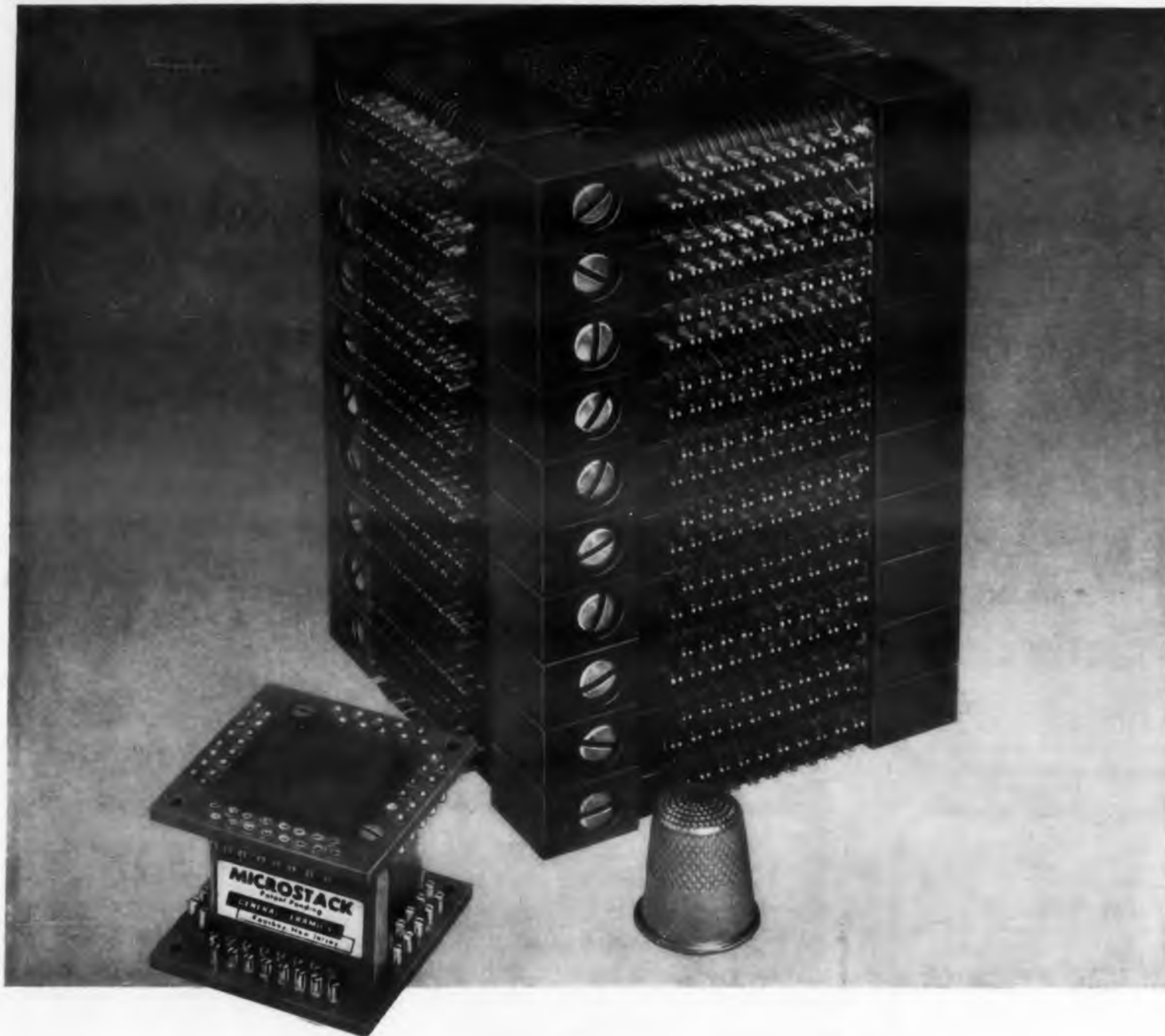


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 LIVINGSTON, NEW JERSEY

Write for Publication 131.

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Designing in miniature? Here's how to save space —



...90% of it!

New G-C MICROSTACK* for coincident current memory systems has a physical volume just 10% that of conventional stack. MICROSTACK shown with 2560 cores measures only 1.125" x 1.4" x 1.4", a reduction in size from 3½" x 3½" x 5".

This miniature stack consists of an array of 16 x 16 x 10. Solder connections are greatly reduced (from 1192 to 104), thereby substantially increasing reliability.

Noise level in the new MICROSTACK is as low as that of conventional types. The new MICROSTACK is available with all standard memory cores. Standard packages are available with coincident current wiring in 10 x 10 x 8, 16 x 16 x 8 and 32 x 32 x 8 arrays.

For further information, please write on company letterhead—address inquiries to Dept. ED.

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CIRCLE 3 ON READER-SERVICE CARD

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4. To reserve the right to refuse any advertisement.

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Canadian Electronics Bouncing Back

ELECTRONICS up North is emerging from its lean years headed in a new direction. The industry, though still convalescent, is aggressively pushing its designs on potential customers in the U. S. Three years ago things were different.

Then, in the face of a rising Canadian Gross National Product and record half-billion electronic sales the year before, sales dropped more than 15 per cent. Protectionist "buy Canadian" talk increased and uncertainty clouded the industry's future. Some companies collapsed, many designers and other engineers drifted to the U. S. and Europe.

The decline was blamed on reduction in defense spending, a sharp rise in importation of parts and products, and a weakening of the consumer electronics market.

Now, Canada's electronics industry is once again confident, expanding and making an impression in design circles. Paralleling this transformation is a tightening of links between the Canadian and U. S. electronics industries.

What has happened? Canadians cite three factors:

- The joint U.S.-Canadian Production Sharing Program, under which Canadian suppliers have easier access than before to U.S. military contracts.

- New emphasis on research and product development—a result of the realization that Canada must be selective in choosing areas of electronic competition.

- An upturn in Canada's consumer electronics market.

Since 1933 and the passage of the "Buy American" act, bids made by Canadians on U.S. military contracts had to be increased by a factor that was equivalent to a tariff. Moreover, end items for

(Continued)

Originality, Novel Layout Win Canadian Design Contest

Two prizes for best Canadian-designed electronic product and component were awarded to two companies exhibiting at the Canadian IRE show in Toronto last month. Criteria for the awards included originality, usefulness, quality of design, human engineering, marketability and other considerations. The contest was judged by men prominent in Canadian electronics, who named as winners Raytheon Canada, Ltd., and Bach-Simpson, Ltd.



This frequency controller-indicator, which combines in a small package a meter and a supervisory system, uses an idea reportedly new to direct-readout freq meters. A motor designed to run synchronously over a wide range of input frequencies and voltages is directly coupled to a small ac generator mounted integrally with it. A signal applied to the motor generates a voltage proportional to the input frequency. Both meter and generator are potted, and the whole design is engineered to keep its characteristics over a continuous operating period of 10 years.



Raytheon's scan converter for bright display of radar-originated information, is built around a scan-converter tube designed by the parent U.S. firm. Intended for continuous duty in air-traffic control, the complete unit was designed for durability, accessibility, and good heat dissipation. Hot parts are mounted on the outside of the chassis on hinged frames. Both the front and back of the cabinet are hinged. Small parts are mounted on horizontal strips on each swinging frame so that all components and parts are completely accessible. Cable entry is through bottom and top of cabinet.

Important News for Computer Designers!

New RCA MEMORY CORES
feature 1 microsecond performance with...
25% Reduction in Power Requirements!
40% Increase in Operating Margin!

*Dramatic improvement over present standard cores offers
greater design flexibility, top performance
in high-speed coincident current memory applications*

New 1- μ sec memory cores 226M1 (XF-4028) and 228M1 (XF-4257) developed at RCA's Materials Lab in Needham Heights, Mass., represent an important step forward in ferrite core design for military and commercial computers. See chart for the significant improvements in power requirements and operating margin now possible in 1- μ sec operation.

Call your local RCA Field Representative and learn how the new 226M1 and 228M1 can fit into your new computer designs. He can also give you information on the entire line of RCA Ferrite Memory Cores, Planes and Stacks available to meet your specific design requirements. For technical data, write RCA Commercial Engineering, Section K-18-NN2, Somerville, N. J.

NOMINAL OPERATING CHARACTERISTICS AT 25°C							
Type	Size	Full Driving Current (Im) (ma)	Partial-Write Current (Ipw) (ma)	Pulse Rise Time (Tr) (μ sec)	Switching Time (Ts) (μ sec)	Response	
						"Undisturbed 1" (μ V _i) (mv)	"Disturbed 0" (dV _i) (mv)
228M1 (XF-4257)	080" x .050" x .025"	620	310	0.2	1	160	18
226M1 (XF-4028)	050" x .030" x .015"	380	190	0.2	1	75	10



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NEWS

the U.S. military had to have a U.S. parts content of at least 50 per cent in general.

These restrictions, though they did not apply to equipment unavailable in the U.S., were inconsistent with the official policies of the American and Canadian Governments to establish cooperation in defense production. Though the U.S. military services interpreted the "buy American" restrictions liberally, preference was clearly given in competitive procurement to U.S. suppliers.

This year, however, the Defense Production Sharing Program was instituted by agreement between the two countries. Under the program, military electronics equipment supplied by Canada to U.S. contractors and military services is, in effect, exempt from provisions of the "Buy American" act.

Canadian suppliers receive preference over all other foreign sources and are often treated as American suppliers. Duty-free privileges can be obtained in subcontract work, and the Canadian electronics industry has been invited to tell its story to the U.S. military services.

The first results of the program are becoming apparent. Canadian Aviation Electronics, Ltd., has earned a fire-control subcontract from Hughes Engineering, and other successes have been made in radar, communications and data processing.

Canada is banking heavily on the Production Sharing Program. The Minister of Defense Production told Canada's Parliament that the Canadian electronic industry is "now in a transition period, which is likely to persist for two or three years, during which Canadian defense electronic production must be reoriented, in a very large measure, to serve a North American rather than a Canadian market."

Because production sharing is linked to R & D, the Canadians are hopeful of eventually receiving either significant research contracts or complete responsibility for a phase of the North American defense effort, or both.

To get its share, Canada's electronic industry has:

- Formed a Defense Production Sharing Committee in the Canadian Electronics Industries Association to help Canadians do business in the U.S.

- Started to set up American subsidiaries to relieve U.S. customers of customs and other paperwork. Both Sinclair Radio Labs and Welwyn Resistor have established two-man offices in the U.S. to handle this chore.

- Undertaken to exhibit in American shows.

In addition Government help is available to companies seeking American markets for their products or services.

The director of the Canadian IRE, A.P.H. Barclay, wrote recently, "In Canada we cannot hope to spread ourselves across the whole electronic horizon but must narrow our sights to particular fields of endeavor."

This sums up the Canadian position: that in a country of some 16 million people, R & D for export rather than mass production for home consumption should be the electronic industry's goal.

Canada's Deputy Minister of Defense Production, D. A. Golden, says: "Canadian industry will be able to share in . . . production programs only if its engineering capacity can be maintained and technical competence advanced through the performance of appropriate development tasks."

Therefore, the Canadian Government underwrites a good deal of electronic research—on the assumption that production sharing presupposes development sharing.

To keep military R & D efforts efficient, an Electronic Component Research and Development Committee advises the Government's Defense Research Board on the development of components to meet or anticipate defense requirements.

Another reason for confidence in Canada's electronics industry, at least for the near future, is the opening of the replacement market for TV sets. Saturation of the TV-set market was an important factor in the sagging sales of the last two years.

More help will be given by the establishment of second TV channels in major cities now served only by the Canadian Broadcasting Company network.

U.S.-Canadian Industries Moving Closer

Most of the exhibitors at last month's Canadian IRE show were either American companies or Canadian subsidiaries and affiliates of American companies. Many of the U. S. concerns wanting sizable business with Canada have set up over-the-border units to get it.

Some Canadian subsidiaries are merely marketing or production facilities for their U.S. parents. But others have strong R & D departments that are contributing substantially to the company record.

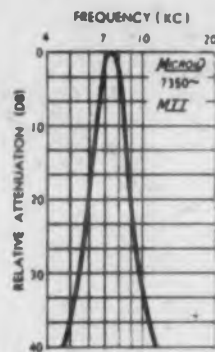
Two engineers from Canadian Westinghouse contributed the paper judged best at last year's National Electronic Conference. Raytheon Canada designed a scan converter around the parent company's scan converter tube and won the best-designed-product prize at this year's Canadian IRE show. Northern Electric, the Bell System's Canadian affiliate, is doing advanced research in a wide range of fields.

With close company tie-ins, with many Canadian engineers working in this country, and with the new Production Sharing Program, the gap between the U.S. and Canadian electronics industries is narrowing. ■ ■

SPACE SHRINKERS

MICROIDS AND MONKEYS— Burnell & Co. welcomes the assistance of their simian friends in the task of gathering data vital to space shrinking. By shrinking toroids, filters and related networks for guidance and communication systems, Burnell helps space vehicles carry bigger payloads — more instrumentation, animals — eventually man. Typical of our accomplishments is the **MTT MICROID®** telemetering band pass filter. Significantly, the combined weight of 23 **MICROIDS** — plus the monkey — is less than the single non-miniaturized telemetering band pass filter pictured here. **MICROID** band width is 15% at 3 db + 60% —40% at 40 db. Frequency coverage is from .4 kcs to 70 kcs.

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Channels 1-6	2x27/32x1/2
Channels 7-10	1-5/16x11/16x11/16
Channels 11-18	15/16x19/32x1/2
Alternates A-E	15/16x19/32x1/2



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CIRCLE 5 ON READER-SERVICE CARD

NEWS

22 Stereo Broadcasting Systems Vie for FCC Nod

How Proposed Stereo Systems Compare FM Stereo Systems With FM Subcarriers

System	Main Channel			Subcarrier			
	Signal	Bandwidth KC	% Mod.	Signal	Bandwidth KC	Freq. KC	Swing KC
Calbest	L+R	15	70	—R	3.5	27	±5
Crosby	L+R	15	50	L—R	15	40	±25
EMI	L+R	15	>90	L' L'+R'	0.1	22	±0.5
Halstead	2L—R	15	70	2R—L	15	41	±7

FM Stereo Systems With AM Subcarriers

GE	L+R	15	50	L—R	15	31.5	d.s.b.
Zenith	L+R	15	90	L—R	15	39	d.s.b. s.c.

Notes: d.s.b.—double sideband s.c.—suppressed carrier

TV Sound Stereo Systems

EMI	L+R	15	90	L' L'+R'	0.1	22	A
GE	L+R	15	100	L—R	15	31.5	B
Motorola	L+R	12	85	L—R	0.3-4	23.6	C
Philco	L+R	7	95	L—R	0.5-7	15.75	D

Notes: A—Same as FM system. B—Same as FM system but suppressed carrier. C—±5 KC swing FM. D—Lower side band suppressed carrier.

AM Stereo Systems

System	L+R Information	L—R Information	
		Bandwidth KC	How Obtained
CBS	Normal AM	?	Phase Mod.
Philco	Normal AM	0.3-?	Phase Mod.
GE	Normal AM	0.3-4	±4 KC FM
RCA	Normal AM	?	±0.5 KC FM
Westinghouse	Normal AM	0.3-3	±3 KC FM
EMI	Normal AM	0.1	±0.2 KC FM
Kahn	(L on one sideband, R on the other)	?	?

FROM PHILCO...

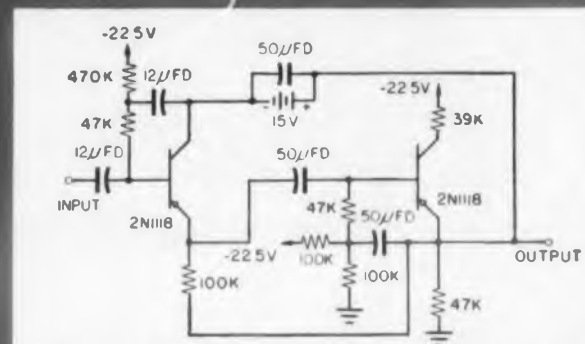
2 NEW

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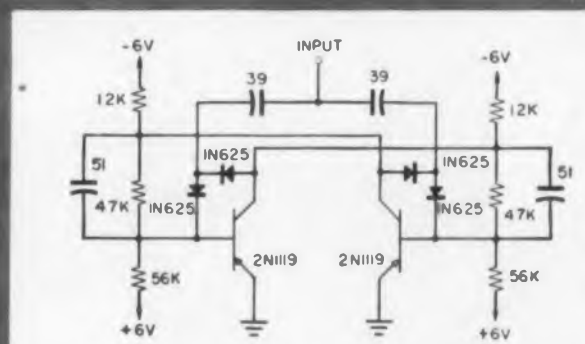
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2 MCS Binary Counter—(-55°C to +125°C)

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Philco continues its leadership in the Silicon high speed PNP field with these highly reliable field-proven SATs. In addition to their other superior characteristics, they have adequate frequency response to fill a large percentage of silicon transistor applications in both military and commercial circuits operating at high ambient temperatures. They are environmentally tested in accordance with MIL-T-19500 A. These two new types supplement and are the electrical equivalents of the widely used 2N495 and 2N496, offering the designer a choice of packages (TO-1 and TO-5). For very high speed switching applications, designers should consider Philco's NPN Diffused-base Transistor 2N1199. Write for complete information, Dept. ED 1159.

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CIRCLE 6 ON READER-SERVICE CARD ➤

THE NAGGING question of multiplex adapter availability was raised again at the recent New York High Fidelity Music Show. With stereo playback equipment dominating the attention of the 46,000 visitors, major manufacturers of tuners and complete packages were besieged with requests for stereo broadcast adapters. But, as in previous years, spokesmen were again compelled to stall the public, because Federal Communications Commission evaluation of proposed systems has not been completed.

No less than 22 stereophonic systems are being evaluated by the National Stereophonic Radio Committee (NSRC) in its effort to help the FCC set up standards for the broadcasting and manufacturing industry.

Though systems are proposed for each broadcast service—fm, am and television—highest priority is being given to fm. The FCC has asked the industry for its recommendations on fm by Dec. 11. NSRC is giving its highest priority to the evaluations of Panel 1 on System specifications, under the chairmanship of C. J. Hirsch.

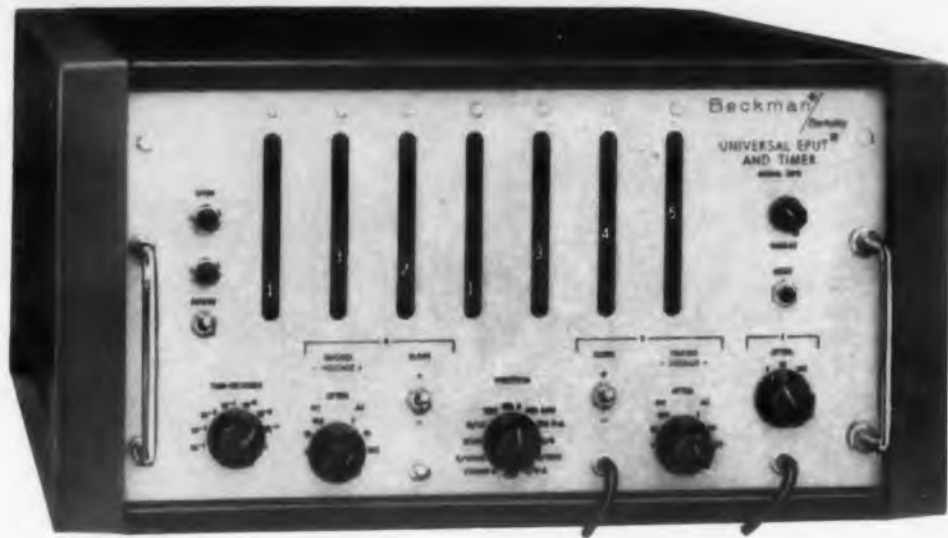
AM-FM Systems Outlined

In a recent report, Mr. Hirsch described the 22 proposed systems and progress toward agreement on which might be the best to offer for the FCC's consideration.

For fm, systems are proposed by Calbest, Crosby, Halstead, Electrical and Musical Industries, Ltd. (EMI); General Electric, Philco, Zenith, Volpe, Svorec, Neeley and Lippincott. For am, schemes have been submitted by GE, Kahn, EMI, Philco, Westinghouse, the Columbia Broadcasting System and Radio Corporation of America. For TV, systems have been offered by GE, EMI, Motorola and Philco.

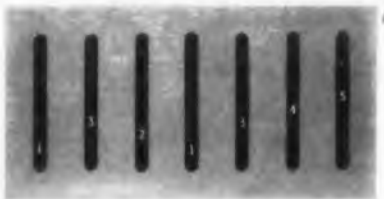
The fm systems are divided into two groups: those with fm subcarrier (EMI, Calbest, Crosby and Halstead) and with am subcarrier (GE, Zenith, Volpe, Svorec, Neely and Lippincott). Philco had an am subcarrier system but withdrew it, stating that its advantages were not

10 Mc Counter displays microwave frequencies



to transfer oscillator

Coupled to a computing transfer oscillator, this counter will display the 13,213.45Mc reading shown...one more instance of the unique utility of Model 7370.



SPEEDY, PRECISE METHOD

1. Operator tunes transfer oscillator in the conventional way—finds two adjacent fundamentals having harmonics that zero-beat with the unknown frequency.
2. Reads harmonic number appearing on built-in automatic calculator.
3. Sets digital switches to harmonic number.
4. Reads microwave frequency as it appears on the face of the counter. The entire procedure takes less than one-fifth the time ordinarily required.

SPECIFICATIONS

Model 7370 used with transfer oscillator (Model 7580)

Frequency measuring range	dc to 15KMc
Types of signals accommodated	CW, AM, FM, pulsed r-f
Sensitivity	100 mv rms
Input impedance	50 ohms
Accuracy	up to $\pm 3p$ in 10^7
Fundamental range of trans. osc.	75 to 150 Mc & 7.5 to 15 Mc
Harmonics available	up to 100th
Stability of fundamental0001% per min

Model 7370 alone

Frequency counting range	dc to 10Mc
Sensitivity	selectable: 0.1v, 1v & 10v
Input impedance	10M ohms
Stability of time standard	3 parts in 10^7 per week
Additional functions	Measures period, phase & frequency ratio.
	Times interval between independent signals.

Prices

Model 7370 Universal EPUT® & Timer	\$1975
Model 7580 Computing Transfer Oscillator	\$1650

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NEWS

great enough to justify prolongation of debate.

At the time of Mr. Hirsch's report, only the fm-am group had offered preliminary findings. NSRC was still awaiting reports from the fm-fm, the am broadcasting and the TV groups. Another committee is completing a theoretical comparison of fm-fm and fm-am systems.

Preliminary Findings Noted

Mr. Hirsch reported the results of the preliminary findings on fm-am systems as follows:

"The GE system provides the least expensive stereo performance, because the receiver does not need to reconstruct the subcarrier.

"Philco and Zenith, because they need not reserve modulation range for the subcarrier, which is nearly suppressed, allow fuller modulation (almost 100 per cent) for L + R channels and therefore are expected to provide superior monophonic and stereophonic reproduction."

"There appears to be little to choose between Philco and Zenith in performance. The same can be said for the time-multiplex systems, since after modification, they will resemble the Zenith approach very closely. However, as stated above, the receivers are more complicated than the GE stereo receiver.

"The Receiver Panel (No. 4) of NSRC will be asked to evaluate the relative complexity of the fm-am receivers. If a system gives greater performance but results in costlier receivers, the facts will be presented to the FCC for decision."

Factors being considered by the committee with the final decision up to the FCC are: compatibility, signal-to-noise (monophonic and stereo), stereo effect, receiver and transmitter complexity, utilization of spectrum space, and effect of propagation (multipath).

The systems specification panel has been suffering delays, Mr. Hirsch said, because adequate test facilities could not be found by Panel 6 (Subjective Aspect). This was resolved by the offer of facilities by Bell Labs.

Thus another year may pass before final system approval is decided by the FCC. Until then, major manufacturers are reluctant to invest in the development and production of adapter units. Monophonic broadcast reception will still prevail for the coming year. ■ ■

Electronics Education to Benefit from Ford Foundation Grants

Two of the most unusual applications of the \$19.5 million recently granted by the Ford Foundation to 10 schools to modernize the teaching

of engineering will directly affect education in electronics.

Case Institute of Technology will use its \$1 million to create centers in engineering design and systems research and Massachusetts Institute of Technology will introduce new curricula to meet the requirements of tomorrow's engineering.

Believing that "the greatest emphasis in engineering education should be placed upon the close relationships and inter-disciplinary character of modern engineering and science," Case will set up an engineering design laboratory that will specialize in authentic design problems. Among projects being considered are those for computer-controlled machine tools, electronically controlled devices for the handicapped, and instruments for unusual environments.

The laboratory will be headed by Dr. J. B. Reswick, who defines engineering design as "the creative experience which begins with an original concept or idea, utilizes science and engineering, and ends with the construction and evaluation of a device or system which meets a human need."

The lab will specialize in "authentic design problems" and will cut across many of the existing boundaries between the special fields in engineering and science, according to Case.

Work at the systems research center will also cross different fields. The center is said to be the first academically based center in systems engineering. It will use the talents of the entire Case faculty.

Systems under study for early work at the center include a complex automatic computer for industrial control and a large-scale communication system.

MIT will use its \$9.275-million grant to support a program of development and innovation in its engineering school. Seven professorships in newly emerging fields will be created, new labs to demonstrate fundamental concepts will be developed, and steps will be taken to help students financially through fellowships and loans.

A major program will be the creation of "new syntheses of courses to couple the basic science with the newly emerging fields of engineering and to introduce students to the 'hard-headed' purposefulness of engineering."

The awards were announced during a meeting of the American Institute of Consulting Engineers by Dr. H. T. Heald, president of the Ford Foundation, who asserted that engineering education had fallen behind engineering developments.

Also of significance to electronics is the use to be made of Ford Foundation funds by the University of Michigan. A major share of its grant, \$900,000, will be used by the university to support an experimental program leading to the widespread use of computers in engineering education.

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Sprague Miniature Pulse transformers give the circuit designer the flexibility he needs to meet the varied requirements of low-power, high-speed computers. Sprague literature details more than 800 standard units in a wide variety of mounting styles, shapes, and encasements for conventional or printed wiring board assembly. Many special types can also be furnished to match specific circuit and packaging requirements.

Sprague pulse transformers handle pulse widths of 20 millimicroseconds and wider...at repetition rates as

high as 10 megacycles... with pulse levels ranging from fractions of a volt to several hundred volts.

Typical circuits utilizing Sprague Pulse Transformers include *pulse amplifiers* (for current or voltage step-up, impedance matching, decoupling, pulse inversion and push-pull operation); *pulse shaping and differentiating*; *blocking oscillators* (in regenerative circuits of the triggered and self-triggered type); *general transistor circuits*.

For application assistance on your pulse transformer problems, write to Manager, Special Products Division, Sprague Electric Company, Union St., North Adams, Mass. A complete series of Engineering Bulletins covering Sprague's standard pulse transformers is available from Technical Literature Section, Sprague Electric Company, 347 Marshall St., North Adams, Mass.

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Input Resistance: Infinite at Null
Resolution: .005v at 500v to .00005v at .1v

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Accuracy: .2% from .5 volt to 500 volts from 30 CPS to 5 KC
Input Voltage Ranges: 500-50-5v
Null Ranges: 10-1-.1-.01v
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Resolution: .005v at 500v to .00005v at .1v

Cabinet Size: 9 3/4"x13"x17"—Net Weight: Cabinet Model—30 pounds

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NEWS

Details of Perceptron Recognition Research Reported

THE FIRST actual pattern-recognition perceptron is nearing completion at the Cornell Aeronautical Laboratories in Buffalo, N.Y., reported Dr. A. E. Murray at the National Electronic Conference last month.

Dr. Murray, who is active in the Navy-sponsored program, delivered a paper describing for the first time many details of the perceptron project.

Perceptron is the class name for a family of pattern recognition machines that operate on principles believed used in the human brain. So far, all except one perceptron exist only as simulations on an IBM 704. The first actual Mark I perceptron is now being completed and is expected to discriminate reliably between such patterns as E's and X's, squares and diamonds, and E's and F's.

The Mark I consists of 400 sensing transducers randomly connected to 512 electro-mechanical memory units called the association system. These units are randomly connected to response, or display, units. The response units are connected, also in random, through feedback circuits to the memory system.

In operation, a portion of an image is picked up by a transducer and passed to some of the memory elements, all of which are unbiased and equally likely to switch one way as another. The signal goes on to the display, from where its effect is fed back to strengthen or inhibit the memory cells so they will provide a memory trace that will dominate future responses.

The perceptron design is potentially versatile. Input can be radar, optical, audio or other stimuli. Output can be any

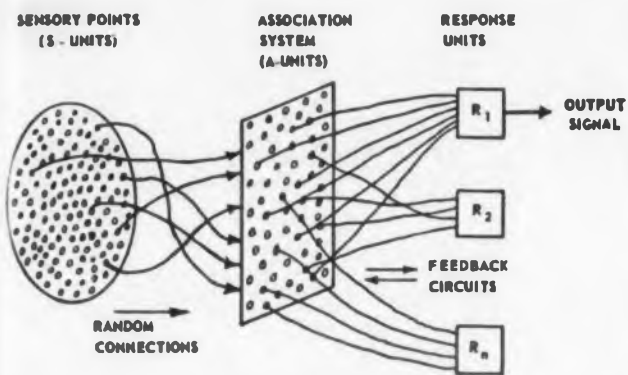
type of readout or display. But, Mr. Murray told ELECTRONIC DESIGN, it is more difficult to force the machine to learn to do useful work than it is to permit it to learn spontaneously.

This is because Perceptron networks have no special relation-detectors and will be incapable of certain kinds of useful behavior. They are at their best when working with relatively noncoherent patterns. For coherent-pattern recognition additional logic for coherence-sensing edge and corner detection, inside-outside before-after, under-over, and other topological relationships, is expected to give improved performance, and will be researched later. Except for work now under way in transform generalization and time relationships, effort has been confined to machines that sense only analytical attributes. But simulated perceptrons have been taught to generalize and discriminate coherent patterns in special circumstances, to spontaneously form "rational" or useful classification for a collection of coherent stimuli.

One simulated perceptron recognized shapes regardless of position or orientation, and in favorable (but not rigged) circumstances a perceptron modified its own transmission characteristics to reflect population characteristics met in its signal environment. In some experiments a perceptron was presented with a succession of horizontal and vertical bars in various vertical and horizontal positions. This machine had only two possible responses each of which eventually and spontaneously come to be associated with just one bar class.

All perceptrons may be classed as multi-

ANNOUNCING A NEW DEVELOPMENT BY BENDIX



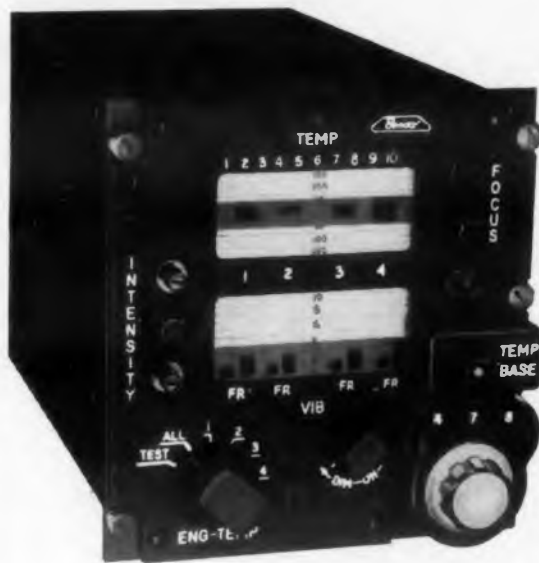
Schematic of perceptron organization shows the three types of units that work together to recognize patterns. Sensory units can be photocells, filters, or any transducer. Output cells can feed any type of readout or display.

port signal transmission networks with transmission characteristics that can be arranged to change automatically or can be changed from the outside to adapt the machine to applications related to complex signal recognition and/or classification. Two of the interesting features are:

- The adaptation is operational. It is on-the-job training, with the adaptation occurring as a result of practicing the tasks to which it will be trained. Neither the original internal circuit details nor the details of the adaptive changes need to be known or specified in order to construct or train a machine for useful or desirable behavior.
- The loss or malfunction of a few components is not likely to affect noticeably the reliability of operation.

Perception Structure

In all perceptrons to date, there have been at least three distinguishable sets or layers of functional units. In a signal flow graph for the network, each unit is a node of the network diagram and the nodes are connected by branches. Nodal units of different layers have different connection constraints and different dynamic properties. Three-layer devices, have, in the first layer, S-units (sensory cells); in the second layer, A-units (association cells); and in the third layer, R-units (response or output cells). So far, except for S-units, non-linear elements have yielded the best results; linear A-units have been only briefly considered. In a practical machine, S-units either are or contain the input terminals for the network. They may include transducers, each sampling some small part of a complex input pattern and converting this information into a signal transmitted to several A-units. In a moderate-size machine of 400 or 500 or more A-units, connections from S-units to A-units may be random—one feasible construction scheme being to begin the wiring at the A-unit level, taking n_0 leads from each



FOR TURBINE ENGINES

Provides a continuous condensed display of turbine engine vibration and temperature conditions

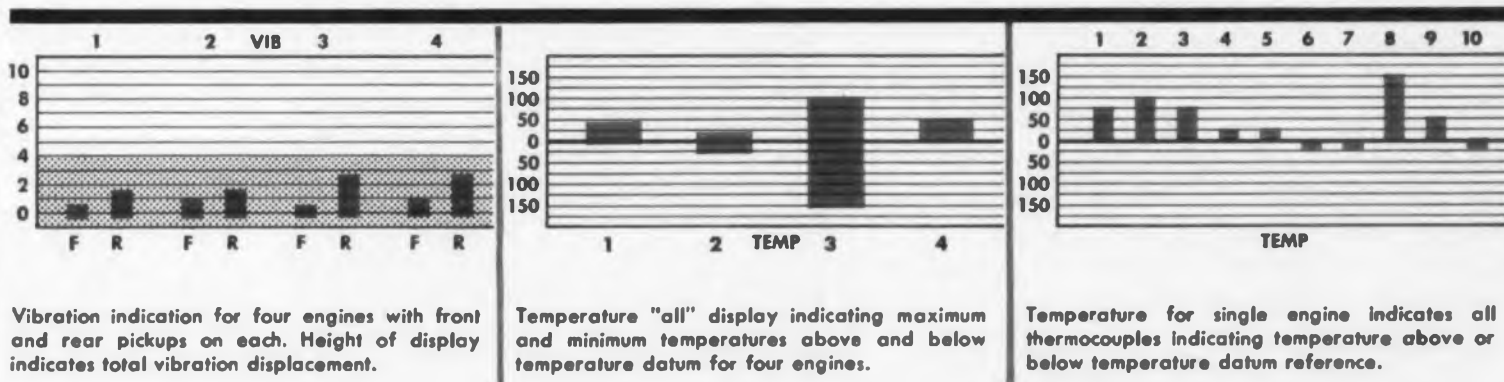
A landmark in engine instrumentation progress is the Bendix* Temperature-Vibration Monitor which simultaneously displays the findings of 40 temperature and 8 vibration sensors strategically located on all 4 engines of a turbine powered aircraft. This data is presented on the flight deck of the aircraft in bar graph form so that it can be continuously monitored and easily read.

The average displacement of 8 vibration pickups is displayed continuously on the lower cathode ray tube with the top of the bar graph indicating vibration displacement on the grid scale. This continuous monitoring of vibration immediately indicates excessive unbalance on the jet engine.

The temperature analysis normally associated with the exhaust gas thermocouples will locate faulty burners, bad combustion distribution and plugged nozzles or any unusual hot or cold

conditions around the turbine engine exhaust. The temperature display in the "all" position presents maximum and minimum temperatures on the upper cathode ray tube continuously for the four engines as reference to a temperature datum set in by the operator. The individual engine temperatures can be displayed as 10 bar graphs whose deflection can be read on the tube scale as deflections above or below the temperature datum, and individual degrees may be accurately and easily read from the digital read-out dial.

The equipment, initially developed for BOAC, is applicable to all airline and military turbine powered aircraft. The equipment for the four engine installation is approximately 30 lbs. and includes the Temperature-Vibration Monitor pictured above and a remotely mounted 1/2 ATR short box. *TRADEMARK



Vibration indication for four engines with front and rear pickups on each. Height of display indicates total vibration displacement.

Temperature "all" display indicating maximum and minimum temperatures above and below temperature datum for four engines.

Temperature for single engine indicates all thermocouples indicating temperature above or below temperature datum reference.

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NEWS

A-unit and connecting them, in random fashion, to the S-units. If the task is pursued in this manner, the number of output leads from each S-unit will be a random variable.

Because of the plurality of outputs from each S-unit and the scrambled wiring between the S-units and the A-unit layer, each A-unit receives connections from several S-units, over which flows a rather unique, small sampling of any activity among the S-units. The uniqueness is enhanced by the provision for some S-units, or at least some S→A branches, to inhibit the A-units they drive.

If the net sum of the signals received by an A-unit is sufficient to turn it "on", it will put out a signal to whatever R-units it has connections. Finally, the states of the R-units, as determined by the signals received from active A-units, either may be read by an observer as an identification or classification label or may be used to direct or otherwise control an external device.

Adaptive changes in the system's performance are effected through lasting changes produced in the output levels of A-units by feedback from the R-units, which is integrated and stored in each A-unit as a level-setting value.

An R-unit may or may not have a threshold. Furthermore, since it acts as a signal port for the network proper, the physical character and utilization of its main output signal is at the discretion of the designer—it has nothing to do with the internal behavior of the network. The logical characteristics, however, are important. R-units may be designed to have any number of output states but it will make examples simpler if we consider an R-unit to be a 2-state device. An auxiliary output signal from one or both of its states is fed back to its A-units, modifying their stores values and thereby affecting their future output strength.

Closure of the feedback loop can occur through some external agent such as an operator or trainer or another machine. But if loop closure is internal to the network proper, the perceptron can be capable of self-training.

Stimuli for a perceptron consist of complex signal patterns of any number of dimensions. In a practical machine, such patterns may be optical images projected onto a retinal mosaic of photo-sensitive elements, waveforms fed to an analyzing filter-bank, or some other such projection of a set of physical attributes.

For optical inputs, each S-unit of a perceptron would possess a photo-sensitive element and an amplifier or other impedance matching device for sending driving signals to A-units. Whether the S-units are chosen to be linear or not depends

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upon the number of them provided and the gray-scale resolution desired. Because any continuous-tone figure can be closely approximated with a sufficient number of small dots of standard density, any continuous-tone image can be closely characterized by a two-dimensional array of on-off elements. However, for a retina, it is probably cheaper to use a smaller number of S-units and have them linear over some reasonable range.

When a stimulus S_j is projected onto a perception retina, a certain set of S-units will be excited. These, in turn will excite a certain set, $A(S_j)$, of A-units but the retinal illumination pattern at the level of the A-units, will be so scrambled that it will lose its original coherence and most other relational characteristics. The combined effect of the outputs from the set, $A(S_j)$, will determine how the relatively small number of R-units will respond.

Feedback operation can be understood more easily by assuming just one binary R-unit, so that the source set for that response unit is therefore the whole population of A-units. Assume also that the feedback from R-unit to A-units is arranged in such a way that A-units may acquire either positive or negative values and, consequently, positive or negative outputs when active. Should the net sum of excitation delivered to the R-unit from the active set $A(S_j)$ be positive, the R-unit will go to the "1" state, otherwise to the "0" state.

Feedback signals from either of these alternative states will add or subtract some small increment, ΔV , from the values of active A-units, thereby affecting their future output levels. Positive feedback from the 1-state will enhance the future effect of those A-units that are presently causing the $R = 1$ response. The same polarity feedback, received by active A-units whose output is unsuccessfully trying to turn on the $R = 0$ response, will decrease their influence toward that response. Hence, a succession of negative experiences may eventually reverse a unit's output polarity, thereby enabling it to receive reinforcements for responding to the same stimuli which once caused decreases in absolute value.

Training a perceptron to a given stimulus environment subjects the population of A-units to a selection and modification process similar in some ways to that which operates in biological evolution. The difference in the two processes stems from the fact that, since A-units neither expire nor have progeny, no genetics or spontaneous mutation are involved. Whatever modification occurs, it takes place within the lifetime of the original set of A-units.

In a perceptron those A-units whose chance connections permit them to be most frequently activated by stimuli of just one class are selected by actual exposure to a stimulus population containing some of this class. Their output polarity is,



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NEWS

at the same time, little by little, adjusted toward the most favored response. Naturally, there are likely to be some A-units whose connections do not fit them for any consistent utility in their signal environment, and they will tend to stay at a relatively low output effectiveness. A mutation process designed to operate on the connections of relatively low-valued A-units could be incorporated and might be beneficial.

Future Plans

Dr. Murray reports that simulation experiments will begin soon with a new and more versatile program, especially on cross-connected A-systems. At about the same time, direct experimentation will begin on the Mark I perceptron.

Multi-layered A-systems are now being studied to discover practical ways for, and advantages of, increasing the logical depth. The researchers hope that future effort will provide mechanisms for recognition of special topological relationships, and additional effort is being directed toward the recognition and utilization of special time relationships. If this work succeeds in sufficiently increasing the sophistication of perceptron capabilities, the Navy will sponsor intensive effort on engineering applications requiring the recognition or interpretation of complex data.

Obvious applications would be in radar and optical surveillance and reconnaissance, language processing and electronic communication, and adaptive control systems for vehicles and production plants. ■ ■

Reps Symposium to Discuss Industry Measurement Needs

The fifth annual Electronic Engineering Representatives Show, to be held in Philadelphia Nov. 12 and 13 will feature a symposium on electronic test instrumentation.

The speakers will include:

Bruno O. Weinschel of the IRE Professional Group for Instrumentation, whose topic will be "Russian Test Equipment for Audio, Radio Frequency, and Microwave Measurements."

C. P. Sherman, General Electric missile and space engineer, who will discuss "Production Testing for Research and the Development Type Components."

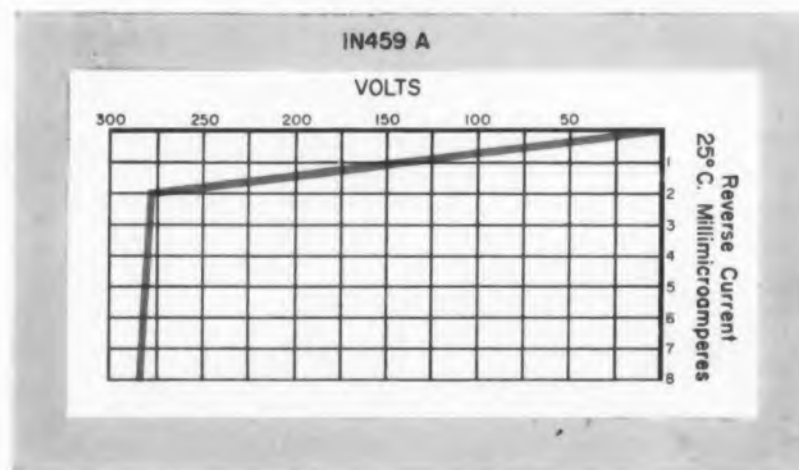
E. C. Wolzien of the National Bureau of Stand-

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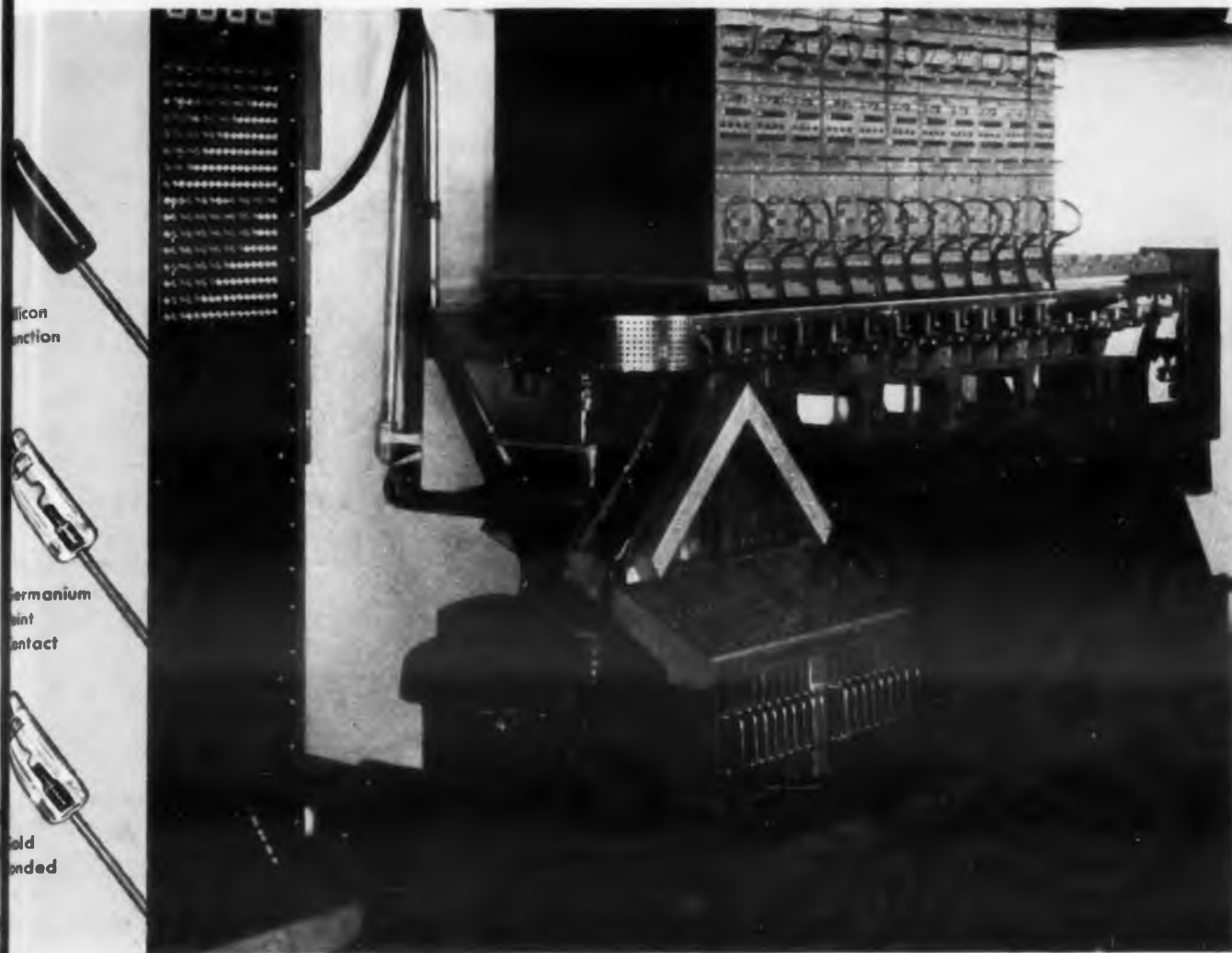
In addition to 100% testing programs for Sylvania diodes, through scientific sampling procedures, are thoroughly tested as follows:
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1N458,A	1N463,A	1N484,A,B	1N488,A	1N128	1N198	1N279	D1248
1N459,A	1N464,A	1N485,A,B				1N281	



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The electronic equipment of over 50 manufacturers will be displayed.

Design Has Many Faces

Remember that huge klystron at WESCON? There's a story behind it. Varian Associates built it on a crash program—when the contract principal began having trouble, Varian as alternate contractor had to step in and make good in a hurry.

Normally klystrons are processed after construction by "breaking down" the cathode (activating it) and then by drawing beam current. During both these processes large amounts of gas are liberated—in particular metallic vapor is released if a high power pulsed beam touches any of the tube sides. This of course destroys the vacuum integrity of the tube. The klystron is re-evacuated and sealed after the break-in process.

Trouble was Varian's facilities for supplying pulsed power hadn't been finished at the time. No beam current could be drawn before delivery



Giant klystron triggered some enterprising design under time pressure.

of the tube. Varian engineers' solution: tack a five liter per sec VacIon pump—also manufactured by Varian—to the top of the klystron . . . and ship on schedule. It worked. Any gas liberated during the tube's initial operation was immediately carried off by the VacIon pump.

EVERYTHING you need for fast, easy

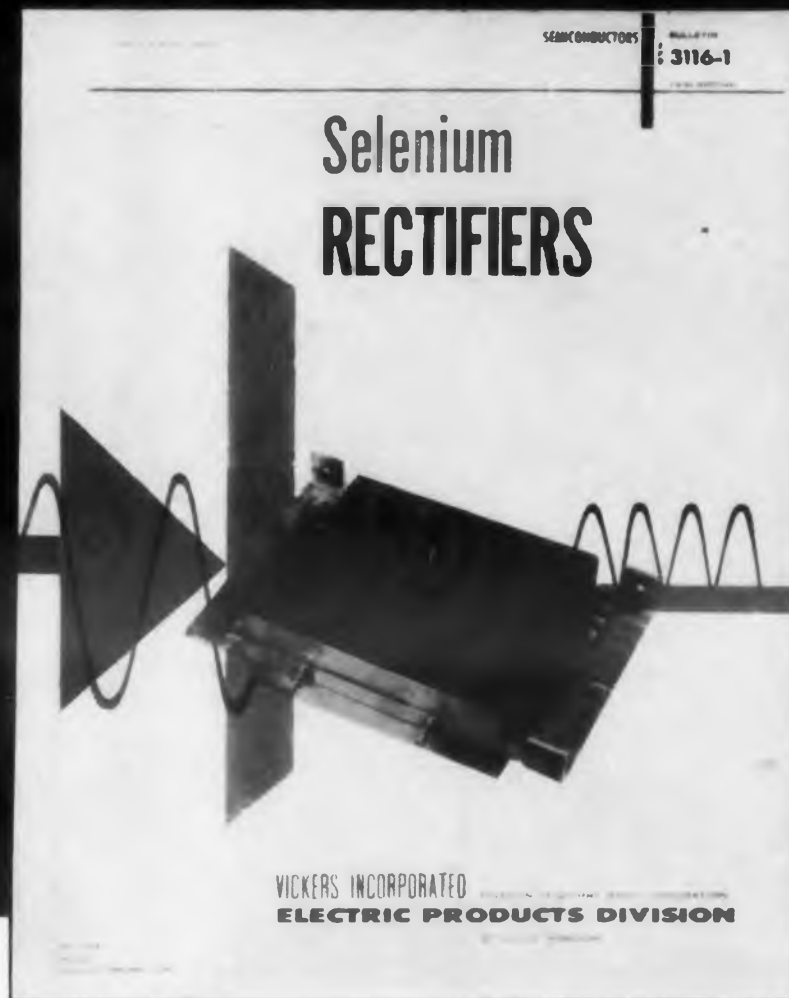
SELENIUM RECTIFIER SELECTION

Over 1200 Rectifiers
Fully Described

48 Pages of Solid
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Complete Information on

CIRCUITS
SIZES
DIMENSIONS
CURRENT RATINGS
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PRICES
INSTALLATION, etc.



VICKERS® Grain-Oriented* SELENIUM RECTIFIERS

The unique characteristics of these rectifiers provide efficiency and economy unmatched by conventional rectifiers.

In Vickers rectifiers, the selenium is grain-oriented: crystals are aligned in the same direction, rather than in the random pattern found in ordinary rectifiers. The result? More working crystals, greater uniformity, better performance per square inch of cell area. Rectifiers provide higher current ratings without increase in cell size, and without danger of overloading; cost per watt of output is lower.

This 48-page bulletin gives you the complete story.

Send for Bulletin EPA-3100-3. Letterhead requests only, please



VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
ELECTRIC PRODUCTS DIVISION

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CIRCLE 13 ON READER-SERVICE CARD

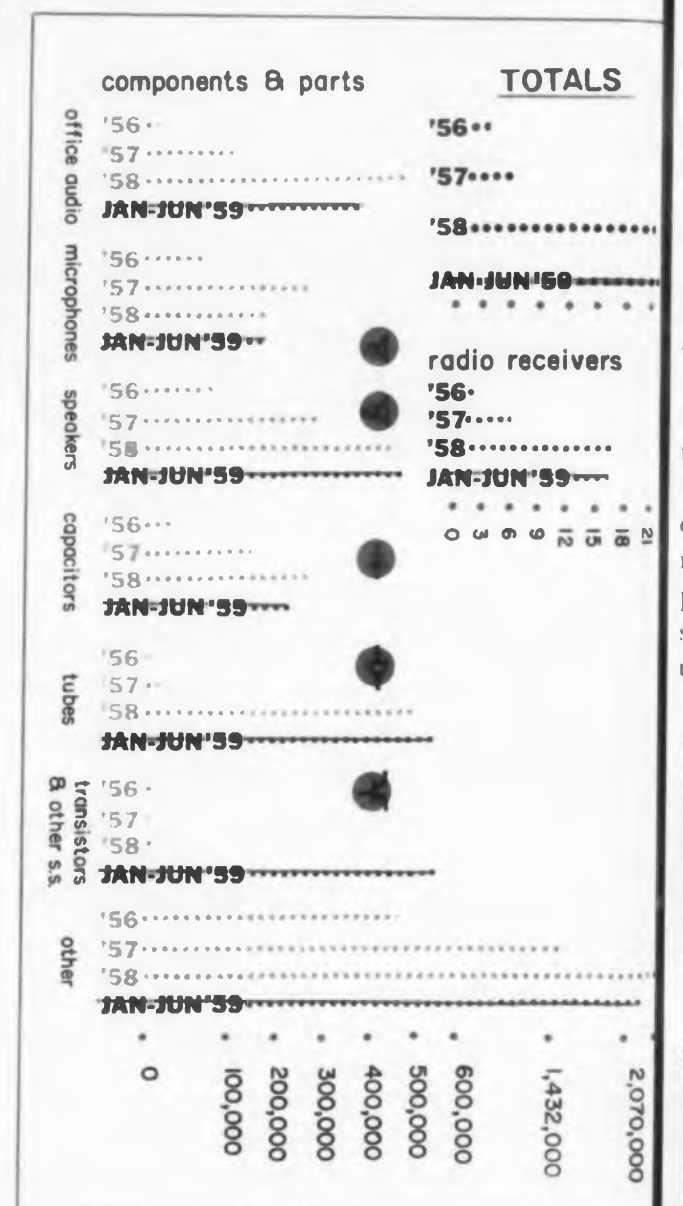
NEWS

U.S. Electronic Imports from Japan In First Half of '59 Top All 1958

The value of electronic imports from Japan totaled \$22.1 million during the first six months of 1959, exceeding by over \$200,000 the value of products imported during all of 1958.

The latest figures of the Business and Defense

HOW ELECTRONIC IMPORTS FROM JAPAN HAVE GROWN IN LAST THREE AND A HALF YEARS



Services Administration, summarized in the accompanying graph, show that transistors and other solid-state parts made the largest gain over last year, and that receivers comprise the largest-valued import.

Educational TV to be First Tryout For CBS Labs' Narrow-Band System

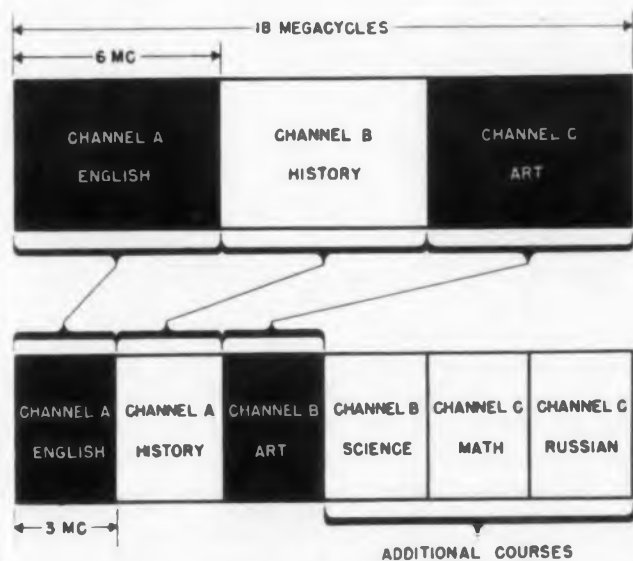
Airborne educational TV will be the first full-scale application of the CBS Labs narrow-band TV system that uses a 2.2-mc bandwidth. Special receivers designed to operate on the 441-line, 48-field standard will be installed in schools scattered over the six-state Midwest reception region chosen for the experiment, in which programs will be transmitted from a plane circling the area.

With the CBS system, developed some time ago for vhf and now adapted for uhf, two channels can be squeezed into the space normally occupied by one. Channels are 3 mc wide, instead of the normal 6 mc, and video bandwidth is 2.2 mc. Horizontal resolution will be equivalent to only a 3.3-mc-bandwidth broadcast-standard picture. But, reports CBS Labs, this is about all that is seen on the average set, which is nominally designed to handle a 4-mc-bandwidth picture.

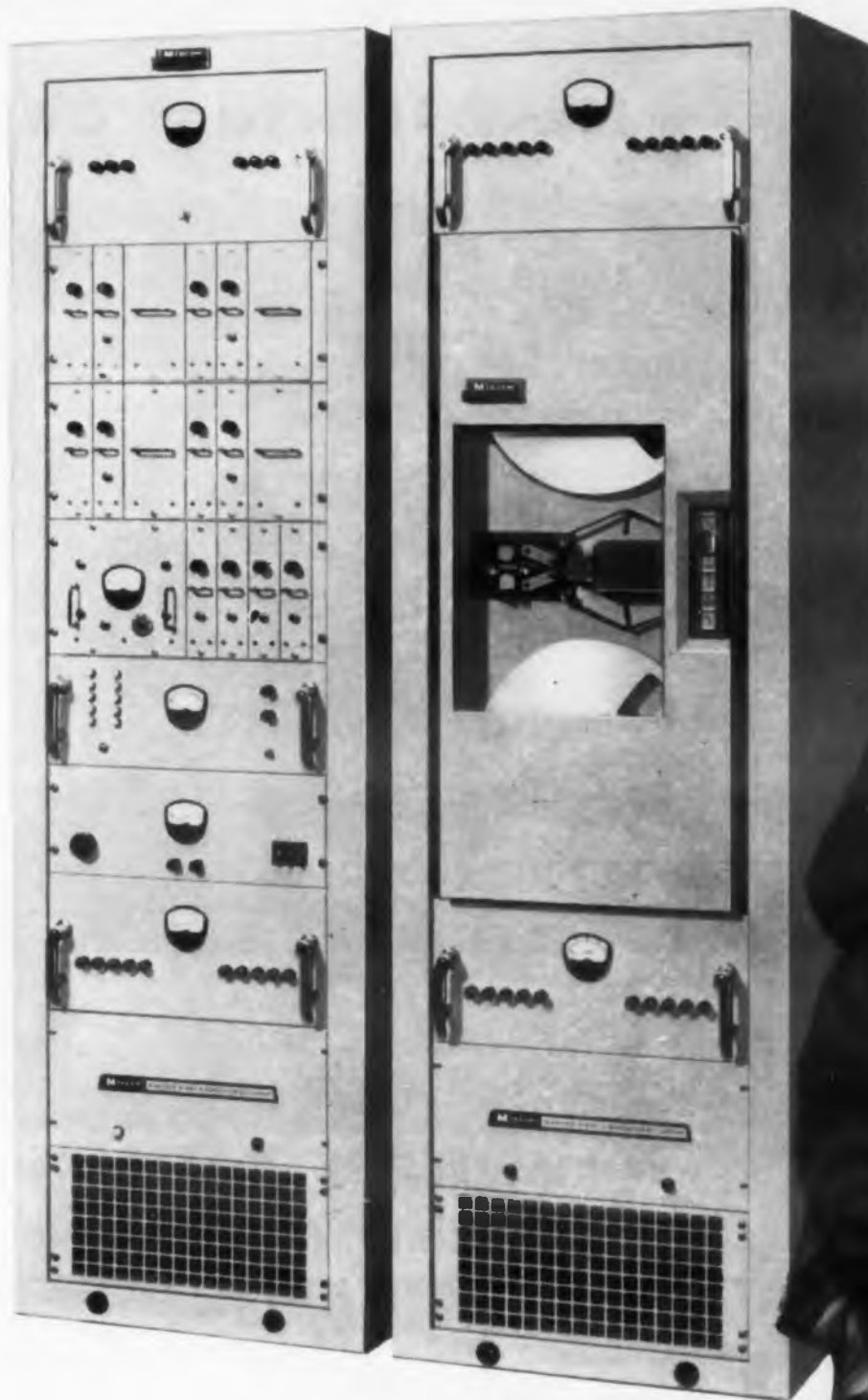
To compensate for flicker resulting from the 48-field-per-sec standard, slow-decay phosphors will be used in the receiver picture tubes. A picture-crispener circuit will also be incorporated in the receivers.

The broadcasts will be made compatible with vhf programming by a master-receiver system in each participating school. Transmissions will be picked up by a master receiver in each school, remodulated, and will be sent by closed circuit to vhf receivers in the classrooms.

The reduced-bandwidth development is a result of research originally instituted to save TV tape; many of the classes to be transmitted in the experimental program will be taped, probably with special cameras. The first broadcasts are scheduled to begin next fall.



Narrow-band television will permit doubling of number of channels in given bandwidth. Special crisp-ening circuits and slow-decay phosphors in receiving will compensate for low resolution of 441-line, 48-frame-per-sec system.



OLD FAITHFUL



Built-in reliability inspires devotion everywhere for the new Mincom Model CV-100 Video Band Magnetic Tape Recorder/Reproducer. Only 12 moving parts, four simple adjustments. No mechanical brakes. Seven 1-megacycle video channels on a single half-inch tape. Tape speed of 120 ips, coupled with specialized circuitry, produces a reliable frequency response from 400 cycles to 1.0 megacycle (each track). Signal-to-noise ratio: 30 db, peak signal to rms noise. All plug-in assemblies, carefree maintenance. Interested? Write Mincom today for specifications.



... WHERE RESEARCH IS THE KEY TO TOMORROW

MINCOM DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

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CIRCLE 14 ON READER-SERVICE CARD

NEWS BRIEFS . . .

. . . A SOVIET PUBLICATION, Prioda, claims a new computer has been developed in the U.S.S.R. that is faster than "all existing Soviet and foreign production-model computers." The unit, designed by academician S. A. Lebedev, "opens a significant perspective in the further development of computers and control machines," and has been recommended for mass production.

. . . IN THE SAME PUBLICATION, the Soviets finally credited the U.S. with discovery of the Van Allen radiation belt. The credit was given in an article on the study of space by rockets and satellites. The article mentioned that the U.S. discovery was made during flights of Explorers I and III.

. . . THE ARMY has proposed a program of information exchange among the three services. The program would use microfilm cards and would be implemented in three control centers that would process and distribute the cards to eliminate duplication of effort and to "give engineers and designers information required for their jobs at a minimum of time and expense."

. . . ANY NOVICE SCIENTISTS around the house? The annual Westinghouse Science Talent Search has begun. More than 25,000 young contestants are expected to apply, hoping to win some of the more than \$34,000 that will go to the 40 finalists. The search is being conducted for Westinghouse by Science Service, a non-profit organization, through the Science Clubs of America.

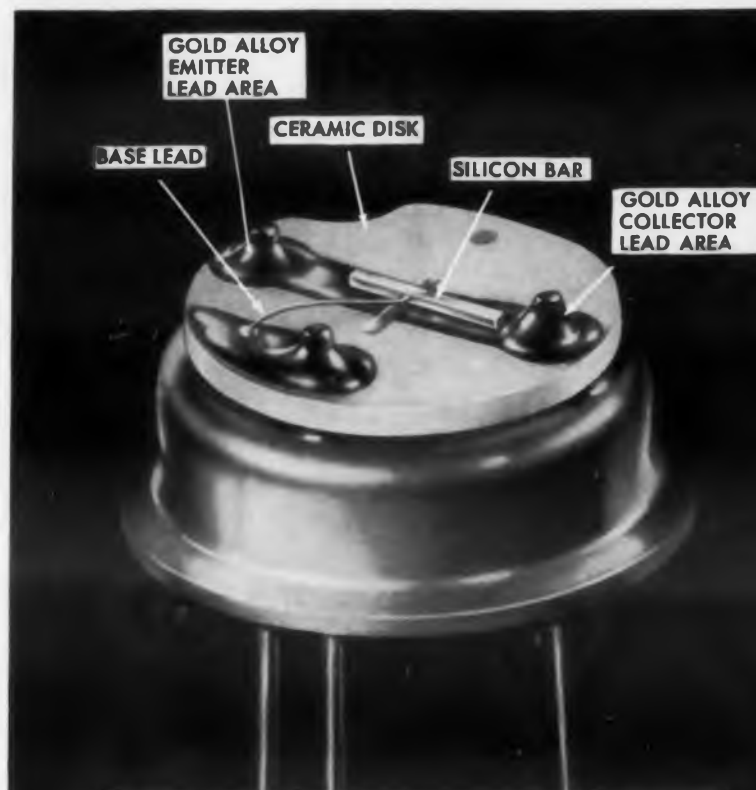
. . . DEVELOPMENT OF ALLOY-DIFFUSION junction transistors with an upper frequency limit of about 2,000 mc, has been claimed by Mullard Research Labs, England. The company also reports work on vhf power transistors with 500 mw ratings.

. . . THE ELECTRONICS PROGRAM conducted by the Air Materiel Command's Manufacturing Methods Division has been approved. Under the program, emphasis is placed on basic manufacturing processes for many materials, rather than on production refinements of single items such as tubes or transistors, as formerly.

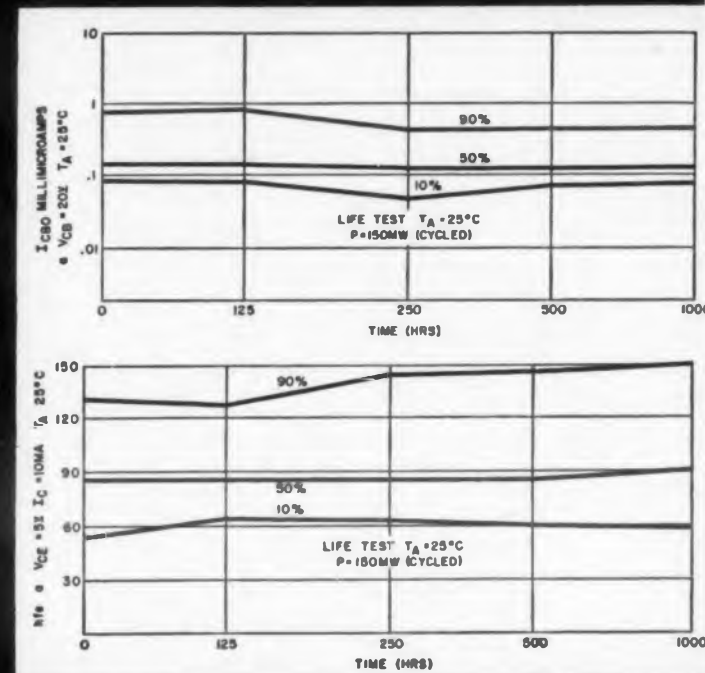
. . . ULTRASONIC GENERATOR line of Westinghouse has been provided with solid-state power supplies, reducing weight and size of ultrasonic cleaners drastically and raising reliability according to the company.

General Electric Semiconductor News

New life test data prove superior



Magnified photo of silicon transistor showing Fixed Bed Construction. All parts are firmly fastened, with no suspended parts except wire lead. Transistor reacts as a solid block in resisting shock and vibration.



Charts show extreme stability of performance throughout 1000 hours of life for beta and I_{CBO} . Test conditions were 150 mw at 25°C, 200°C storage and 25 mw at 125°C. Drift rates were substantially the same under all conditions.

New NPN Tetrolodes: Higher gain at high temperature and low current

LARGE QUANTITIES OF TYPES 3N36 AND 3N37 TESTED AND PROVED. HIGH RELIABILITY THE RESULT OF TWO YEARS OF MANUFACTURING EXPERIENCE.

Mechanical Reliability Test	Results	% Survival
3-ft drop-shock (2500 G's. Mil Std calls for 500G's)	2 out of 595 did not survive	99.66
Temperature cycling (-55°C to 100°C)	1 out of 375 did not survive	99.78
Life Test Reliability		
Cycled power @ 50 mw (device rated at 30 mw)	6 out of 500 exceeded parameter limits at 1000 hours	98.8
Oven @ 85°C	17 out of 500 exceeded parameter limits at 1000 hours	96.8
Shelf	No parameter failures of 500 units at 1000 hours	100.0

*General Electric's rigid standards call for only a slight shift in parameters to be a "failure." Many of these "failures" are still within EIA limits.

Here are two new germanium transistors that operate on lower voltages, require less current and are more rugged (see box below) than any other transistors that perform a like function. Furthermore, they deliver a high and constant gain at various voltages and at low power dissipation levels. Therefore, they are not only useful at high temperatures, but they also simplify circuit design and eliminate the need for close voltage regulation.

Features: Maximum gain at 1 ma, 5 volts or 5 mw. Flat gain noise factor from 1 ma to 5 ma. **Where to use them:** Mobile communications (made possible the first transistorized portable receiver). Wide band amplifier, oscillator and switching applications for radar and video at frequencies to 200 mc. **Availability:** Now . . . from your General Electric Semiconductor Sales Representative and in stock at your G-E Semiconductor Distributor's.

Absolute Maximum Ratings (25°C)	3N36	3N37	Electrical Characteristics (25°C)		
Collector voltage to base 1 or base 2 (V _{cs})	+ 7	+ 7	Output capacity (C _{ob})	2	1.5
Emitter to base 1 or base 2 (V _{es})	+ 2	+ 2	Noise figure (NF)	11	11
Collector current (I _c)	+ 20	+ 20	Input impedance (h _{ie})	100-;27	80-;10
Emitter current (I _e)	- 20	- 20	Current transfer ratio (h _{fe})	2.2/ -81°	1.1/ -100°
Base 2 current (I _{b2})	2	2	Common base cutoff frequency (f _{cb})	50 MIN.	90 MIN.
Total Power dissipation	30	30	Common Emitter power gain (G _e)	11.5	9
			Measurement frequency	60	150

stability of G-E silicon transistors

Uniform characteristics out to 1000 hours exhibited by silicon transistors featuring Fixed Bed Construction

Comprehensive tests performed on General Electric silicon transistors show remarkably stable performance throughout 1000 hours of operation at high temperatures. Each test was run on seven lots of fifty Type 2N337 or 2N338 transistors (part of the series 2N332 through 338). These are the results:

350 units were given a 150 mw operating test at 25°C.

Only two units exceeded parameter limits, a successful performance rate of 99.4 percent.

350 units were given a 200°C storage test.

Only three units exceeded parameter limits, a successful performance rate of 99.1 percent.

Fixed Bed Construction, plus stabilized pro-

cessing makes these results possible. No fluxes, resins or solders are used — only a gold alloy which forms an integral bond between all parts.

Besides the demonstrated electrical characteristics, General Electric's silicon transistors can absorb physical punishment far beyond normal specifications. All parts are solidly fixed together and react as a solid block in resisting shock and vibration. Test units have been fired from a shotgun, struck with a golf club and rattled freely in an auto hubcap for 700 miles—and worked afterward.

Electrically and mechanically, this series of transistors is the most thoroughly tested and proved today—your assurance of high stability and reliability. Call your General Electric Semiconductor Representative for further details.

ABSOLUTE MAXIMUM RATINGS AT 25°C

	2N332-6	2N337-8	
Collector to base voltage	45	45	volts
Emitter to base voltage	1	1	volt
Collector current	25	20	ma
Collector power dissipation	150	125	mw
Operating temperature	-65°C to 175°C		-65° to 150°C

Absolute Maximum Ratings at 25°C

Collector to base voltage	20 volts
Emitter to base voltage	15 volts
Collector to emitter voltage	20 volts
Collector current	300 ma
Base current	50 ma
Emitter current	300 ma
Storage temperature	85°C to -65°C
Operating junction temperature	85°C
Power dissipation	150 mw

Now available—4 new NPN alloy transistors

Four new germanium switching transistors, made by the highly controllable NPN alloying process, are now being warehoused by General Electric and its distributors. The four transistors, Types 2N634, -5, -6 and 2N388, feature extremely consistent parameters. I_{CO} for instance, multiplies up in a normal fashion, so that higher temperature I_{CO} may be predicted from low temperature readings.

The transistors provide 150 mw power dissipation. They are useful in emitter-follower applications in computers, high current flip-flops, and are ideal as complementary devices to PNP computer transistors, such as the 2N396.

For complete information call your General Electric Semiconductor Sales Representative, your G-E Semiconductor Distributor, or write Section S23119 Semiconductor Products Dept., General Electric Company, Electronics Park, Syracuse, New York.

GENERAL ELECTRIC

Semiconductor Products Dept., Syracuse, New York

CIRCLE 15 ON READER-SERVICE CARD

SIGNIFICANT CONTRACTS . . .

. . . TO KEARFOTT CO., Inc., from the Air Force, initial funding of \$99,800 for the study phase of a contract to design and build a solid-state celestial comparator for space navigation use.

. . . TO RADIATION, Inc., from Northrop, \$400,000 for development of an advanced pulse-code-modulation flight-test data acquisition and data-processing system.

. . . TO SYLVANIA ELECTRIC PRODUCTS, Inc., from the Signal Corps, \$15 million for development of a high-precision weapons-locating radar designated AN/MPQ-32.

. . . TO NCR ELECTRONICS Div., from the Air Force, \$70,000 for study of a rod-type magnetic switching and storage device. Switching speed in a coincident-current mode is expected to be about 70 msec.

. . . MAGNETOHYDRODYNAMIC power generation produced 1 kw for five seconds, General Electric reports. Efficiency was negative because of the high-powered plasma arc that was used as a source of ionized gas. GE believes, however, that in a closed-cycle operation, nuclear or solar energy might be used to provide efficiency higher than that of heat-to-electricity generators known so far.

. . . TO FXR, INC., Woodside, N.Y., \$500,000 through Cornell Aero Labs for design and manufacture of the "most powerful radar transmitter ever built." Goal is peak power of 50 megawatts, with a variety of pulse lengths and repetition rates and average power of up to 50 kw.

. . . TO AMERICAN BOSCH ARMA CORP., Hempstead, N.Y., \$53.35 million from the Air Force for an advanced and lightweight all-inertial guidance system for operational Atlas ICBMs.

. . . TO ALLEN B. DU MONT LABORATORIES, Inc., Clifton, N.J., \$266,706 from the Signal Corps for an engineering test model countermeasures set.

. . . TO HOFFMAN LABORATORIES, Los Angeles, \$600,000 from the Air Force for development of a fully orienting large-area solar-electric power system for use in space satellites.

NEWS

Soviet Reports Moon Photo Hinged on 2 Big Advances

Man's first glimpse of the far side of the moon was accompanied by Russian claims of two major triumphs in space photography.

The Soviet said its scientists had solved the problem of turning a cosmic vehicle in space by signals from the earth, so that the lens was pointed at the moon when the camera started operating.

In addition the problem of transmitting half-tone photographs of high quality from cosmic space to the earth by television was declared solved.

The Soviet reported that four fixed antennae protruded from the top of their moon-circling satellite, in whose center was a large lens. An automatic switch controlled from the ground was said to have swung this eye toward the moon while the satellite was clipping through space about 37,000 to 43,000 miles from the sun-lit body.

After a 40-minute series of exposures, the film was developed automatically in the rocket, the Soviet said. Then, by means of a "special radio transmission system," the carrier sent its television photos to the earth as it approached the lowest point of its orbit.

Meanwhile the National Aeronautics and Space Administration has decided to try again to send a payload to the moon. The shot is scheduled for late this month and, if successful, may be followed by an attempt next month to place a payload near Venus.

U.S. plans to achieve a lunar orbit Oct. 3 died prematurely when the Atlas-Able launching rocket that was to have carried the satellite exploded during a static ground test.

The lunar shot now planned will be more difficult in some respects than the Soviet ones so far. An attempt will be made to put the satellite in orbit around the planet. This would require not only precision in initial guidance of the vehicle but the firing of a retro-rocket to slow the satellite, trap it in the moon's gravitational field and so achieve an orbit instead of further soaring into space.

From the standpoint of science, such a satellite would be also more valuable, since it would stay near the moon, gathering and relaying data to earth for a considerable time.

The U.S. vehicle is to carry instruments to measure any magnetic field the moon may have and to find out if the planet is surrounded by a belt of charged particles, the way the earth is. A television-type scanner will also be aboard, and it is hoped to shoot a crude picture of the moon's far side.



FOR COMMUNICATIONS
AND CW RADAR

VARIAN KLYSTRONS

VA-802
1.7 to 2.4 kMc
1 kW cw

WIDE TUNING RANGE • AIR COOLED

The highly efficient VA-802 has been designed to meet the rigid demands of both fixed station installations and transportable service. Simple to install and operate, it provides rugged reliability at low operating cost — with power output of 1 Kw, tuning range of 1.7 to 2.4 kMc. Features of this 18" Klystron with permanent magnet include: Trouble-free internal assemblies, low noise and long life.

Varian makes a wide variety of Klystrons and Wave Tubes for use in Radar, Communications, Test and Instrumentation, and for Sevens Environmental Service Applications. Over 100 are described and pictured in our new catalog. Write for your copy — address, Tube Division.



VARIAN associates
PALO ALTO 35, CALIFORNIA

VA-800	1.7 to 2.4 kMc	1000 cw
VA-801	1.7 to 2.4 kMc	1000 cw
VA-802	1.7 to 2.4 kMc	1000 cw
VA-803	1.7 to 2.4 kMc	1000 cw
VA-804	1.7 to 2.4 kMc	1000 cw
VA-805	1.7 to 2.4 kMc	1000 cw
VA-806	1.7 to 2.4 kMc	1000 cw
VA-807	1.7 to 2.4 kMc	1000 cw
VA-808	1.7 to 2.4 kMc	1000 cw
VA-809	1.7 to 2.4 kMc	1000 cw
VA-810	1.7 to 2.4 kMc	1000 cw
VA-811	1.7 to 2.4 kMc	1000 cw
VA-812	1.7 to 2.4 kMc	1000 cw
VA-813	1.7 to 2.4 kMc	1000 cw
VA-814	1.7 to 2.4 kMc	1000 cw
VA-815	1.7 to 2.4 kMc	1000 cw
VA-816	1.7 to 2.4 kMc	1000 cw
VA-817	1.7 to 2.4 kMc	1000 cw
VA-818	1.7 to 2.4 kMc	1000 cw
VA-819	1.7 to 2.4 kMc	1000 cw
VA-820	1.7 to 2.4 kMc	1000 cw
VA-821	1.7 to 2.4 kMc	1000 cw
VA-822	1.7 to 2.4 kMc	1000 cw
VA-823	1.7 to 2.4 kMc	1000 cw
VA-824	1.7 to 2.4 kMc	1000 cw
VA-825	1.7 to 2.4 kMc	1000 cw
VA-826	1.7 to 2.4 kMc	1000 cw
VA-827	1.7 to 2.4 kMc	1000 cw
VA-828	1.7 to 2.4 kMc	1000 cw
VA-829	1.7 to 2.4 kMc	1000 cw
VA-830	1.7 to 2.4 kMc	1000 cw
VA-831	1.7 to 2.4 kMc	1000 cw
VA-832	1.7 to 2.4 kMc	1000 cw
VA-833	1.7 to 2.4 kMc	1000 cw
VA-834	1.7 to 2.4 kMc	1000 cw
VA-835	1.7 to 2.4 kMc	1000 cw
VA-836	1.7 to 2.4 kMc	1000 cw
VA-837	1.7 to 2.4 kMc	1000 cw
VA-838	1.7 to 2.4 kMc	1000 cw
VA-839	1.7 to 2.4 kMc	1000 cw
VA-840	1.7 to 2.4 kMc	1000 cw
VA-841	1.7 to 2.4 kMc	1000 cw
VA-842	1.7 to 2.4 kMc	1000 cw
VA-843	1.7 to 2.4 kMc	1000 cw
VA-844	1.7 to 2.4 kMc	1000 cw
VA-845	1.7 to 2.4 kMc	1000 cw
VA-846	1.7 to 2.4 kMc	1000 cw
VA-847	1.7 to 2.4 kMc	1000 cw
VA-848	1.7 to 2.4 kMc	1000 cw
VA-849	1.7 to 2.4 kMc	1000 cw
VA-850	1.7 to 2.4 kMc	1000 cw
VA-851	1.7 to 2.4 kMc	1000 cw
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VA-863	1.7 to 2.4 kMc	1000 cw
VA-864	1.7 to 2.4 kMc	1000 cw
VA-865	1.7 to 2.4 kMc	1000 cw
VA-866	1.7 to 2.4 kMc	1000 cw
VA-867	1.7 to 2.4 kMc	1000 cw
VA-868	1.7 to 2.4 kMc	1000 cw
VA-869	1.7 to 2.4 kMc	1000 cw
VA-870	1.7 to 2.4 kMc	1000 cw
VA-871	1.7 to 2.4 kMc	1000 cw
VA-872	1.7 to 2.4 kMc	1000 cw
VA-873	1.7 to 2.4 kMc	1000 cw
VA-874	1.7 to 2.4 kMc	1000 cw
VA-875	1.7 to 2.4 kMc	1000 cw
VA-876	1.7 to 2.4 kMc	1000 cw
VA-877	1.7 to 2.4 kMc	1000 cw
VA-878	1.7 to 2.4 kMc	1000 cw
VA-879	1.7 to 2.4 kMc	1000 cw
VA-880	1.7 to 2.4 kMc	1000 cw
VA-881	1.7 to 2.4 kMc	1000 cw
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VA-883	1.7 to 2.4 kMc	1000 cw
VA-884	1.7 to 2.4 kMc	1000 cw
VA-885	1.7 to 2.4 kMc	1000 cw
VA-886	1.7 to 2.4 kMc	1000 cw
VA-887	1.7 to 2.4 kMc	1000 cw
VA-888	1.7 to 2.4 kMc	1000 cw
VA-889	1.7 to 2.4 kMc	1000 cw
VA-890	1.7 to 2.4 kMc	1000 cw
VA-891	1.7 to 2.4 kMc	1000 cw
VA-892	1.7 to 2.4 kMc	1000 cw
VA-893	1.7 to 2.4 kMc	1000 cw
VA-894	1.7 to 2.4 kMc	1000 cw
VA-895	1.7 to 2.4 kMc	1000 cw
VA-896	1.7 to 2.4 kMc	1000 cw
VA-897	1.7 to 2.4 kMc	1000 cw
VA-898	1.7 to 2.4 kMc	1000 cw
VA-899	1.7 to 2.4 kMc	1000 cw
VA-900	1.7 to 2.4 kMc	1000 cw

VARIAN ASSOCIATES, INC. MANUFACTURES: THERMIONIC TUBES, X-RAY TUBES, ELECTRON BEAM TUBES, HIGH VOLTAGE PUMPS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, SPECTROMETERS, MAGNETS, MAGNETRON TUBES, STAGES, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

CIRCLE 16 ON READER-SERVICE CARD

The American lunar vehicle, weighing 375 pounds, will be on the order of the Explorer VI middle-wheel earth satellite launched Aug. 6.

Airborne Antenna Saves Space, Weight



Engineer checks feed structure of retarded wave surface antenna built as one-sixth-size model. The antenna, said to have high gain, is designed for airborne early warning radar. A 33-foot retarded wave antenna of this design would be only 1.5 feet thick and weigh 400 pounds, significantly less than a parabola type, reports Chance Vought Electronics.

Future of Radio Astronomy Pictured at Crossroads

Attempts to commercialize more radio-frequency bands may threaten the future of radio astronomy, a University of Michigan professor warns.

Prof. Leo Goldberg, chairman of the university's Department of Astronomy and vice-president of the International Astronomical Union, notes that in the next ten years advances in space communications are almost certain to multiply demands for radio channels. The military will want to transmit messages from rockets and satellites, he says, and commercial radio and telegraph companies may seek to use the moon or satellites to bounce messages around the world.

Professor Goldberg has called on the United States to protect the bands most valuable to radio astronomy. Use of frequency bands is being discussed in Geneva by the United Nations' International Telecommunications Union, he noted. Originally, only a weak proposal by the Dutch to protect six bands for radio astronomy was before the international conference.

The American delegation in reaction to a Washington meeting between protesting U. S. scientists and government officials, changed its proposal for protecting of only one band, the hydrogen line, to a proposal supporting allocations of 17 channels stretching from 2.5 to 30,000 mc.

are you silicon wait-bait?



avoid unnecessary delays GT DELIVERS SILICON TRANSISTORS IN 24 TO 48 HOURS!

No need to get hung up with delays or hooked by unkept promises! GENERAL TRANSISTOR delivers sample quantities of GT Silicon Transistors in 24 to 48 hours... production quantities in 2 to 4 weeks!

These are not mere claims, but firm promises on which you can base your design and production schedules.

Quality? Yes—plenty of weight here without waiting. General Transistor is today one of the largest suppliers of highly dependable devices, delivering quality in quantity.

For full information—and fast delivery—call your local General Transistor representative, or contact us directly. Write for Silicon Brochure S-100.

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A Few of the GT Alloyed Junction Silicon Transistors Now Available

- HIGH SPEED SWITCHING
- MEDIUM SPEED SWITCHING
- HIGH VOLTAGE
- HIGH SPEED LINEAR AMPLIFIER
- MEDIUM SPEED LINEAR AMPLIFIER

PNP:	2N1219	2N1220	2N1221	2N1222	2N1223
V _{ceo}	30 v	30 v	30 v	30 v	40 v
V _{cco}	25 v	25 v	25 v	25 v	40 v
V _{ceo}	20 v	20 v	10 v	10 v	10 v
I _{co}	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.
t _{rc}	18 min.	9 min.	—	—	—
f _{ab(mc)}	5 min.	2 min.	5 min.	2 min.	2 typ.
t _{fe}	—	—	18 min.	9 min.	6 min.

FOR IMMEDIATE DELIVERY FROM STOCK CONTACT YOUR NEAREST AUTHORIZED GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK FOR EXPORT GENERAL TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. PRECISION MAGNETIC RECORDING HEADS AVAILABLE FROM GENERAL TRANSISTOR WESTERN CORP., 8110 VENICE BLVD., LOS ANGELES, CALIF.

CIRCLE 17 ON READER-SERVICE CARD

For Capacitors with **GREATER RELIABILITY . . .**

Choose
El-Menco

*The Capacitors You
Find Wherever
There's Electronics!*

EL-MENCO DUR-MICA CAPACITORS

Only 1 Failure Per 43,000,000 Unit-Hours!

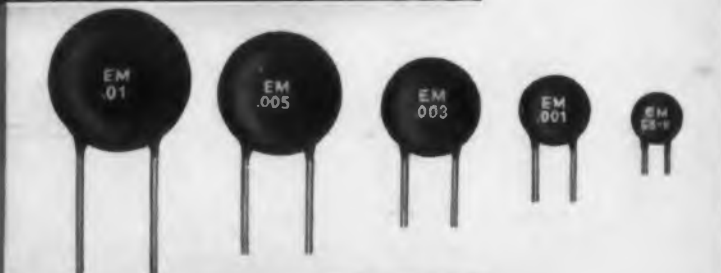
- It has been computed that "debugged" DM30, 10,000 MMF units, when subjected to 257,000 hours of life at 85°C with 100% of the rated DC voltage applied, will yield only 1 FAILURE PER 43,000,000 UNIT-HOURS!
- DM15, DM16, DM19, DM20 . . . perfect for miniaturization and for new designs using printed wiring circuits. Also available in DM30, DM42 and DM43.
- New "hairpin" parallel leads insure easy application.
- Exceed all electrical requirements of military specification MIL-C-5A.



EL-MENCO CERAMIC DISC CAPACITORS

Toughest Ever!

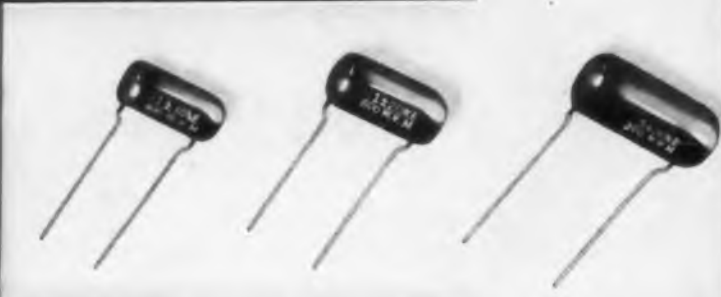
- Available in 500 working volts DC and 1,000 working volts DC ratings.
- Low-loss phenolic coating that is wax impregnated.
- Flat design assures reduced self-inductance . . . particularly adaptable to very high frequency applications.
- Insulation resistance far exceeds the 10,000 megohms minimum requirement.
- Exceed all electrical requirements of E.I.A. specifications RS-198.



EL-MENCO MYLAR-PAPER DIPPED CAPACITORS

Only 1 Failure in 7,168,000 Unit-Hours!

- Life tests at 100°C with rated voltage applied have yielding only 1 FAILURE PER 7,168,000 UNIT-HOURS for 1 MFD. Since the number of unit-hours of these capacitors is inversely proportional to the capacitance, 0.1 MFD Mylar-Paper Dipped capacitors will yield only 1 FAILURE PER 7,168,000 UNIT-HOURS!
- Working volts DC: 200, 400, 600, 1000 and 1600.
- Durez phenolic resin impregnated.
- Tolerances: $\pm 10\%$ and $\pm 20\%$ (closer tolerances available).
- Dielectric strength: 2 or $2\frac{1}{2}$ times rated voltage, depending upon working voltage.
- Exceed all electrical requirements of E.I.A. specification RS-164 and military specifications MIL-C-91A and MIL-C-25A.

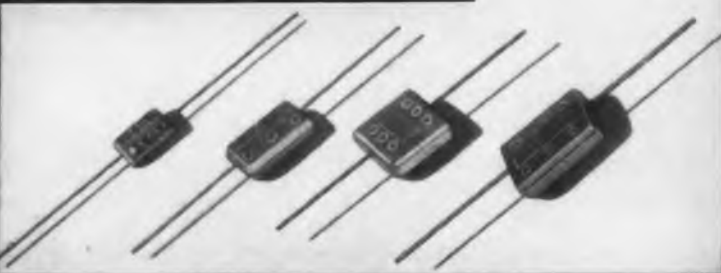


EL-MENCO MOLDED MICA CAPACITORS

Superior Performance!

- Unmatched for excellent stability, dielectric strength, high insulation resistance, extremely high "Q" and correspondingly low power factor.
- Units can be subjected to a short "debugging" life test at elevated voltage and temperature for removal of early life failures and for improved reliability.

*Write for Free Samples and Booklets
on Any of The Above Capacitors*



EL-MENCO OFFERS A COMPLETE LINE OF CAPACITORS . . .
STANDS READY TO SERVE ALL YOUR CAPACITOR NEEDS.

THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors
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- molded mica • dipped mica • mica trimmer • dipped paper
- tubular paper • ceramic • silvered mica films • ceramic discs

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Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

El-Menco
Capacitors

NEWS

Electronic Space Camera Slated To Observe World's Weather

Weather observations from space in the form of a continuous strip of pictures around the world may soon be possible with an electronic satellite camera under development by the Radio Corporation of America.

The camera is based on a combination of television and electronic printing techniques. It uses electrostatic tape to store images for later broadcast.

Elementary details of the camera, described as "radically new and simple," were outlined by three scientists of RCA's Astro-Electronic Products Div., Princeton, N.J., to a convention of the Society of Motion Picture and Television Engineers in New York.

At the same meeting, two RCA system engineers related that environmental conditions in space were presenting new headaches to the designers of image sensors.

Camera Has Two Elements

The space camera is a compact, single unit whose basic elements are a special electrostatic tape and an electron gun of the type used in common TV camera tubes.

In the laboratory model, the elements are built into a glass vacuum tube roughly the shape of a mushroom. The neck is a television pickup tube containing the electron gun. The bulb contains a roll of electrostatic tape mounted in an automatic assembly for winding and rewinding during exposure and readout, somewhat in the manner of standard motion picture film.

Installed in a satellite, the camera would be linked to a conventional photographic lens sys-



Face of RCA's electronic space camera, designed for global observations. Pencil points to reel of electrostatic tape upon which light image is focused by a lens system (not shown). The electrical-charge image is stored on the reel for ultimate transmission via TV-type signals to the earth.

ten and a low-power transmitter to broadcast the picture data to earth.

Key Advantages Listed

The scientists describing the camera said it had several potential advantages for remote viewing of terrestrial clouds or even the moon's surface from space. They listed these key advantages:

- Extreme simplicity and durability, contrasted with systems that combine TV cameras and magnetic tape storage.

- Very large picture capacity, because of ability to erase and re-use the tape after each passage, in contrast with photographic film.

- Reduced sensitivity to radiation effects in space.

- Widely variable speed of operation, ranging from a few pictures per orbit, if desired, to the 16-frames-per-second rate of an 8-millimeter movie camera.

Image Failures Analyzed

The two RCA engineers who discussed image sensors and the potential hazard of space environment—Milton Ritter and M. H. Mesner of the Astro-Electronics Products Div.—attributed failures outside the earth's atmosphere to these possibilities:

- Loss of atmospheric cooling.
- Explosive decompression.
- Boiling and leakage through seals.
- Solar radiation.
- Bombardment by solid particles.
- Presence of disassociated gases.

Zero gravity and thermal problems are major difficulties for the designer to overcome, the engineers said. Most operational failures of satellites to date, they noted, have been credited to improper temperature regimes.

Maximum reliability can be built into the system, the two indicated, but only at the cost of size, weight, power, performance, capacity and other vital factors. Compromises must therefore be made, they said.

The engineers described the vidicon image sensor as of the "utmost importance" in space vehicles, because it permitted operation with reduced transmitter power.



Programmer makes operational check from "driver's seat" of IBM 709 Data Processing System — the most up-to-date system utilizing electron tubes.

Tung-Sol 5687 contributes to the prime reliability of the **IBM 709** Data Processing System!

The IBM 709 Data Processing system counts on unfaltering dependability from over 500 Tung-Sol 5687 Twin Triodes — approximately 340 5687's are found in the Arithmetic and Logic unit; the remainder in the Magnetic Drum Storage unit.

Because the Tung-Sol 5687 offers excellent power handling ability, the IBM 709 employs it largely in power follower circuits to supply high current requirements . . . in driving lines with high capacity loading. Frequent 200 millimicrosecond pulses make the latter a key job in the 709. Other special-circuit uses of the 5687

include: master oscillator, pulse shaping inverters, magnetic drum write head drivers, relay drivers and single-shot multivibrators.

5687 performance points up the reliability you'll find characterizes Tung-Sol tubes and semiconductors. It gives designers in-use testimony that lets them specify Tung-Sol for critical sockets with complete assurance of full-life trustworthiness. For full technical information on the Tung-Sol 5687, or other Tung-Sol tubes or semiconductors, contact: Tung-Sol Electric Inc., Newark 4, New Jersey.



TUNG-SOL®

CIRCLE 19 ON READER-SERVICE CARD >

NEWS



CDC Computer Uses Only Two Power and Levels Throughout

Control Data Corporation's completely transistorized 1604 computer uses only two power supply levels, two signal levels and has basic bi-level amplifier-inverters that operate at an equivalent phase-rate of 5 mc.

The general-purpose, stored-program computer, which is being readied for its first delivery, is designed with single-address logic and a magnetic-core storage capacity of 32,768 48-bit words.

Input-output operations are carried out independently of the main computer program. Storage is random-access; read access time is 2.2 microseconds.

Each storage unit has a total storage cycle time of 6.4 microseconds. The storage cycles of the two storage sections overlap one another so that the effective cycle time is 3.2 microseconds when addresses of alternate memory banks are referenced.

New Nitrides and Silicons Added To Thin-Film List

Additional materials have been declared suitable for use in thin-film electronic devices.

Researchers at Batelle Memorial Institute, working under Air Force contract, have learned that chromium-titanium-nitride is most promising among nitrides studied for resistive applications. By adjusting film thickness and nitriding temperature, resistances of 60 to 800 ohms per square centimeter have been obtained.

EIMAC

is an electron tube specialist

EIMAC FINDS WAY TO END PREMATURE TUBE FAILURE

No matter how carefully you operate vacuum tubes, power overloads can't always be avoided. In most tubes, the resultant overheating produces vacuum loss or internal arcing. Tubes often fail immediately or fall off in performance.

To overcome this, Eimac developed a group of internal-anode radial-beam tetrodes with exceptional ability to withstand repeated power overloads and peak powers. Operated for millions of hours in every class of service, these rugged tetrodes have proved they last longer, *perform better*, than any comparable internal-anode tubes.

Their amazing reliability is due partly to Eimac's exclusive Pyrovac plate. This outstanding internal-anode material reduces internal arcing, actually absorbs gases which might ruin tube vacuum.

In these tetrodes, low inter-electrode capacitances and low lead inductances assure stable operation at high frequencies. Their high power gain and low driving power requirements simplify driver requirement and associated circuits.

For complete technical and application data on these outstanding tetrodes, see the attached Eimac Report to Design Engineers.



EITEL-McCULLOUGH, INC.
San Carlos, California

Eimac Application Engineers work closely with equipment designers and users.



CLEANER, HARDER VACUUMS INCREASE TUBE LIFE

During production Eimac-designed rotary vacuum pumps evacuate gas at high temperatures. This, plus clean electrode design and non-emitting grids, helps make Eimac internal-anode tetrodes the most reliable available.



NEWEST TUBE TYPES, TUBE IMPROVEMENTS COME FROM EIMAC RESEARCH AND ENGINEERING

First to develop internal-anode tetrodes, Eimac is also the recognized leader in ceramic-metal vacuum tubes. With emphasis on new tube types, Eimac constantly improves conventional tube types, too.

Black Box Minimizes Howling



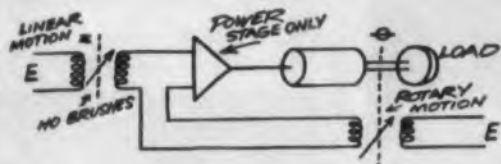
Frequency shift modulator under researcher's arm is hooked into PA system between speaker and microphone to minimize howling. It shifts feedback frequencies of room reverberations as they enter microphone. Only about a 5-kc shift of input signal will equalize it to the mean distance between the major peaks and adjacent valleys of the room's gain response characteristic. Then energy generated at the gain peaks is quickly absorbed in the valleys of the response characteristic after one trip of the sound energy around the acoustic feedback loop. Dr. M. R. Schroeder of Bell Labs developed the unit.

\$9.3 Million Contract For Advanced Radar

A contract for \$9,373,728 has been awarded to Texas Instruments, Inc., by the Navy for the company's advanced anti-sub search radar, AN/APS-80.

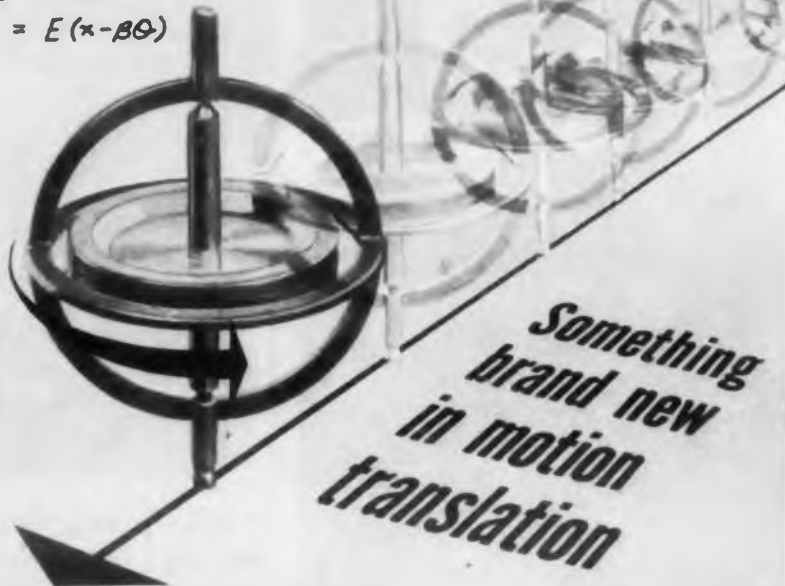
The highly sensitive, 500-pound equipment was developed for long range detection of surfaced subs and the disturbances caused by snorkel emergence.

◀ CIRCLE 22 ON READER-SERVICE CARD



$$C_{fb} = B\theta$$

$$E = E(\alpha - B\theta)$$



Something
brand new
in motion
translation



TYPICAL SPECIFICATIONS,
size 15 linear motion ac/ac Transipot:
Input range: 20, 50, or 100 mills
Sensitivity: 1 v rms/mil
Input: 26 vac, 400 cps
Output impedance: 1000 ohms
Independent linearity: 0.5%
Null change with temperature:
less than 0.006%/°F
Sensitivity change with temperature:
less than 0.06%/°F
Useful frequency range: 300-3000 cps

... ARNOUX'S TRANSIPOT®
a brushless, linear and rotary
motion transducer for
critical applications in
all types of indicating
or feedback
control systems

With the appearance of *Transipot*®, Arnoux introduces a totally new concept in variable-reluctance transformers: very high sensitivity at low impedance levels, with excellent linearity over a wide input range. Available as ac/ac or ac/dc. Other features: high efficiency...infinite resolution...inherent reliability...insensitive to vibration...noise-free because brushes aren't used...modular construction with standard servo mounting. Rated for operation to 125 C; specials available to several hundred degrees Centigrade.

Can be used for telemetry, indication, data reduction, and as a transmitter and/or receiver for detecting any combination of linear or rotary motion as part of a feedback control system—in fact, wherever the requirement is for small-motion detection with infinite resolution and with high outputs.

Matching characteristics in both types of Transipot permit an interchange of linear and rotary motion without special gearing, giving the design engineer great new freedom. Bulletin 900.

Arnoux Corporation

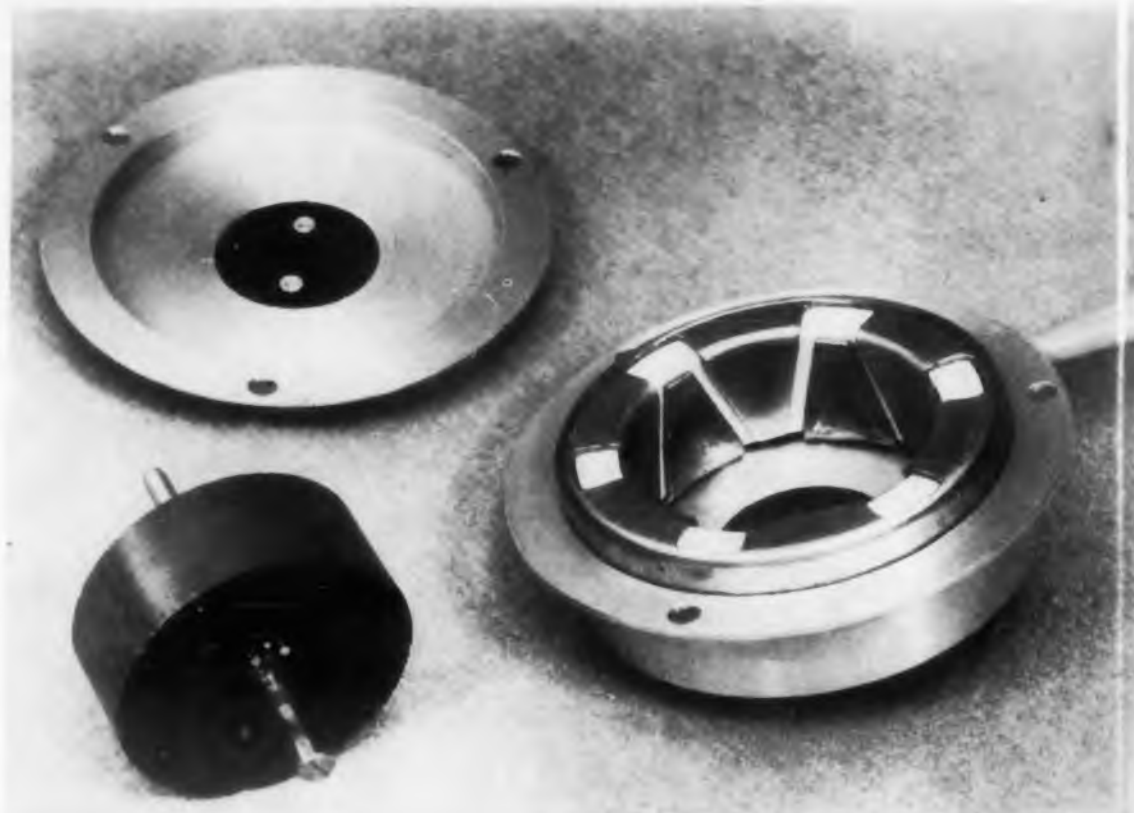
11924 W. Washington Blvd., Los Angeles 66, California

ARNOUX

phonetically, say Are'new

TRANSIPOTS®

CIRCLE 23 ON READER-SERVICE CARD



Trilec motor has ferrite rotor magnetized to operate with stator fingers, which bear alternate polarities. In this version, shaft rides freely in rotor within limits imposed by pins in shaft and rotor.

French Develop Ferrite

FRENCH designers have put the properties of magnetic ferrite to work in a sub-fractional motor that promises:

- High power-to-weight ratios,
- No possibility of sparking,
- Magnetically controlled direction of rotation,
- Easily achieved stepping operation,
- Low-cost production.

The motor has been developed in synchronous, self-starting universal, and stepping versions. All use a magnetic ferrite rotor that carries an alternating North-South field around its surface. The stators are single cylindrical windings enclosed in

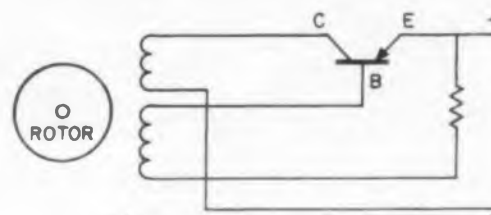
a sheet-iron pole-piece.

The portion of the pole-piece forming the stator's inside surface is cut into fingers, which carry a dc-excited field alternately from finger to finger. These fields work with those on the rotor.

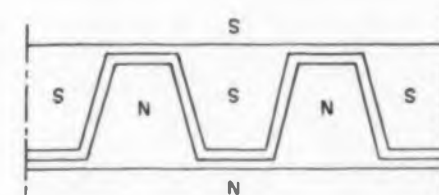
A small dc current will rotate the stator a few degrees until a rotor N pole is opposite a stator S pole. With an additional starting device and an ac current the motor operates as a classical synchronous motor.

How Self-Starting Is Achieved

An unusual feature of the stator is its



Transistor oscillator circuit works off dc to make motor universal, in another version.



Stator is wound to distribute poles as shown.



Other side of aluminum housing shows spring that helps rotor start turning and insures that rotation is always in desired direction.



Field-strength in ferrite rotor determines power-weight ratio.

rrid rotor

free-spinning shaft. Were it not for a pin in the shaft and two pins in the stator (all visible in the large photo) the stator would spin freely on the shaft, though not enough to start the motor.

When ac is applied, the rotor vibrates, kicking the shaft into rotation. Shaft rotation is affected, however, by a spring (also shown in the photo). If the shaft rotates counter-clockwise the spring unwinds. If it rotates clockwise the spring winds around the shaft, acting as a brake. Then, when the rotor moves in the opposite direction, the spring releases, helping the shaft rotate.

With this design the rotor always moves in the same direction regardless of instantaneous polarity of the starting ac. Torque is constant. Power increases with saturation of the ferrite rotor and with high frequency.

Transistor Makes It Universal

A small auxiliary winding is added to the stator to become part of a transistor oscillator circuit. This circuit, in effect, transforms dc to suitable ac. Oscillating frequency is mainly a function of the electrical constants of the circuit. Therefore, rotation speed is largely independent of supply volt-



In achieving airborne radar reliability... **HAZELTINE** SPECIFIES **AMP** TAPER TECHNIQUE

Designed for this U. S. military Airborne Early Warning Radar plane is one of the most important radar systems in the free world—Hazeltine Corporation's new AN/APS-95. Developed for duty around the clock in all weather, it cannot fail.

And—because it must not fail, Hazeltine engineers specified A-MP Solderless Taper Pins and matching Blocks for all critical circuits. A-MP Taper Technique gives Hazeltine the uniform top reliability and compact size it demands as well as great versatility: formed or pre-insulated solid taper pins in three series; wide size range of stackable one- or two-piece blocks plus precision crimping tools. Everything is solderless, of course.

Industry-proved reliability can be yours too, with this outstanding A-MP Taper Technique. Write today for more information.



The AN/APS-95 is a fitting tribute to the 35th ANNIVERSARY OF HAZELTINE CORPORATION. Pictured above is the Radar Set Control of this important system.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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

CIRCLE 24 ON READER-SERVICE CARD

FIELD-PROVED HONEYWELL COMPONENTS

for measuring, balancing and positioning applications

CONVERTERS



These synchronously driven choppers handle d-c signals as small as 10^{-8} volt. Sensitive, stable performance. Available with special features such as fungus proofing, grounded housing, mica-filled base, various contact percentages. Weight: 10 oz. Prices from \$39.

ELECTRICAL CHARACTERISTICS					
Part No.	354210-2	354210-3	354210-1	354210-4	355081
Modulation Frequency	20-30 cycles	40-45 cycles	50-65 cycles	50-65 cycles	360-440 cycles
Switching Action (SPDT)	(Make-before-break) Each contact closed 55% of each cycle ($\pm 2\%$) Other actions, as specified			(Break-before-make). Each contact closed 47% of each cycle	Each contact closed 57% of each cycle ($\pm 7\%$)
Driving Coil Requirements	6.3 v, 60 ma at rated frequency				18 v, 94 ma at rated frequency
Contact Rating	100 microwatts at 6 v max.; 10 ma max.				
Electrostatic Stray Pickup	2×10^{-6} volts per ohm of input circuit impedance				2×10^{-6}
Electromagnetic Stray Pickup	Less than 2×10^{-6} volts, constant to within 2×10^{-7}				2×10^{-5} volts constant to 2×10^{-6}
Phase Shift	Output voltage lags driving phase by $17^\circ \pm 5^\circ$				Lags driving phase by 45° to 50°
Symmetry	Within 2%				Within 7%
Shielding	Frame and coil shield, grounded through pin No. 2				Shell and coil shield, grounded through pin No. 2
Load Characteristics	Resistive or Inductive				
Vibration Resistance	Output voltage varies less than 2% with rates of vibration from 0 to 10g				

MOTORS



Designed for chart drives, servos and balancing circuits, these motors are available in three general types: Stack type, with easily maintained sectional housing; self-lubricated, oil-sealed type; and fungus-proofed, oil-sealed military motors. Prices from \$40.

Nominal No Load R.P.M.*	R.P.M.*	Gear Ratio	Intermittent Rated Load (oz.-in.)	Max. Starting Torque (oz.-in.)	Pull-in Torque Min. (oz.-in.)	Continuous Torque (oz.-in.)	Power (Watts) Loaded	Current (amps.) Loaded	Temp. Rise °F
Two Phase Induction Motor									
330		44:1	4	10			11.5	0.11†	70
144		10:1	5	20			11.5	0.11†	70
48		30:1	15	60			11.5	0.11†	70
23		60:1	30	110			11.5	0.11†	70
Synchronous									
	180	10:1			12	12	24	0.21	100
	180	10:1			2.0	2.0	11.5	0.11	65
	90	20:1			14	12	11.5	0.11	65
	60	30:1			21	18	11.5	0.11	65
	30	60:1			42	36	11.5	0.11	65

*1/6 less at 50 cycles †Field winding 11.0 watts, balance in amplifier winding
Note: Some speeds available at 25 cycles
All motors are available in two phase and synchronous models

AMPLIFIERS



They amplify a d-c or a-c microvolt input signal sufficiently to drive one field of a two-phase balancing motor. Three stages of voltage amplification are followed by the power-output phase discriminator stage, which supplies power for the motor. Extremely low stray pickup . . . adjustable sensitivity . . . fast response. Priced from \$110 to \$250.

Gain	Sensitivity (Microvolts)	Nominal Input Impedance (Ohms)
10^4	4.0	400, 2,200, 50,000
4×10^4	1.0	400, 7,000, 50,000
12×10^4	0.4	400, 2,200, 7,000
40×10^4	0.1	2,200

POWER SUPPLY—115 v., 60 cycles (fused power line)

OUTPUT—2 to 18 ma. into 12,000 ohm load

SENSITIVITY—Continuously variable screwdriver adjustment. Recessed slot protects setting

MOUNTING—Operation unaffected by mounting position

OPTIONAL FEATURES—(a) thermocouple burnout protection, (b) without desensitizing adjustment, (c) parallel T feedback, (d) velocity damping, (e) special connecting cables and plugs, (f) without tubes, shields, and converter, (g) for 25 cycles.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Aves., Phila. 44, Pa.

Honeywell



First in Control

CIRCLE 25 ON READER-SERVICE CARD

NEWS

age and load. Any waveform will provide suitable operation.

Differently shaped pole fingers, a shaft locked to the rotor, addition of a stator secondary winding, and addition of another ferrite ring around the stator; heighten the stepping effect and, when their design is optimized, make the motor a stepping unit that rotates in one-finger steps.

In the stepping version, control is achieved with very moderate power. There are no delicate parts, no adjustments required and no moving contacts with attendant possibility of sparking.

The stepping motor can be made to work with pulses of either polarity, and with plain sine-wave ac.

The sub-fractional motor is made by the Paris firm Trilec, which states that the basic design is applicable to motors of any size, the only limit being the relative cost of ferrite to standard rotor materials. ■ ■

Microwave Satellite Communication Predicted Within Ten Years

Reliable microwave communications through use of earth satellites were predicted within five or ten years by D. W. Atchley, Jr., president of Microwave Associates, Inc. "Among the types of satellites being investigated for communications purposes, Mr. Atchley said, "from a military point of view, the moon is the only acceptable one.

"A passive reflector, such as the moon can be used simultaneously in many ways at many frequencies and within many power levels without cross-talk. It also is highly resistant to electronic countermeasures.

"However, since ground installations for passive-satellite, broad-band communication would require very costly antennas, transmitters and receivers, for commercial rather than military purposes it seems desirable to concentrate on the active repeater.

"It seems that the frequency range that will be utilized will be around 10,000 mc. However, at present, suitable low-noise repeaters, are more difficult to make above 4,000 mc, and as yet no really long-life microwave repeater tubes have been constructed.

"It is estimated that such a satellite system could be placed in use by 1965, after an initial development cost of at least \$100 million.

"A 1000 channel, 3000 land-mile satellite system with several ground terminals could possibly be constructed for \$7 million. This figures out at \$2.50 per voice-channel mile, indicating that the active satellite is well worth pursuing."

Later, Mr. Atchley discussed Soviet electronic

devices, observed on his recent trip to the U.S.S.R. He described a potential millimeter-wave amplifying tube as "one of the most unusual tubes I have ever seen."

The tube uses a sheath of charged gas particles rather than a wire helix to interact with the electron beam. "It promises to provide amplification and generation of millimeter waves," he said.

Mr. Atchley was also shown in Moscow the Spiratron traveling wave tube, which amplifies efficiently over a broad frequency range, according to the Soviets.

Spaced-Array Radiotelescope Will Operate at 11.4 meters

What is billed as the world's largest radio telescope is nearing completion at Clark Lake in California's desert region.

Though two months short of ultimate completion, the two-mile long array of dipoles has been used to study 11.4-meter waves (26.3 mc) radiated from near the sun.

An extremely intense burst of radiation has already been recorded. Scientists of Convair, which is building and operating the telescope, suggest that the radiation was caused by atomic particles in the sun's corona accelerated by sun spot activity.

The telescope will be composed of a rectangular grid of 256 dipoles of copper wire suspended from posts in eight parallel rows covering two miles, and bisected by a two-mile transmission line.

East-west resolution is 0.25 degree, north-south resolution will eventually be 1.5 degrees. Through electrical modification of the branch feeder system, focus can be shifted as much as 45 degrees off the vertical.



"Largest" radiotelescope, now being built is able to operate during day because mountains shield against local radiation.

STACKPOLE Coldite 70⁺

fixed composition **RESISTORS**
1/2-, 1- and 2-watt sizes

The resistors that are setting today's higher performance standards! Unmatched for load life and moisture resistance. They're approved resistors—from a MIL-R-11 approved manufacturer. And now, for the first time, you can get such resistors in a *complete* line of RC-42 (2-watt); RC-32 (1-watt) and RC-20 (1/2-watt) types from stock from leading distributors!



NOW YOU CAN GET THEM
Immediately!

... at lowest prices in lots up to 1,000 of a value
... in any standard value or tolerance
... for small runs, for production emergencies,
for military prototypes and for hurry-up
design and engineering projects.

FROM STOCK . . . from these selected STACKPOLE distributors:

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C & G Radio Supply Co.

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Bond Radio Supply Co. Inc.

WEST PALM BEACH, FLA.

Goddard Distributors, Inc.

WICHITA, KANSAS

Interstate Electronic Sup. Corp.

WILBRAHAM, MASS.

Industrial Components Corp.

WINSTON-SALEM, N. C.

Dalton-Mege Radio Supply

. . . and G-C/STACKPOLE, TOO!

Attractively packaged by G-C Electronics for service replacement uses, Coldite 70+ Resistors are also available through over 800 G-C distributors.



CIRCLE 26 ON READER-SERVICE CARD



*boil it
bounce it*



New fusion-sealed resistor from Corning with zero moisture absorption

When your work borders on the exotic and your components all have to be *ultra*, take a look at this new glass-enclosed, fusion-sealed resistor.

The glass enclosure lets this 1/4-watt resistor defy all environmental conditions... exceeding MIL-R-10509C, Characteristic B. We've even boiled it in salt water for days without altering electrical characteristics. The glass enclosing the resistor has zero moisture absorption.

The glass-to-metal seal is comparable to that in a vacuum tube... and is even more resistant to physical shock.

The Dumet leads, sealed to a thermally compatible

glass case, create a true hermetic seal. The leads are fused directly to the resistance element.

The tin oxide film resistance element is similar in design and performance to that of a Corning N-style resistor. Resistance ranges from 100 ohms to 360 K ohms; full rating at 70°C. with derating to 150°C. Temperature coefficient is less than 300 ppm/°C.

For the complete story, write for data sheet to **Corning Glass Works**, 540 High Street, Bradford, Pa. Or contact our sales offices in New York, Chicago, or Los Angeles.



CORNING ELECTRONIC COMPONENTS

CIRCLE 27 ON READER-SERVICE CARD

NEWS

Small Business Saluted By Military at Exhibit

The Department of Defense played a major role in the recent Great Lakes Exhibit of Business Opportunities, demonstrating again its policy of encouragement to small business.

The department maintained 311 booths, occupying 10,000 square feet of floor space, at the



ELECTRONIC DESIGN photo

Fig. 1. ITT Labs exhibit was one of many by large businesses at the Great Lakes Exhibit of Business Opportunities.

Allen County Coliseum in Fort Wayne, Ind. Elaborate displays of the Army, Navy, Air Force and other agencies stressed the government's eagerness to buy from small business as well as large.

Large business shared the spotlight at the exhibit, showing equipment it sold to the government and displaying parts it had purchased from smaller business organizations.

At the Signal Corps exhibit a new packaging and quality assurance program was shown publicly for the first time. The program, described in a Sig-Pak Manual entitled "*Packaging Data Code System*," spells out the requirements for packaging

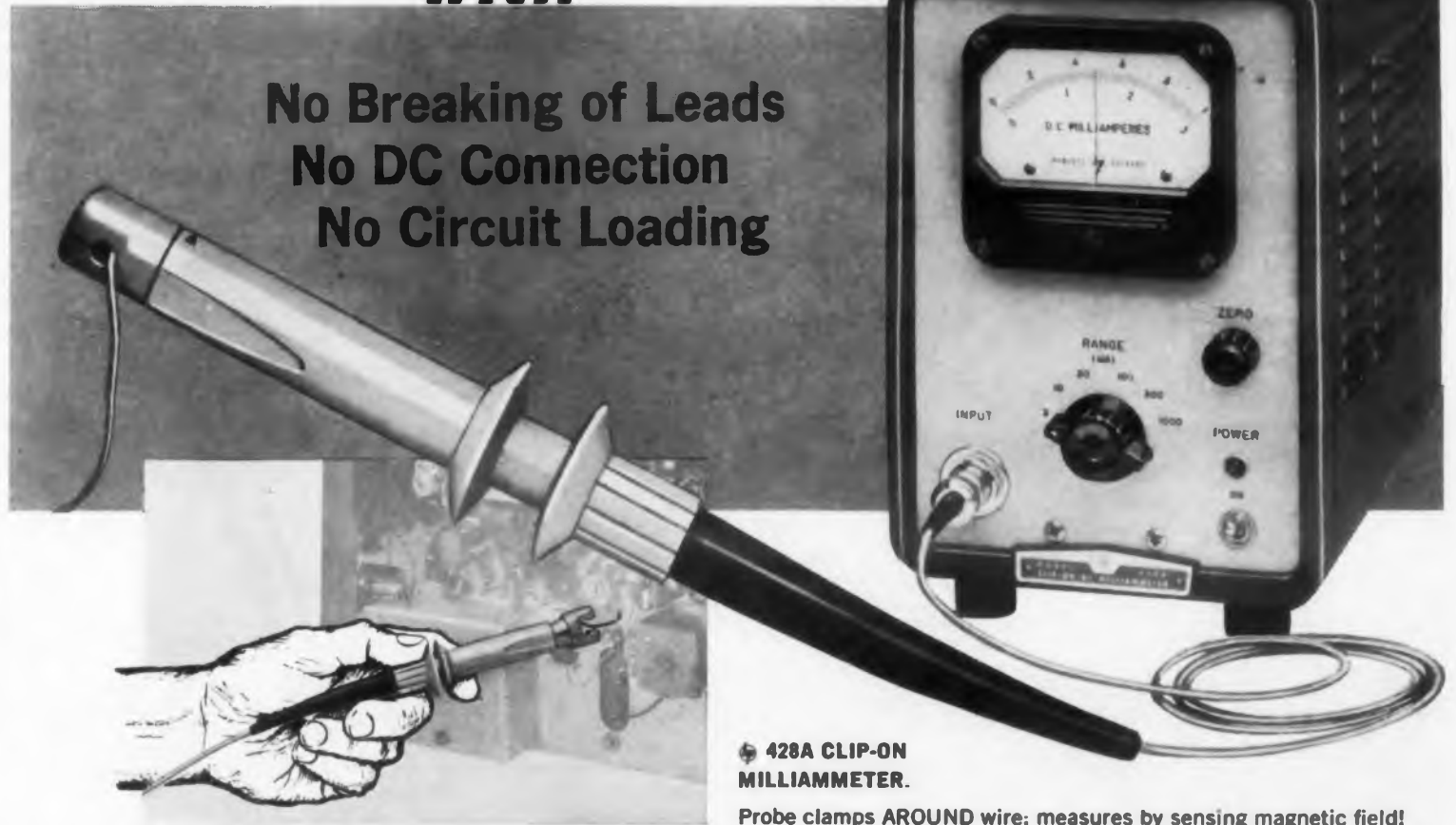


ELECTRONIC DESIGN photo

Fig. 2. Signal Corps exhibit showed businessmen how and what to sell to the corps.

Measure dc currents 0.3 ma to 1 ampere with

No Breaking of Leads
No DC Connection
No Circuit Loading



428A CLIP-ON
MILLIAMMETER.

Probe clamps AROUND wire; measures by sensing magnetic field!

Specifications

Current Range: Less than 0.3 ma to 1 amp, 6 ranges. Full scale readings from 3 ma to 1 amp: 3 ma, 10 ma, 30 ma, 100 ma, 300 ma, 1 amp.

Accuracy: $\pm 3\% \pm 0.1$ ma.

Probe Inductance: Less than 0.5 μ h maximum.

Probe Induced Voltage: Less than 15 mv peak.

Effects of ac in circuit: Ac with peak value less than full scale affects accuracy less than 2% at frequencies different from the carrier (40 KC) and its harmonics.

Power: 115/230 v $\pm 10\%$, 50-60 cps, 70 watts.

Size: Cabinet mount, 7 $\frac{1}{2}$ " wide, 11 $\frac{1}{2}$ " high, 14 $\frac{1}{4}$ " deep. Weight 19 pounds. Rack mount, 19" wide, 7" high, 12 $\frac{1}{2}$ " deep. Weight 24 pounds.

Probe Tip Size: Approximately $\frac{5}{16}$ " x $\frac{7}{16}$ ". Wire aperture diameter $\frac{3}{16}$ ".

Price: (Cabinet) \$475.00; (Rack) \$480.00.

Data subject to change without notice.

Prices f.o.b. factory.

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Test the new  405A DC Digital Voltmeter

CIRCLE 28 ON READER-SERVICE CARD



ELECTRONIC DESIGN photo

Fig. 3. Display board highlights the Signal Corps' new Packaging Data Code System.

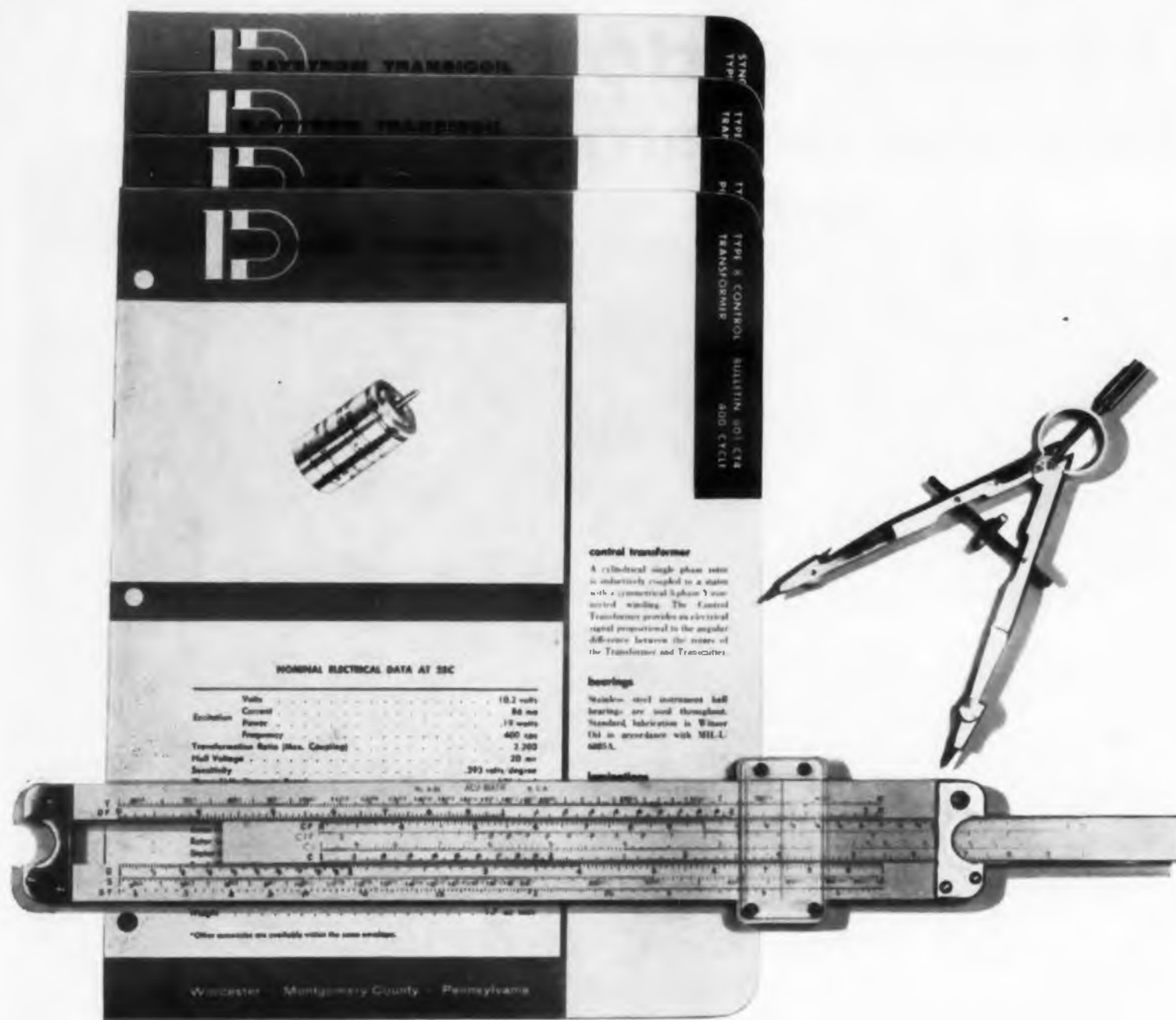
ing equipment for the Signal Corps in greater detail than ever before.

A display board displayed the code, which should help standardize the packaging and marking of bin-stock items.

Ceramic Stable to 3600 F



translucence, strength, and high temperature resistance are the featured characteristics of this new ceramic, Lucalox. The polycrystalline ceramic was developed at General Electric Research Laboratory by Dr. Robert Cottle, shown here comparing the new material with a disk of conventional ceramic. The basic material is fine grain, high-purity aluminum oxide. Microscopically small pores or bubbles found in conventional ceramic materials have been eliminated, according to G.E. Possible applications include envelopes for high-intensity incandescent or discharge lamps. Lucalox is stable at temperatures up to 3600 F.



size 8 synchro data

Synchro data for the asking! Daystrom Transicoil has prepared comprehensive data sheets on its popular Size 8 Synchro Line. All the synchro information you need is clearly presented . . . with photos, detailed drawings, electrical characteristics, mechanical specifications, and electrical diagrams.

Data Sheets cover transmitters, control transformers, differentials, repeaters, resolvers, and inductive potentiometers. All units are corrosion resistant construction throughout. Accuracies to $\pm 5'$ are available on special order.

Write for your free set of Size 8 Data Sheets. Technical information on our Size 11 line is also available. Daystrom Transicoil, Division of Daystrom, Inc., Worcester, Montgomery County, Pa. Phone JUNO 4-2421. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Foreign: Daystrom International Div., 100 Empire St., Newark 12, N. J.

DAYSTROM TRANSICOIL DIVISION OF DAYSTROM, INC.
Representatives in Canada and Other Foreign Countries

CIRCLE 29 ON READER-SERVICE CARD

NEWS

Computers May Eliminate Future Cash Exchange

Computers supporting a universal credit-card system may eliminate cash and check transactions in the future, S. M. Humphrey, management consultant, told a group of computer users last month. "From a technological point of view it will be possible to handle automatically transactions at stores, utilities, hotels and transportation offices merely by insertion of a credit card."

Even income taxes could be handled electronically, said Mr. Humphrey. Company payrolls would be compiled on magnetic tape and transmitted to employee's accounts at national or central banks, all of which would have inter-bank transmission equipment.

Not all payments would be handled this way, Mr. Humphrey added. "Transactions between individuals, and other low-volume transactions will not be subject to mechanization through the recording devices."

However, "almost every individual does have access to a device which could be used for sending information to the central bank's data processor—the dial telephone."

Satellite Scanner Shoots Earth



A two-pound slow-scanning device in the Explorer VI paddle-wheel satellite has taken the first "television" picture of the earth from space. Radioed shot, which covered a portion of the North Central Pacific Ocean, was made Aug. 14 as the satellite spun 19,500 miles over Mexico. Photo at left shows the result, detailed enough for scientists to discern cloud formations. Scanner, developed at Space Technology Labs of Inglewood, Calif., formed image that was sent over 1.5-cps-bandwidth signal to Hawaiian tracking station. A single photo took 40 minutes to transmit. At right is National Aeronautics and Space Administration's interpretation of the signals, superimposed on a globe.

Suppressed-Carrier AM Best So Far For Low-Noise in FM-AM Stereo

In a progress report to the System Specifications panel of the Electronic Industries Association's stereo committee (NSRC), a subgroup has reported that a system using suppressed carrier am gives the best signal-to-noise ratio of six fm-am systems studied.

However, the subgroup reported that another system with good signal-to-noise, but which does not use carrier suppression, would result in an appreciably simpler receiver. A receiver panel of the NSRC will report on receiver complexity of the systems under study.

Other activities underway by various NSRC groups include:

- Tests of fm-fm systems for minimum bandwidth required for good stereo broadcasting, and optimum compromise bandwidth for combined stereo and background music broadcast;

- Theoretical studies of the relative merit of fm and am subcarriers for fm stereo broadcasting;

- Classification of am stereo systems so far proposed;

- Tests of the British EMI system, which will be made by comparison listening with other systems.

SAGE System Gets New-Design Antenna



110-foot-long rotating radar antenna slated for SAGE defense system will be mounted on the structure housing the complete radar system, designated WPS-28. Raytheon is the antenna designer.

**CUT
PRECISION
PARTS COSTS
AS MUCH AS
75%**



Deep drawn ball bearing race cuts costs 75% and eliminates screw machine operation. Concentricity held within extremely close tolerance even after heat treating.



Transistor dome has .018 weld flange made from .013 stock, without showing any indentation on reverse side.



Full stock thickness at top of draw on .018 brass case improved watch quality and saved assembly time



Spring for razor blade dispenser feeds automatically in high-speed assembly machine. Spring steel properties are held during heat treating. Parts are produced free of burrs, without finishing.

Improve quality at lower cost

Increase production and speed assembly

Eliminate screw machine costs

Now a ball bearing race is being made for a textile machine by deep drawing 1050CR steel to .843 within tolerances previously believed impossible. Savings of 75% are reported and the 25% reject rate experienced when this part was made on screw machines was eliminated.

This is only one of a host of examples where United's specialized skill in metal forming provides production economies on made-to-order eyelet-like and other metal specialties for many industries.

Special conveyor-type austempering furnaces are used when required to produce uniform toughness, with specified hardness. Parts are clean, free of quench cracks, and have minimum distortion. Call or write today for analysis and quotation on your most challenging problem.

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CIRCLE 30 ON READER-SERVICE CARD

the right capacitor for the application...


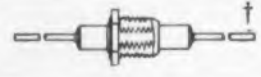




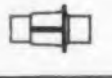
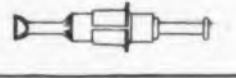
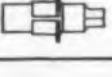

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choose from **TEN TYPES**
of Centralab
FEED-THRU
CAPACITORS

in a wide range of values, voltage ratings,
tolerances and physical sizes

Wherever you need a feed-thru capacitor, you can be sure that CENTRALAB can meet your needs. The table below shows the many varieties that make up the most complete line in the industry—and you get the added benefit of CENTRALAB's unequalled experience in the design and manufacture of ceramic capacitors. Whether it's for high frequency, filtering, bypass, or coupling, you'll find the unit you need in this group.

CENTRALAB Engineering Bulletins (FT Group) give you all the details. Write for your copies today.

TYPE	ACTUAL SIZE ILLUSTRATION †	CAP. RANGE mmf	RATING		APPLICATIONS
			VDCW	VDCT	
Bushing type DA-717		10-4000	500	1000	High frequency filtering, bypass, etc. ± 5% tolerance in lower values
Bushing type DA-720		10-5000	500-1500	1000-3000	
Step type DA-728		10-1500	500	1000	Med. freq. use, bypass, TV tuners, etc. ± 10% tolerance below 200 mmf.
Step type DA-729		10-1500	500	1000	
Ring type DA-740*		10-1000	500	900-1300	Symmetrical design. Inserts from either end... ideal for automatic insertion
Ring type DA-741*		10-1000	500	900-1300	
Eyelet type DA-784		25-1000	500	1000	For high frequency filtering and bypass, where size is important
Eyelet type DA-785		25-1000	500	1000	
Eyelet type DA-787		25-1000	500	1000	
Resistor- Capacitor type 732		470 gmv. .3 to 1.0 meg. only	1000	**	Resistor-Capacitor in parallel. ** 1500 VAC test when immersed in Silicone oil cooled with dry ice.

*patents pending

†Units marked † are 1/2 actual size

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CIRCLE 31 ON READER-SERVICE CARD

NEWS

Meeting to be Programmed by Electronic Computer

The Federation of American Societies for Experimental Biology will use machine methods to program its 1960 meeting.

The test of programming a meeting by computer will be made as part of a larger study to develop and test machine methods of scheduling thousands of papers at large meetings. The National Science Foundation has awarded a grant to the federation for this research.

Plans for the machine system call for development of a hierarchical subject classification of papers. Coding sheets will be provided authors who will classify their individual papers. These papers will then be automatically grouped and assigned to sections. The subject classification assigned by authors and punched on cards may also serve as a subject index.

Both the mechanical and traditional systems will be used and the two resulting programs will be compared and evaluated.

Techniques resulting from the study are expected to reduce greatly the magnitude and complexity of the scheduling process and to increase the effectiveness of scientific meetings.

"Robot" Works in Hot Lab



Electronic control, through multiplexing units, permits this newly developed handler to work remotely in radioactive areas. Multiplexing units are installed in the control console and in the body of Mobot. Actual control circuits for hydraulic arms are in the arm-base unit on which are mounted cameras for TV closeups of the claws. Over 100 commands can be sent through cables to handling unit, which draws 7.5 kva. Mobot was developed by Hughes Aircraft for Sandia Corp.

British Develop Remote Indicator of Rocket Roll, Pitch and Yaw

A new missile attitude indicator to measure the roll, pitch and yaw of research rockets in flight has been developed by British General Electric for the Royal Air Force.

The rocket is illuminated by two high-power cw X-band transmitters on either side of the range center line. In the rocket, fixed to a strong ring, are three flush-mounted microwave aerials and associated circuitry, forming two orthogonal interferometers.

The angles subtended between each interferometer base line and each transmitter are measured by a phase comparison technique. Then, by combining any three of these four angles with the rocket's known position in space, its pitch, roll and yaw can be calculated to within a few minutes of arc.

A special circuit has been developed to overcome the difficulty of maintaining equal phase responses in two separate amplifier channels. A low frequency, from a microwave single-sideband modulator, is added to the local oscillator to one mixer. Frequency and phase differences are kept constant during mixing, and the two signals are combined and passed through a single amplifier, followed by a detector and another amplifier.

Finally the phase of the if signal is compared with a reference frequency obtained from the modulator, the resulting voltage being a measure of the phase difference at the receiving aerials. This is fed into the telemetry transmitter for reception on the ground.

Simulator to Train Tankers



Computer-controlled system simulates tank battle situations for Marine Corps tank crews, who perform 23 operations using readings from 10 instruments. Simulator was developed by Jam Handy Organization, Detroit, Mich.



BELDEN

MAGNET WIRE HANDBOOK 14

1960 Edition

Now Available

Over 90 pages . . . handy desk and pocket size (4¾" x 7½")
A special feature dealing with "Factors Involved in Selection of Magnet Wire"

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Performance data on all types of magnet wires

Dimensional tables on all types of magnet wires . . . including bare aluminum, bare copper, and tinned copper

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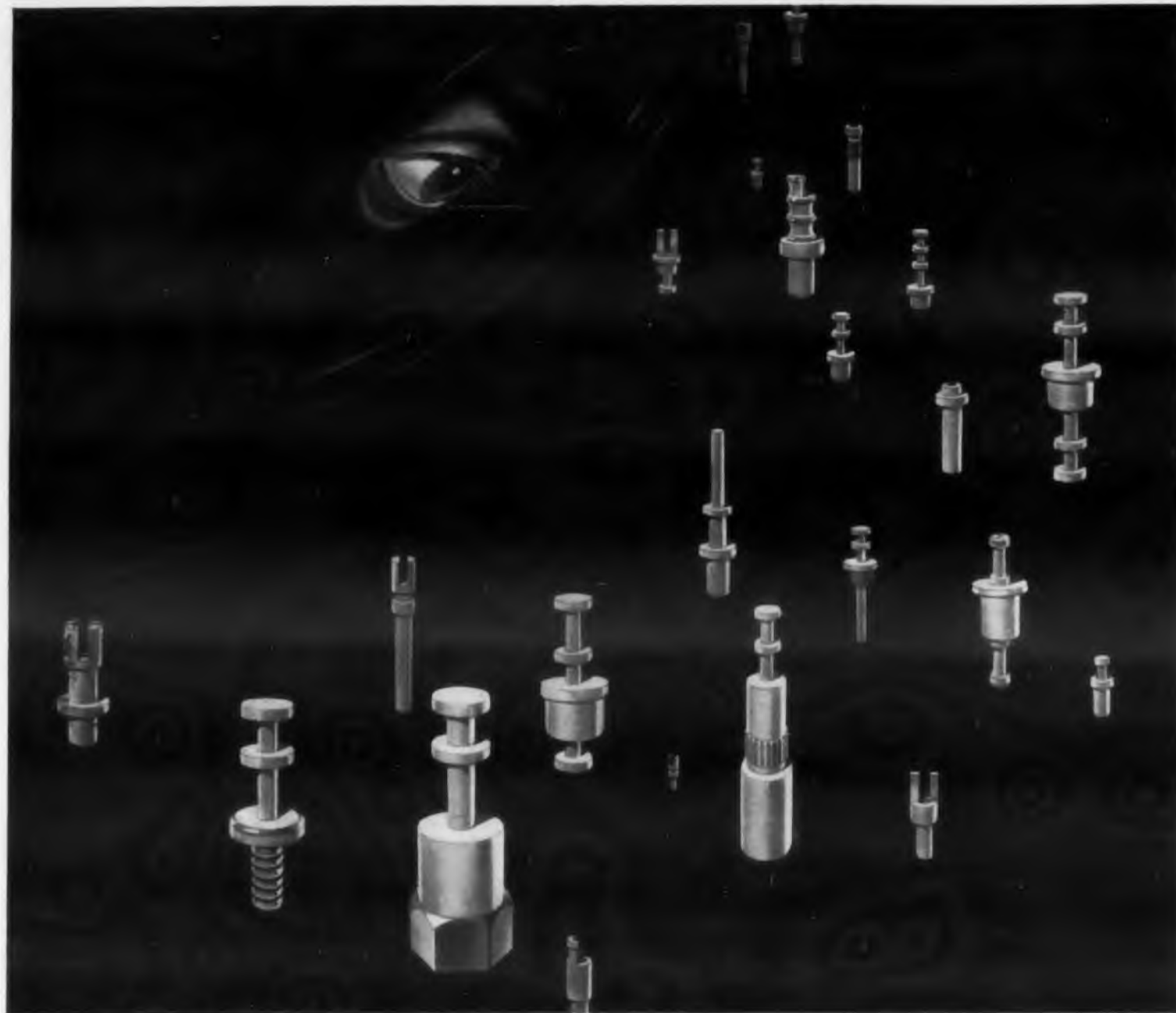
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WIREMAKER FOR INDUSTRY
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lead wire • magnet wire • power supply cords •
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automotive replacement wire and cable •
aircraft wire • electrical household replacement cords



The CAMBION Line contains more than 60 types of solder terminals including both conventional and printed circuit types. All meet or surpass applicable military specifications.

Millions pass the same rigid inspection

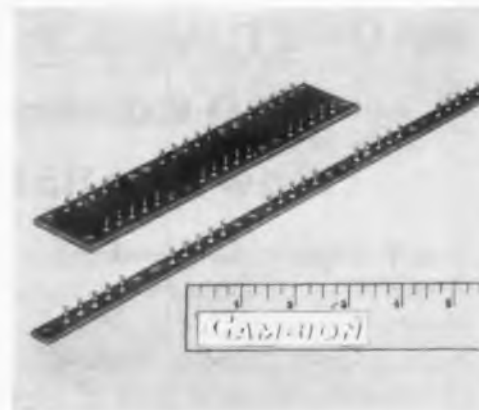
There are more than 30,000,000 CAMBION® Solder Terminals in stock . . . swage-mounting, thread-mounting, press-mounting types . . . single, double, and triple turret types . . . feed-through, double-ended, hollow, and split types. And *all* were manufactured under the same extremely rigid quality control standards.

Starting with top quality brass per QQ-B-626a, each CAMBION Solder Terminal is precision machined to close tolerances, then electroplated with silver. (Other finishes available: electro-tin, hot-tin cadmium, gold flash, or gold plate.) A microscopic cross-sectional analysis is made of plating thickness on all significant surfaces. In addition, dimensional and visual quality control checks are made per MIL-Q-5923C. Small wonder CAMBION Solder Terminals *guarantee* you the precision you need. And, they're always immediately available in any quantity.

All CAMBION Products are made under the same high manufacturing standards. Get complete details on CAMBION capacitors, swagers, hard-

ware, insulated terminals, coils, coil forms, and many other guaranteed electronic components. Contact your local CAMBION Distributor or write Cambridge Thermionic Corporation, 457 Concord Avenue, Cambridge 38, Mass. On the west coast: E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles, Calif. In Canada: Cambridge Thermionic of Canada, Limited, Montreal, P. Q.

CAMBION Terminal Boards are available in any quantity both in standard and miniature all-set boards or designed precisely to your specifications. Special CAMBION swaging machines assure proper insertion of terminals . . . eliminate danger of cracking rivet portion of terminal or the board . . . protect structural integrity of both parts.



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NEWS

Radiation Tracking Transducer Uses Lateral Photo Effect

A solid-state transducer making use of the lateral photo effect has been developed for the Army Ballistic Missile Agency to track radiation.

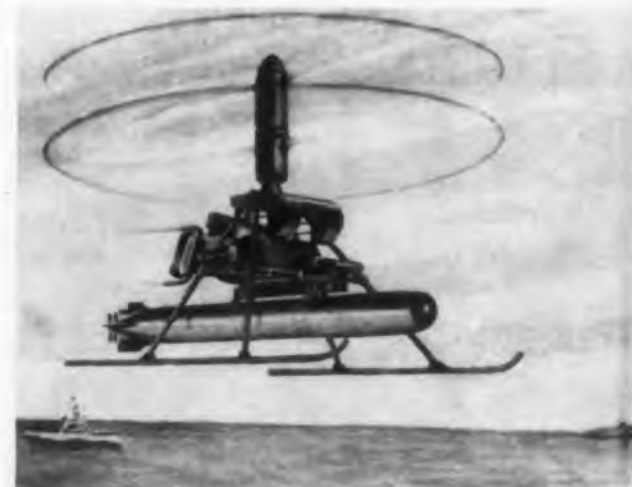
The radiation transducer, a pn junction wafer about the size of a nickel, can track aircraft or other flying objects without need for complex mechanical apparatus, according to the developer Electro-Optical Systems, Inc., of Pasadena, Calif.

It can also be used in celestial navigation applications in place of gyroscope systems, in horizon seeking for space vehicles, missile launch orientation, target ranging, location of light flashes on the ground and specialized ground communication systems. And it is applicable, the company says, to instrumentation, automatic control and computer techniques.

The unit is said to be capable of detecting and resolving the position of emissions at angles of motion smaller than 0.1 second of an arc. It is aimed electrically, so mechanical rotation of the cell is unnecessary.

Presently available units are sensitive to light wavelengths from 0.5 to 1.1 microns.

Remotely Controlled Copter for ASW



Artist's conception of the remotely controlled DSN-Drone, a torpedo-carrying coaxial helicopter being developed for the Navy by Gyrodyne Co. of America Inc., L.I., N.Y. The rotary-winged craft, carrying homing torpedoes, are scheduled for anti-submarine duty aboard destroyers as part of the Navy's DASH weapon system.

NEWS BRIEFS . . .

. . . **TV SCANNER** for first U.S. moon probe has already been built as bench model. Final version of NASA high-resolution unit will be part of system designed to relay back to earth between 10 and 100 photos of probe's approach to moon.

. . . **NAVY REVEALS** that its infrared Sidewinder missile incorporates 35 patentable inventions: in the seeker, 18; servo, 5; servo and power supply, 3; voltage supply 4; flight control, 1; gas generator package, 4.

. . . **SPECIALLY DESIGNED** transistors made possible General Instrument Corp.'s 9-1/2-oz transistorized tuners for portable TV sets. Company has also developed miniaturized deflection components for the portable receivers.

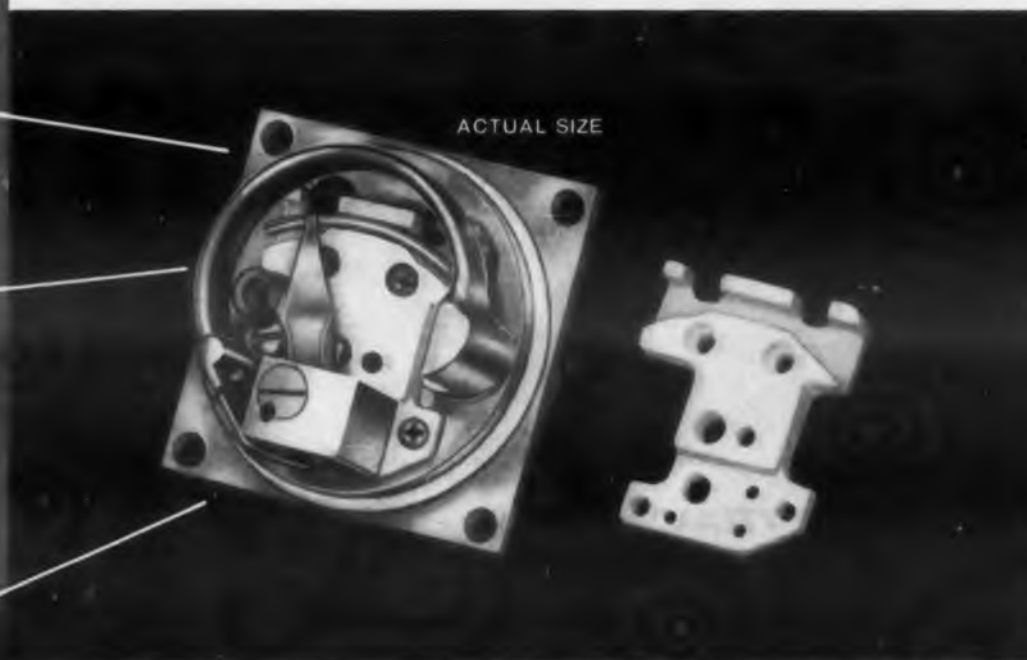
. . . **TWO MORE PATENTS** for electronic solutions to character recognition problems have been awarded to Farrington Mfg. Co. One is for an electronic extension of stroke-recognition reading machine, the other is for a shift-register recognition method. In this technique, output of a scanner is introduced to the first stage of a tapped delay line, which is sampled to pick up combined signal outputs introduced to the line at different times.

. . . **SEARCHING SCANNER** designed by Western Reserve University for retrieval of library information will be built in a high-speed prototype version by General Electric. The GE-250 computer-like scanner will be able to search 100,000 abstracts per hour; the WRU scanner, used successfully in a metallurgical literature program, searches 30 abstracts per hour.



SUPRAMICA® 555 ceramoplastastic

the world's most nearly perfect
precision-moldable electronic insulation



for total reliability . . . at high temperatures
. . . specified in **BOURNS Inc.** transducers

Why did BOURNS, INC. select SUPRAMICA 555 ceramoplastastic as the insulating base for its ultra high-temperature differential pressure transducers?

BOURNS' engineers cite three reasons . . . each a contribution to the total reliability of these airborne telemetering devices. "First is temperature. The sensitive element of the mechanism must withstand high operating temperatures. Next, SUPRAMICA 555 offers a combination of excellent insulating characteristics, which are essential to the highly accurate functioning of the potentiometer. In addition, this ceramoplastastic material is readily moldable into complex shapes, such as that required for this intricate part."

For other applications SUPRAMICA 555 is used under operating conditions as high as +700°F. . . SUPRAMICA 555 is one of the many ceramoplastastic and glass-bonded mica insulation materials produced by MYCALEX CORPORATION OF AMERICA, in precision-molded and machinable formulations. Whatever your insulation need there is a MYCALEX product to meet it—for example, SUPRAMICA 620 machinable ceramoplastastic, which has a maximum operating temperature of +1550°F. Write today outlining your design problem for specific information.

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No.17 • Mars Outstanding Design Series



LIGHT TRAVEL — You may need to postpone your trip a half century or more but you will make up for lost time. So says Philip Schlesinger, of Buffalo, N. Y., who designed this light-powered space ship which will take you to distant space at almost the speed of light.

Based on Einstein's theory that matter can be converted into light, this Photon Powered ship derives its basic power from a small atomic reactor. The reactor is housed in a unit which also contains reflectors. Comparable to fluorescent screens, these convert the reactor heat, under great pressure, into light and thrust. The thrust is low, but extremely constant.

Launched disassembled inside a cargo rocket, the ship is assembled in space. It cannot land (a landing vehicle is provided for that purpose), but remains in orbit.

This is one more example of the creative contributions today's designers are making. To help them translate their pace-setting ideas from concept to reality, they require the best of drafting tools.

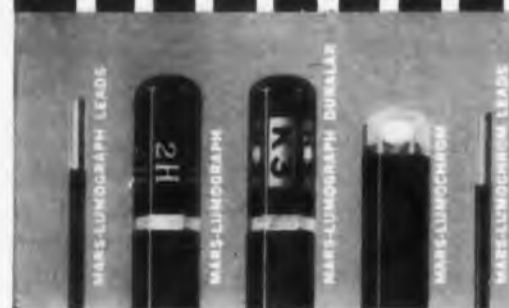
In pencils that means MARS, long the standard of professionals.



Among the famous imported Mars drafting products are: Left — 1001 Mars-Technico push-button lead holder. Above — 1904 Mars-Lumograph drawing leads, 18 degrees, EXB to 9H. Below — 2886 Mars-Lumograph drawing pencils, 19 degrees, EXEXB to 9H; 2830 Mars-Lumograph Duralar—for drafting on Mylar®-base tracing film — 5 special degrees, K1 to K5; Mars-Lumochrom colored drawing pencils, 24 shades. Not shown — Mars Pocket-Technico for field use; Mars pencil and lead sharpeners; Mars Non-Print pencils and leads.

Mars Products are available at better engineering and drafting material suppliers.

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*for the man
who's going places ...*

the pencil that's as good as it looks

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CIRCLE 35 ON READER-SERVICE CARD

NEWS

... NEW YORK'S HI-FI SHOW displayed \$5-million worth of equipment to about 60,000 viewers during its run earlier this month. Hi-fi dealer sales for 1959 are expected to reach \$300 million, a 15 per cent increase over 1958 sales. As expected, stereo dominated the show. But still unresolved is tape question: will stereo tapes come in cartridges or reels? Bell Labs showed a precedence-effect stereo system that permits "monophic" reception of stereo programs on one speaker through use of a 10 millisecc delay in signal transmission.

... A NEW WORD has been coined to name the newly formed Intellectronics Laboratories of Ramo Wooldrige, which will work in industrial process control, automatic language translation, information retrieval and man-machine systems.

... DIFFUSED MESA TRANSISTORS with switching speeds of less than a tenth of a microsecond and 10 amp ratings have been delivered to the Air Force by Pacific Semiconductor. Company is also working on 20, 50 and 100-amp units.

... SPACE SURVEILLANCE Operations Center, at Dahlgren, Va., is capable of displaying on a screen map of the earth the path of missiles or satellites that cross a radar "fence" reaching across the southern U.S. Two transmitters, in Alabama and Arizona, provide the entire coast-to-coast coverage.

... TELEMETERING LINK has been extended by telephone by Boeing engineers relaying Bomarc flight data from Cape Canaveral range to Seattle (photo below). Flight telemetry data recorded on 60-ips tape is recorded at 1-7/8 ips at acquisition station, for transmission by telephone with frequency and bandwidth compressed by a factor of 32. At Seattle station, data is recorded at 60 ips.



QUOTES IN THE NEWS...

On data processing:

"Experience to date shows that the introduction of data processing equipment is often accompanied by an explosive increase in communications requirements . . . if a data processor requires only one day to prepare a report . . . [a] . . . three-day delay in the mail becomes the overwhelming factor determining report preparation time, and an obvious bottleneck." *W. E. Leubert, Army Signal R & D Lab, Fort Monmouth, in a paper at the Fall AIEE meeting, Chicago.*

On meeting Japanese competition:

"Instead of breaking our necks and integrity to cut costs by using imported parts of dubious quality, we are continuing to concentrate on top performance, outstanding convenience features, and appealing new designs of our instruments . . ." *L. C. Truesdell, Zenith V.P. at a marketing meeting.*

On the data processing market:

"The electronic data processing market, including general-purpose and special-purpose computers, and other digital systems, this year will amount to more than \$1 billion. And all present indications are that the market will at least double itself by 1965, and keep right on rising." *R. E. Lewis, president of Sylvania at the dedication of a new Sylvania computer plant.*

On the instrument lag:

"The necessary instrumentation for thorough exploration of space is not on the drawing boards at the present time." *Dr. Thomas Gold, Cornell University at a physics colloquium during which he predicted that scientists would be able to produce basic instruments to measure magnetic fields and gas densities in space.*

CIRCLE 36 ON READER-SERVICE CARD ➤

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No Substitute
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Reliability—

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Magnetic Modulators

All Magnetic Modulators strictly conform to MIL-T-27A. Some typical circuit applications for Magnetic Modulators are algebraic addition, subtraction, multiplying, raising to a power, controlling amplifier gains, mechanical chopper replacement in DC to fundamental frequency conversion, filtering and low signal level amplification.

FASTER RESPONSE TIME
NEGLIGIBLE HYSTERESIS
EXTREME STABILITY
(Ambient Temp. Range from -65°C to +135°C)
COMPACT SIZE
LIGHTWEIGHT
INFINITE LIFE
COMPLETE RELIABILITY

Miniaturization of the new Magnetic Modulator makes it possible to incorporate this component into wafer type structures and transistorized printed circuit assemblies without sacrificing ruggedness or reliability.

CONSULT GENERAL MAGNETICS on magnetic amplifier components for automatic flight, fire control, analog computers, guided missiles, nuclear applications, antennas, gun turrets, commercial power amplifiers and complete control systems. Call or write for Catalog B on miniature and standard components.



Magnetic Input Modulator



Magnetic Input Modulator



Magnetic Thermocouple Converter

TYPE NUMBER	IMM-436-2	IMM-436-3	MTC-435-2
Excitations Frequency—Carrier	400 cps	400 cps	400 cps
Signal Winding DC Resistance	1000 ohms ±15% each signal winding	1000 ohms ±15% each signal winding	10 ohms ±15%
AC Excitation Volts	5.5 V. @ 400 cps	2.5 V. @ 400 cps	6 V. RMS
Input DC Signal Range	0 to ±100 μa.	0 to ±80 μa.	0 to ±10 mv.
AC Output Range	0 to 2.2V. @ 400 cps (sine wave)	0 to 1.5V. @ 400 cps (sine wave)	0 to 2.7V. @ 400 cps (sine wave)
Overall Dimensions (Inches)	27/32x27/32x1 5/16	27/32x27/32x1 3/16	1 1/4x7/8x5/8
Null Amplitude (Noise Level)	20 mv. RMS	15 mv. RMS max.	25 mv. RMS max.
Output Impedance	7000 ohms	7000 ohms	10,000 ohms
Null Drift (In terms of input signal) -65°C to +100°C	±0.5 μa. max.	±0.5 μa. max.	±0.1 mv. max.
Hysteresis — % of maximum input signal	0.5% maximum	0.5% maximum	0.5% maximum
Type of Mounting	Male Stud	Female Insert	Male Stud
Maximum % Distortion in Output	25%	15%	20%
Weight Ounces	1.3 oz.	1.2 oz.	1.5 oz.



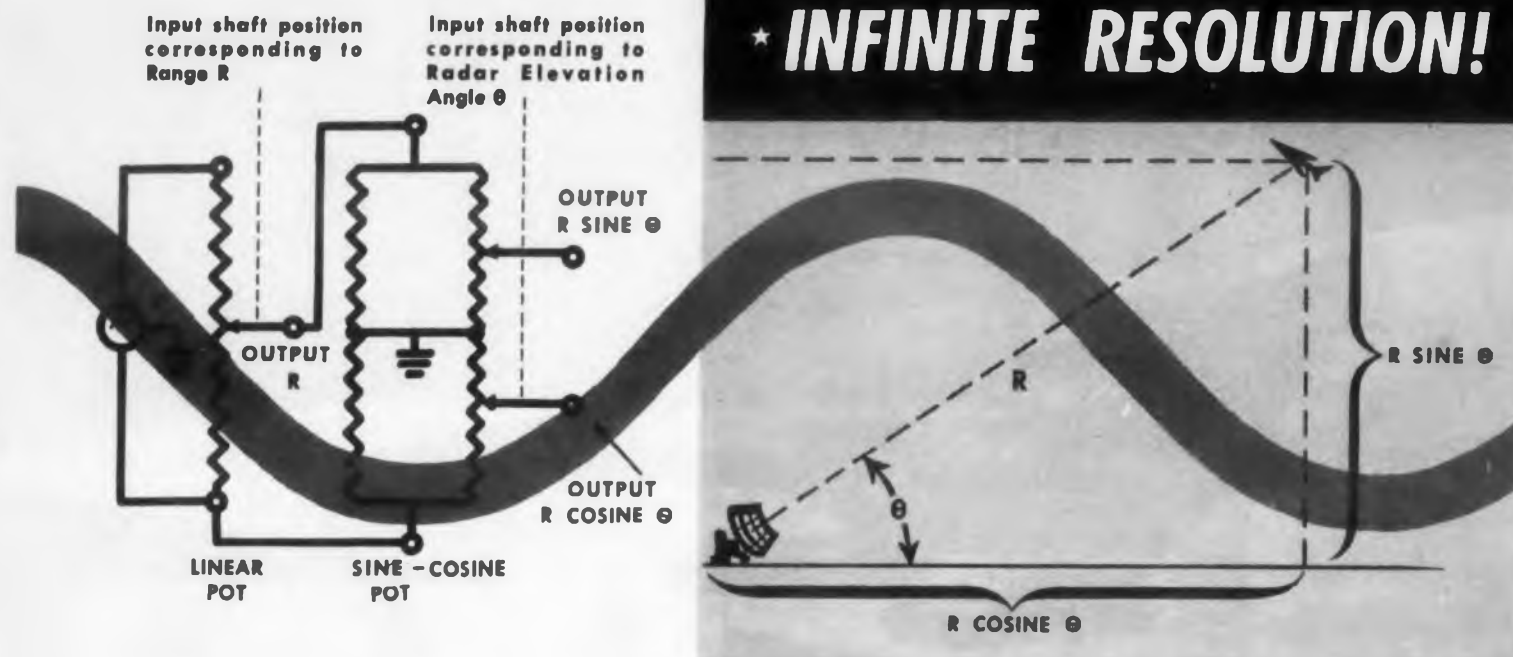
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★ INFINITE RESOLUTION!



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Range to Target: 50,000 yards
Radar Elevation Angle: 45°

Error with
Wire-Wound Pots

Quadrature due to Inductance of Windings (@ 1000 cps) . . .	35
Resolution	30
Linearity	50
	<hr/> 115 yds

Error with
C.I.C. Film Pots

Quadrature due to Inductance	0
Resolution	0
Linearity	8
	<hr/> 8 yds

YOU DON'T HAVE TO ACCEPT THE ERRORS IN WIRE WOUND POTS!

Engineers recognize the obvious superiority of C.I.C. Film Sine-Cosine Pots; THOUSANDS are currently in use in Hawk, Atlas, Nike and other missile systems, as well as in the APS-81, ASG-15 fire control system and AN/ASB-4 Bombing/Navigation system, all used on the B-52 Bomber, AN/APA-125 Radar Indicator, and many others. You too can have superior systems with C.I.C. Film pots. Send us your specifications today!

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CIRCLE 37 ON READER-SERVICE CARD

WASHINGTON REPORT



Ephraim Kahn

New Weapons And Space Projects, A Budget Worry

Budget problems are perplexing the Pentagon. Proposed solutions range from suggestions of ways in which bigger budgets might be made palatable to reluctant admissions that belt-tightening will probably be the course that must be followed. Coincidentally, high officials have implied that there is no "space race" with Russia and that U.S. space projects will be at least as impressive as the Soviets' as soon as proper booster capacity is developed.

In the purely military field of missiles, however, no such graceful acceptance of the U.S. situation can be found. Philip B. Taylor, Assistant Air Force Secretary for Material, reflected prevailing opinion when stating bluntly that this country must "match or surpass" Russia's missiles lest the deterrent effect of American military forces be jeopardized and the country find itself "drifting toward the position of falling victim to Soviet nuclear blackmail."

The fact is that the Pentagon is becoming more and more concerned about being squeezed between rising weapons costs and a relatively rigid budget. There seems to be little hope that the defense budget will rise substantially. In fact, the Air Force budget director has observed that this "would be completely out of the question without a drastic reorientation of the nation's attitude toward taxation."

For the present, the solution would appear to consist in a judicious, but unflinching, pruning of projects whose promise is limited. The extent to which this will adversely affect the electronics industry can not be foretold, though it is clear that cancellation of any advanced weapons (or space) project will cost the industry money. The electronics industry is, however, fortunately situated in that it is heavily involved with R&D. It is quite clear that the government is determined to keep acquiring knowledge.

National Program Of Research

Thus, Secretary Taylor has called for a constant level of R&D as a national policy "if we are to counter the balanced offensive of our opponent

with a balanced defense of our own." Similarly, the Army's R&D chief has warned that "a national program of dynamic research" by government and industry is necessary if the U.S. is to avoid the danger of "running out of new basic knowledge."

Specifically, Lt. Gen. Trudeau, in charge of Army R&D, would like to get more money so that "every area of research that promises a profitable return" can be exploited. "Management," he said, "must place the emphasis in research where it is needed." He also urged that all organizations engaged in research promote interchange of scientific information. Only by diligently fostering basic investigations can "the background of theories and information so vital to the proper pursuit of applied research and development" be provided.

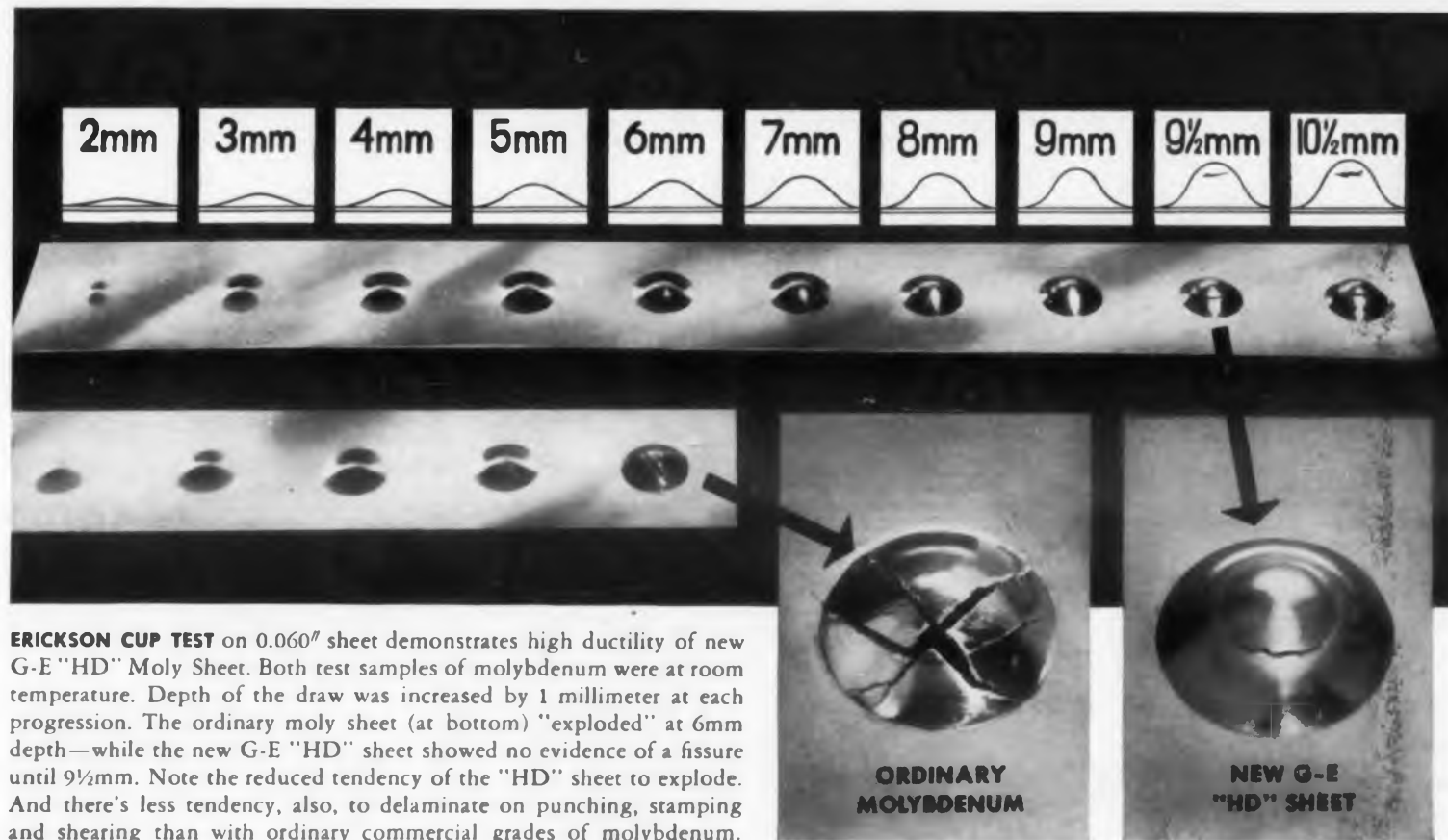
Budget Difficulties

There are, of course, limits to the extent that any organization can indulge its desire to explore all promising research areas—and the limits are budgetary. This at times may lead to seemingly anomalous situations. For example, a rocket booster project might show great promise and be well advanced in terms of the current state of the art. It might nevertheless be out of line with anticipated needs by the time its end-product is ready. In such a case, it might be judged discreet to cancel the project and devote the funds required for its completion to something else which, upon completion, would better fill the needs of the military. On the other hand, a good case might be made that completion of such a well-advanced project that does not quite fill the bill is fully justified because it would give this country a leg up in space exploration, provide valuable experience, and improve America's international public relations.

Defense officials recognize that fine lines must be drawn, but they would like to hedge a bit. This could be done more easily if there were some sort of yardstick for defense funds which could be recognized as reasonable by industry, labor, the public, and Congress. Trial balloons concerning this are being sent up by the military. One proposal is to gear the defense budget to the U.S. Gross National Product—the total output of goods and services. The defense budget is now "running somewhere around nine percent of the GNP," says Maj. Gen. R. J. Friedman. "If we can agree that a defense effort of this level is not damaging the economy today—and that if this ratio is maintained it would not damage the economy in the future—we then might reasonably expect dollar increases in the defense budget proportionate to the gain" in GNP. About \$1.5 billion a year in new money might accrue to the military if this system were adopted. (By contrast, the 1958 Rockefeller Report recommended \$3 billion.)

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... with General Electric's new High-Ductility (HD) Molybdenum Sheet



ERICKSON CUP TEST on 0.060" sheet demonstrates high ductility of new G-E "HD" Moly Sheet. Both test samples of molybdenum were at room temperature. Depth of the draw was increased by 1 millimeter at each progression. The ordinary moly sheet (at bottom) "exploded" at 6mm depth—while the new G-E "HD" sheet showed no evidence of a fissure until 9½mm. Note the reduced tendency of the "HD" sheet to explode. And there's less tendency, also, to delaminate on punching, stamping and shearing than with ordinary commercial grades of molybdenum.

DRAW IT! FORM IT! PUNCH IT!—all without preheating! General Electric's new "HD" Moly Sheet can take it—and you can do all these operations in thicknesses previously impossible . . . or requiring up to 1000°F preheating. Even in cases where small amounts of heat may be needed, it's always less than with ordinary molybdenum sheet.

TIME SAVER, MONEY SAVER! The improved ductility of General Electric's new "HD" Molybdenum Sheet is of particular significance in sheet thicknesses of 0.020" to 0.125"—as used in electronic tubes and semiconductor

diodes, rectifiers and similar products. It has a high melting point (2622°C, 4752°F), low vapor pressure, and excellent strength at elevated temperatures. So it will be of great value to any company using refractory metals.

PLAN ON G-E "HD" SHEET Available in commercial quantities, so there's no better time than right now to get all the facts about this new kind of molybdenum. Write: General Electric Co., Lamp Metals and Components Dept. ED-11, 21800 Tungsten Road, Cleveland 17, Ohio.



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EVEN WITH NO PREHEATING!**

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No matter what you need in ultrasonic cleaning equipment, you'll find Narda's complete line of production-size units have the quality, power, performance, capacity and appearance of cleaners selling up to three times their price! Write for more details now and we'll include a free questionnaire to help determine the precise model you need. Address: Dept. IRED-19.



Generator G-202 35 watts Transducerized Tank NT-202 Capacity: 3/4 gallon

An amazingly efficient, yet inexpensive, ultrasonic cleaner. Duty cycle timer permits operator to turn the unit on, set it, and leave; the SonBlaster will turn off automatically at the end of the cycle. Four choices of timers—from 0-15 min. to 0-120 min. Also available without timer at slightly lower cost (G-201).

\$220



Generator G-601 60 watts Transducerized Tank NT-602 Capacity: 1 gallon

A more powerful production-type unit, with a special circuit and selector switch permitting operator to alternate between two tanks, when items being cleaned require different solutions or a two-step process.

\$350



Transducerized Tank NT-1505 Capacity: 5 gallons Generator G-1501 300 watts

The lowest price in the industry for a tank of this capacity and activity. Generator also will operate 2, 3 or 4 submersible transducers at one time, with just a turn of the load selector switch on the front panel.

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Transducerized Tank NT-5001 Capacity: 10 gallons

Generator G-5001 500 watts

Generator features standby switch for longer life and load selector switch on the front panel to operate up to 8 submersible transducers or 8 NT-602 or 2 NT-1505 transducerized tanks at one time. Larger tanks available on special order.

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Submersible Transducer NT-605

Heli arc welded stainless case, hermetically sealed for safe, leak-proof immersion. Radiating face: 27 sq. in. Effective plane of radiation: 40-50 sq. in. (approximately 10" x 5"). Effective cavitation of volumes up to 1200 cu. in. at 24 in. tank height (5 gal.) and 2400 cu. in. at 48 in. tank height (10 gal.). Bulkhead electrical fitting on back allows all wiring connections to be made on outside of tank. For use in any arrangement or location in any shape tank you desire to use. Also available—model NT-604, identical with NT-605, except for pipe thread instead of bulkhead fitting, permitting electrical connections inside of tank.

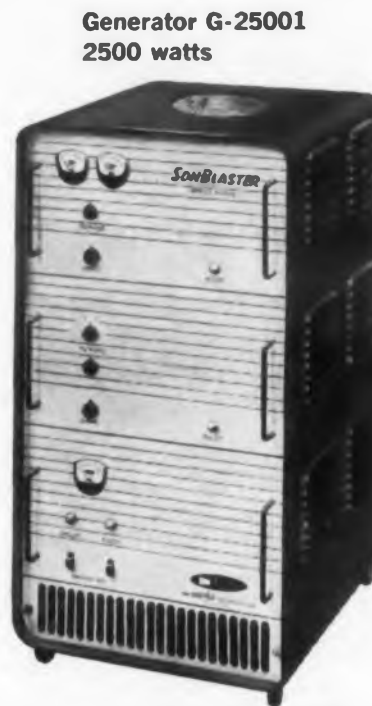
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Transducerized Tank NT-25001 Capacity: 75 gallons

Powerful unit drives the largest mass-produced industrial-size transducerized ultrasonic cleaning tank made! Also energizes up to 40 Narda 60-watt submersible transducers (NT-604 or -605). Capable of energizing tanks measuring up to 15' square feet of area by 2' or 3' high.

\$4360



Generator G-25001 2500 watts

Consult with Narda for all your ultrasonic requirements. The SonBlaster catalog line of ultrasonic cleaning equipment ranges from 35 watts to 2.5 KW, and includes transducerized tanks as well as immersible transducers which can be adapted to any size or shape tank you may now be using. If ultrasonics can be applied to help improve your process, Narda will recommend the finest, most dependable equipment available—and at the lowest price in the industry!

For custom-designed cleaning systems, write to our Industrial Process Division; for information on Chemical processing applications, write to our Chemical and Physical Process Division; both at the address below.

MEETINGS

Calendar of Events

November

- *16-19 Conference on Magnetism and Magnetic Materials, AIEE, Office of Naval Research, American Physical Society, IRE, and the Metallurgical Society of A.I.M.E. Sheraton-Cadillac Hotel, Detroit, Mich.
- *16-20 14th Annual Meeting and Astronautical Exposition, American Rocket Society, Sheraton Park Hotel, Washington, D. C.
- *16-20 5th International Automation Congress and Exposition, New York Trade Show Building, New York, N. Y.
- 17-19 Northeast Electronics Research and Engineering Meeting, IRE, Boston Commonwealth Armory, Boston, Mass.
- *19-20 6th Annual Meeting of the Professional Group on Nuclear Science, IRE, Somerset Hotel, Boston, Mass.
- 23-24 Symposium on Solid State Techniques in Instrumentation, ISA, IRE, AIEE, Benjamin Franklin Hotel, Philadelphia, Pa.

December

- 1-2 1959 Eastern Joint Computer Conference, AIEE, ACM, PGEC, Statler Hilton Hotel, Boston, Mass.
 - 1-2 4th Midwest Symposium on Circuit Theory, Marquette University, Milwaukee, Wis.
 - 3-4 Professional Group Vehicular Communications, Colonial Inn & Desert Ranch, St. Petersburg, Fla.
 - 3-5 3rd Annual International Visual Communications Congress, Society of Reproduction Engineers, SRE, Statler Hilton Hotel, New York, N. Y.
 - 8-10 2nd National Conference on the Application of Electrical Insulation, AIEE, NEMA, Shoreham Hotel, Washington, D. C.
- *Includes meetings described herewith

5th Conference On Magnetism and Magnetic Materials, November 16-19

The Conference on Magnetism and Magnetic Materials will be held in Detroit, Mich., at the Sheraton-Cadillac Hotel. This Conference, sponsored by the Magnetism Subcommittee of the Basic Science Committee of the AIEE, seeks to bring together those interested in basic and applied work in magnetism. For further information contact the Local Conference Committee Chairman: D. M. Grimes, Dept. of Electrical Engineering, University of Michigan, Ann Arbor, Mich.

14th Annual Meeting and Astronautical Exposition, November 16-20

The American Rocket Society's Annual Meeting will be held at the Sheraton Park Hotel in Washington, D. C. The Opening session will cover: Guidance and Navigation; Physics of the Atmos-



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Sphere and Space; Propellants and Combustion; Ion and Plasma Propulsion; Man in Space; Flight Mechanics; Human Reliability and Physics of the Atmosphere and Space. Meetings and Public Relations Manager is Roderick L. Hohl, 500 Fifth Ave., New York 36, N.Y.

5th International Automation Exposition and Congress, November 16-20

Richard Rimbach Associates, management for the International Expositions, announces the New York City Trade Show Building as the site for the IAE. The exhibit is expected to present over 100 clinic sessions covering computers, process instrumentation, machine tool control, materials handling and office automation, servomechanisms and components in control. Also temperature pressure, flow and dimensional measurement and control will be treated. In addition to the clinic sessions the Technical Program for the Congress will include 12 separately sponsored conferences of professional interest. Managing Director is Richard Rimbach, 845 Ridge Ave., Pittsburgh 12, Pa.

Northeast Electronics Research and Engineering Meeting, November 17-19

The NEREM will be held at the Boston Commonwealth Armory, Boston, Mass. Some of the areas to be covered will include: electron devices, medical electronics, circuit theory and practice, machine control, equipment design consideration, semiconductors, instrumentation, Doppler radar techniques for air navigation, reliability quality control and computer techniques. Technical papers will be presented at sessions scheduled to run concurrently with the exhibitions. Address correspondence to: Miss Shirley Whiteker, IRE Boston Office, 73 Tremont Street, Boston, Mass.

6th Annual Meeting of the IRE Professional Group on Nuclear Science, November 19-20

The IRE Professional Group on Nuclear Science will hold its 6th Annual Meeting on November 19 and 20 at the Somerset Hotel, Boston, Mass. Special emphasis will be placed on Nuclear Rocket Propulsion. The Technical Program will include sessions on: Nuclear Science and Space Exploration, Electronics for Plasma Production and Diagnostics, Research Instrumentation for High Energy Nuclear Science, Nuclear Reactor Instrumentation and Control, and Automatic Systems for Nuclear Data Processing. This meeting will overlap the NEREM which will have complementary technical sessions and exhibits. Chairman is Hugh F. Stoddart, Atomium Corp., 940 Main St., Waltham 54, Mass.



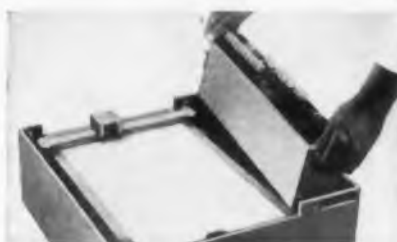
PUSH BUTTON PANEL controls operations rapidly, even at remote locations.



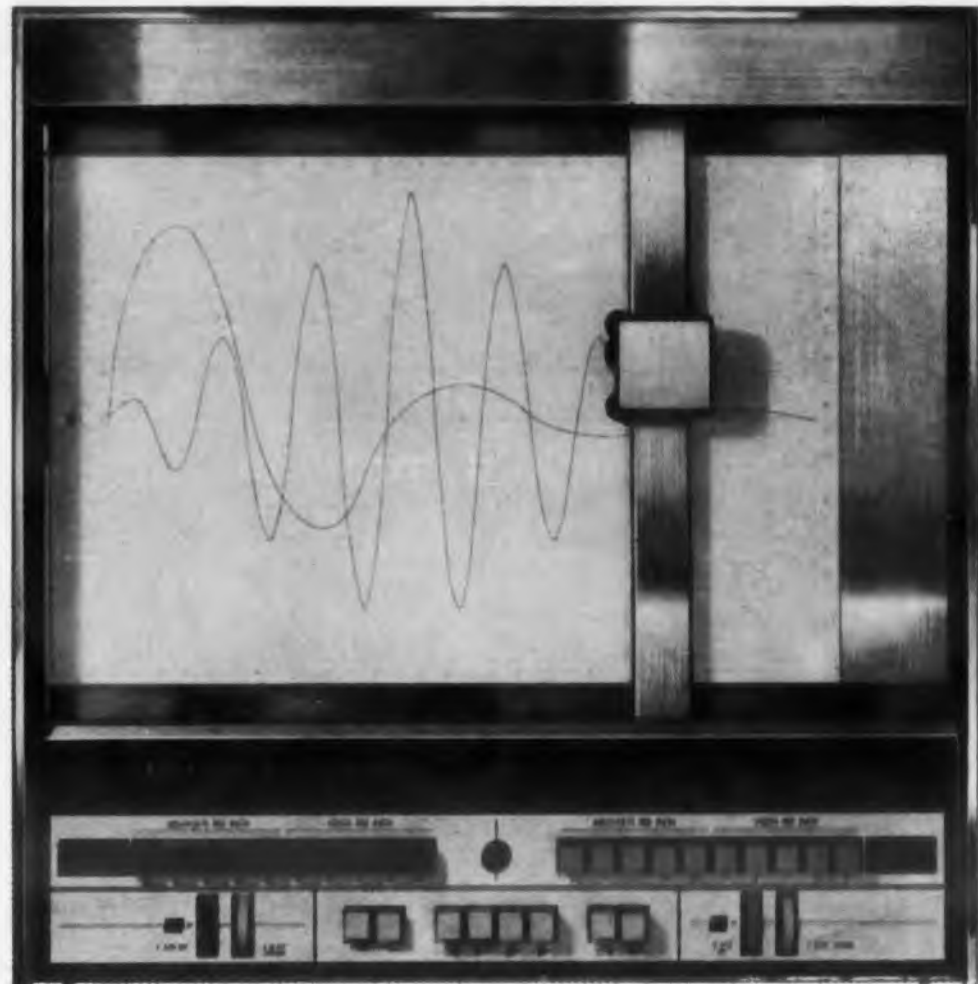
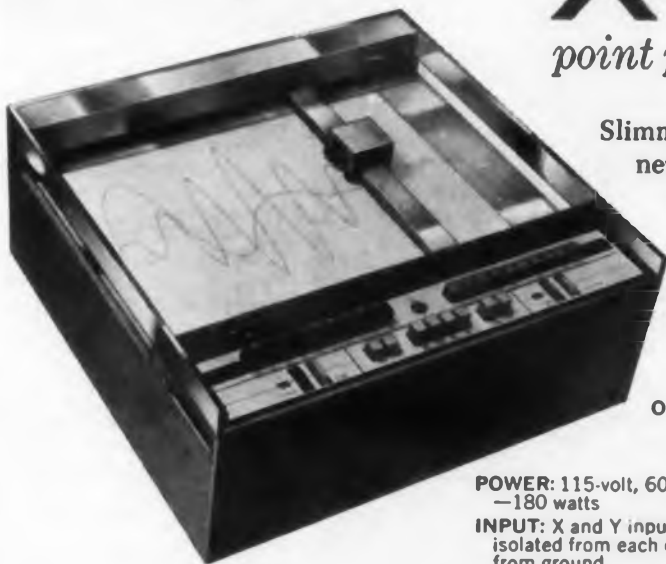
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isolated from each other and
from ground.
INPUT RESISTANCE:
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volt on .5 millivolts per inch
to .1 volts per inch scales.

INPUT SENSITIVITY: .5 millivolts per inch
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volts per inch and .1, .5, 1, 5 and 10 volts per
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COAX HYFEN

CONNECTORS

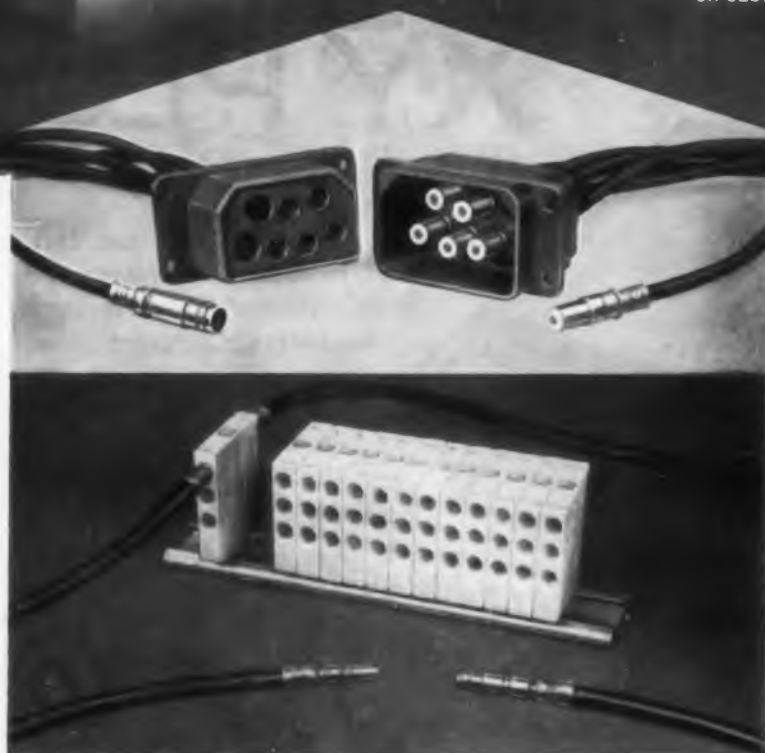
with crimp-type
snap-locked contacts



Snap-lock action of Burndy coax HYFEN connectors recommends them for many applications. Contacts may be installed on cable wherever convenient and then snapped in or out as required. These connectors are now in use in critical circuits

ME7X
...Rack-and-panel Coax HYFEN with one-piece die-cast shell and one-piece block. Mates with existing solder types.

COAX MODULOK
...Modular terminal block. Modules snap together or apart and are mounted on cadmium-plated steel track.



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CONNECT QUICKLY
...high speed tooling for volume production results in low installed costs.

CONNECT EASILY
...snap-lock action and simple design with few parts make installation easy—tool crimps contacts in any circumferential position.

CONNECT RELIABLY
...tool-controlled crimp provides strain relief for conductors, guarantees a uniform indent for measurable quality control. There is no heat to damage insulation.

NEW PRODUCT

Printed Circuit Connector With Crimped, Snap-locked Contacts



A new addition to the HYFEN® line, a pin-type printed circuit connector is in production by the Omaton Division of the Burndy Corp.

This connector, type MC combines the high reliability and the wiring technique embodied in the HYFEN principle for use with printed circuits. This principle allows crimping to be done before or after the harness or wires are in place. It also allows sockets to be easily and quickly snapped in, to be removed with a simple extraction tool for circuit changes or checks, and to be reinserted.

The printed circuit HYFEN is available in 31 and 45 place configurations. The male side of the connector utilizes right angle pins with one side assembled to the board and the other to the receptacle. The side assembled to the board is held in place mechanically and the connection to the circuit is usually dip soldered with the other components on the board. Guide pins align the plug and receptacle, which is mounted on the chassis. Three sizes of HYFEN solderless crimp-type snap-locked sockets, accommodating wire sizes #22, #14 and combinations of these sizes, are available for the receptacles. These crimped connections eliminate time-consuming solder operations and the high rejection rate inherent in the use of fluxes and dissimilar metals characteristic of solder.

Both hand-operated and semi-automatic installation tooling can be used for crimping these sockets. The blocks are made of diallyl phthalate.

BURNDY

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ELECTRONIC DESIGN • November 11, 1959 ELEC

EDITORIAL

Helping Education Catch Up

The Ford Foundation's grant of \$19.5 million to 10 major schools for modernizing engineering education deserves both our gratitude and our close attention.

Most of the money will be used to strengthen faculties, raise salaries, and improve teaching and research facilities—all solid actions that will eventually affect the quality of design engineers.

The rest of the "magnificent" grant will be used on bold innovations in engineering education. These could have an earlier and deeper effect on our industry.

Cleveland's Case Institute of Technology will use its \$1 million grant to create pioneering centers in engineering design and in systems research. Believing that "the greatest emphasis in engineering education should be placed upon the close relationships and interdisciplinary character of modern engineering and science," Case is setting up (1) an engineering design lab that will specialize in "authentic design problems" (many of which will be electronic) and (2) a systems research center that will make use of the entire faculty to teach systems thinking in design.

Massachusetts Institute of Technology will use part of its nearly \$10-million grant to "evolve new syntheses of courses to couple the basic sciences with the newly emerging fields of engineering and to introduce students to the 'hard-headed' purposefulness of engineering."

Exactly fitting some of the important needs of the electronic industry are three of the "themes" being considered by MIT for the new curricula: materials—manipulating atoms and particles to produce new devices; energy processing—new ways of converting one source of energy to another; and information processing—developing computer systems and other devices for communication, analysis and control.

We would do well to watch closely and to consider expanding these two imaginative projects to help engineering education meet tomorrow's needs. As Dr. H. T. Heald, president of the Ford Foundation says, we must help this education catch up in the "hopeless race against time and reality," where "most engineering students . . . are being equipped for the engineering of the last half of the century by being indoctrinated with the art and practice of the Nineteen Fifties."

Alan Corneretto

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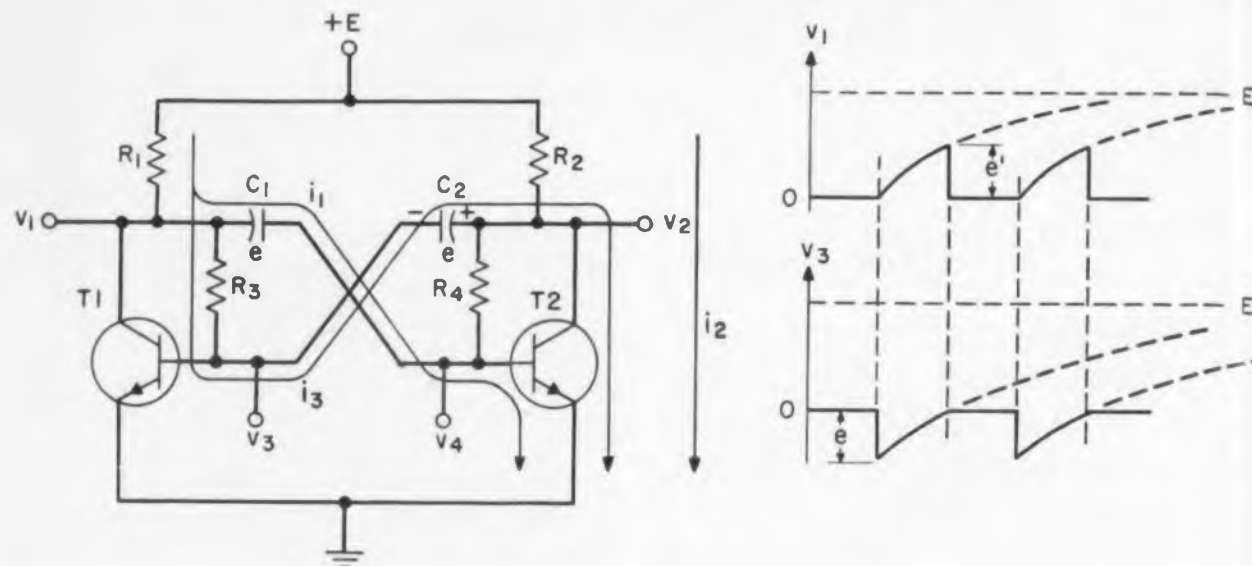
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Fig. 1. Circuit and waveforms of the basic self-starting multivibrator.



How to Design a Sure-Starting Multi and Couple It to a Load

Irwin Dorros
Bell Telephone Laboratories
Whippany, N. J.

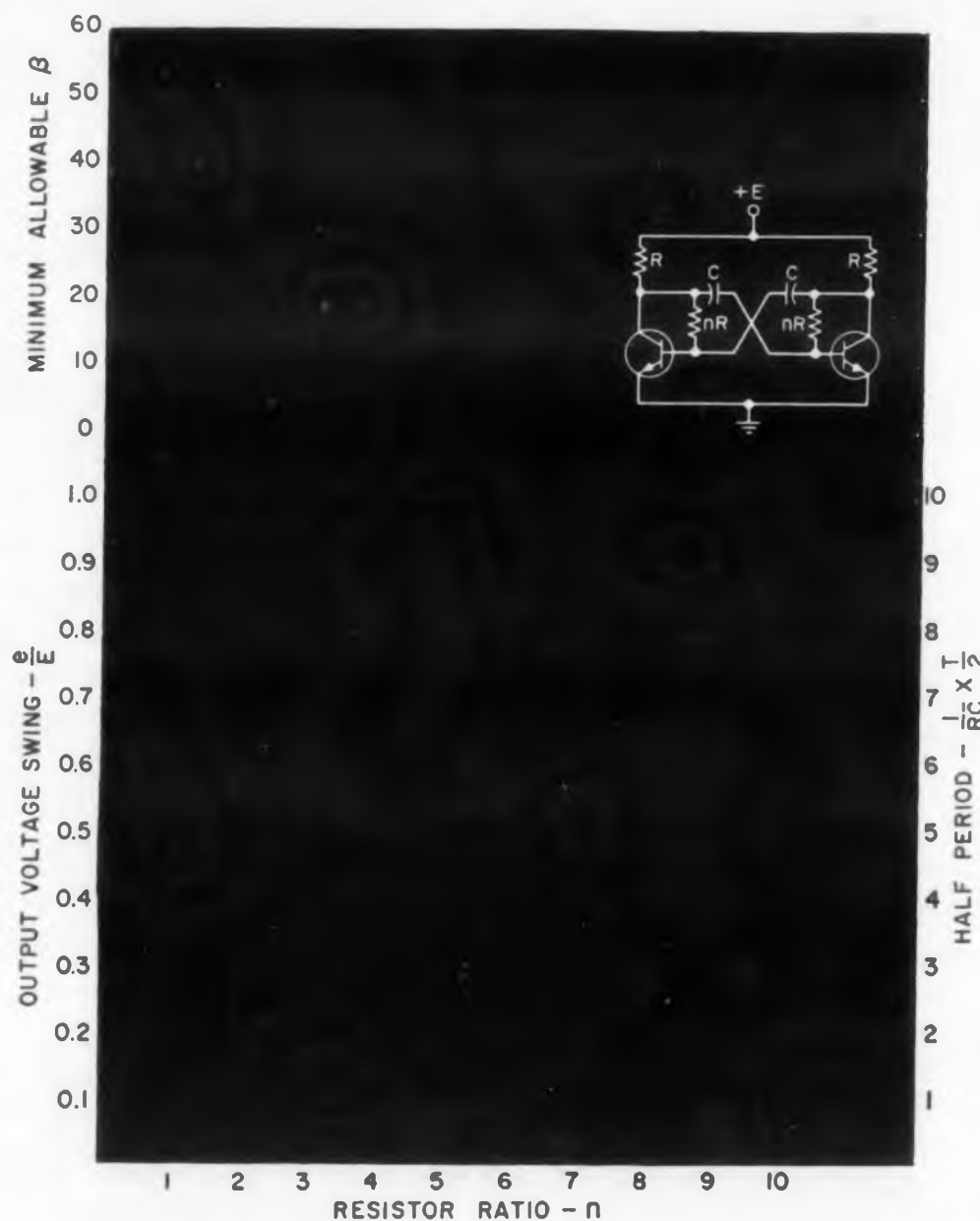


Fig. 2. Design curves for determining voltage swing, half period, and minimum allowable beta for the self-starting multi.

Irwin Dorros had a problem. He needed a master clock oscillator that would be self-starting and would start every time. He describes the circuit here and shows how to design it with simple curves and how to couple it to a load.

SOME MULTIVIBRATOR configurations do not start reliably. Coupling to the load alters the calculated operating conditions. Often capacitor coupling to the load is undesirable. Faced with these problems the engineer finds it difficult to obtain design information covering these areas. This article provides the answers to these problems.

The circuit shown in Fig. 1 is self-starting. The feature leading to self-starting is the forward bias voltage, which is applied as v_3 and v_4 . It results in the transistors having gain whether or not current is passing through the capacitors C .

How The Circuit Operates

Assume the state of each transistor has just changed. $T1$ is cut off, $T2$ is saturated, the voltage on C_1 is zero, and the voltage on C_2 is some value e , with indicated polarity. Neglecting leakage currents and voltage drops across forward junctions, $v_1 = v_2 = v_3 = v_4 = 0$, and $v_3 = -e$. The currents prevailing until the transistors again change state may be divided into three components. At E/R_2

i_2 is fixed and i_1 and i_3 follow complex exponential paths towards zero. Throughout this part of the period $v_2 = v_4 = 0$. The voltage v_3 follows a complex exponential path from $-e$ toward $+E$, and v_1 follows another complex exponential path from 0 toward $+E$.

The transistors will not switch under two conditions: (1) If the current i_1 through C_1 be sufficient to keep T_2 saturated. (2) If the voltage across C_2 remains greater than zero with the indicated polarity.

The transistors will switch if either of these two conditions are not satisfied. If the circuit is designed to switch due to insufficient i_1 the switching speed is slow, and the period dependent upon the Beta of the transistors. This circuit is therefore designed to preclude condition 2.

Assuming that i_1 is at all times sufficient for T_2 to remain saturated, the first part of the period ends when v_3 crosses zero on its excursion toward E . During this interval, C_2 becomes discharged to zero volts by i_3 , and C_1 becomes charged by i_1 to some voltage e' . A solution for the unknowns e and e' leads to the necessary design information. Only the symmetrical case in which $e = e'$ is treated in this article.

How To Design The Basic Unloaded Oscillator

A set of curves is shown in Fig. 2 from which the half period, the voltage swing e and e' , and the minimum allowable Beta can be determined. The reader interested only in choosing parameters for application with negligible load need not refer to Fig. 5.

Circuit equations were solved for the two half periods, and the initial and final conditions were matched at the transition times. The two lower curves on Fig. 2 are plotted from the results.

For all resistor ratios n , there is a lower limit to the permissible value of Beta due to the necessity for providing sufficient current to the base of the saturated transistor to insure saturation for the entire half period. Because $i_1(t)$ is a minimum at $t = T/2$, this limiting condition is:

$$\frac{E - e}{R_1} - \frac{e}{R_3} > \frac{e}{R_4} + \frac{E}{R_2 \beta}$$

where the resistors are as shown in Fig. 1. For $R_3 = R_4 = nR_1 = nR_2 = nR$, this condition becomes:

$$\beta > \frac{1 + \frac{e}{E} \frac{1}{n}}{1 - \frac{(n+1)}{n} \frac{e}{E}}$$

In Fig. 2 the minimum Beta is plotted along with the e and $T/2$ curves for practical values of n .

From the curves the reader can choose the parameter values for a required frequency and voltage amplitude, and determine the minimum allowable



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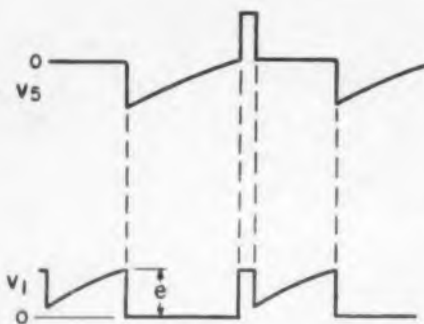
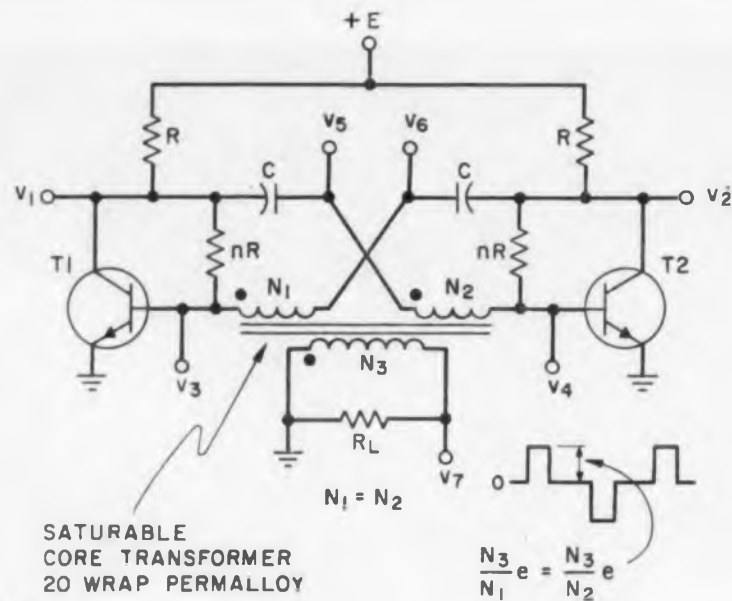


Fig. 3. The transformer-coupled self-starting multi, and its waveforms.

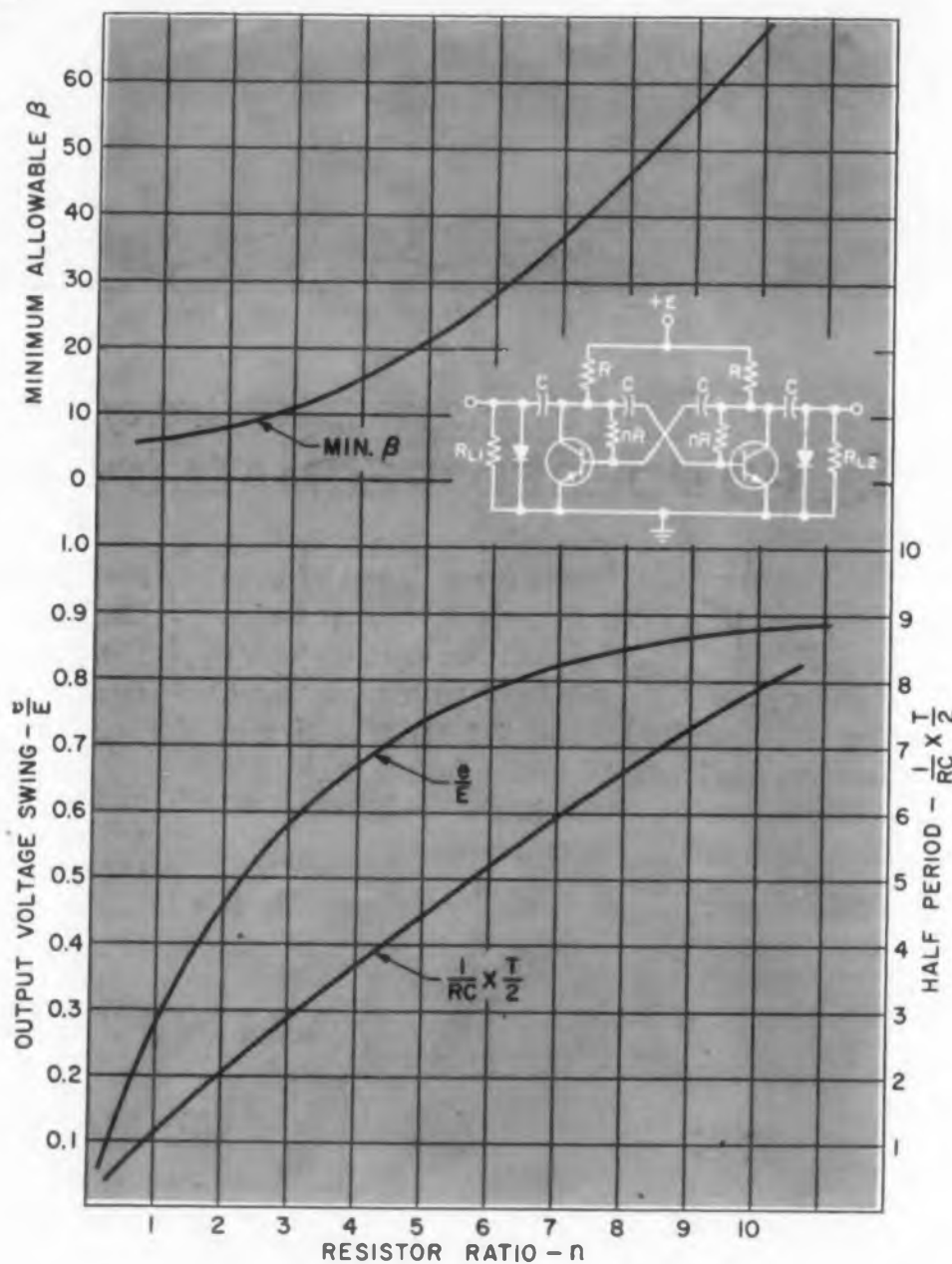


Fig. 5. Design curves for the capacitor-coupled multi.

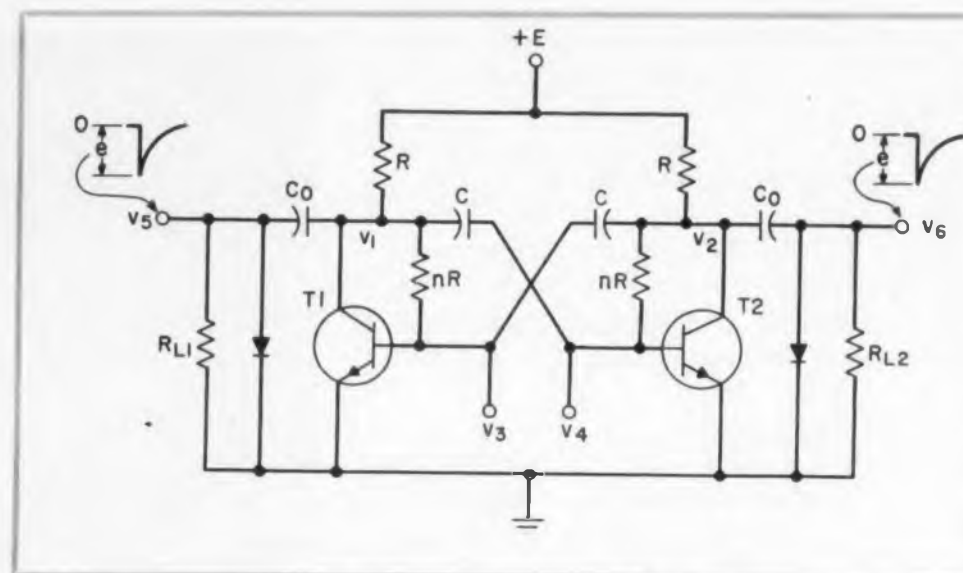


Fig. 4. Circuit for capacitor-coupling to a load.

Beta under those conditions. Supply voltage E has little effect on frequency and is therefore chosen for power and output amplitude requirements.

Forward biased junction voltage drops and leakage currents are neglected, causing some error, particularly for low values of E . The curves are not continued beyond $n=10$, since Beta becomes prohibitively large.

Transformer Coupling The Load

In Fig. 3 a method of transformer output coupling is illustrated. The transformer core is made of square loop material to shape the flat-topped output pulses. It is assumed the reader has a basic familiarity with square loop magnetic material techniques. N_1 equals N_2 , and N_3 is chosen for load requirements. The currents in windings N_1 and N_2 aid in inducing current in N_3 . As the transistors change state the currents in N_1 and N_2 reverse and the core goes into its high inductance state. The voltage across $N_1=N_2=e$, and the output voltage becomes v_7 .

$$v_7 = \frac{N_3 e}{N_2} = \frac{N_3 e}{N_1}$$

Although the windings have high impedance at this time, the saturated transistor is sustained by the constant magnetizing current, (nI_0) , through the windings.

The length of time that the core persists in the high impedance state determines the output pulse width. This is given by:

$$T = \frac{N_1 \Delta \Phi}{e}$$

where $\Delta \Phi$ is the change in flux necessary to switch the core. When the core saturates, output voltage

drops and the windings look like "short circuits." This condition continues for the remainder of the half-period. The circuit operation differs from that in the previous section only during the output pulse. During this time the high winding impedances cause the calculated timing transients to be delayed until the end of the Pulse when the core saturates. To a first approximation the curves in Fig. 2 for the unloaded case apply, with the half-period lengthened by the output pulse width. This coupling method allows accurate control of pulse width, provides a means for impedance matching to the load, and draws energy from the circuit only during the pulse.

The circuit was built with $R=2k$, $R_L=200$ ohms, $n=1$, $C=0.012$ mfd., $E=25$ v, $B_1 \cong B_2 > 30$, $N_1=N_2=64$ turns and $N_3=16$ turns. The core was 20 wraps of #479 permalloy, 0.125 mils thick, wound on an Arnold Engineering Corp. #1 bobbin. The resulting voltage swing e was 9.3 and the half-period was 26 μ sec including a 3 μ sec output pulse. This agrees closely with the predicted operation from Fig. 2.

Capacitor Coupling The Load

The more conventional RC type coupling is shown in Fig. 4. The output pulses are decaying exponentials of amplitude e and a time constant fixed by the coupling capacitors and load resistors. If capacitors C_0 are small compared to C_1 , circuit operation becomes the case of negligible load considered earlier. If C_0 is much larger than C_1 , the circuit is heavily loaded and it is difficult to fulfill the condition of supplying enough current to the saturated transistor during the entire half-period. The somewhat arbitrary case of $C=C_0$ is therefore considered here. Modified circuit equations were solved for this case and the results are plotted in Fig. 5.

Minimum Beta is raised by a factor of 2 for this configuration since the current available to sustain the saturated transistor must be shared by C and C_0 . The condition becomes:

$$\frac{1}{2} \left(\frac{E-e}{R} - \frac{e}{nR} \right) > \frac{e}{nR} + \frac{E}{R}$$

which reduces to:

$$\beta > \frac{2 \left(1 + \frac{e}{E} \frac{1}{n} \right)}{1 - \frac{(n+1)}{n} \frac{e}{E}}$$

The circuit designed in accordance with the material presented here fulfilled the requirements for a self starting relaxation timing oscillator. ■ ■

The author is indebted to A. Feiner for suggestions concerning circuit configurations, and to D. F. Hemmer for laboratory assistance.

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Calibrating Frequency Standards

When assigned to set up a frequency standard for Stromberg Carlson, Mr. Jaensch, Test Engineer, investigated various possibilities for calibration. After analysis and check of several systems, he came to the conclusion that newer techniques could be used with marked improvement in accuracy without essentially higher cost. His article deals with the newer versions along with a comparison of methods in use.

Seven methods of calibrating frequency standards are described. An outline of procedures, types of equipment required and comparison of results is also included.

VARIOUS methods, ranging from simple beat-frequency checks to elaborate electronic counter systems, are applicable for calibration of commercial frequency standards. To achieve the same order of accuracy, however, a time interval of many days is required with less complicated, and cheaper procedures as compared with several hours for the more complex and expensive counter techniques.

Definition of Accuracy

The actual accuracy of a frequency standard is the sum of the following three factors of uncertainty:

- Stability of the standard, meaning the greatest possible change in frequency over a specified interval of time. Stability is a property of the individual frequency generator, resulting from design and make, and from the properties of its components.
- Greatest possible error in checking the standard in question against a master standard. The present article describes various methods for this check, and specifies practical tolerances for each of them. Moreover, possible deviations of received master frequency or time signal may be included in this factor, as far as they are caused by wireless transmission between master and test station.

- Accuracy of the master standard used for calibrating or checking the frequency standard in question. In most practical cases, standard frequencies or time signals transmitted by WWV station are used as master standard. These signals provide the highest accuracy available to the public in this country. Table 1 lists the specifications of WWV transmission as far as they are of interest for calibrating frequency standards.

Primary and Secondary Frequency Standards

Easily misleading common terms should be mentioned. Time is a fundamental unit of physics; frequency is not. Therefore, standard frequency sources are often classified as primary or secondary standards.

A Primary Frequency Standard is defined as one whose frequency is determined directly in terms of time. This is done by integrating a certain great number of cycles of the frequency, and comparing the elapsed time with time signals of a master primary standard, such as time pulses from WWV.

A Secondary Frequency Standard is defined as one whose frequency is determined by comparison with the frequency of a primary or secondary standard. The beat method described is the typical way of checking a Secondary standard.

Klaus Jaensch

Stromberg Carlson Co. Rochester, N. Y.

It should be realized, that the classification as Primary or Secondary standard does not specify restrictions for accuracy and stability, though these two factors actually determine the usefulness of a frequency standard.

Method 1: Beat Frequency—Observation by Individual

The easiest and fastest way of checking a standard oscillator against WWV is the well-known beat method. A radio receiver is tuned to a WWV frequency, for example, the 10 mc channel. The output of the oscillator under test is loosely coupled to the receiver's antenna.

Assuming the oscillator frequency is approximately 1 mc, its tenth harmonic mixed with 10 mc of the WWV carrier will produce beats. One beat per second would indicate the tenth harmonic of the oscillator is actually 10,000,001, or 9,999,999 cycles. In other words, the oscillator is off frequency by one part in ten millions, or 1×10^{-7} . This resultant frequency deviation, multiplied by the possible error in determining the frequency of beat cycles, states the accuracy of the test.

Transmission Fading

When the master frequency is received through the air over a distance of more than several miles, transmission "fading" deteriorates the accuracy in two ways:

First, fading of the received signal strength interferes with the actual frequency beat, making determination of very slow beats in the order of several seconds impossible. This can be overcome by deliberately setting the oscillator off frequency a small amount, so as to produce a higher beat frequency. At the same time, this trick eliminates any doubt whether measured frequency

changes are directed to the high or low side. For most applications of the standard, such slight deviation from the nominal value is acceptable as long as the actual frequency is exactly known.

The second disadvantage of wireless transmission is more serious. The effect commonly called fading is caused by sky waves of the transmitted signal changing their path to the point of reception. At frequencies above 3 mc, transmission to distances over 100 miles depends entirely on such sky waves reflected from the ionosphere.

Changes of Time Signals and Frequency by Wireless Transmission

To explain the influence of wireless transmission on remote frequency and time measurements, a simplified numerical example is shown.

Assume the following conditions (Fig. 1):

Distance between transmitter and receiver, 500 km (310 miles).

Height of reflecting layer in ionosphere during daytime, 100 km.

Height of reflecting layer in ionosphere during night time, 110 km.

Resultant length of path during daytime, 538.5 km, during night time, 546.3 km.

In the present context, only changes of transmission conditions are considered. Difference of path length, 7.8 km, is important and equals a difference in time of travel:

$$\frac{7.8 \text{ Km}}{300,000/\text{Km}/\text{sec}} = 26 \times 10^{-6} \text{ sec}$$

Under conditions assumed, at night a signal is received with 26×10^{-6} sec longer time delay.

During either period of constant path length, the frequency received is exactly the same as that

at the transmitter. But, while the reflecting layer is moving from one position to the other, the Doppler effect causes the received frequency to be different from the one at transmitter. As a further assumption, in the example, the path length may change steadily from one extreme to the other in half an hour (1800 sec). During these periods, frequency received will vary from the one at transmitter for

$$\frac{26 \times 10^{-6} \text{ sec}}{1800 \text{ sec}} = 14 \times 10^{-9} = \frac{\Delta f}{f}$$

being slow in the evening (path extending), but fast in the morning (path shortening).

The above example is extremely simplified for demonstrating the action of fading and the order of magnitude of its effects. Actually, many more variables are involved. Different layers of the ionosphere are responsible for the reflection, depending on frequency and distance of transmis-

sion. This results in almost unpredictable frequency deviations between zero and several parts in 10^{-7} . Most correct reception of a frequency can be assumed to occur when the amplitude of incoming signal remains constant. Over periods of more than ten seconds, deviations in frequency can rarely be expected to be less than 1×10^{-9} .

In case of wireless reception of master frequency, the beat method with direct visual or aural observation of beat frequency is therefore usually limited to an accuracy in the order of 5×10^{-9} .

Method 2: Beat Frequency—Evaluation of Recorded Beats

Errors caused by wireless transmission can be cut down considerably by recording the beats over a longer time. A chart recorder may be connected in place of, or in parallel with, the tuning meter of the receiver. Using a suitable speed as time axis, a continuous record of beat waves ver-

Fig. 1. Wireless transmissions; example of skywaves with different path length, 538.5 km, or 546.3 km, respectively.

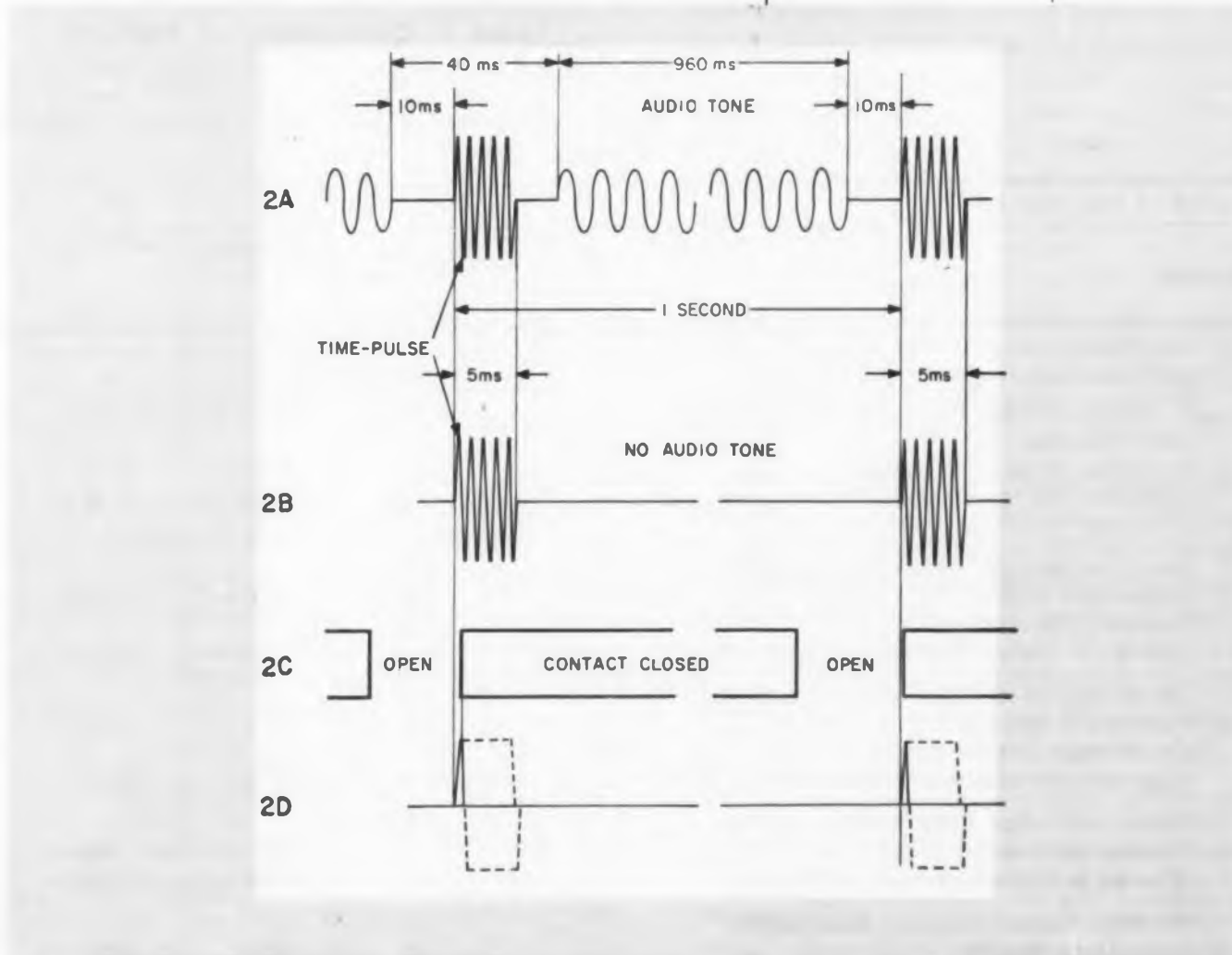
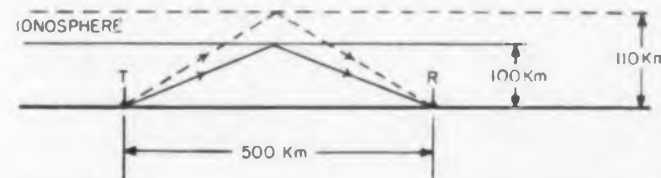


Fig. 2. Time-check waveforms. A: WWV modulation for 3 minutes; B: WWV modulation for 2 minutes; recurring in 5 minute periods. Time pulse occurs in either case, consisting of 5 cycles of 1 kc; C: Contact of synchronous clock opens for a short instant each second; D: WWV signal B, cut by clock contact to limit of audibility.

Table 1: Specifications of WWV transmission

	W W V	W W V H
Location of Transmitter	Washington, D.C.	Hawaii
2.5 Mc	0.7 KW	—
5 Mc	8 KW	2 KW
10 Mc	9 KW	2 KW
15 Mc	9 KW	2 KW
20 Mc	1 KW	—
25 Mc	0.1 KW	—
Carrier Frequency		
Stability	1×10^{-9}	5×10^{-9}
Max. Deviation	2×10^{-10} per day	4×10^{-10} per day
1 second		
Time Pulse	5 cycles 1,000 c/s	5 cycles 1,200 c/s
Accuracy of Time Pulse	$1 \times 10^{-8} \pm 1$ microsecond	
Audio Tones	440 and 600 c/s	
Accuracy of Audio Tones	1×10^{-9}	

sus time can be obtained for later evaluation.

As a practical example, oscillator frequency may be set off nominal value by 2×10^{-8} . Checking against 10 mc WWV, the resulting beat period is about five seconds. A recording speed of six in. per minute produces one beat wave on every half inch of strip, thus allowing the evaluation of one hundred beat periods without difficulty. Figuring the accuracy of paper speed and evaluation as 2 per cent, the overall accuracy of frequency reading comes out to 2 per cent of 2×10^{-8} , or 4×10^{-10} .

Electro-Mechanical Clock for Checking Frequency Against Time

The common method for checking frequency against time is by means of a special electric clock. By means of dividers such as triggered multivibrator or synchronized tuned circuits, the frequency of the standard oscillator is divided down to a frequency in the audio range. The resultant frequency, having essentially the same accuracy as the standard, is used to drive a synchronous clock. Comparing the indication of this clock over a longer interval of time with standard time, shows the deviation of oscillator frequency

from its nominal value.

For precise reading of this clock, a contact is operated by the shaft of the second hand. The contact is adjustable and a dial indicates the relative setting of the contact in fractions of a second.

Method 3: Electro-mechanical Clock—Acoustical Observation

The simplest procedure uses acoustical observation of the WWV time pulse. The clock contact is connected to short the output of the receiver. During a brief time of contact opening every second, the audio signal from WWV can be heard.

The opening period of the contact is adjusted to coincide with the received time pulse.

This pulse consists of exactly five cycles of 1 kc frequency (Figs. 2a, 2b). Finally, the contact is adjusted to let only a fraction of the first 1 kc wave through, which can be observed as the lowest audible "click" (Fig. 2d). Limit of this acoustical observation may be stated as 5×10^{-4} sec.

The same procedure is repeated after a certain interval of time, for instance, once every day. Each time, after obtaining the same condition of audibility, the final setting of the contact dial is

written down. From these readings, frequency deviation can be calculated. The difference in dial setting between two readings, expressed in fractions of a second, divided by the time interval between two readings, equals the frequency deviation of the oscillator to be tested.

Method 4: Electro-mechanical Clock-Oscilloscope Observation

Using the same contact clock, accuracy can be improved by observing WWV time pulses on an oscilloscope. The clock contact is used to start the sweep of the oscilloscope. A small battery may be connected through the contact to trigger the sweep externally at a repetition rate of one second. Employing a slow sweep speed, the five 1 kc waves appear somewhere on the trace. By operating the contact adjustment, the instant of sweep triggering with respect to the WWV signal can be adjusted. By this means, the WWV pulse is shifted to the start of the trace. Now, sweep speed is switched to faster values for more precise observation on the oscilloscope screen.

The practical limit of accuracy in this type observation is about 1×10^{-5} sec. In addition to the possible error in observation, the uncertainty of

Table 2: Comparison of Methods

Attainable accuracy of frequency test—versus period of test, for different test methods described. Figures in () include error to be expected by wireless transmission.—Refer to text for basis of individual figures.

Period of Test (Seconds)	Tolerance of Reading $\times 10^{-6}$		100	10^3	10^4	10^5	10^6
	Item	Total	Accuracy of Test $\times 10^{-9}$				
Beat Frequency							
1 Individual Observation (Frequency change by wireless transmission)	.002 (.005)	.002 (.007)	2 (7)	2 (7)	2 (7)	2 (7)	2 (7)
2 Beat Frequency Evaluation of recorded beats (Frequency change by wireless transmission, evaluating intervals of constant amplitude only)	.0004 (.002)	.0004 (.0024)	0.4 (2.4)	0.4 (1.0)	0.4 (0.5)	0.4 (0.5)	0.4 (0.5)
3 Electro-mechanical Clock; contact stability	100						
Contact-dial Reading	500	1100	11,000	1,100	110	11	1.1
Acoustical Observation (Change in wireless transmission Time)	500 (10)	(1110)	(11,100)	(1,110)	(111)	(11.1)	(1.1)
4 Electro-mechanical Clock; contact stability	100						
Contact-dial Reading	500	610	6,100	610	61	6.1	0.6
Oscilloscope Observation (Change in wireless transmission Time)	10 (10)	(620)	(6,200)	(620)	(62)	(6.2)	(0.6)
5 Electro-mechanical Clock; contact stability	100						
Oscilloscope Reading (Change in wireless transmission Time)	10 (10)	110 (120)	1,100 (1,200)	110 (120)	11 (12)	1.1 (1.2)	0.1 (0.1)
6 Electronic Counter as Clock; pulse stability	0.2						
Oscilloscope Reading (Change in wireless transmission Time)	10 (10)	10.2 (20.2)	102 (202)	10.2 (20.2)	1.0 (2.0)	0.1 (0.2)	
7 Electronic Counter as Clock	0.2						
Other Electronic Counter for Reading (Change in wireless transmission Time)	2 (10)	2.2 (12.2)	22 (122)	2.2 (12.2)	0.2 (1.2)	0.02 (0.12)	

dial reading has to be considered. This applies to both of the methods described above. Usually, the dial is designed to allow a smallest reading in the same order as the limit of acoustical observation, which was stated as 5×10^{-4} sec.

Method 5: Electro-mechanical Clock-Oscilloscope Reading

For measuring minute deviations of frequency, the setting of the clock contact may be left unchanged for the successive readings. In this case, the exact positions of the WWV pulse waves on the trace have to be noted as individual readings. Shift of position between two readings shows difference in time.

In contrast to methods three and four, observation and reading are here the same operation. Therefore, possible error in reading, including observation, can be stated the same as in method four for observation only: 1×10^{-5} sec.

All three methods described thus far contain one more factor of uncertainty, namely the stability of clock contact operation with respect to the oscillator output. A synchronous clock converts the output of the frequency standard under test into steady mechanical rotation. From this rotation, the time pulse required for the check is produced by means of a mechanical contact.

Thus, the pulse is not directly related to a certain period of the oscillator frequency. Changes of friction in bearings and gears of the clock result in slight phase shift of the pulse with respect to the driving frequency. Assuming clock driving frequency of 1 kc, a clock motor phase shift corresponding to one electrical degree of this driving frequency produces an error of $1/(1000 \times 360)$, or 2.8×10^{-6} sec. Moreover, pulse phase is subject to the general limits in stability of mechanical contacts.

For a well-designed and built synchronous contact clock, the sum of these variations need not exceed 1×10^{-4} sec.

Electronic Counter to Replace Electro-mechanical Clock

An electronic counter can fulfill the same function as a synchronous clock. It can integrate a great number of cycles of a fixed driving frequency and display certain multiples of cycles.

By contrast to an electro-mechanical clock, the counter delivers pulses at certain multiples of frequency periods as a by-product of its operation. These pulses appear in exact relation to a fraction of a period of driving frequency, which is the oscillator frequency itself in this case. Superiority in pulse accuracy of an electronic counter over a synchronous clock for measuring a frequency of 1 mc is in the order of 1,000. (Clock contact and phase stability, 10^{-4} sec,

compared with electronic counter accuracy, 10^{-7} sec.)

For precise readings, the 1 sec pulse from the counter must be brought into coincidence with the master time pulse from WWV. Versatile commercial counters permit doing this by means of a gate. Oscillator frequency to be measured is fed into the counter permanently, but initially the gate is closed. When the receiver output is connected to the "Start" input, the first WWV time pulse opens the gate and allows the instrument to start counting. The one-second output pulses then appear immediately after the start front of WWV time pulse. This operation can be done conveniently during the minutes with no audio tone transmission.

The shape of the counter output pulse needs attention to achieve full accuracy of this method. This pulse, used to trigger the oscilloscope sweep, should have a steep front with a rise time in the order of one microsecond. Directly at the unloaded output of the appropriate binary unit, the requirement is fulfilled. However, loading this point with the capacity of a shielded cable would increase the rise time, thereby permitting inevitable small amounts of superimposed hum to influence the instant of triggering. Therefore, it is advisable to employ a buffer amplifier between this output and the trigger input of the oscilloscope. A double-triode amplifier may be located inside the counter cabinet, thus allowing a short unshielded connection to the sensitive binary output.

Method 6: Electronic Counter as Clock-Oscilloscope Reading

This method uses an electronic counter as a frequency integrating device. Reading is done on an oscilloscope the same way as described in method five which used electro-mechanical clock contacts.

Method 7: Electronic Counter as Clock With Additional Counter for Observation

A further improvement can be achieved by using an additional electronic counter for indication. This counter must have separate inputs for opening and closing the gate, usually designated "Start" and "Stop" inputs.

The time pulse of the clock counter, formerly used to trigger the sweep of the oscilloscope, is now applied to the "Start" input of the indicating counter. Receiver output delivering WWV signals is connected to the "Stop" input. In this arrangement, the front of the clock time pulse opens the gate. The first wave of the WWV pulse following this instant closes the gate. The time between both events, a fraction of a 1 kc wave, is indicated by the counter.

A digital recorder connected to the output of

the indicating counter is convenient. It allows taking an average over a greater number of successive readings, thus improving the accuracy.

Comparison of Methods

Table 2 presents a compilation of the seven methods described. The factors of uncertainty characterizing each method are listed separately. The sum of these individual factors indicates the total tolerance of reading for the respective method.

As previously explained, methods of measuring frequency against time consist of two readings, one at the start and one at the end of a certain interval of time. The difference between both readings, divided by the time interval, equals the deviation of frequency during this time. Five columns itemize different intervals of time, from 100 sec to one million sec. At the cross points of these columns with the various methods, the accuracy of frequency test can be found.

These results demonstrate that a frequency standard can be tested with the same accuracy using any one of the different methods. The qualitative difference between methods is distinguished by the time interval over which the test has to be carried out to achieve a certain accuracy. For example, method three requires a period of approximately 1,000,000 sec, equal to 11.6 days to attain an accuracy of 1×10^{-9} . By contrast, only 10,000 sec, or 2.8 hrs, are needed for a test with the same accuracy using method six.

Obviously, shorter test periods are desirable for several reasons. "Slow" methods do not allow measuring short time stability of the frequency standard under test. Temporary failure of power during the period of a test spoils the result. This is more likely to happen during a long test period.

When the master time signal is received by wireless transmission, possible variations in transmission time influence the actual accuracy of each reading. This effect has been described in connection with beat frequency methods. Maximum uncertainty caused by it may be assumed as 10 msec on each reading for methods three to seven, provided that both readings of a test are done either during day or night, and during normal ionospheric conditions.

Figures in brackets () of Table 2 include this factor of uncertainty for wireless transmission.

Actually, limits for this factor are quite different, depending on frequency, distance from transmitter, geographical direction of transmission, and type of terrain in the area of receiver. The value of 10 msec is based on experience in Rochester, N.Y., for transmission of 5 mc from WWV in Washington, D.C. (320 miles). ■ ■

Oscilloscope Trace Recording With Polaroid Land Photography

Part 3

Kemon P. Taschioglou
Polaroid Corp.
Cambridge, Mass.

Tube Phosphors and Filters Special Techniques

Hy P. Mansberg
Airborne Instruments Lab.
Mineola, L. I., N. Y.

THOUGH LAND film can capture traces on all commonly-used scope phosphors, an engineer is wise to know the effects on his film of different phosphors and filters.

Phosphors and Filters

Polaroid® Land films can be used on all tube phosphors commonly employed for cro work, P-1, P-2, P-5**, P-7, P-11, and P-15**. Two of these phosphors, P-2 and P-7, have different color outputs in initial phosphorescence and in afterglow.

The light output of some phosphors makes them better suited for photography than others. For example, the P-11 and the P-15 are the most efficient for recording high speed transients. Of the phosphors intended primarily for visual work, the P-1 and P-2 are effective for stationary patterns and low speed transients.

Filters—green, amber, and blue—are commonly furnished by cro manufacturers to separate the initial fluorescence and afterglow and to aid the observer during extended observations. A blue filter is used to eliminate cathode glow on unaluminized phosphors and for cutting out the long-persistence yellow afterglow on P-2 and P-7 traces.

In general, a filter absorbs a considerable amount of light and can cause slight degradation in image quality from surface interreflection. A

standard blue filter, for example, will require an additional exposure of from 2 to 2-1/2 stops.

A brief description of tube phosphors, their use with filters, and their application in photography are presented here and summarized in Table 4.†
P-1. This phosphor is the most commonly used in oscilloscopes. Its green output is efficient in recording repetitive traces. It is not recommended for recording high speed transients. Green filter is frequently used for viewing but is not beneficial for photo recording.

P-2. Versatile, especially for tubes with high accelerating potentials. Has initial fluorescence and afterglow. Blue-green fluorescence is efficient for photography. Blue filter can be used to eliminate the yellow afterglow which can cause blurring with moving traces. Before taking pictures, it is necessary to remove any amber filter used for long persistence observations, because the initial fluorescence is most actinic for recording. Not recommended for recording high speed transients.

P-5. This has a blue trace of very short persistence. It may be used for photographing high speed transients, though not as efficient as the P-11 phosphor. Blue filters are commonly used for visual work but not for photographic work.

P-7. Similar to the P-2, with an initial blue fluorescence and yellow afterglow. P-7 has greater persistence at lower accelerating potentials and can

be used for seeing as well as recording stationary patterns and low speed transients.†† Relatively low fluorescent output and high afterglow make this phosphor not as desirable as P-2 for photo recording of transients. Blue filter can be used for recording only the initial actinic blue fluorescence. Amber filter (for visual comfort) should be removed before photo recording.

P-11. Highest actinic output with short persistence makes it most valuable for recording steady state patterns as well as high speed transients. Blue filter is used for visual work but not for photographic purposes except to reduce cathode glow fog.

P-15. Common in television and kinescope recording. Has blue-green output almost as efficient as the P-11 for photography. Usually more pleasing than the P-11 because of its green color. A green filter improves visual contrast but has no benefit for photo recording.

A double image, as seen in Fig. 14, is sometimes recorded by cameras using beam splitter mirrors with P-1 or P-2 phosphors. Since these mirrors are designed primarily for P-11 phosphors with blue output, some of the green light from P-1 and P-2 phosphors is reflected from both surfaces of the mirror. A blue filter will eliminate the double trace. This double image usually occurs only with excessive exposure.

Fig. 14. (right) Double image traces are caused by reflections from both surfaces of beam splitter mirror with P-1 phosphor. Blue filter will eliminate second image.

*Polaroid is a registered trademark of the Polaroid Corporation.

**P-5 and P-15 are usually available only on special order.

†Source: DuMont Industrial Cathode Ray Tubes, Industrial Tube Sales Dept., DuMont Laboratories, Passaic, N.J., 1956.

††The P-2 is a mixed phosphor screen while the P-7 is a cascaded screen with a blue fluorescent layer and a yellow persistence layer.

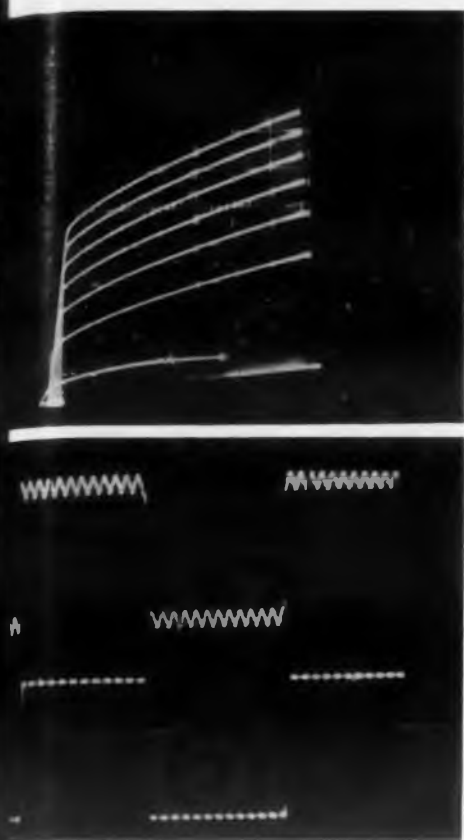


Fig. 15. (above) Vertical pips are added for time interval calibration. Lower trace has Z-axis signal modulating intensity for time calibration.

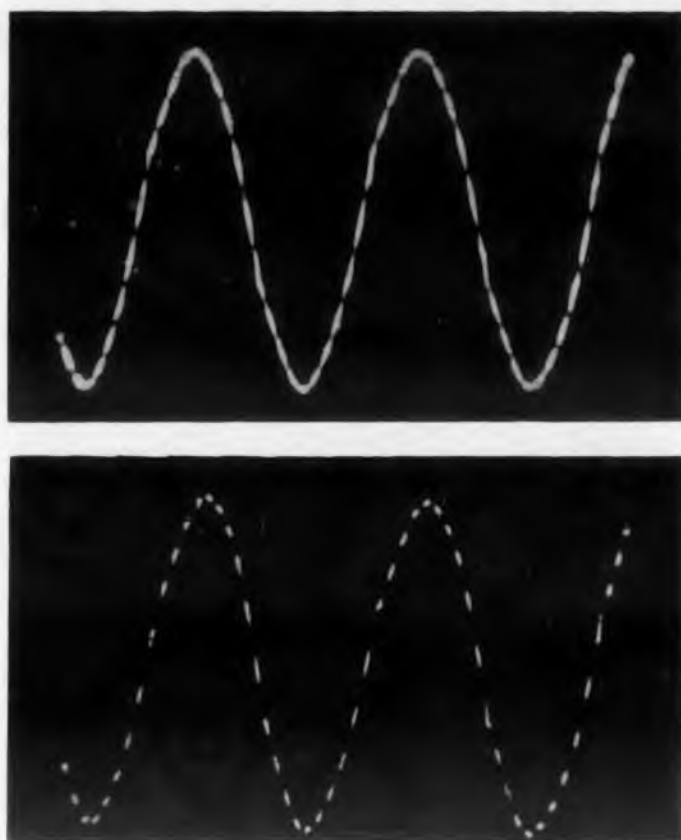


Fig. 16. Upper trace has insufficient Z-axis amplitude. Lower trace has picture improved by lowering intensity setting and increasing development time.



(Courtesy AVCO Corp.)

Fig. 17. A convenient technique for recording long time-base sweeps. Time base is presented as a raster with Z-axis markers every 10 microseconds.

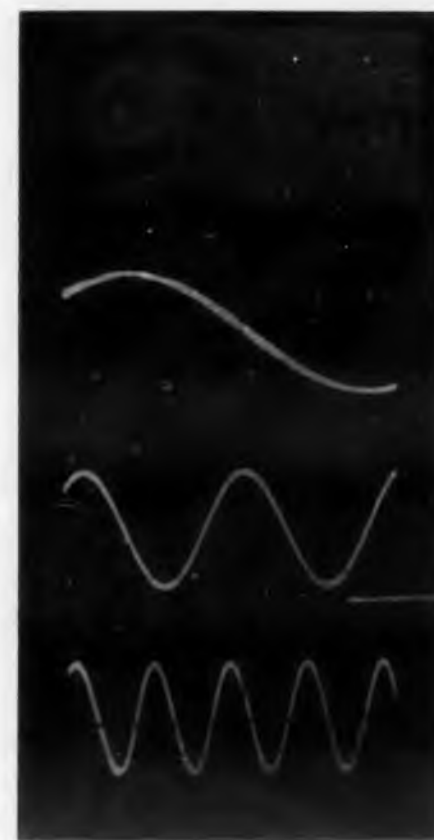


Fig. 18. Data card exposed to identify trace recordings at f/5.6 and 1/2 sec on Type 47 film.

Special Techniques

It is often useful to record markers, graticules, data charts, and calibrated wave forms on the same picture as the trace recording. These records are made by exposing both the trace and data at the same time or by exposing the film with the extra information before or after recording the trace itself.

Calibration Markers. For adding time information to a trace, calibration markers are usually either superimposed on the vertical axis of the trace or they are used to modulate the intensity of the trace. Examples are shown in Fig. 15.

If the intensity modulation signal is not strong enough to provide noticeable effect on the photograph, improvement is possible by reducing the cro intensity and increasing the contrast of the land print through increased development to two or three minutes, as shown in Fig. 16.

Another interesting technique for using calibration markers is indicated in Fig. 17, where an especially long time base had to be recorded in one picture. The time base is converted into a raster which is displayed on the crt face with time markers.

Graticules. Illuminated graticules can usually be recorded with the trace on a single exposure by

turning up the graticule scale brightness and lowering the cathode ray tube intensity.

With some oscilloscopes it is more convenient to make two separate exposures to record both the graticule and the trace. This is especially true when one does not wish to change the trace intensity from a convenient viewing brightness level.

One should first record the graticule with its illumination turned up and the crt intensity turned down. One should then turn off the graticule and record the trace with cro intensity at normal setting.

Where there is a choice between white or colored graticule illumination, best results are in photographing white light illumination.

Care should always be taken that the graticule is in sharp focus because graticule and trace are not in the same object plane. One should keep camera apertures to a minimum and make sure that the glass or plastic plate is positioned so the lines face the crt screen and are flush against it.

Data Charts. Some oscilloscope cameras have a ground glass surface on which identifying data can be written with pencil. Internal illumination exposes this data on the film. The data card, as shown in Fig. 18, required another exposure.

The intensity of the trace and of the graticule scale must be turned down before exposing the

data card to avoid double exposure of the trace. For Type 47 film, an exposure of about 1/2 second at f/5.6 is sufficient with the light emitted from two No. 112 lamps driven by a 1-1/2 v battery. (Du Mont type 302 camera).

Continuously Varying Patterns. A continuously varying pattern often can be "stopped" for study only by a photograph. When using a cro with built-in beam gate, the driven sweep and external sync controls permit triggering the gate for one sweep during a continuously varying pattern without difficulty. When scopes are used without built-in beam gates, the shutter speed can sometimes be adjusted to an "open" time which is short relative to the rate of change of the pattern.

Notice the differences in the recordings of a varying signal in Fig. 19. The first trace is blurred because many cycles of the signal were recorded; the second varying exposure was electronically gated to display only one trace.

Radar Displays. Recording the high intensity PPI scope radar returns is very simple and straightforward. Usually a long persistence P-7 phosphor is employed. With an aperture setting at f/11 or f/16, and the shutter open on "B" or "T," a test exposure or two will establish the proper intensity level of both the radar display and the azimuth scale setting. Care should be taken to record

Fig. 19. Continuously varying trace is blurred as several cycles are recorded in the upper photo with camera shutter at 1/10 sec. Below, electronic gating displays only single cycle for camera recording with shutter held open.



only a single complete sweep and to avoid the overlap. Hand controls on the camera shutter are usually sufficient.

Single frame recordings of A-Scope patterns have limited applications because the trace is usually varying so rapidly. To record traces on this crt. usually with a P-5 phosphor, one should open

the aperture wide, turn the intensity level of the A-Scope to as high a level as is feasible, and keep exposure time to an absolute minimum.

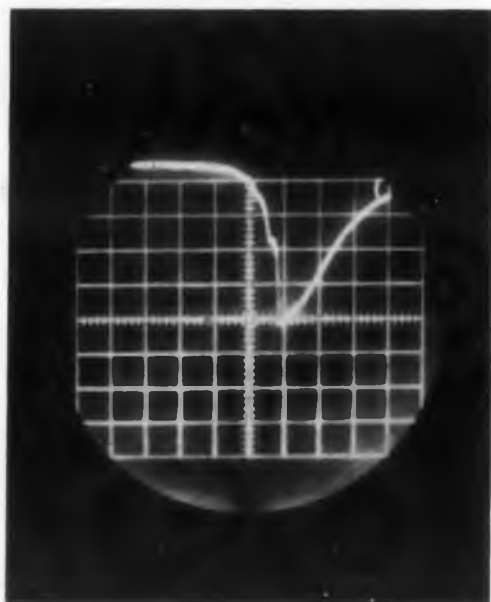
Most cameras will mount directly on the standard five inch A-Scope flange. For the common seven inch PPI scope, a special mount must be constructed. A number of special radar camera

Phosphor	Color		Persistence	Application	Filters	Use Of Land Films
	Initial Fluorescence	After-glow				
P-1	Green	Green	Medium	General purpose work, repetitive or transient waveforms. Most frequently used on low voltage scopes.	None	Relatively efficient for recording stationary or repetitive patterns. Brilliant output at low accelerating voltages.
P-2	Blue-Green	Yellow-Green	Long	General purpose. Needs higher accelerating potentials. Durable phosphor for high accelerating potential cros.	Dark blue filter eliminates long persistence yellow component for photography. Amber filter eliminates initial blue-green flash.	Blue component is short persistent and has high photographic efficiency. Records successive transient phenomena, and low rate repetitive traces.
P-5	Blue-Violet	Blue-Violet	Very short	Display of high speed transients such as Radar A-Scope.	None	Relatively efficient for single frame recording. Not as high light output as P-11 phosphor.
P-7	Blue-White	Yellow	Blue-White is short. Yellow long	Similar to P-2, operates at lower accelerating potentials with longer persistence. Useful for radar, low speed transients, and integrating repetitive phenomena.	Blue filter eliminates long persistence yellow component. Amber filter eliminates initial blue flash.	Relatively high photographic efficiency for single frame recording. Not as efficient as P-2.
P-11	Blue	Blue	Short	Photographic recording of transient phenomena. Longer persistence than P-5.	None	Highest photographic efficiency makes it most useful for recording transients and repetitive traces.
P-15	Blue-Green	Blue-Green	Extremely short	Flying spot scanners, TV kinescope recording.	None	Not as high actinic output as P-11, but is effective with Land films for high resolution, high frequency recording.

Fig. 20. Cathode glow fogging from unaluminized phosphor resulted from shutter being left open for eight minutes waiting for a random transient.



Fig. 21. Inadequate mounting and bright ambient light permitted light to leak into camera, causing fog. Camera shutter was left open two minutes to await random transient.



have been developed for military radar systems.

Avoiding Fogging

Though undesirable fogging can take place from several sources, in most cases it can be easily eliminated. Fogging usually comes from one of three general sources:

1. The crt trace itself.
2. Internal sources within the crt (cathode glow).
3. Light leaks within the camera.

The most common source of fogging is from the crt itself. High intensity traces or overexposure can cause halation due to interreflections in the crt face and excessive reflection from the internal walls of the camera. This fogging is controlled by careful adjustment of camera settings and cro intensity settings.

When recording transients on a cro without automatic beam blanking a stationary spot on the screen can cause film fogging. To eliminate this fogging, position the spot near, but not beyond, the edge of the screen. Mask the stationary spot with tape or black opaque paint. Do not move the spot too far off the screen, or the mask will not cut off the glow caused by reflection.

Cathode glow and stray emission are two sources of fog that come from internal parts of the crt. Cathode glow, shown in Fig. 20, is caused by the red and infrared radiation of an incandescent cathode, penetrating an unaluminized thin phosphor screen. It can cause serious fogging when the shutter is open for long periods of time.

This type of fogging does not occur on cameras which have backs perpendicular to the crt because the blue reflecting dichroic mirror does not reflect this part of the spectrum. A blue filter can help eliminate the glow when the cro does not use a metalized screen and very long exposures are required.

The stray emission due to electron reflections from deflection plates on some older type oscilloscopes will show a slight glow on the crt and can cause fog on the film. Slight adjustments in the position of the electron beam or reduction in the deflection amplitude can usually eliminate such defects.

Fogging caused by camera light leaks is shown in Fig. 21, where fogging is due to light leaking in between the bezel and the cathode ray tube mount. As with cathode glow, this problem sometimes occurs when the shutter has to remain open for long periods. The only practical answer is to exercise more care in mounting the camera and to shield it from very bright external light.

Fog can also occur when the operator neglects to close the viewing ports or the camera lens setting ports before making an exposure.

(Continued on p. 58)



Meter Relays: 2" and 3", AC and DC



Edgewise: Vertical, DC

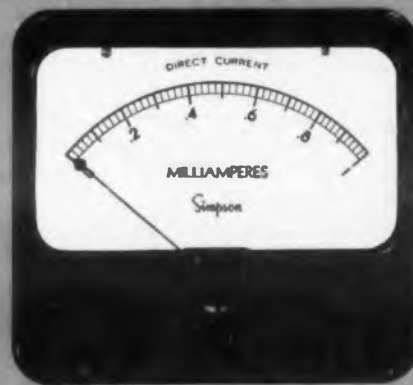


Wide-View: 2 1/2", 3 1/2", 4 1/2", AC and DC

These are Simpson panel instruments...



Round: 3", DC



Rectangular: 4", 4 1/2", 5 1/2", AC or DC, RF, 7" and 9", DC or RF



Front Adjust Relay: 2 1/2", 3 1/2", 4 1/2", DC. Rectangular also.

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Elapsed Time: 3 1/2", 60-cycle AC



Fan Shape: 4 1/2", AC or DC



Modernistic: 2 1/2", 3 1/2", 4 1/2", 5 1/2", AC, DC, RF

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CIRCLE 47 ON READER-SERVICE CARD

Fig. 19. Continuously varying trace is blurred as several cycles are recorded in the upper photo with camera shutter at 1/10 sec. Below, electronic gating displays only single cycle for camera recording with shutter held open.

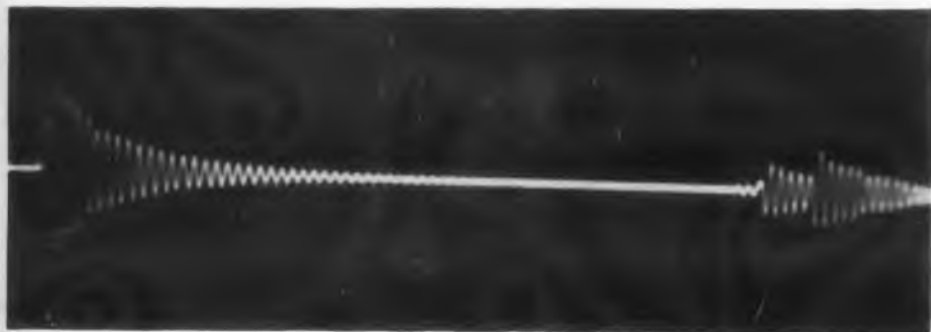
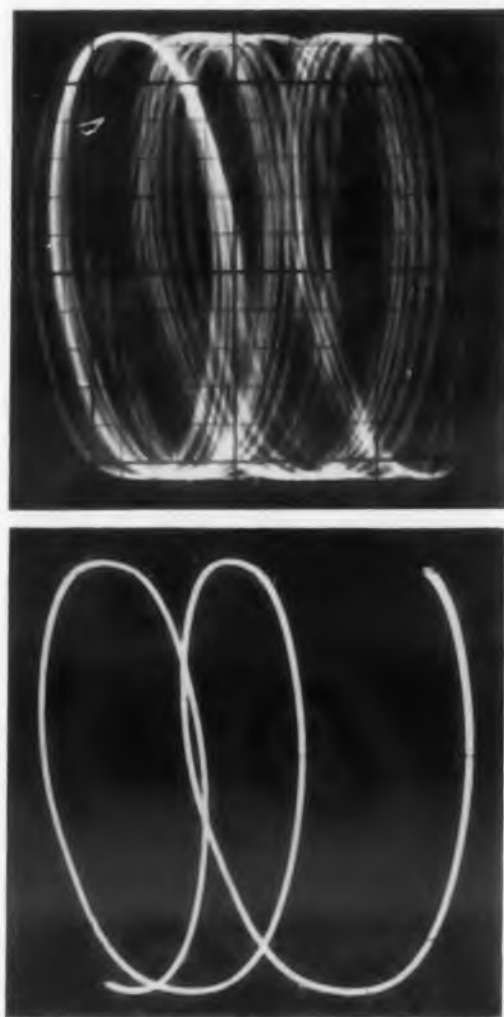
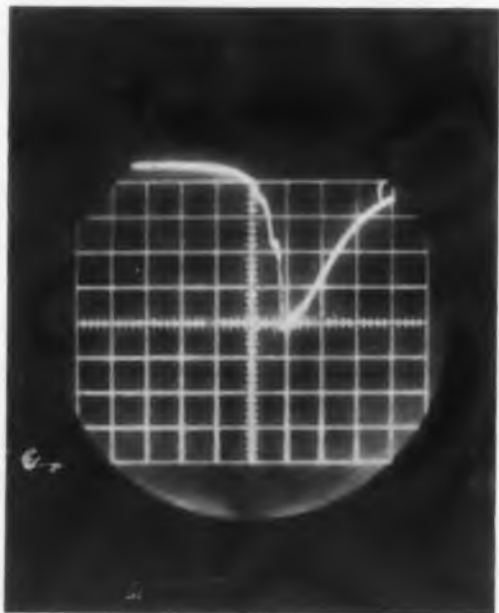


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(Continued on p. 58)



Meter Relays: 2" and 3"; AC and DC



Edgewise: Vertical, DC



Wide-Vue: 2½", 3½", 4½"; AC and DC

These are Simpson panel instruments...



Round: 3", DC



Rectangular: 4", 4½", 5½", AC or DC, RF; 7" and 9", DC or RF



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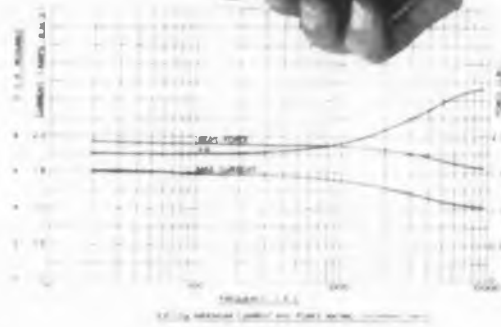
CIRCLE 47 ON READER-SERVICE CARD

VIBRATION TEST AND ANALYSIS

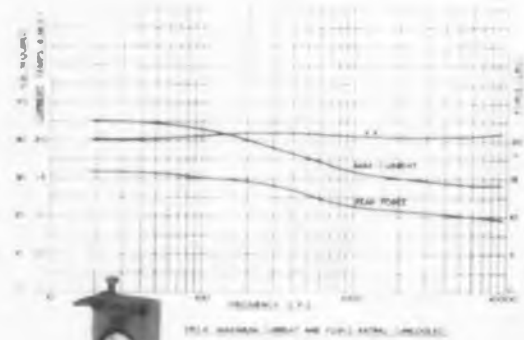
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SHAKERS!**



MINIATURE
MODEL V47
Weight: 2 lbs.



SPECIFICATIONS	V47	390A
Maximum Frequency	10 kc/s	4 kc/s
Mass of Moving System	6.5 gm	0.16 lb.
Static Force Factor (lb/A)	0.9	5.0
Maximum Continuous rms Current at 500 cy. (Uncooled)	1.5A	1.75A
(Air-Cooled)		3.50A
D.C. Resistance (Ohms)	2.5	6.4



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390A**

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CIRCLE 48 ON READER-SERVICE CARD

How to Develop Prints

In general, 45 seconds is long enough to develop prints of cro traces. The 60-second standard development time serves only to build up contrast in the middle gray areas of the picture—a characteristic not important for most cro traces.

To record complex detail, a full 60-second development time is recommended when adequate brightness and exposure are available. To increase writing rate, reduced development time of 20 to 30 seconds will help, but will cause a slight loss in trace sharpness and background density.

The effect of overdevelopment, up to two to three minutes, will increase contrast, increase the blackness of the background and eliminate some details in high writing rate portions of a trace. Occasionally, faint, undesirable, high-frequency noise can be eliminated from a photograph by overdevelopment.

Copying Prints

There are three direct ways of copying Polaroid prints. These are outlined in Table 5.

Care and Storage

For permanent retention of important experimental data, it is essential that all prints be coated and all transparencies be treated in Dippit after removal from the camera. In storage, Land prints and transparencies should be given the

same careful attention as any photographic material. The best way to store both prints and transparencies is in acetate sleeves.

Land prints should not be glued or taped directly to other sheets. Glue and bonding agents in tape often contain harmful chemicals which may deteriorate a photographic image.

Polaroid transparencies can be safely handled and stored in regular Polaroid slide mounts. For even further protection, the transparencies can be placed between conventional lantern-slide cover glass. Glass is essential if transparencies are to be used in projectors with inadequate cooling.

One should not write directly on the image surface or back of a Polaroid print, either before or after coating with any material. Writing can crack the coating. One may write on margins or tabs with grease pencil or ballpoint pen.

Projection Film

Polaroid Land Projection film produces a positive transparency from the back of the camera in much the same way a positive print is produced. However, the handling and the use of the film is quite different from that of the positive print.

Standard developing time is two minutes, but as with paper prints, one can remove them from the camera in less than the standard time for most cro work. One minute after the picture is taken a transparency can be pulled out of the back of

Original Picture	To Reproduce As		Submitting for Publication
	Print	Transparency	
Print (Types 42 and 47)	Direct copies produced on Land film with Print Copier. Direct copies on conventional photographic paper from Polaroid Copy Service.	Direct copies produced on Polaroid Transparency Film with Polaroid Print Copier.	Originals or copies can be submitted.
Transparency (Types 46 and 46-L)	Diazotype direct copy to produce on any diazotype papers. Direct copies on conventional photographic paper through Polaroid Copy Service.	Diazotype direct copy easy to produce on any diazotype films. Direct copies on conventional photographic film through Polaroid Copy Service. Enlarged conventional negatives easy to produce.	Transparencies and printed material on translucent master easy to reproduce for inter-office reports. Polaroid print copies or conventional 3-1/4 x 4-1/4 print copies are desirable. Most publications prefer not to have transparencies.

the camera with only a slight loss in the density of the background.

Another useful feature of the transparency film is that one does not have to wait for development time between pictures. As soon as a picture is taken, a frame can be advanced; another picture can be taken and the tab advanced again, so that the incompletely developed transparency is pulled through the slot-opening of the camera.

It must be kept in mind that the transparency has to stay in place on the negative-positive sandwich for at least one minute. Removing it in a shorter time interval usually causes some of the image to be left behind on the negative.

Accurate measurements of time intervals, amplitudes, and slopes can be made from a projected transparency more readily than they can be made from a print. Another technique is to make projection enlargements from a transparency onto matte surface photographic paper. Measurements again are traced from this enlargement.

The emulsion layer of the transparency is wet and delicate before it is placed in a Dippit. Therefore, it provides a good surface for writing information directly with a sharp instrument such as a pen point or pencil. The transparency is then placed in a Dippit as usual.

One of the most desirable features of the transparencies is the ease with which they can be used for illustrating a small number of copies of report papers. Any diazotype machine (such as Ozalid, Tecnifax, Bruning, Pease, etc.) can be used.

By attaching a transparency directly to the translucent original of a report page for diazotype reproduction, both the printed information as well as the illustration can be produced in one pass through the machine.

Here's how it is done: First, information is typed onto a high quality vellum tracing paper, producing a master sheet. (Some manufacturers of diazo-type papers provide papers ideal for this purpose.) For best results one should use an electric typewriter. Unless an acetate ribbon is in the typewriter to give deep, black, sharp letters, the master sheet should be backed with a soft carbon paper.

The Polaroid transparency is then taped on the back of the master sheet in the open area where the illustration is to appear. For a "right-reading" reproduction, the transparency must go emulsion side down. (Or, if the oscilloscope trace is reversed by the camera, one should place the emulsion side up to obtain a "right-reading" trace.) Minnesota Mining and Manufacturing Company's Tape No. 810 can be used for taping the transparency down to eliminate dark borders.

The master sheet is placed face up on top of the diazo-sensitized paper and fed into the machine. Any inexpensive standard blue-line or black-line diazo-sensitized paper can be used. ■ ■

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Exceptional flexibility is achieved in the new centrifuges through the use of a "building block" design concept. Machines are assembled from six basic off-the-shelf components: drive system, drive motor, boom, test compartment, console and accessories. You simply select components to meet your specific requirements. Component interchangeability permits easy modification as requirements change. Kits are available for modification by the customer.

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An integral, variable-speed transmission based on the new Rouveral* ball-galaxy principle achieves high torque characteristics while maintaining the inherent accuracies of a hardened steel-to-steel ball-disc integrator.



BRIEF SPECIFICATIONS

Model No.	Diameter	Test Object Weight	Capacity G-pounds	RPM Max.	G-Range Max.	Test Object Dimensions
A-1010	30" table	50 lbs. dead weight	2,500	800	.1 to 200 g's	
A-1020	60" arm	100 lbs. dead weight	10,000	600	.1 to 250 g's	12" cube
A-1030	96" arm	100 lbs. dead weight	10,000	355	.1 to 150 g's	18" cube

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How To Specify High Level Audio Transformers

Wallace W. Wahlgren, Technical Director, Electro Engineering Works

TWO TRANSFORMERS may fully meet what is apparently a complete specification for the transformer. But they may react differently in a specific application on which complete details were not given to the transformer designers. This happens when engineers, who would ordinarily know better, forget pertinent factors when specifying transformers.

These factors cover particularly modulation transformers for wide-range broadcast transmitters and special-purpose communications transmitters—used for telemetering and high-speed facsimile transmission. It also includes high-level output transformers used in sonar, ultrasonics, vibration machines and sound systems, and variable high-cycle power applications.

One problem in specifying transformers is terminology. It is customary to think of audio transformers in terms of impedances and ratios. But a high-level audio transformer is a power transformer. The designer must reduce audio terms to voltages and turns ratios and produce a product made of iron and copper wire.

Physical Aspects

With respect to the physical environment, the designer must know the extremes of temperature to be met and duration. Other considerations include shock and vibration and requirements of magnitude, humidity, corrosive atmosphere and altitude.

When space and weight are not limiting parameters, tight low-frequency response specifications can be easily met by oversize construction. These transformers are often much larger than equivalent power transformers. The trend, however, is toward smaller units because of improvements in core materials, insulation and general know-how. It is now possible to meet almost any desired performance parameters without oversize construction.

What Type Construction?

The designer should know if the buyer prefers a specific type of construction (cased or open type) or if he is free to use the best design for the specific application.

When space is at a premium and power handling requirements are less than 2 kw, the designer might specify a cased transformer with oil or oil silicol solution as the insulation and heat conductor. Since oil, when not in motion, is not a good coolant, an oil-based solid organic potting compound is often used in this class of transformer. The compound provides oil insulation, yet because of direct contact through a mineral material, effective heat conduction is achieved.

For handling higher power and where space is available, dry-type transformers are often specified. Spacings are large enough to permit application of relatively high voltages without danger of breakdown. The trend in dry-type transformer construction is toward encapsulation. The coils are impregnated in resin or varnish. Epoxy-resin and caps prevent entrance of moisture and provide physical protection.

When voltages in the order of 6000 v dc and higher are to be encountered, oil-filled construction is desirable to provide adequate insulation for high peak voltages. Also, because of the presence of high frequency audio at high voltages, oil is needed to keep the insulation from overheating owing to dielectric losses.

A typical spec sheet in which the buyer notes his desired objectives and mandatory requirements is shown in Table 1.

Signal and Duty Cycle Important

The transformer design engineer must also know what kind of a signal is to be handled. A smaller transformer, for example, will suffice if the signal has a complex and varying waveform, as in music or speech, than when the signal is a sine

wave of higher average power. More power must be handled by an output transformer in a vibration machine than in a high-power sound system, because of the character of the waveform.

There can be a vast difference in size, weight and cost of a transformer that is used only for a few minutes at a time, compared with one operated continuously. It is important to know how many minutes per hour the transformer must handle full power. This is customarily specified in terms of percentage of full-power volt-amperes. Sometimes, particularly in the case of modulation transformers, capacity to handle half-power (kva) on a full-time basis or 100 per cent modulation 30 per cent of the time, is specified. In the case

Applicable MIL specs (if any)	_____
Grade	_____ Class _____
Ambient temperature range	_____ C, + _____ C
Life expectancy	_____ hours
Shock	_____ Vibration _____
Altitude	_____ Feet. Temp. rise _____ C.
Duty cycle	_____
Is electrostatic shield required?	_____
Type of construction	_____
Type of mounting	_____
Maximum dimensions	_____
Weight limit objective	_____
Kind of terminals	_____
Other data	_____

Table 1. In specifying transformers the above physical considerations should be spelled out.

Widest Option in Low-Power Rotary Switches

In a broadcast transmitter, the duty cycle requirements will be far more severe than in a communications transmitter operated on a push-to-talk basis.

Electrical Aspects

It is vital for the transformer design engineer to have full details of the electrical environment. The character of the load must be known, how it varies and to what extent.

The performance of a modulation transformer, for example, is affected by the load, which is generally a radio frequency amplifier. High-frequency response can be affected by the shunt capacitance imposed on the modulator by the rf tank tuning capacitors, by-pass and blocking capacitors, and the capacitance of the rf amplifier tube. This shunt capacitance can vary, depending upon the tuning of the transmitter. At the low end of the transmitter's tuning range, more capacitance to ground customarily exists because of the settings of the tuning condensers. At the high end, the reverse is true. An rf choke in the circuit may cause slight attenuation of higher audio frequencies. Thus it is important for the designer to know what shunt capacitance and series inductance the load will impose.

Compensation Possible

If the designer is aware of these factors, he can provide compensation in the transformer to offset their effects. Leakage inductance, for example, can be calculated and used to advantage in offsetting capacitance in the load.







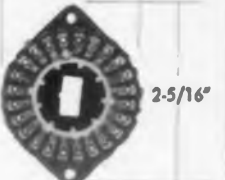



When a transformer is fed through a capacitor into a reactor, as in a transmitter, the shunt reactance of the transformer should be related to the inductance of the reactor. Thus the designer needs data on the reactor, the values of the coupling, by-pass and filter capacitors in the associated circuits and the load. Their values may have a significant effect on the transformer's frequency-response curve.

In the case of an output or modulation transformer, the plate voltage applied to the tubes must be specified. Not just the optimum value, but the minimum and maximum limits between which satisfactory performance is required. While the equipment designer may think of normal voltage conditions, allowance should be made for over and under voltage conditions that could occur in the field. It may be necessary to deliver more audio power under high-voltage conditions to achieve 100 per cent modulation in a transmitter.

Turns Ratio Figured

Dealing with voltages and power, the transformer designer must know what turns ratio to provide. He takes into consideration peak voltages across the entire primary (plate-to-plate) as well

SECTIONS

 <p>THROW: 30°, 36°, 45° INSULATION: stator glass silicone; rotor, KEL-F</p>	 <p>THROW: 30°, 45°, 60°, 90° INSULATION: phenolic, Mycalex, ceramic</p>	 <p>THROW: 25.7°, 30°, 36°, 45°, 60° INSULATION: phenolic, ceramic</p>	 <p>THROW: 18°, 20°, 30°, 36°, 45°, 60°, 90° INSULATION: phenolic, Mycalex, ceramic</p>	 <p>THROW: 30°, 36°, 45°, 60°, 90° INSULATION: phenolic, Mycalex, ceramic</p>
 <p>THROW: 20°, 40° INSULATION: phenolic</p>	 <p>THROW: 15°, 30° INSULATION: phenolic</p>	 <p>THROW: 20°, 40° INSULATION: phenolic, Mycalex</p>	 <p>THROW: 12.85°, 25.7° INSULATION: phenolic</p>	 <p>THROW: 12.85°, 18°, 25.7°, 36° INSULATION: phenolic</p>

METAL PARTS AND FINISHES

STANDARD COMMERCIAL—Punched steel parts are lead-coated, cold-rolled steel. Parts such as nuts, lockwashers, etc., are cadmium-plated steel. Shafts may be cadmium-plated steel, brass, or aluminum. Brass parts are unplated.

TROPICAL OR 50-HOUR SALT SPRAY MILITARY SPECIFICATIONS—All steel and brass parts are cadmium-plated and chromate-dipped. Stainless steel parts are passivated.

200-HOUR SALT SPRAY MILITARY SPECIFICATIONS—All brass parts are nickel plated. All stainless steel parts are passivated. Shafts, "C" washers and index springs, balls and plates are stainless steel.

CONTACTS

Famous Oak double wiping, high-pressure design. Riveted in place and keyed from turning. Rotors shorting or nonshorting.



TYPE 1—Contacts are spring brass, silver-plated. Rotors are brass, silver-plated. Temperature limit: 100°C constant ambient.

TYPE 2—Contacts, spring tempered-silver alloy. Rotors, coin-silver alloy. Temperature limit: 100°C constant ambient.

TYPE 3—Contacts and rotor blades made of Oak alloy

CMS-202. This is a special alloy for high temperature operation to 150°C.

GOLD-PLATED CONTACTS—Type 1 or 2 contacts may be gold-plated .0002" thick. Not to be confused with gold flash.

FOR PRINTED CIRCUITS—Standard Oak contacts with a lug extending from the terminal end. Lug inserts in board for dip soldering.

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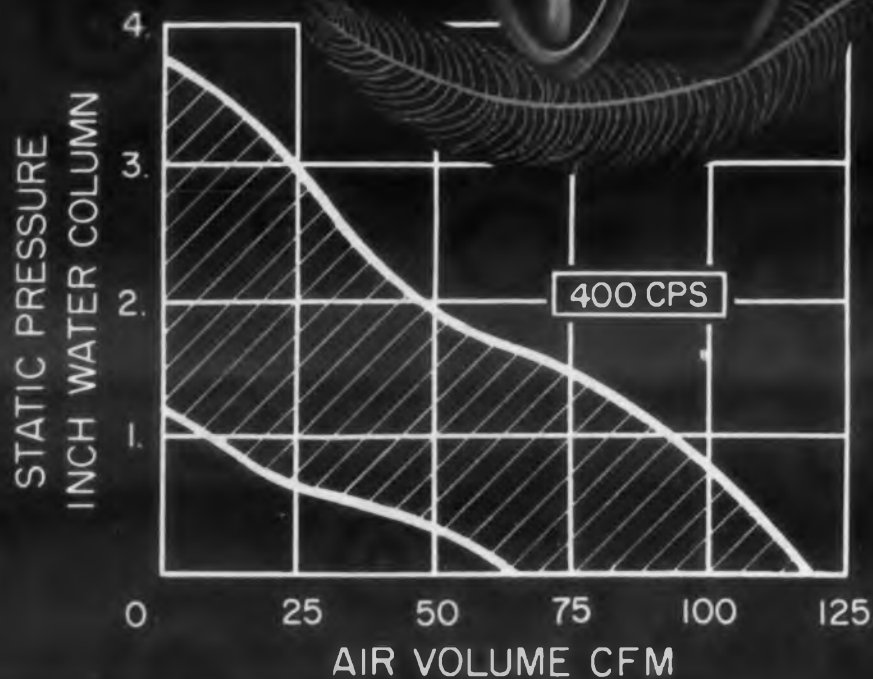
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SEND FOR THIS GUIDE CHART TO OAK SWITCHES

Bulletin unfolds to 17" x 22" wall chart (right) which matches 34 rotary switch sections (shown actual size) to corresponding frames. Also contains specifications and dimensions for rotary, pushbutton and lever switches.



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CIRCLE 51 ON READER-SERVICE CARD

Modulation Transformer Performance Specification No. _____

Transmitter classification — Standard Broadcast _____ watts. Other _____
 Modulator: Tube Type _____ Plate Voltage _____ ± _____ %
 Class of operation _____ Power Output _____ w. Distortion _____ %
 With resistive load of _____ ohms plate to plate (objective)
 Bias volts _____ Peak input volts per grid _____
 Final amplifier. DC volts _____; DC current _____ amp, ± _____ %
 Total capacitance load on modulation reactor _____ max _____ min μfd
 RF choke _____ mh Secondary Series Capacitor _____ μfd
 Modulation reactor rating, _____ henry _____ amp _____ dc volts
 Final filter capacitor: Modulator _____ μfd ; TF amp _____ μfd
 Frequency response, ± 1 db limits _____ cps to _____ cps
 Overall distortion objective, _____ % to _____ cps; _____ % to _____ cps
 Reflected impedance. (above conditions) _____ to _____ cps = _____ ohms \pm _____ %

Table 2. The buyer should also list electrical considerations as itemized above.

Transformer Characteristics: Type of construction: _____
 Rating duty cycle: _____ va @ _____ minutes per hour: _____ va continuous
 Max. volts, half primary _____ rms @ min _____ cps. No load current
 _____ amp. Tol. \pm _____ %: 60 cps _____ v _____ amp _____ watts $\pm 10\%$
 Leakage ind. half primary (with full primary shorted) _____ mh max.
 Leakage ind. half primary (with secondary shorted) min. _____ mh, max. _____ mh.
 Secondary no load volts (max.) _____, — _____, — _____ v rms.
 Max. sec. load current _____ amp. Max. I^2R loss (1-2) _____ w (2-3) _____ w
 Typical Test Results (half primary)
 Response, $R_s =$ _____ ohms, 1 db points _____, _____ cps. _____ db points _____, _____ cps.
 Reflected impedance peaks: (1) _____ cps. _____ ohms (2) _____ kc _____ ohms (3) _____ kc _____ ohms
 Receiving dielectric tests: Prim. & Sec. to ground _____ kv RAC*
 Primary to secondary: _____ kv ac. 60 cps. *Rectified AC. RMS Value.

Marking: Primary, plates (1-3) Centertap (2) Secondary; low end (4)
 Secondary; high end (5) to R.F. load. Sec. taps L,M,H (connect jumper only.)

Tap impedance ratio (half prim.); $L = \frac{p}{s} \frac{\text{ohms}}{\text{ohms}}$ $M = \frac{p}{s} \frac{\text{ohms}}{\text{ohms}}$ $H = \frac{p}{s} \frac{\text{ohms}}{\text{ohms}}$

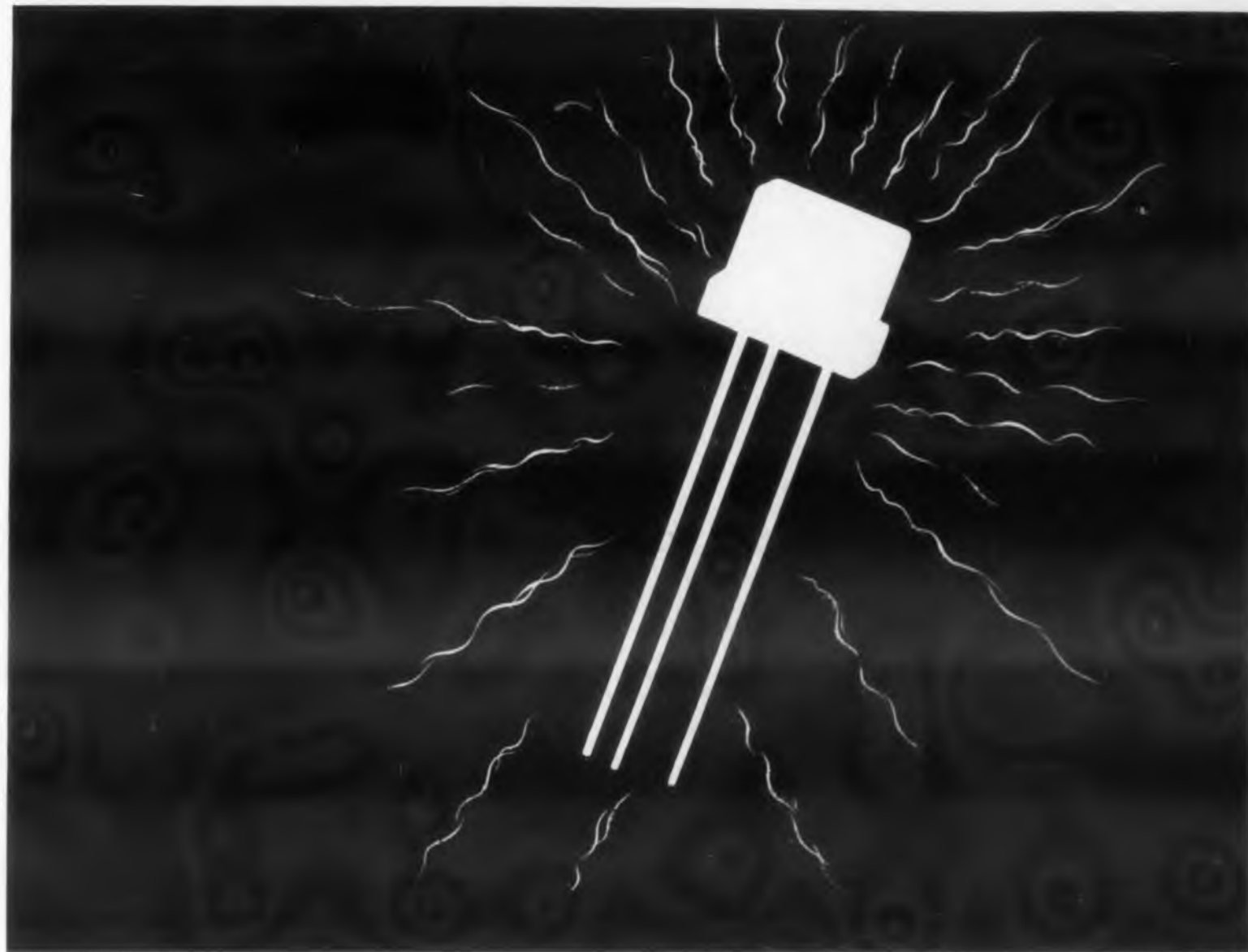
Remarks:

Customer approval. Date _____ by _____ name _____ title _____ company

Approved transformer: EEW #E _____ Rev. _____ Date _____

Table 3. The transformer design engineer is the best qualified person to specify what tests should be made on transformers. He fills out a sheet, like this, outlining production test specifications.

Metallurgical Memo from General Electric



How to tame a "hot" transistor

**Magnetic Materials Section reports on G-E thermistors
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General Electric thermistors reduce their resistance substantially upon slight increases in temperature, making them especially suitable for temperature compensation of transistor circuits. Frequently, a thermistor or thermistor network is used in place of a base biasing resistor. Thermistors restrain transistors from running away at high temperatures, and often result in further economies.

For example, replacing an expensive uncompensated silicon transistor with a low-cost germanium transistor compensated with a thermistor permits savings of 80 per cent and more! Also, high-priced, low-temperature-coefficient resistors and capacitors may be replaced with inexpensive, high-temperature-coefficient units—

resulting in additional cost reductions. What's more, a higher gain in the circuit for given temperature variations may be achieved.

Because they are small and contain no moving parts, G-E thermistors are ideal for other temperature compensation applications, such as copper, magnetic amplifiers, and diodes. Other uses for thermistors include temperature measurement, time delay devices, voltage regulators, and current inrush suppressors.

Through new production facilities, General Electric can now design and manufacture thermistors to your specifications. For resistance values from 1 to 10,000,000 ohms, and with temperature coefficients of resistance from -1% to -5% at 25°C., there is a G-E thermistor for you. For further information, write: *Magnetic Materials Section, 7820 N. Neff Road, Edmore, Michigan.*

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CIRCLE 52 ON READER-SERVICE CARD

rms voltage required by the load.

In a class B modulator or power amplifier operating at 60 to 70 per cent efficiency, the rms voltage developed across the full primary is almost the same as the dc plate voltage. At 66 per cent efficiency, this voltage is 94 per cent of the dc plate voltage. Peak voltages are considerably higher and should be taken into account, particularly in the case of transmitters where the 5000-v peaks of a 5000-v signal may cause overmodulation.

It is undesirable to have any substantial portion of the windings unused. Where more than 10 per cent of the over-all windings are unused, performance is severely handicapped. If taps are required and part of a winding is unused, it is necessary to make the transformer bigger to offset degradation of performance. It is not feasible to design a transformer that will provide the best performance for a large number of different conditions. Taps, when necessary, should be provided only for minor adjustment of ratio.

Some Distortion Unavoidable

The distortion limit objectives are customarily specified. Even when a pure resistive load is used, some distortion will result. While it is not produced by a properly designed transformer, distortion may be in the circuit.

While it is not necessary for the designer to know what tubes are to be used, this data is generally wanted to double check the other information received. Bias and peak grid voltages are also of importance to him as supplemental information.

Since it is practical to build transformers that provide a constant impedance reflected load within ± 10 per cent or better, with high power factor over wide frequency range, these requirements should be spelled out in the specification. Heretofore the scientific feasibility of this has not been generally recognized.

A typical spec sheet giving the electrical environment data, filled in by the buyer, is shown in Table 2.

Tips on Testing Transformers

While it is the responsibility of the transformer maker to ensure that his product meet the requirements of applicable specifications, some buyers stipulate what tests should be made. Sometimes these test specifications are inadequate, too strict or just plain inept.

A transformer should be subjected to tests that determine its usefulness in its intended application. Arbitrary test specifications may result in a transformer considerably larger and more costly than required. Only the transformer designer knows how the windings are interleaved. He is the only one qualified to determine what kind of hipot tests should be made. A typical production test spec made up by the design engineer after designing the transformers is shown in Table 3. ■ ■

Voltage Controls This Variable Bandwidth Amplifier

Joseph L. Dautremont, Jr.

TelAutograph Corporation, Los Angeles, Calif.

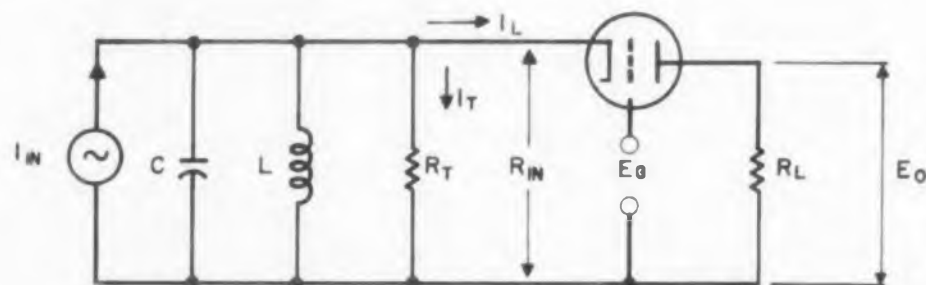


Fig. 1. Equivalent circuit of the basic variable bandwidth amplifier, including circuit losses.

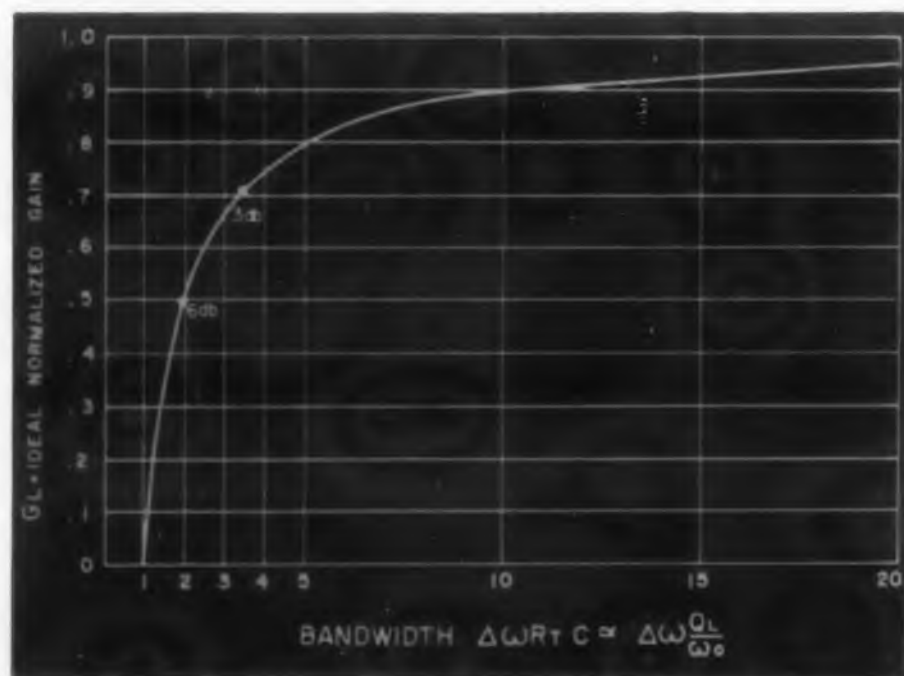
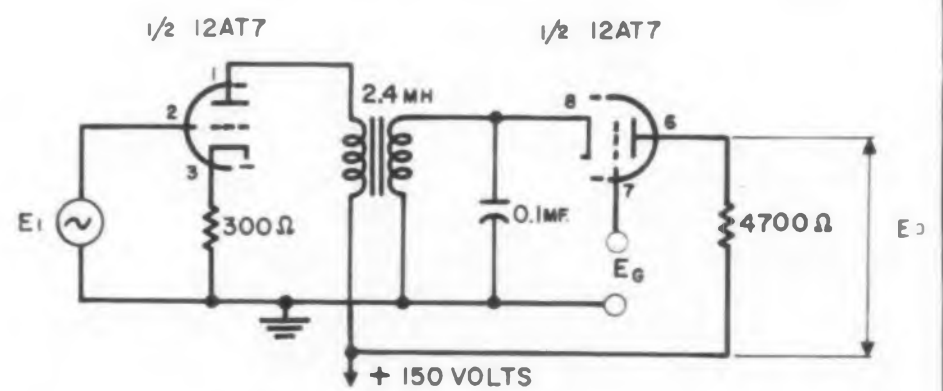
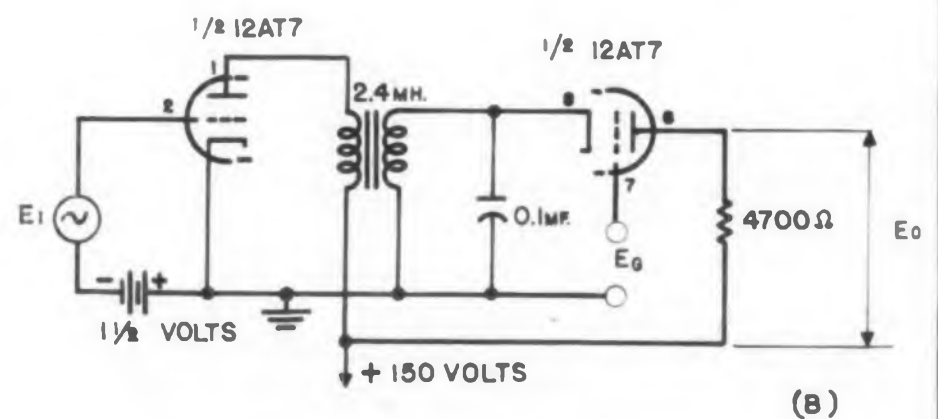
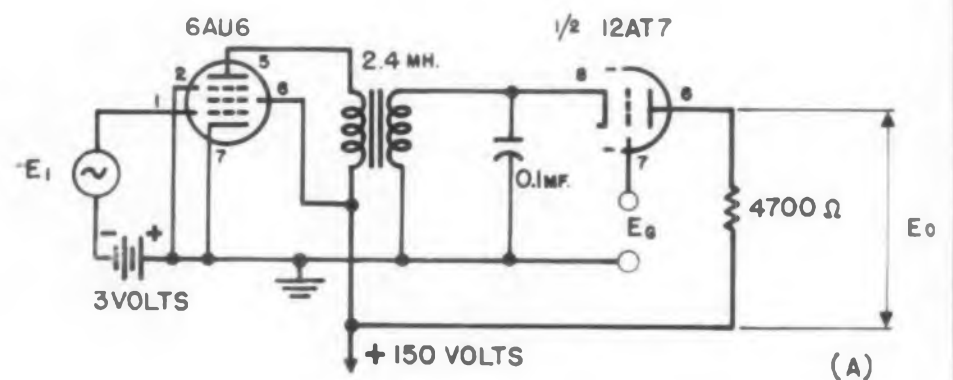


Fig. 2. Ideal normalized gain vs. bandwidth for the variable bandwidth amplifier.



TYPICAL VTBA CIRCUITS

Fig. 3. Three typical VBA circuits. (A). A pentode serves as an ideal current source. (B). A simpler circuit with quality almost matching that of the pentode circuit. (C). An improved version of the circuit in (B).

BANDWIDTH of this amplifier varies as a function of control voltage. Applicable from audio through very high frequencies, this simple circuit may also be used to alter the bandwidth of a nonlinear servo system with respect to a derivative of the output, thus improving system stability.

The basic VBA schematic is shown in Fig. 1. The 3 db bandwidth of the amplifier is that of the tuned circuit:

$$\Delta\omega = 2\pi\Delta f = \frac{1}{RC} \quad (1)$$

Since

$$R_{in} \cong \frac{1}{G_m}$$

for a grounded grid amplifier, Eq. (1) becomes:

$$\Delta\omega \cong \frac{G_m}{C} \quad (2)$$

Bandwidth Varied By Small Bias Voltage

The bandwidth is reduced by increasing the tube bias, E_g . Losses in the inductance cause a loading effect limiting the minimum bandwidth and reducing the gain as R_{in} increases. These effects may be calculated as:

$$G_t = \text{normalized gain at resonance} = \frac{i_L}{i_{in}} = \frac{R_t}{R_t + R_{in}} \quad (3)$$

(R_t is the effective parallel resistance of the losses in the inductance).

$$\Delta\omega = 2\pi\Delta f = \frac{1}{\left(\frac{R_t R_{in}}{R_t + R_{in}}\right) C} \quad (4)$$

Combining Eqs. (2) and (3):

$$G_t = 1 - \frac{1}{\Delta\omega R_t C} \quad (5)$$

Knowing R_t and C , the gain for any bandwidth may be found using Eq. (5), which is plotted in Fig. 2. Note from Eq. 3 and Fig. 2 that gain is reduced 6 db when $R_t = R_{in}$.

The three variations of VBA in Fig. 3 were tested. R_t was 10,000 ohms for all three. Circuit 3A, a pentode, is nearly an ideal current source. The previously derived equations apply directly, and the overall gain is:

$$\frac{e_o}{e_i} \bigg|_r = -G_m R_L G_t \quad (6)$$

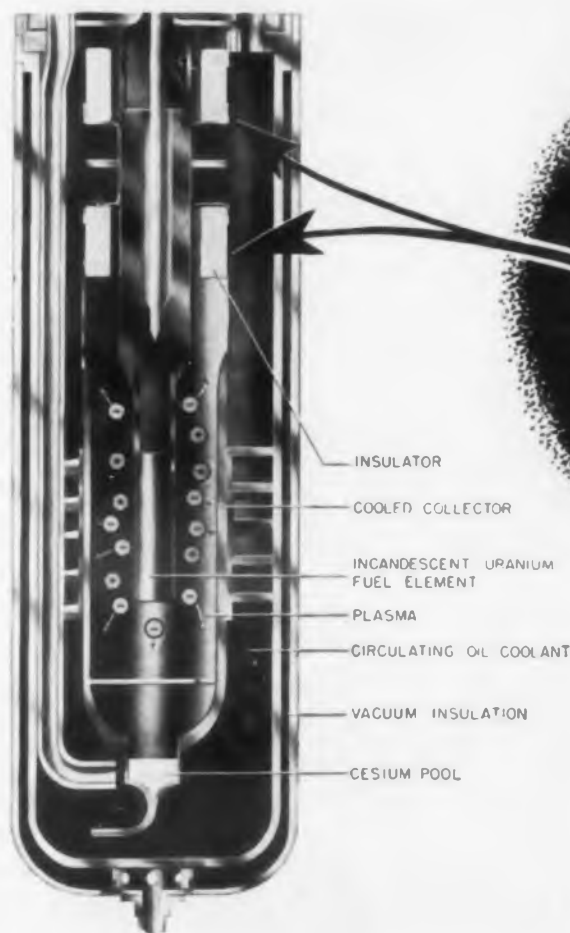
where G_m is the transconductance of the pentode. Measured results are given in Figs. 4, 5, and 6.

Circuit 3B is simpler, without appreciable loss in quality, as shown in Figs. 4, 5 and 6. The voltage gain, assuming infinite Q_1 , is:

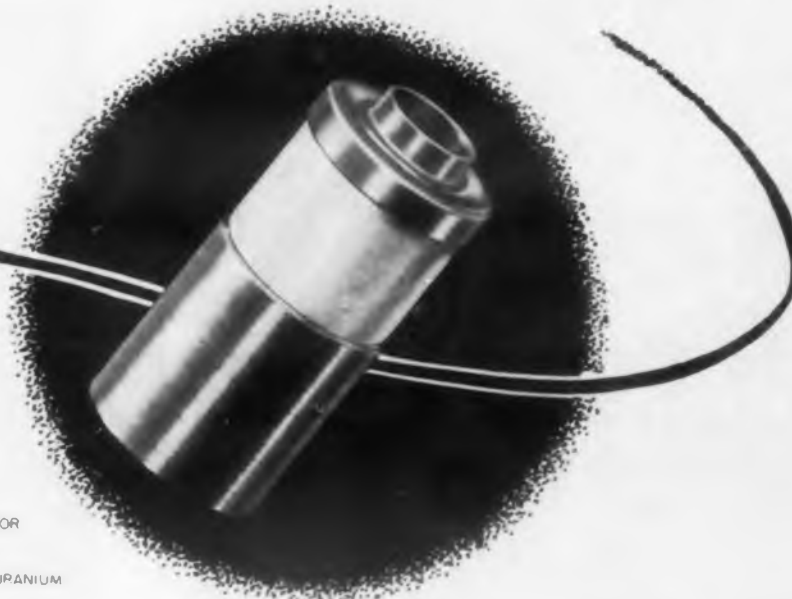
$$\frac{e_o}{e_i} \bigg|_r = -\frac{\mu_1 (1 + \mu_2) R_L}{R_{p1} (1 + \mu_2) + R_{p2} + R_L}$$

(Continued on p 66)

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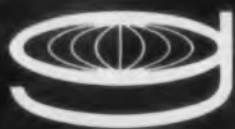
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CIRCLE 54 ON READER-SERVICE CARD

(Continued from page 65)

Subscripts 1 and 2 refer to triodes 1 and 2 respectively. Choosing circuit parameters such that:

$$R_{p1}(1+\mu_1) \gg R_{p2} + R_L$$

then:

$$\frac{e_o}{e_i} \approx -G_{m1} R_L$$

Response curves for various values of tuning bias are given in Fig. 6.

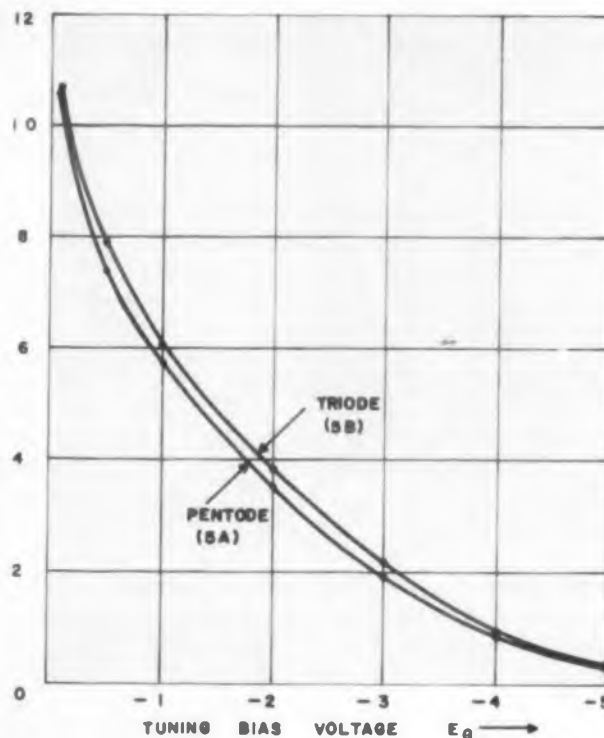


Fig. 4. Bandwidth vs tuning bias for the circuits of Figs. 3A and 3B.

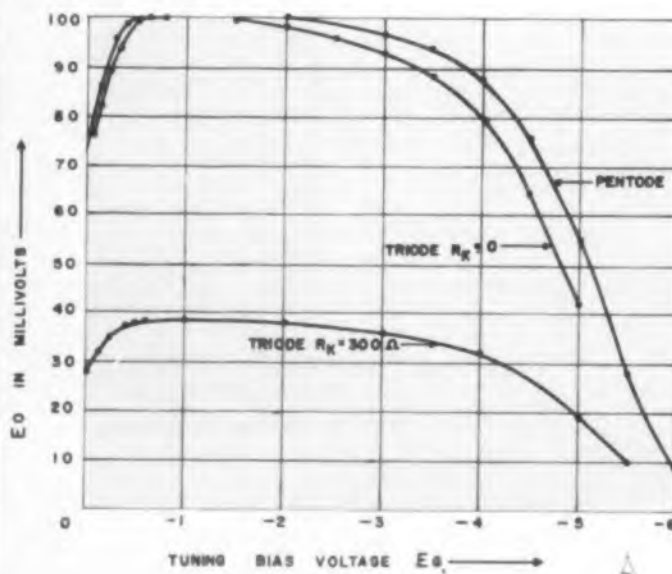


Fig. 5. Output at resonance for the circuits of Fig. 3.

The response curve of 3B may sometimes be improved by adding cathode resistor R_k as in Fig. 3C. The resistor is not justified in this case, since it decreases gain, with little improvement in response.

This method is useful when a tube with low plate resistance must be used, since current feedback increases output impedance. The gain, assuming infinite Q_1 , is:

$$\frac{e_o}{e_i} \bigg|_r = \frac{\mu_1(1+\mu_2)R_L}{(1+\mu_2)R_{p1} + R_k(1+\mu_1) + R_{p2} + R_L}$$

If

$$(1+\mu_2)[R_{p1} + R_k(1+\mu_1)] \gg R_{p2} + R_L$$

then:

$$\frac{e_o}{e_i} \bigg|_r \approx \frac{\mu_1 R_L}{R_{p1} + R_k(1+\mu_1)}$$

which implies that the gain at resonance is dependent on the parameters of the first triode only.

Useful In Low Noise Applications

A modified Wallman cascode lends itself to the VBA principle, as in Fig. 7. This circuit is significant because the cascode is often used in the first stage of i-f amplifiers. The noise figure of the VBA is not noticeably affected till the bias decreases the gain of the cascode beyond the 3 db point.

A low pass VBA is shown in Fig. 8, functioning as a resistive shunt across the plate capacitor. In this case, the dc level of E_o is affected, therefore the dc plate voltage of the pentode must be confined within the limits over which it acts as a current source. This reduces the useful bandwidth

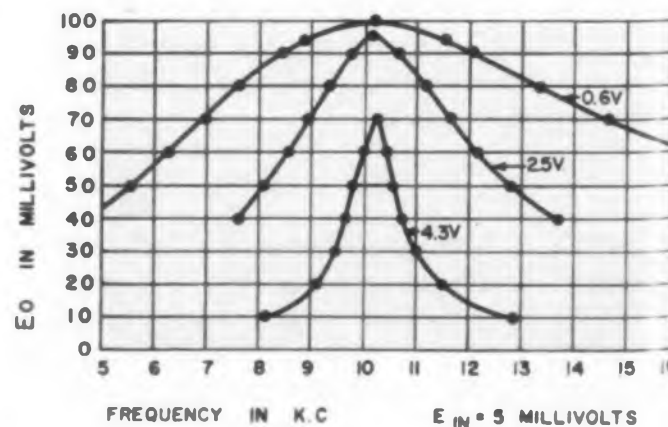


Fig. 6. Response of the circuit in Fig. 3B at three values of E_0 .

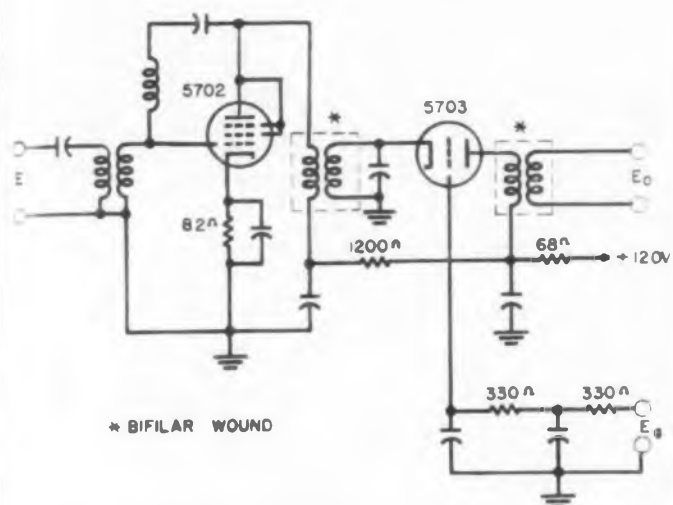


Fig. 7. Modified Wallman cascode as a VBA.

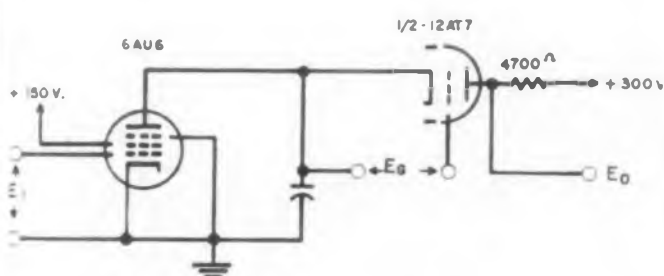


Fig. 8. A low pass VBA.

to approximately a three to one range.

Design Procedure

Given the cascode of Fig. 7 with an i-f frequency of 30 mc. The tube used has a minimum R_{in} of 300 ohms.

The desired bandwidths are one mc minimum, and ten mc maximum, with 3 db maximum change over the tuning range.

From Eq. 1:

$$C \approx \frac{1}{2\pi (\max \Delta f) (R_{in} \min)} \approx \frac{10^{-6}}{2\pi (10) 300} = 53\mu\text{mf} \text{ or less}$$

From Fig. 2:

$$\Delta \omega R_t C = \Delta \omega \frac{Q_t}{\omega_0} \geq 3.42$$

Hence:

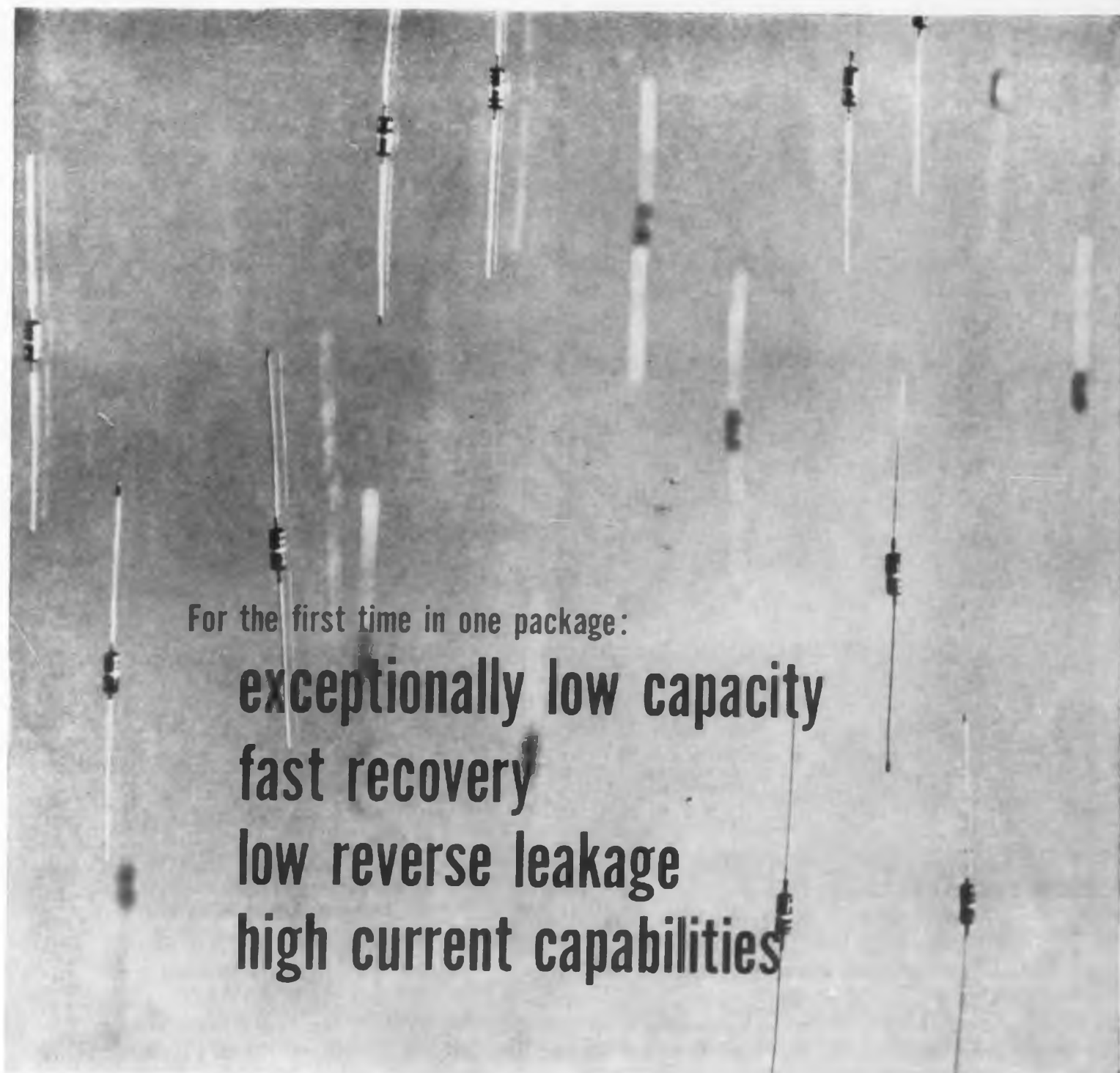
$$Q_t \geq 3.42 \frac{30 (10^6)}{1 (10^6)} = 105 \text{ minimum}$$

Suitable values are:

$$C = 10\mu\text{mf} \quad L = 2.8\mu\text{h} \quad Q > 105$$

(C is the total capacity, including stray and inter-electrode capacities). The rest of the circuit is designed as if it were a conventional cascode. ■ ■

Thanks are extended to John La Terra for his valuable assistance in preparation of this paper.



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Syracuse, 224 Harrison Street; Syracuse 2, N. Y.; GRanite 1-0163

Chicago, 6120 West North Ave.; Chicago 39, Ill.; NAtional 2-0283
Philadelphia, 1 Bala Avenue; Bala-Cynwyd, Penn.; MOhawk 4-8365
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Or write, Hughes Products, Marketing Department,
SEMICONDUCTOR DIVISION, NEWPORT BEACH, CALIFORNIA.

Type	Min. Forward		Max. Reverse Current (μA)		Reverse Resistance (R) (ohms)	Reverse Recovery* Maximum Time (μsec)
	Min. Ex. Current @ 25°C (@ 100 μA)	(@ +1.0V)	@ 25°C	@ 100°C		
1N840	50	150	0.1 @ 40V	15 @ 40V	400 K	0.3
1N837A	100	150	0.1 @ 80V	15 @ 80V	400 K	0.3
1N841	150	150	0.1 @ 120V	15 @ 120V	400 K	0.3
1N843	250	150	0.1 @ 200V	15 @ 200V	400 K	0.3
1N844	100	200	0.1 @ 80V	15 @ 80V	400 K	0.5
1N845	200	200	0.1 @ 160V	15 @ 160V	400 K	0.5

*Measured in JAN test circuit and switched from 30mA forward current to -35V.
 TYPICAL CAPACITANCE: $C_{-10} = 2.2\mu\text{mf}$ $C_{-1.5} = 4.4\mu\text{mf}$ $C_{-0.5} = 9.0\mu\text{mf}$
 Operating Temp. Range: -65°C to +150°C Storage Temp. Range: -65°C to +200°C

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Picking a Potentiometer:

A DESIGN ENGINEER specifying potentiometers can use either a wirewound or film unit. Which should he choose? A look at the record will help the careful engineer explore the advantages and disadvantages of each.

In performance, the carbon film potentiometer is better than the wirewound, as shown in the accompanying table. This is a result of the configuration and construction of the film unit. But cost must be considered, too: the film unit is more expensive. So let us compare further.

Although the film potentiometer has a higher degree of accuracy and reliability, the wirewound shows a smaller variation with temperature and humidity. Special resistance wire alloys are available with a resistance change of not more than +0.002 per cent per degree F.

Carbon film units have a temperature coefficient of about -0.01 per cent per degree F. In con-

tinuous 100 per cent relative humidity, wirewound potentiometers have shown a resistance decrease of about 5 per cent. Carbon film units have shown a resistance increase of about 25 per cent.

In wirewound units, the resistance change with humidity is usually accompanied by a change in linearity and resolution because of internal shorting of windings. In carbon film units there is no deterioration of linearity or resolution with humidity.

Construction of Wirewound Pots

The wirewound potentiometer is made by winding a fine insulated resistance wire around a straight insulated metal core. In a non-linear unit, the core is of non-uniform cross section. The turns may be spaced and the wire diameter varied.

The wound core is left straight in a translatable unit. It is bent in circular form in a rotary unit. And it is bent in a helical shape in a multi-turn



Film or Wire

potentiometer. The wiper traverses the length of the wound core in a direction transverse to the windings.

The potentiometer output voltage thus varies in a series of small steps, corresponding to the wiper contact, with successive turns of wire. This resolution ability deteriorates in nonlinear units where varying wire diameter or spacing is used.

Shortcomings of Wirewound Pots

Shortcomings in wirewound potentiometers that result from their construction are:

- Integrity of resistance element depends on hair-like wire.
- High speed is limited by wiper bounce.
- Shorted turns develop because of fragility of insulation.
- Linearity is limited by the discrete nature of winding.
- Resistance values obtainable are limited by wire size.
- Output becomes noisy with running.
- Wiper riding transverse to winding is abrasive and shortens life.
- Windings are reactive. They are capacitive to the core and inductive to each other, producing errors when excited with high frequency voltages.
- Corrosive products produce shorted turns, opens in the output, poor shelf life.

Construction of Film Pots

The film potentiometer is made by applying a thin, continuous resistive film to a base having a shape compatible with the types of wiper motion. It is straight for translatable motion, circular for rotary, single-turn or multi-turn motion. The film

A Comparison of Film And Wirewound Potentiometers

Characteristic	LINEAR POTENTIOMETER		SINE-COSINE POTENTIOMETER	
	Wirewound	Carbon Film	Wirewound	Carbon Film
Case Diameter	2 in.	2 in.	2 in.	2 in.
Resistance	10 K	10 K	10 K/quadrant	10 K/quadrant
Linearity (best)	0.075%	0.03%	0.25%	0.1%
Resolution	0.05%	0.001%	0.1%	0.001%
Starting Torque	0.75 oz.-in.	0.30 oz.-in.	2 oz.-in.	0.7 oz.-in.
Operating Speed (max.)	300 rpm	2000 rpm	150 rpm	2000 rpm
Life (at 100 rpm)	2 x 10 ⁶ rev.	20 x 10 ⁶ rev.	1 x 10 ⁶ rev.	20 x 10 ⁶ rev.

Herbert H. Adise is the president of the largest producer of film potentiometers in this country. He believes that too many engineers specify wirewound potentiometers more out of habit than analysis. In this article he hopes to stimulate a closer look at the film potentiometer.

Herbert H. Adise
Computer Instruments Corp.
Hempstead, L.I., N.Y.

Wirewound

is permanently bonded to the base and presents to the wiper a continuous, smooth, low-friction surface. Resolution is virtually infinite. The only resolution effects are secondary ones introduced by wiper spring and play in shaft bearings. The resolution is independent of the nature of the output, being the same for linear and nonlinear types.

Film potentiometers are made with metal or carbon films. To achieve useful values of resistance, the thickness of metal films is so small as to limit film life. The carbon film unit is consequently much more widely used and has been developed to a high state. Since it is representative of film potentiometers, carbon film characteristics are discussed below.

By control of film properties—thickness, width, and resistivity—very high linearities or nonlinear conformities may be achieved. In effect, carbon film may be regarded as a surface across which a potential difference is applied. A family of orthogonal equipotential, current flow lines exist in the film, uniformly spaced for the linear case. The wiper serves as a pick-off, indicating the potential at its contact point with the film.

Wear, which occurs along a current flow line, does not disturb the field nor impair accuracy. At the end of the film's life, wear does, however, manifest itself in increasingly erratic output voltage that ultimately shows opens. Relocating the wiper path restores potentiometer output to its original quality.

The carbon film potentiometer offers flexibility, because of the ease with which the "resolutionless" film may be deposited in narrow or irregular paths.

Film Pots Give Failure Warning

The film potentiometer has an "early warning" characteristic and indicates impending failure. The wirewound unit does not.

In the wirewound pot, the transverse-wound fine wire is subjected to maximum wiper abrasion and local heating because of the construction developed by wear.

The failure of any one of the thousands of turns of wire results in an open winding. Failure in the wirewound unit is sudden and catastrophic.

The resistance element of the carbon film potentiometer, on the other hand, can be likened to a single slidewire. It has a thickness several times that of the wire used in wirewound units and has at least 100 times the width. The wiper path occupies but a small fraction of the width. Thus, as the carbon film wears under the abrasion of the sliding wiper, the current-carrying capacity of the resistance element is not limited. Wearing does not develop any hot spots. As the element thickness is reduced from wear under the wiper, the voltage output begins to show local irregularity. With continued wear, this irregularity becomes more pronounced.

At the extreme end of life, irregularities may appear as loss of signal (opens). But these will be localized. Thus with carbon film units there is a gradual deterioration in output that gives the "early warning" of system failure.

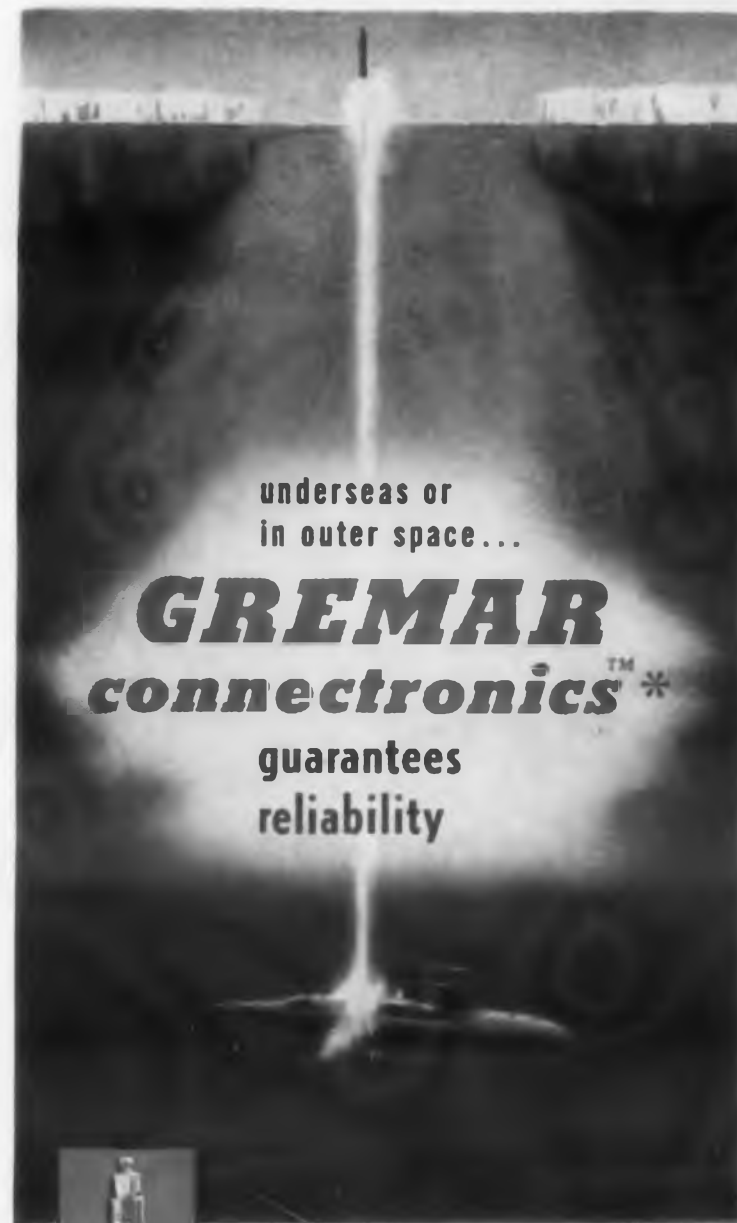
How Surge Currents Affect Pots

It is not unusual that the failure of some other component in a system will produce an imbalance in the electrical circuit—resulting in a surge of current through the wiper of a potentiometer. In the wirewound unit, the turn of wire immediately under the slider at that instant overheats, softens, melts and tears. The winding opens, and the unit is completely inoperative.

With the carbon film potentiometer, this surge of current causes only local carbonization of the film. The remainder of the film is unaffected. The carbon film unit continues to operate normally with an irregular output appearing only when the wiper traverses the locally burned spot.

Because of its higher resistance stability, the wirewound unit may be more suitable for use as a rheostat where a close tolerance is required on resistance variation with shaft position. A typical application of the precision rheostat is its use in an RC network for frequency control.

For instrumentation and control applications, where the potentiometer is used as a voltage divider and the resistance stability is of secondary importance, the carbon film unit may be the preferred component because of its better accuracy and reliability. ■ ■



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INFRARED

Infrared Measurement and Calibration

Loren H. Ford and Paul Mengers

LMED, General Electric Co.
Ithaca, N. Y.



Loren H. Ford, left, presently engaged in advanced photonics engineering for General Electric, LMED, is a graduate of Michigan State University. He has been in various phases of military electronics since joining GE in 1951. Paul Mengers, right, is a mathematician and is currently developing techniques for making rapid approximate determinations of the spectral content of radiation. The authors wrote this article to disclose some of the test methods used at GE which they hope will prove helpful to others in the field.

Many new techniques for making infrared measurements are being developed. In this article some of the present measuring methods and equipment in use are discussed.

IN INFRARED system design and synthesis, a knowledge of detector characteristics is of great importance. The system designer often has to utilize their capabilities to the limit. Uniformity of detector characteristics has improved during the past few years but considerable variation still exists among individual detectors of the same nominal performance. Because of these two facts, the designer often finds it advisable to make measurements on individual detectors. For most system applications, the following characteristics are of most interest: (1) optimum bias; (2) time constant; (3) responsivity; (4) noise spectrum; and (5) spectral response.

The order in which the measurements are made is important. For example, optimum bias should be determined before the noise spectrum is measured. It is also convenient if the frequency of the radiation input signal does not exceed the time

constant limitations of the detector. Data on spectral response may be taken when convenient but must be known before the Noise Equivalent Input can be calculated.

Optimum Bias

Many infrared detectors require some form of bias supply. A typical circuit is shown in Fig. 1. The optimum bias is that value of bias current through the detector which maximizes the signal-to-noise output from the detector-load resistor network. To determine this value for photoconductive cells, a radiation signal whose magnitude does not need to be known as long as it does not saturate the detector is put into the detector. The output signal is then measured for increasing values of bias current. Usually the signal output increases approximately linearly and then flattens out. Next, with no signal applied, the noise volt-

age output in the frequency region of interest is measured as a function of bias current. This will generally increase with bias also. Computing the signal-to-noise ratio and plotting as a function of bias will generally result in a broad maximum for most detectors. Fig. 2 shows the results of a typical optimum bias measurement on a PbS cell.

For thermistor detectors, a different procedure is used. This consists of determining the peak voltage attainable across the detector under steady state thermal conditions. That is, after each change in bias is made, sufficient time is allowed for a new thermal equilibrium to be established before measurements are made. Fig. 3 is a typical voltage-current curve of a thermistor. The peak voltage is determined by Eq. 1.

$$\frac{V_p}{R_p} = C_t (T_t - T_a) \quad (1)$$

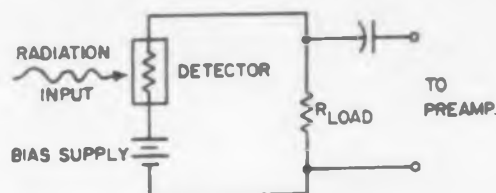


Fig. 1. Infrared detector bias supply.

where:

V_p = peak voltage

R_p = peak resistance

C_t = steady state rate of heat dissipation

T_t = thermistor temperature

T_a = ambient temperature

Maximum voltage is due to the high negative temperature coefficient of resistance which causes the resistance to drop at increased power levels. Optimum bias is chosen to be 0.6 of the peak voltage. At this level current noise is small compared to the limiting noise which is thermal. Since signal-to-noise ratio is proportional to bias voltage, 0.6 V_p is found to be a good compromise which allows for some variation in ambient temperature.

Time Constant

There are two commonly used methods of measuring the time constant of an infrared detector. The first method utilizes a neon flasher which is capable of producing pulses of light with a frequency which can be easily varied from dc to about 10 kc. By plotting the signal output as a function of input frequency, a graph similar to Fig. 4 will be obtained in which the output will begin to fall off beyond a certain frequency. The frequency at the break-point where the output is

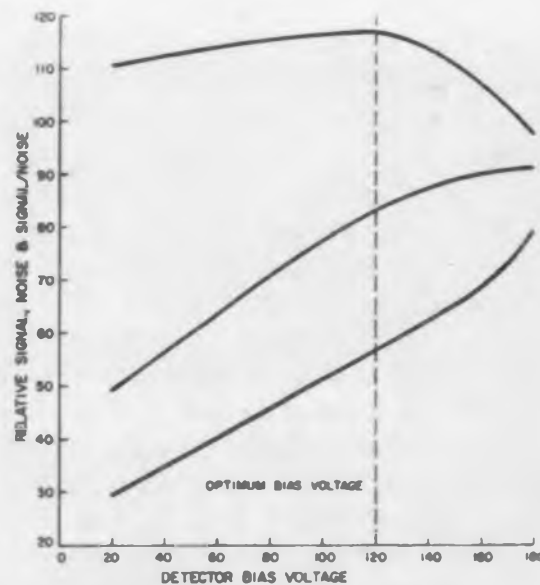


Fig. 2. Typical optimum bias curve.

down 3 db, is the reciprocal of the time constant. The disadvantage of this technique is that the output of the neon lamp is in the visible part of the spectrum and may not give an accurate measure of the frequency response of the detector to radiation of longer wavelengths.

A preferable technique which is simpler, though slightly less accurate, is to apply a square wave radiation input from a blackbody source to the detector and display the output on an oscilloscope. By making the square wave duration in the neighborhood of three or four time constants and photographing the trace displayed on a calibrated sweep, a sufficiently accurate determination of the time constant can be made by measuring the time

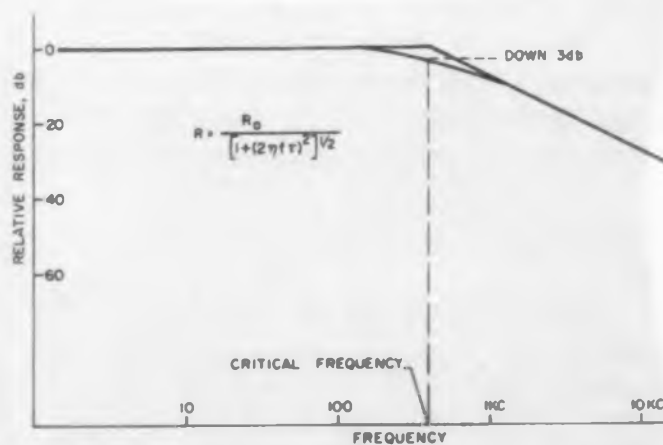


Fig. 4. Typical photoconductor frequency response.

for the trace to rise to 67 per cent of its asymptotic value. This method will also determine the existence of any significant second time constant the detector may possess.

A typical setup for this measurement is illustrated in Fig. 5. The beam defined by the collimating apertures should be as small as practicable in relation to the chopper slit in order to cut the rise time of the radiation input signal.

Responsivity

This quantity is defined as the ratio of output signal voltage to the radiation input signal. Several qualifications are in order here. First the chopping frequency should be less than the break-point or critical frequency. Second, the detector should be operated under optimum bias conditions. Third, the input and output signal should be measured in terms of the root-mean-square of the third requirement. When the input signal is a square wave, the rms of the fundamental is 0.45 times the peak-to-peak value.

With the equipment shown in Fig. 5 a narrow band filter and an rms voltmeter to replace the oscilloscope, would be adequate for responsivity measurements. There are a number of calibrated and temperature controlled blackbody sources

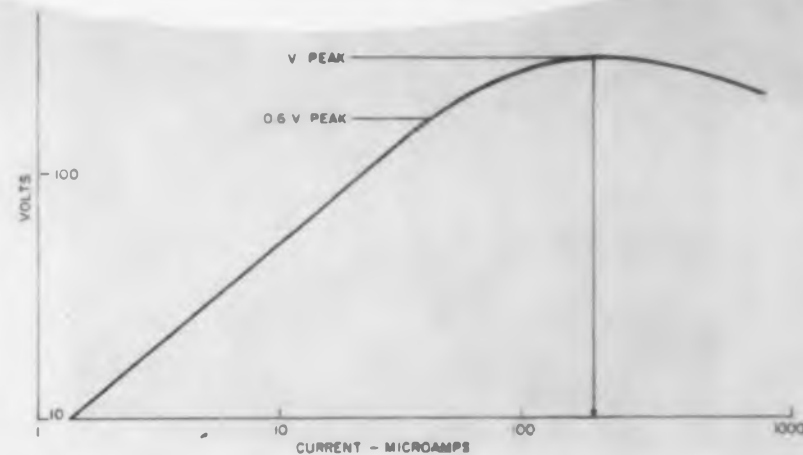


Fig. 3. Typical voltage-current relation for thermistor detector.

commercially available. The input signal is the difference between the radiation input from the blackbody and a reference (usually the chopper blade). Radiation input from which the responsivity or more accurately, the total responsivity is calculated is the difference in the integrated radiation inputs from the source and reference as indicated in Eq. 2.

$$R = V_s \left[B_1 \left(\int_{\lambda_1}^{\lambda_2} J_{bb}(\lambda) S_d(\lambda) d\lambda - \int_{\lambda_1}^{\lambda_2} J_{ref}(\lambda) S_d(\lambda) d\lambda \right) \right]^{-1} \quad (2)$$

where

B_1 = ratio of rms of fundamental to peak-

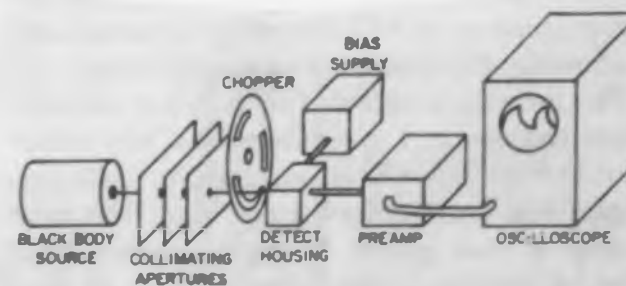


Fig. 5. Trace-time measuring equipment.

peak radiation difference

V_s = rms of output signal voltage

λ_1, λ_2 = spectral response limits of detector

J_{bb} = spectral distribution of blackbody

J_{ref} = spectral distribution of reference source

S_d = relative spectral response of detector

Note that R will depend on the temperature of

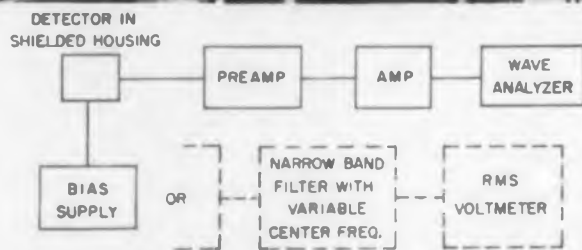


Fig. 6. Measuring setup for NEI, chopping frequency and bandwidths (a), and its block diagram (b).

the blackbody. Thus it is necessary to specify this temperature in reporting such data. Since the responsivity also depends upon the temperature of the detector itself, this fact should also be noted.

Noise Voltage Spectrum

A knowledge of the noise voltage spectrum of the detector is essential in determining such system parameters as NEI, chopping frequency, and bandwidths. Fig. 6 shows a measuring setup.

The detector is shielded as in other measurements and operated at optimum bias. The output noise voltage is fed to an adjacent low noise preamplifier and is then further amplified. This noise voltage is then passed through a narrow band filter of variable center frequency but of fixed bandwidth. Output is then measured with an rms

voltmeter. Care should be taken to shield the detector and preamp and keep the preamp lead as short as possible. In most cases, a low noise triode such as a 12AY7 or a 6533 is desirable in the preamplifier first stage. A 6CB6 pentode has also been found to be excellent for this purpose. The filter bandwidth is usually about 4 or 5 cps. Since most meter movements have a similar bandwidth, the needle tends to fluctuate about a mean at this frequency which makes estimation of the mean difficult. We, therefore, use an auxiliary meter with an integrating network thereby relieving the operator of the necessity of mentally performing this integration. Dividing by the gain and the square root of the filter bandwidth, and plotting the values obtained against frequency results in a graph as shown in Fig. 7.

Spectral Response

The setup for measuring spectral response is shown in Fig. 8. A Nernst Glower is used to provide a strong and concentrated source of infrared radiation. An image of the source is focused on the slit, s , of a monochromator. The radiation is twice dispersed by the prism, and chopped between the first and second pass through the prism. The entrance slit is then focused on the exit slits, s' , which passes only a small portion of the spectrum onto either the thermocouple detector by means of the movable mirror, m , or onto the detector being measured.

At this point, two procedures may be followed. The first is to leave the slit width fixed as the wavelength of the radiation on the detector is changed. The output of the detector and thermocouple are recorded at each wavelength setting. Since the source intensity decreases at longer wavelengths, both the detector and thermocouple output will change due to this effect. If the thermocouple is properly blackened, its responsiv-

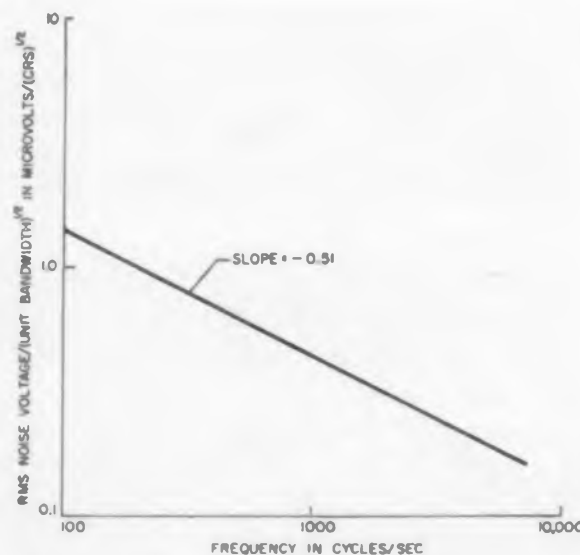


Fig. 7. Noise-frequency spectrum.

ity is independent of wavelength so that if the ratio of detector output to thermocouple output is plotted, the variations with wavelength should be due only to variations in detector responsivity.

An alternate procedure is to adjust the entrance slit width at each wavelength so that the thermocouple output is maintained at a fixed level. The radiation is then directed to the detector and the output so obtained is a direct measure of the response at that wavelength. It should be noted that both procedures essentially eliminate any extraneous effects due to such things as radiation absorption or slow changes in source output during the course of the measurement.

One of the most useful equipments for taking accurate radiation measurements such as sensitivity vs. wavelength and sensitivity vs. angular view angle of an optical equipment is the collimated optical bench shown in Fig. 9. It is capable of simulating targets at an infinite distance within a reasonable dimension of space by collecting radiant energy from a point source and projecting it along parallel paths in a beam the diameter of the

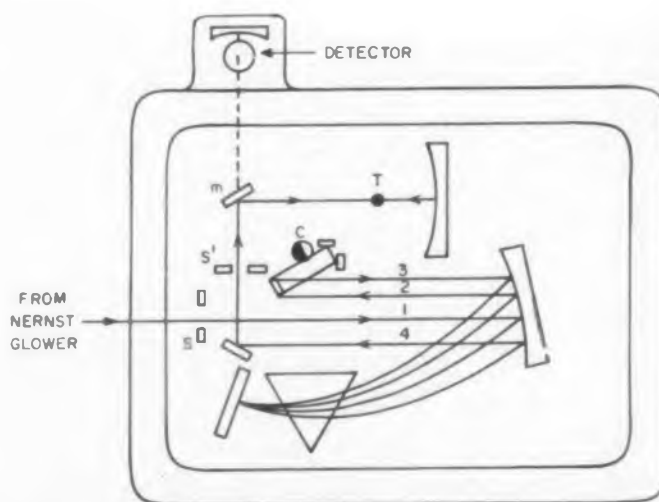


Fig. 8. Setup for measuring spectral response.

projecting mirror. In so doing, an optical system which is to be tested for image quality, absolute sensitivity, losses due to vignetting or spectral response can be placed within the parallel radiation beam and thus receive realistic radiation incidence for precise measurements.

A point source whose temperature is controlled and whose spectral passband is variable by insertion of spectral filters is placed at the focal point of the collimating mirror. Its energy is masked so that radiation from the source is only toward the mirror. The mirror collects this energy and re-radiates it in a parallel path down its major axis. The test optics gathers the parallel energy and focuses it upon its detecting element which in turn passes the detected signal in the form of a

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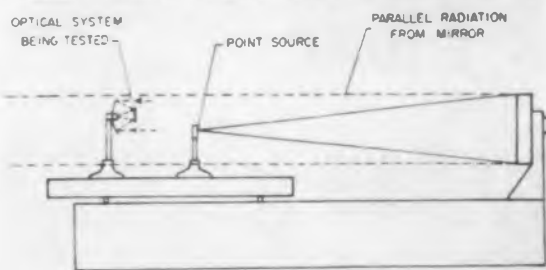


Fig. 9. Collimated optical bench (a), and drawing showing its parts (b).

chopped voltage to a readout meter calibrated to give the required test data. Generally, this is in the form of rms amplitude which is proportional to the energy received by the test optic. If the test optic is large the projected area of the source must be subtracted from the gathering power of the test optic since the source blocks this amount of energy.

The bed which supports the optical elements and source has been constructed to eliminate errors due to stresses and strains due to movement of the bench or temperature changes. The bench bed is constructed of 12-inch tubular steel reinforced at the ends with welded plates for rigidity. The collimating mirror is kinematically mounted on three points to allow for expansion and contraction without distortion to the alignment of its major axis.

A precision 3-point suspension, optical bench is used as the test bed for the source and the test optic. Its alignment is maintained by the same type of mounting as the collimating mirror.

Bench Specifications are:

- Collimating mirror—Spherical First Surface
- Focal length—231.03 cm
- Diameter collimating mirrors—28 cm
- Resolution—usable to 1 deg off axis
- Height of image above optical bench—11 in.
- Source—any point source of size required by test optics for image definition.

The entire unit is made mobile by three large casters allowing the test bench to be located in any convenient area. The system can be leveled easily and ready for a test installation within 10 minutes. ■ ■



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f_{osc} (max) 1000 mc
PG (neut.) 14 db @ 200 mc

- **High Temperature Operation.** All units baked-out under high vacuum at 200°C and stabilized at 100°C for 168 hours. Each lot must pass life tests of 1000 hours at 100°C. Units are rated for operation at 100°C.
- **High Efficiency.** A highly efficient oscillator, some points on the 2N700 efficiency-frequency curve are:

Frequency	Efficiency
40 mc	80%
100 mc	62%
200 mc	44%
400 mc	20%

- **Uniformity.** The Motorola Mesas are unquestionably the most uniform transistors available. Instead of the usual "selection process," closely controlled diffusion, etching and evaporative techniques enable Motorola to produce the Mesas to exact specifications. Such uniformity enables the engineer to tighten circuit tolerances, provide improved performance and simplify circuit design. It eliminates concern for variations in such factors as breakdown voltage, current handling capacity, frequency parameters, switching characteristics and saturation resistance.
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TYPE	SIZES	MIN. OHMS	MAX. MEG.	MIL-R10509C MAX. DC Voltage	Type	Equivalent to MIL-R-10509C	
						Char.	Tol.
CPM-1/2	1/4 x .735	10	2.49	350	RN70	B	F
CPM-1	3/8 x 1 1/2	10	5.11	500	RN75	B	F
CPM-2	3/8 x 2 1/2	30.1	10.0	750	RN80	B	F

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Flyspeck Diode Stands 20,000 g

ONLY SLIGHTLY larger than a pen's ball point and weighing 14.09 mg, the micro diodes in the PD-100 series can withstand a shock of 20,000 g. The units—20,400,000 fit in a cubic foot—are said to be the smallest commercial-type computer diodes and fill two per cent of the volume occupied by the average sub-miniature diode.

The diodes—made by Pacific Semiconductors, Inc., 10451 W. Jefferson Blvd.,

Culver City, Calif.—measure 0.08 in. long and 0.035 in. in diameter, excluding the leads. Some of their claimed uses are “hand-sized computers,” and “pocket-sized space instrumentation systems.”

A molecular bonding process is one of the contributing factors to the diode's small size. The molecules of the silicon crystal are chemically bonded with the surface elements that serve as a protective coating. This process is called a “chemical

Electrical Specifications

Type No.	Min. Sat. Voltage @ 100 μ A (v)	Min. Fwd. Current @ + 1.0 V (mA)	Maximum Reverse Current (μ A)		Reverse Recovery Characteristics	
			25°C	100°C	Reverse Res (Ohms)	Max. Recov. Time (μ S)
PD-101	50	5	1 (10v)	25 (10v)	100K	1.0
PD-102	50	20	0.5 (10v)	25 (10v)	100K	0.3
PD-103	50	100	0.5 (10v)	25 (10v)	100K	0.3
PD-104	100	5	0.5 (10v)	25 (10v)	100K	0.3
PD-105	100	20	0.5 (10v)	25 (10v)	100K	0.3
PD-106	100	50	0.5 (10v)	25 (10v)	100K	0.3
PD-107	100	100	0.5 (10v)	25 (10v)	100K	0.3
PD-108	200	10	0.5 (10v) 5 (100)	25 (10v)	200K	0.3
PD-109	200	10	0.025 (10v) 1 (100)	5 (10v)	200K	0.3

A contributing factor in miniaturizing the diode is the process which molecularly bonds the silicon crystal and the protective surface elements.

surface passivation technique." Diode crystals are normally encapsulated in a container which contributes to their larger size.

All nine of the PD-100 series diodes are rated at 250 mw dissipation at 25 C. This is derated linearly to 150 C. The maximum storage and operating temperature range is -65 to +150 C. The typical inverse capacitance at -10 v is 2 μ mf, and the peak pulse current is 20 amp for 1 μ sec at a one-per-cent duty cycle.

The units will survive thermal shock tests in accordance with Method 107 of MIL-STD-202 as well as repeated immersion cycling from 0 to +100 C and the moisture resistance test of Method 106 of the same specification. In storage at very high temperatures—that is, above 150 C—and when used within published ratings, the reliability of the diodes are "at least one order of magnitude greater than that of any conventional diode," it is reported.

All of the diodes are tested 100 per cent to the electrical specifications, and receive a 200 hr, 175 C "burn-in" process for reliability.

Mechanical Data

The gold-plated nickel leads, which have a minimum length of 1/2 in., are easily soldered or welded, and they can be bent to meet 0.1 in. grid spacing on printed circuit boards. The materials and construction are good to temperatures above 200 C, no soft solders or fluxes are used. More than 10 180-deg bends, at a repetition rate of two bends per second, can be withstood by the leads. They can also withstand 2.5 to 4.5 lb of tensile force.

A rosin-flux is recommended for soldering purposes; the diodes may be dip-soldered within 0.06 in. of the diode body for 60 sec at 230 C. And they can be cleaned for at least 10 min at 35 kc in any of these common solvents: water, trichloroethylene, ethyl alcohol, methyl alcohol, and toluene.

In calculating the packing density of 20,400,000 units per cubic foot, it is assumed that diodes are packed side by side with a space allowance for the leads equal to the diode's body volume, which is 0.04×10^{-3} cu in.

For more information on these diodes, turn to the Reader-Service Card and circle number 101.

COUNTERMEASURES and the horny protoparce sexta



"RAVEN" SPELLS TROUBLE FOR THIS FELLOW but it once spelled security for our military

The protoparce (Tomato worm) faced with the serious problem of existing from day to day, does so by the logical method of vanishing before the eyes of his enemies. To a Raven, he seems only another part of whatever bush or tree he sits upon. This is an application of basic countermeasures.

On the other hand "Raven", the World War II code name for countermeasures, meant security for us and trouble for our enemies.

INSTRUMENTS FOR INDUSTRY, a leader in the field of countermeasures, has long been active in successors to project "Raven."

Recently under development is a device which effectively intimidates counter-interception equipment aboard attacking enemy aircraft, resulting in our planes literally disappearing before the eyes of the enemy.



You can't shoot down a shadow...but that's all that can be found. Another countermeasure by I.F.I.



INSTRUMENTS FOR INDUSTRY, Inc.
101 New South Road, Hicksville, L. I., N. Y.

Graduate engineers with two or more years of circuit application in the fields of electronics or physics are invited to meet with Mr. John Hicks in an informal interview or send complete resume to: Dir. Personnel, IFI, 101 New South Road, Hicksville, New York.

CIRCLE 60 ON READER-SERVICE CARD

first TRUE MINIATURE "E"

altitude-moisture resistant

AMPHENOL *MINNIE* connectors are the first true miniature "E" types—the only miniatures able to pass the new, exacting altitude-moisture immersion test. In this test mated, wired connectors are immersed in salt water and altitude cycled to 80,000 ft. for one minute, 65,000 ft. for one-half hour and then returned to ground pressure for another half-hour. *MINNIE* insulation resistance after this test is a minimum 1000 megohms.

In aircraft, in missiles and in exacting ground and sea applications AMPHENOL *MINNIE* connectors will provide outstanding service. Any company working with environmentally-resistant connectors is invited to write for complete *MINNIE* information.

Unfitted end grommet, stainless steel bayonet slots and pins, hooded socket contacts are other Minnie E features.

AMPHENOL CONNECTOR DIVISION

Amphenol-Borg Electronics Corporation CHICAGO 50, ILLINOIS

Avoid Gear Reduction with Servo

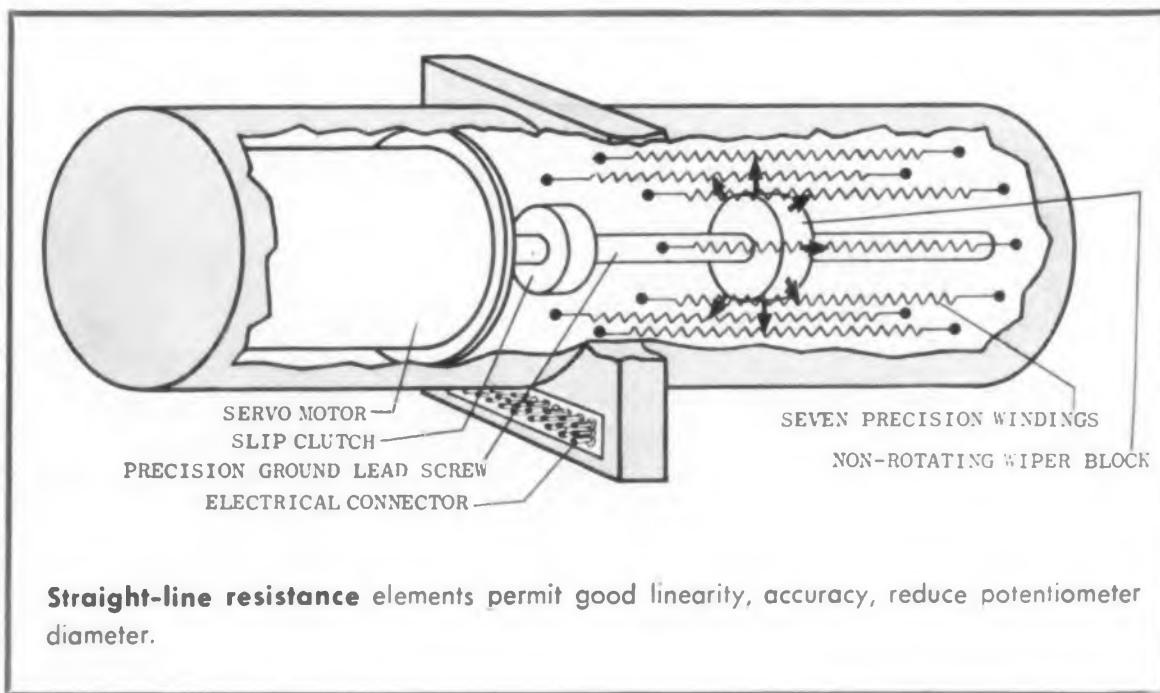


Standard gear trains can be omitted between servo motor and precision ground lead-screw of this multi output servo driven potentiometer, saving space and weight.

HIGH GEAR RATIOS and good precision can be obtained by using only the leadscrew of a new multi-output servo-driven potentiometer. No gear train is necessary. With straight-line resistance windings instead of the conventional rotary windings, the seven-gang pot provides a high accuracy network package in a small cross section.

Manufactured by Bourns, Inc., P.O. Box 2112, Riverside, Calif., the Model 801 is used, typically, to provide servo-controlled attenuation of gain with altitude for missile controls. With seven gangs, simultaneous control, feedback and telemetry signals can be provided.

A typical special function would require six outputs with 20 db attenuation, plus one output with 40 db attenuation.



th Servo Driven Pot

Attenuation is provided as a change in resistance with a ± 0.5 db conformity.

In operation, a servo motor's input function is converted to linear motion through the pot's precision ground lead-screw, which can, if desired, accommodate various gear ratios. As the lead-screw is turned, it pushes a set of contacts ahead of it along the length of straight resistance windings. A slip clutch is provided to be sure that overtravel will not damage the unit and will, in turn, stall the motor at the range extremities without allowing it to continue free running.

Supported by Class 5 bearings, the precision-ground leadscrew permits low breakout voltage for servo motor inputs.

Linearity is an independent ± 0.1 to ± 0.25 per cent. In the past such linearity has been common only to large diameter potentiometers.

Resistance available in the Model 801 ranges between 1 K and 100 K, with 1.5 w per element power rating. Torque required is 0.15 oz-in. variable with turns ratio. There is no back-lash. Resolution is 0.03 to 0.2 per cent.

The 801 is rated at two million traversals life. It is filled with dry nitrogen and hermetically sealed; meets MIL-E-5272A requirements for humidity, salt spray, sand and dust and fungus. Temperature range of operation is -40 to $+165$ F and shock rating is 60 g in 11 msec.

For further information on this servo-driven multi-output potentiometer turn to the Reader-Service card and circle 102.

USE LOTS OF TAPE?

"SCOTCH" BRAND Instrumentation Tapes cut operating costs

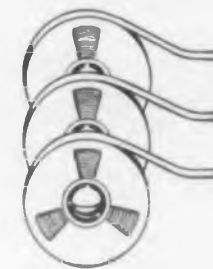


Let's develop our own small theory of relativity. For everything's relative, after all—even economy. Clearly, an economy effected now and *corrected* later is no economy at all. In instrumentation tape, there's only one genuine economy—reliable performance. And in performance, the last two words for any acute tape-user are "SCOTCH" BRAND.

First to last, "SCOTCH" BRAND Magnetic Tapes offer uniformity and reliability—born of the experienced 3M technology that created the first practical magnetic tape and continues to advance the art of tape-making day by day.

But let's look at economy from another viewpoint—in terms of some things around the periphery that might not come so readily to mind—storage, use, waste, and time saved.

What other kind of record is so permanent it may last a lifetime, yet requires so little space for storage? Three reels of "SCOTCH" BRAND like those at the right "contain" 30 million characters. What other medium serves input, output and memory functions at such high speeds? Accepts both digital and analogue data?



What other kind of record is not *consumed*, even when it is used? "SCOTCH" BRAND Magnetic Tape is run and rerun for analysis, erased and used again, permits retaping with corrections, editing and new data.

Last, but far from least—in these days when time is money, what other medium speeds up data acquisition, reduction and control programming in a way that keeps critical projects rushing forward at full tilt? Or cuts production lead time and human error to a point where a 1000% saving may be realized?

At any cost, "SCOTCH" BRAND Magnetic Tapes would be a good buy. And in every application, "SCOTCH" BRAND Tapes offer that greater economy—reliability. "SCOTCH" BRAND High Resolution Tapes 158 and 159 let you pack more bits per inch, offer extra play reels. "SCOTCH" BRAND Sandwich Tapes 188 and 189 end rub-off, build-up, cut head wear to an absolute minimum, show little wear in 50,000 computer passes. "SCOTCH" BRAND High Output Tape 128 offers top output at low frequencies, even under ambient temperature extremes. "SCOTCH" BRAND Instrumentation Tapes 108 and 109 offer top performance at lowest cost.

Where there's no margin for error, there's no tape like "SCOTCH" BRAND Magnetic Instrumentation Tape. For details, write Magnetic Products Div., 3M Company, Dept. MBQ-119, St. Paul 6, Minn., or mail the reader inquiry card. © 1959 3M Co.

"SCOTCH" is a registered trademark of 3M Company, St. Paul 6, Minnesota. Export: 99 Park Avenue, New York, N.Y. In Canada: London, Ontario.



SCOTCH BRAND MAGNETIC TAPE
FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
... WHERE RESEARCH IS THE KEY TO TOMORROW



CIRCLE 62 ON READER-SERVICE CARD

Count Individual Electrons with High Z Voltmeter

Precision voltmeter has input impedance higher than free space surrounding instrument. Mercury cells for powering isolated amplifiers can be seen through door and shields.



SIXTY ELECTRONS per second can be sensed by a new precision voltmeter which measures from one to 250 v. Input impedance is 10^{17} ohms—greater than the impedance of the free space surrounding the instrument, greater than the teflon insulating the input terminal contacts.

Output impedance, however, is much less than ten ohms, perhaps as low as 0.2 ohm. Manufactured by Halex, Inc., 310 E. Imperial Highway, El Segundo, Calif., the Model 301E voltmeter is a precision follower suitable for driving test equipment and control devices, external oscilloscopes, low voltage meters, servo systems and the normally-highly accurate, but relatively low impedance, digital voltmeters.

Voltage-following accuracy of the instrument is

0.02 per cent with the low impedance output terminal. It is the same or better with the high impedance ($5 \cdot 10^5$ ohms) output jack. Input signal can be low frequency ac or dc up to 250 v, of either polarity—500 v peak-to-peak ac. The meter is calibrated to two per cent full scale, and overall accuracy is held to two per cent. The meter is protected from overvoltage of either polarity by a Zener diode and registers the actual voltage at the 301E output terminal. It has 11 ranges.

Grid current is adjustable to 10^{-18} amp or less; the output/input following ratio is 0.9998 at the low impedance terminal. Zero drift is adjustable from the front panel.

Operating on a new principle of "relativistic coupling" (see below), the voltmeter's first ampli-

How It Works— No Feedback in Output-Ground Connections

RELATIVISTIC coupling is what Donald Dimon, consultant to Halex, Inc., calls his approach to electronic design. He says it's the "connecting of active systems into another, more complex system wherein the relations existing in each component system are undisturbed."

In analog circuitry, for example, very few ground connections are used. Instead, moving reference planes serve as grounds for each internal system.

Relativistic coupling, a powerful analysis and synthesis tool, paid off in the design of Halex's precision voltmeter. Let's see how it works.

A block diagram of the voltmeter is shown in Fig. 1. Three precision unity gain amplifiers are surrounded by three distinct shields. Ground for the innermost amplifiers is the shield for the succeeding amplifier.

Approximate electrical properties of the

three amplifiers are given in the Table. Note the input impedance of the first precision unity gain amplifier— 10^{14} ohms. But the overall properties of the entire system include an input resistance of $5 \cdot 10^{17}$ ohms. Input capacitance is $2 \cdot 10^{-3}$ μ mf; voltage gain on the low jack is 0.9996, high jack 0.99999; output impedance of the low jack 10 ohms (or less), high jack $5 \cdot 10^5$ ohms.

How is the input impedance of the first



Unbuttoned, precision voltmeter shows nesting of relative-coupled amplifiers. Note concentric input jack.

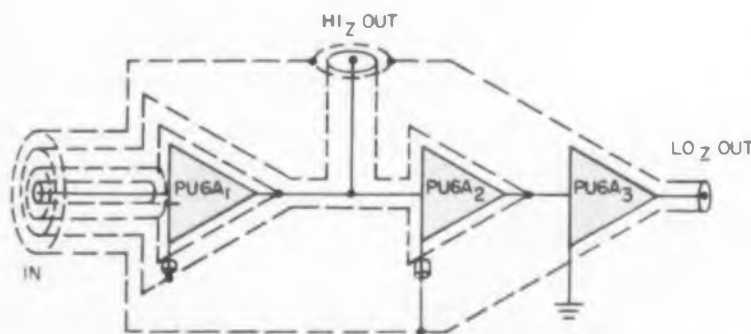


Fig. 1. Block diagram of precision voltmeter, showing relativistic shielding.

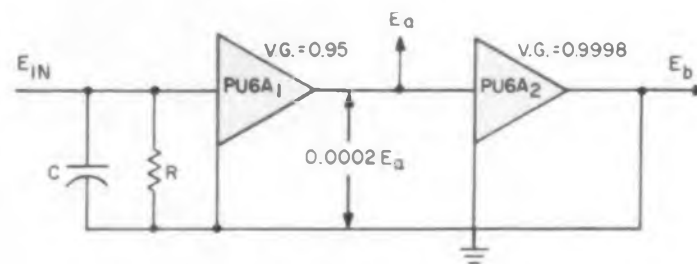


Fig. 2. To raise effective input impedance of first amplifier ($PUGA_1$), circuit is connected like this. Note the voltage between the output of $PUGA_2$ and the output of $PUGA_1$ is only $0.0002 E_a$.

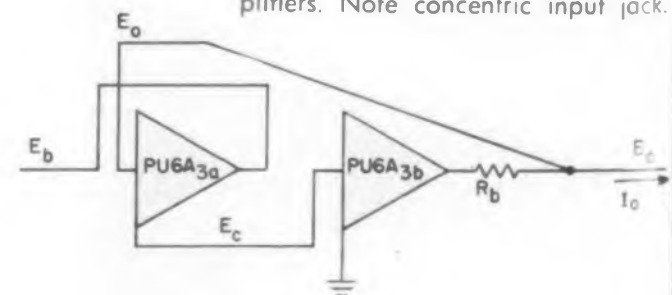


Fig. 3. The third precision unity gain amplifier in the package is made up of two amplifiers, connected as shown. Output impedance is less than ten ohms.

is isolated, self-powered, shielded by its own ground and independent of the rest of the system. This separate amplifier has an input impedance of 10^{14} ohms, as is commonly available with electrometer amplifiers; and is arranged as a voltage follower having a gain of 0.95, an output impedance of about 100 ohms. This amplifier floats on the output of another complete precision unity gain amplifier (voltage gain: 0.9998), which has an input impedance of 50 meg, output impedance of 100 ohms.

The second amplifier's output becomes the relative ground plane for the first amplifier and is also connected to the input of a third amplifier, which has an output impedance of less than 10 ohms.

The Halex Model 301E is 10 x 7 x 4 in. in size, has a large number of accessories for high-precision integrating, low impedance circuit voltage measurements, high voltage measurements, use as a regulated power supply, precision current source, micromicroammeter (actually giving an analog presentation of electron counting) or as a micromicrocoulombmeter.

For further information on this precision high impedance voltmeter, turn to the Reader-Service Card and circle 103.

amplifier, $PUGA_1$, effectively raised? See Fig. 2. For the purpose of the input impedance is considered to be separate and external to the amplifier; and is made up of R and C in parallel.

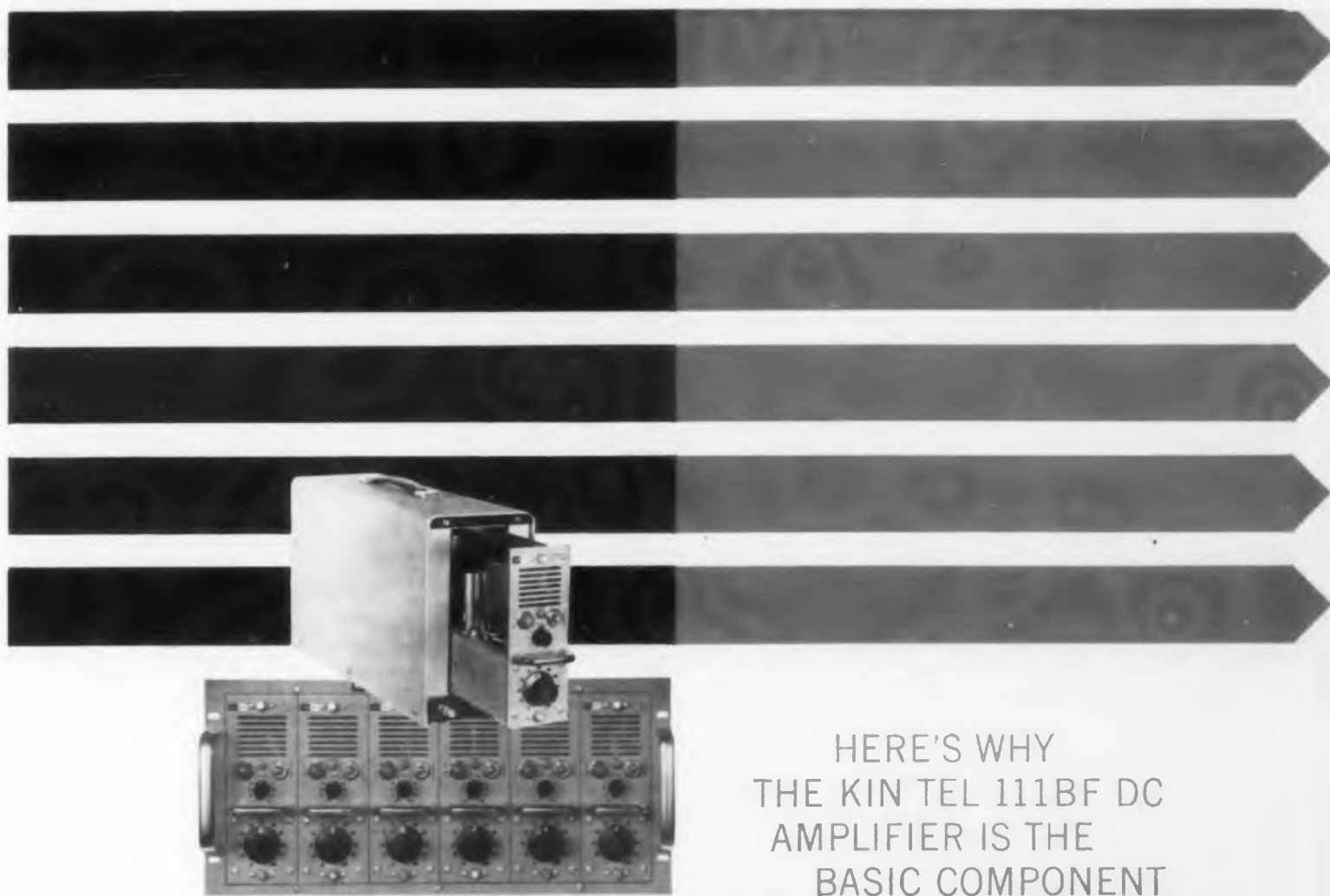
But the overall input impedance is seen by an external source to be E_{in}/I_{in} of the system. In the case of Fig. 2, E_{in} is essentially the same as E_a and E_b since the amplifiers are followers; but I_{in} is substantially reduced because the voltage across R and C is $0.0002 E_a/0.95$ —approximately one five-thousandth of the total input signal voltage. The new input impedance is then about $5000 \cdot R$, and C $5000: 5 \cdot 10^{17}$ ohms and $0.002 \mu\text{f}$.

Voltage Follows Accurately

The input voltage needed to support a signal of E_a and the E_a terminal (the voltmeter's high accuracy terminal) is the sum

Electrical Characteristics of Precision Unity Gain Amplifiers in High Impedance Voltmeter

	PUGA ₁	PUGA ₂	PUGA ₃
Input R	10^{14} ohms	$5 \cdot 10^7$ ohms	$5 \cdot 10^9$ ohms
Input C	10 μf	20 μf	20 μf
Volt Gain Dc	0.95	0.9998	0.9998
Output Z	100 ohms	100 ohms	10 ohms



111BF DC amplifiers in Model 195 single-amplifier cabinet and Model 190 six-amplifier 19" rack module.

KIN TEL 111BF DC wideband amplifiers allow extremely accurate measurement of dynamic physical phenomena such as strain, temperature, vibration, pressure, flow, torque, and displacement. They greatly simplify the design of data measurement systems, offering more bandwidth and accuracy, reduced maintenance, and none of the capacitive balance problems inherent in AC carrier equipment. KIN TEL's proved chopper amplifier circuitry with multiple feedback loops assures operational stability and uniform frequency response regardless of load or gain changes. The capability of providing full bandwidth and full output into large capacitive loads, at high gain settings, places virtually no restrictions on the type of output device that can be driven and allows the use of longer output cable runs.

The 111BFO, an operational version of the 111BF, has an open-loop position instead of a zero-gain position. In this position the user may employ external networks to provide up to 100% resistive or capacitive feedback around the amplifier, allowing its use as an integrator, active filter, or to generate complex linear transfer functions.

Many thousands of KIN TEL DC amplifiers, with millions of cumulative hours of operation, are in day-to-day use. Virtually all major missile programs—including ICBM—employ KIN TEL DC amplifiers in ground support instrumentation.

HERE'S WHY THE KIN TEL 111BF DC AMPLIFIER IS THE BASIC COMPONENT FOR ACCURATE, DRIFT-FREE AMPLIFICATION OF MICROVOLT-LEVEL SIGNALS:

- Less than $2 \mu\text{v}$ drift for 100's of hours
- DC - 40kc bandwidth
- 0.1% gain stability
- $\pm 45\text{v}$, $\pm 40\text{ma}$ output
- $100\text{k}\Omega$ input, $< 1\Omega$ output impedance
- 20 to 2000 gain
- Full output into $1 \mu\text{f}$ loads
- Integral power supply

Prices:

111BF DC Amplifier	\$625
111BFO DC Amplifier	\$635
195 Single-amplifier Cabinet	\$125
190 Six-amplifier 19" Rack Module	\$295

Immediate delivery from stock on reasonable quantities.

(Note: Amplifiers must be operated in 190 Module or 195 Cabinet.)

KIN TEL manufactures electronic instruments for measurement and control, and closed circuit TV. Representatives in all major cities. Write for detailed literature or demonstration.

5725 Kearny Villa Road, San Diego 11, California. Phone: BRowning 7-6700

KIN TEL
A DIVISION OF
COHU
ELECTRONICS, INC.

CIRCLE 63 ON READER-SERVICE CARD

Advancing the
solid-state

art . . .
NO. 2

DC POWER

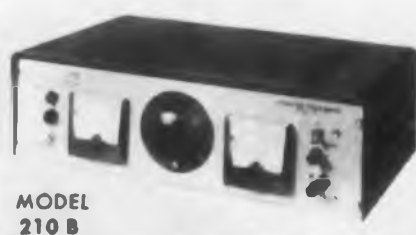
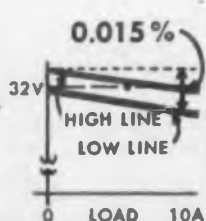
...**STEADY AS A ROCK!**

Maintain Tight Regulation
Despite Combined Effects of
Time, Dynamic and Temperature,
Static Line and Load Changes.

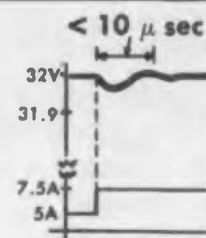
You can solve your power supply problems **overnight** by selecting the appropriate set of our Transistorized Power Supplies, because we *think of, design for, and test to* all the requirements for truly rock-solid DC power.

A certified report on 17 production tests accompanies each ARMOUR supply. Here is typical performance data:

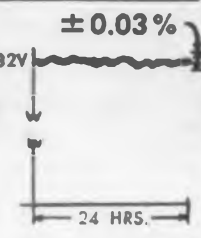
TOTAL STATIC REGULATION —
against worst combination of simultaneous static line and load changes.



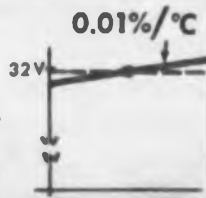
DYNAMIC RESPONSE —
duration of transient component of output change due to instantaneous load (or line) change.



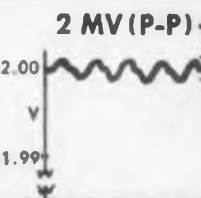
STABILITY —
after warm up, with constant line, load and ambient conditions.



THERMAL REGULATION —
output variation due to ambient temperature change, at constant line and load.



RIPPLE —
total of spikes, hash, periodic and h-f aperiodic components of output.



	OUTPUT RANGE		STATIC REGULATION		RIPPLE	PANEL	
MODEL	VOLTS	AMPS	LOAD	LINE	MV RMS	(INCHES)	PRICE
T-200-B	0-10	0-3	.02% or 3MV	.01%	0.7	3 1/2"	\$395
T-205-B	0-10	0-10	.03% or 6MV	.01%	0.7	3 1/2"	\$495
T-210-B	0-10	0-30	.02% or 6MV	.01%	0.7	5 1/4"	\$725
T-215-B	0-32	0-1	.02% or 3MV	.01%	0.7	3 1/2"	\$450
T-220-B	0-32	0-3	.02% or 3MV	.01%	0.7	3 1/2"	\$525
T-225-B	0-32	0-10	.02% or 5MV	.01%	0.7	5 1/4"	\$695
T-230-B	0-150	0-0.75	.01% or 1MV	.03%	2.0	3 1/2"	\$545
T-235-B	0-150	0-2	.01% or 4MV	.03%	2.0	5 1/4"	\$625

AE

ARMOUR ELECTRONICS

Division of Cardinal Instrumentation Corporation
4201 Redwood Avenue, Los Angeles 66, California

TRANSISTORIZED POWER SUPPLIES
TRANSISTOR TESTERS • LINE REGULATORS

CIRCLE 64 ON READER-SERVICE CARD

How It Works (Cont.)

of the voltage across the input and common of $PUGA_1$ plus the output voltage of $PUGA_2$. The two voltages are $0.00021 E_a$ and $0.9998 E_a$, a total of $1.00001 E_a$. The ratio of output to input is therefore $E_o/1.00001 E_a$; 0.99999.

Low output impedance for the instrument is obtained by connecting two separate amplifiers as one, as in Fig. 3. The two amplifiers, $PUGA_{3a}$ and $PUGA_{3b}$ each have an input impedance of $5 \cdot 10^5$ ohms, voltage gains of 0.99 and 0.98 respectively and 100 ohms and one K (R_b of Fig. 3). R_b is brought out externally for analysis; it is the output impedance of $PUGA_{3b}$.

The voltage E_c is about $1.02 (E_o +$

$I_o R_b)$ since the gain of $PUGA_{3b}$ is 0.98. The signal into $PUGA_{3b}$ is $(E_o - E_c)$, which is $-0.02 E_o - 1.02 I_o R_b$. The output of $PUGA_{3b}$ is 0.99 of the input signal. Suitable derivation shows E_b equal to $1.0002 E_o + 0.0102 I_o R_b$.

Since output impedance is the relative change in output voltage with a change in output current, $Z_o = E_o/I_o$, which equals $0.0102 R_b$ —about 10 ohms. The voltage following accuracy is $1/1.0002$, or 0.9998 unloaded.

In practice, the Halex 301E's final stage circuit is not identical to the one in Fig. 3, though the principle is the same; and the true output impedance appears to be about 0.2 ohms. To be safe, the company calls it "less than ten ohms."

The voltmeter is so sensitive that cur-

Plugboard Logic Computer



Logic rewiring is done quickly and easily by changing interconnections on plugboard. Ordinarily board is removed from machine, but due to low voltages (16 v max) it is safe to rewire while computer is operating.

DESIGNED for designers, a small digital computer gives the engineer an opportunity to test out computer logic designs with maximum ease. Boolean equations can be realized by wiring up a plugboard, slipping the board into the computer and turning the "on" switch. If the logic design proves faulty no breadboarding time or component expense is lost. The computer cannot be damaged by miswiring the plugboard.

Manufactured by Computer Control Co., Inc., 2251 Barry Ave., Los Angeles 64, Calif., the SPEC (Stored Program Educational Computer) Mark III is so organized as to permit its use as a general purpose computer or as a digital differential analyzer. Prewired A-MP, Inc. plugboards are used to interconnect the same logical elements in different ways—"rewiring" of the internal logic, rather than simple program insertion.

SPEC contains the basic features of larger computers—adders, counters, comparison circuits, operation code and memory selection matrices, memory storage and one mc clocking. It is designed to simulate a big machine on a small (about \$25,000) scale.

As a DDA (with a prewired plugboard supplied by the manufacturers) the computer contains 20 integrators with a maximum word length of 20 bits. Maximum accuracy is one part in 524,000, iterative

re. t flow along a glass rod can easily be measured. Mr. Dimon demonstrated this setup. He attached a 100-v source to both ends of a 4-in. long, 1/8-in. diam glass rod, grounded one end. The 301E was grounded at one end and a stiff metal wire inserted in the input jack. By touching the wire to the glass rod and moving it along its length, the meter was made to vary between zero and 100 v. Nothing but the conductance of the glass and surface leakage served to pass the current.

By using the short length of wire as an antenna, the potential difference between the meter and a glass rod rubbed with a piece of silk registered from three or four feet away. The meter needle faithfully followed the motion of the rod as it was moved from the voltmeter.

rate 2380 iterations per sec per integrator. Interconnections are set up by the inserted stored program. Any integrator output may be used as an independent variable input; and any three integrator outputs may be summed into each integrator output.

The octal keyboard is used to program information and to set up scaling and initial conditions for the integrators. Digital to analog conversion of outputs from any two integrators is provided so outputs can be displayed on a scope or x-y plotter.

SPEC's magnetostrictive memory is a plug-in package consisting of three sections: driver circuit, nickel-iron magnetostrictive delay line and amplifier circuit. Each unit will store 32 words in a circulating loop at a one mc pulse repetition rate. Total capacity per circulating line is 416 bits.

For logic design, the engineer can wire an empty plugboard in any way he wants, with perfect assurance that even if his equations are wrong no damage to the machine will result. Due to all-transistor circuitry, there are no voltages higher than 16 v in the unit. The computer should prove valuable for teaching engineers logical design and implementing the designs of more experienced designers.

For further information on this plug-board computer turn to the Reader-Service Card and circle 104.



For connections you
must count on...

be sure, be safe with

TWIN LOCK TERMINAL BLOCKS

SIMPLE

The terminal connector, crimped onto the wire end, slips easily into the block cavity. No screws or washers to remove, nothing to drop, just insert it.

SPEEDY

When connectors have been inserted, they're locked electrically and mechanically. Then, when the circuits have been checked, a few quick turns of the lock screw and they're double-locked.

SURE

When the connector has been inserted and tightened, the Twin Lock terminal block connection is positive—electrically and mechanically. Over 100 lbs. force is required to break this connection.

Twin Lock terminal blocks offer the ultimate in terminal reliability, speed of assembly, and versatility of application. Molded of a lightweight phenolic base with reinforced barriers between cavities, the Twin Lock block will accommodate up to 40 connections quickly and surely. Twin Lock's exclusive, insert-and-tighten two-way locking action cuts harness assembly time to a fraction of that required by any other block. Twin Lock contact points, either tin plated, gold plated or plated to customer specification, assure lowest resistance connection. Wire end connectors, compatibly plated, can be supplied for manual or automatic assembly. Available in either vertical or side entry types, the Twin Lock block is applicable wherever a fast, positive, reliable electrical connection is required. For complete information on these remarkable new blocks, write for the T-1000 and T-1010 Terminal Block Brochure.

TWIN LOCK INCORPORATED

1024 West Hillcrest Blvd.
Inglewood, California

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CIRCLE 65 ON READER-SERVICE CARD

NEW PRODUCTS

Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.



Bandpass Filters Cover 300 to 100 Mc Range

Operating in the frequency range of 300 to 1000 mc, the HFF(C) series of bandpass filters are designed and packaged to operate under military environmental conditions. The filters operate from a 50-ohm and into a 50-ohm impedance and have a selectivity ratio of less than 3 to 1. Typical of the units is one for operation at 332 mc with a 3 db bandwidth of 24 mc. It weighs 20 oz. Dimensions of the case are 5-1/8 x 1-11/16 x 3-1/4 in. Packaging of the units can be tailored to customer requirements.

Applied Research Inc., Dept. ED, 76 S. Bayles Ave., Port Washington, N. Y.

CIRCLE 67 ON READER-SERVICE CARD

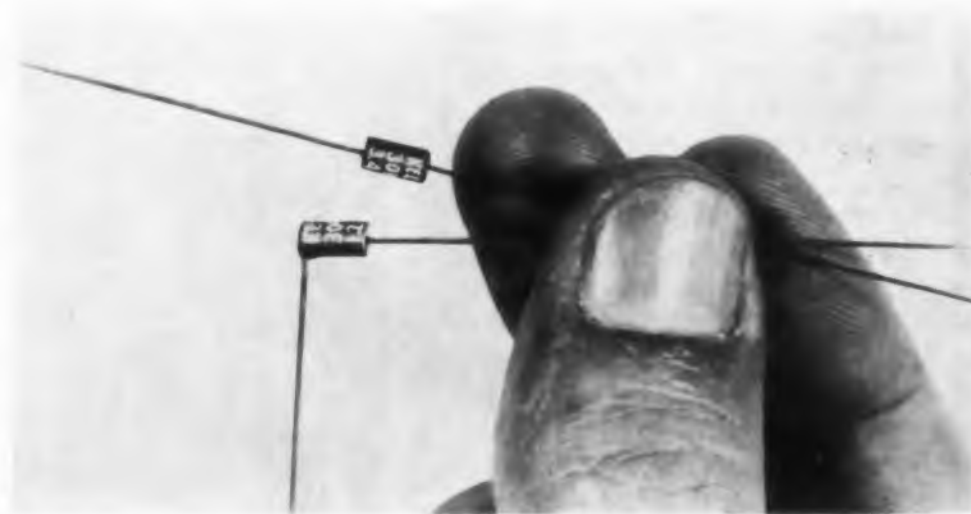


Analog Computer Solves Seventh Order Differential Equations

The model 3500, 23-lb analog computer can be used to study almost any physical system that can be described by linear differential equations. The 10-amplifier unit will solve up to a seventh order differential equation or a ninth degree Laplace transform. It performs accurately with 1% or 0.1% computing components. It measures 5.25 x 19 x 10.25 in. and the problem board tilts up for rack mounting. For solving complex problems, up to three units can be slaved together for 10, 20 or 30 amplifier operation.

Donner Scientific Co., Dept. ED, Concord, Calif.

CIRCLE 68 ON READER-SERVICE CARD



Noninductive Wirewound Resistors Measure 1/8 x 1/4 in.

Type 301-P precision, noninductive wirewound resistors measure 1/8 x 1/4 in. long, with axial or axial/radial leads. They are encapsulated to withstand humidity, mechanical shock and a temperature range of -65 to +125 C. Their temperature coefficient is $\pm 0.002\%$ per deg C; wattage rating is 0.1 w. The units come with resistance ratings of 10 ohms min to 100 K max.

Kelvin Electric Co., Dept. ED, 5907 Noble Ave., Van Nuys, Calif.

CIRCLE 69 ON READER-SERVICE CARD



Relay Magnetic Preamplifier Has Power Gains Above 100,000

This relay magnetic preamplifier, model 761, gives power gains of more than 100,000 in a single stage. It delivers 0.3 w from dc control signals of less than 3 μ w. It permits driving small power relays from thermistor bridges, photocells, null detectors, and similar low energy dc signals. The unit requires 0.6 w of 26 v, 60 cps supply power. It can be used in both industrial and military applications.

Acromag, Inc., Dept. ED, 22519 Telegraph Rd., Southfield (Detroit), Mich.

CIRCLE 70 ON READER-SERVICE CARD



Analog To Digital Converters Accommodate Any DC Input

Designed for both airborne and ground support data systems, the SBI-401 series of analog to digital converters uses self-balancing potentiometer circuitry. They can accommodate any dc signal input and can thus be used with pressure transducers, strain gages, accelerometers, thermocouples and any other transducer that represents a variable as a dc voltage. Standard units are normally supplied with brush type encoders, but they are also available with magnetic or optical encoding assemblies. They measure 7 x 3 in. in their basic configuration and provide a full scale sensitivity of 10 mv and a response time, also for full scale, of 2 sec. Shaft angle accuracy is $\pm 0.5\%$. They operate from 115 v, 400 cps power.

North Atlantic Industries, Inc., Instrumentation Div., Dept. ED, 603 Main St., Westbury, N. Y.

CIRCLE 71 ON READER-SERVICE CARD

*first in
Performance
Reliability
and Quality*

Kepeco

TRANSISTORIZED V.R.P.S.*

* VOLTAGE
REGULATED
POWER
SUPPLIES



Model SC-32-2.5



Model
SC-18-2M

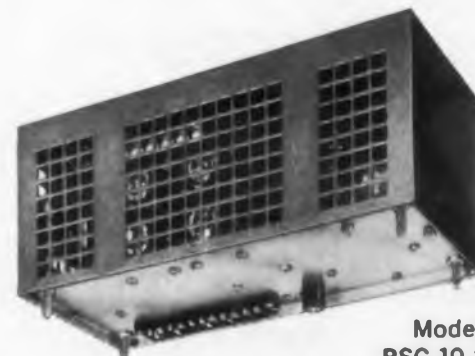
0.1% REGULATION
STABILITY

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.
SC-18-0.5	0-18	0-0.5
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

the most
complete
line of
POWER
SUPPLIES

Kepeco
offers more than
120 standard voltage
regulated power supplies
covering a wide range
of transistor, tube
and magnetic types.

For complete specifications,
write for Brochure B-591



Model
PSC-10-2

0.01% REGULATION
STABILITY

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.
SC-32-0.5	0-32	0-0.5
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-32-10	0-32	0-10
SC-32-15	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

0.02% REGULATION
STABILITY

COMPACT PACKAGE TYPE

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

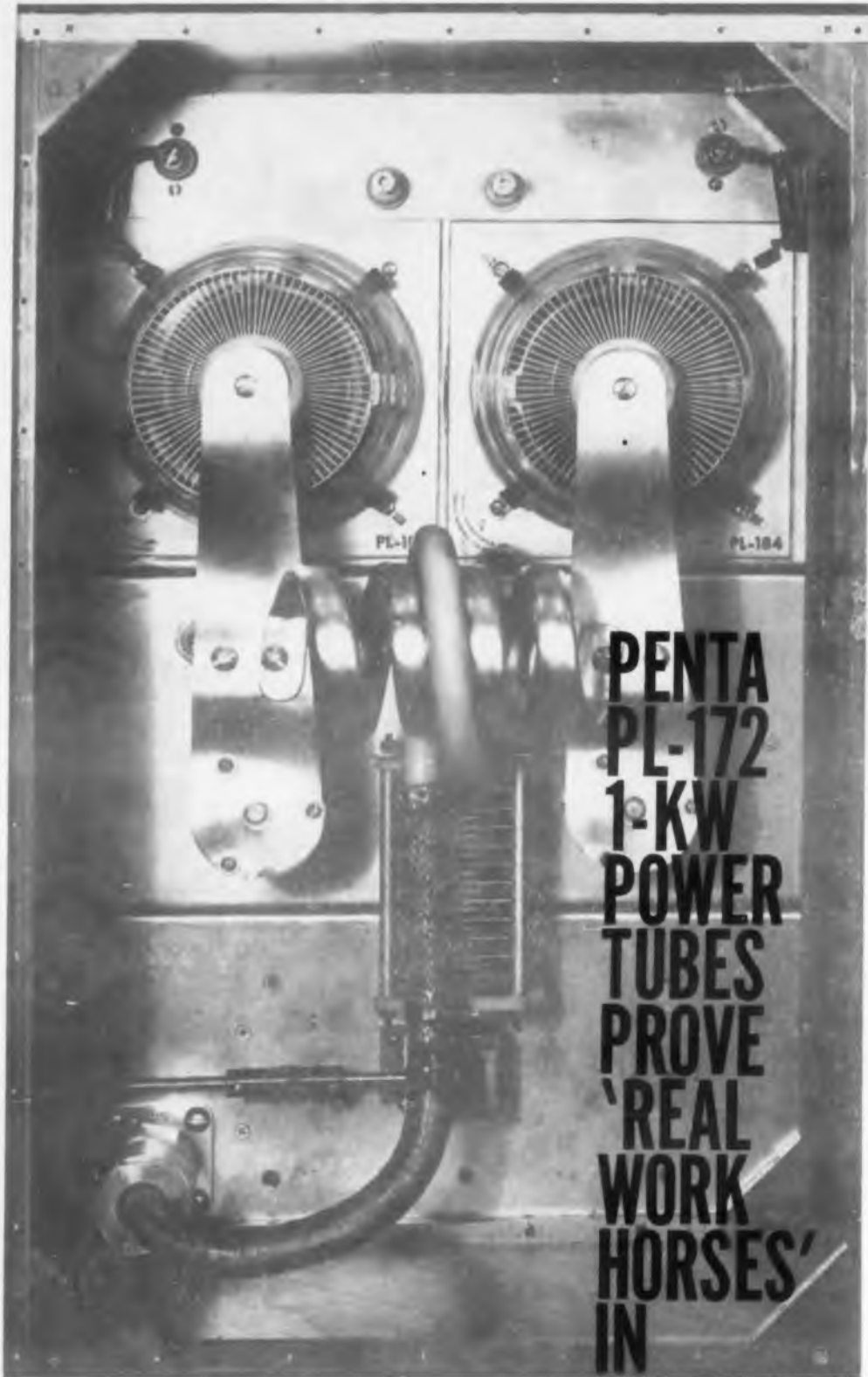


*first in
Performance
Reliability
and Quality*

Kepeco INC.

131-38 SANFORD AVENUE • FLUSHING 55, N.Y. • INDEPENDENCE 1-7000

CIRCLE 72 ON READER-SERVICE CARD



**PENTA
PL-172
1-KW
POWER
TUBES
PROVE
'REAL
WORK
HORSES'
IN**

HUGHES

**EXOTIC
METEOR
SCATTER
SYSTEM
TESTS**

"We really cut loose with the Penta PL-172's in our meteor scatter system testing, and do they hold up!" says project engineer John Chambers of Hughes Aircraft Communications Division. "We run our Pentas continuously eight hours a day, day after day, at their full 5-kw output. They're real work horses!"

Hughes communications engineers use the PL-172 beam pentodes in the power amplifier section of the exotic 49-mc scatter system transmitter, which utilizes ionized meteor trails in place of the ionosphere for reflection of electromagnetic waves.

Penta PL-172 1-kw power pentodes are available immediately off the shelf. Call or write now.

We'll be glad to send a data sheet on the PL-172, including full ratings, characteristic curves, and information on Class-AB₁ and Class-C operation.



PENTA LABORATORIES, INC.
312 N. Nopal St., Santa Barbara, Calif.

CIRCLE 73 ON READER-SERVICE CARD

NEW PRODUCTS

Insulation Testers

With audible signals



These insulation breakdown testers have audible signals which sound at preset leakage current values. The units have an ac test potential up to 6000 v. Series 4003 testers have visual as well as audible leakage indicators and have a standard adjustment range from 300 μ a to 300 ma; ranges extending to 10 ma are available on special order.

Associated Research Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

CIRCLE 74 ON READER-SERVICE CARD

Temperature Potentiometers

Error is $\pm 0.2\%$ of range



Having an error limit of $\pm 0.2\%$ of range span, these portable temperature potentiometers have 20 temperature ranges and four millivolt ranges which are all interchangeable. Both provide an output in millivolts equivalent to the temperature setting of the instrument for use in checking similar potentiometers, recorders, and controllers. The maximum external resistance is 50 ohms. Type 8692 single-range unit is calibrated for one type of thermocouple for temperature measurements or for millivolt measurements using one of the four ranges. Double range type 8693, shown here, can be supplied with one or different types of ranges for the same thermocouples. One range can measure temperature and the other, millivolts.

Leeds and Northrup Co., Dept. ED, 4932 Stenton Ave., Philadelphia, Pa.

CIRCLE 75 ON READER-SERVICE CARD

THE MARK OF QUALITY



quick solutions
to various
electronic
problems



Ultra-Sensitive Relays

Operating on input powers of 40 to more than 1,000 microwatts, the Barber-Colman Micropositioner polarized relay is ideal as a differential relay in electronic plate circuits, as a null detector in resistance bridge circuits, or as an amplifier in photoelectric circuits. Resonant relays also available from Barber-Colman



Reversible Small Motors

Shaded pole a-c type, up to 1/25 hp . . . adaptable to a variety of control circuits, including transistor and vacuum tube types. Ideal for use with servo mechanisms and other follow-up and positioning units. Available with or without gear-heads. A wide range of gear ratios for gear motors . . . open or enclosed



Small Motors with Blowers

In both a-c and d-c types with cooling fans or blowers for quick, dependable dissipation of heat from tubes, circuit components and other equipment mounted in confined enclosures.

BARBER-COLMAN COMPANY
Dept. W, 1283 Rock Street, Rockford, Illinois

CIRCLE 76 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

DC Power Supply

Total output is 5.8 kw

Able to furnish 17 different closely regulated and unregulated levels of power for all types of electrical data processing and computing machines, this transistorized power supply has a total output of 5.8 kw. A built-in transistor test circuit allows for quick detection of failure of any of the 200 power transistors without shutting down the supply. The complete unit weighs 1490 lb, measures 5 x 5 x 1-3/4 ft, and consists of 17 easily replaced plug-in components. It is made for military as well as commercial use.

Bogue Electric Mfg. Co., Dept. ED, 52 Iowa Ave., Patterson 3, N.J.

CIRCLE 77 ON READER-SERVICE CARD

Precision Is The Standard At Coors



Ceramic Wafers for Micro-Modules

Micro-Module Wafers

The hottest news in extreme miniaturization of electronic equipment is the micro-module—an amazingly small combination of sub-miniature electronic circuit components. The fundamental unit of a micro-module is the high alumina ceramic base plate—a tiny ceramic wafer, approximately 0.300" square x 0.010" thick. Upon this is deposited or metalized a component of a circuit—a resistor, capacitor, transistor, diode, etc. The micro-module is a combination of several of these elements in a small space to serve a specific circuit function—amplifier, oscillator, etc.

Coors is manufacturing these precision wafers in large quantity production runs for several manufacturers working on the same project. Coors holds all dimensions of the tiny ceramic wafer to extremely close tolerances so that the micro-elements produced from them are entirely interchangeable from manufacturer to manufacturer.

Broadband Rotating Joints

Cover the range of 2.6 to 40 kmc



These broadband rotating joints cover the range of 2.6 to 40 kmc with a minimum vswr. The joints can be pressure sealed to 30 psi. The design allows for continuous rotation in either direction with negligible rotational variation. Units are suitable for fast or slow operation through small angles or for continuous rotation. Mechanical stability is provided by means of double ball-bearing mountings; bearings are isolated from rf. Four configurations can be supplied. All combinations of 90 deg and colinear arms are available, both on the fixed and movable side.

DeMornay-Bonardi, Dept. ED, 780 S. Arroyo Parkway, Pasadena, Calif.

CIRCLE 78 ON READER-SERVICE CARD

CIRCLE 79 ON READER-SERVICE CARD



Miniature Tube Envelopes

Tube Envelopes

Coors makes high strength ceramic envelopes to extremely close dimensional tolerances and in a wide range of sizes for use in modern electron tubes. Certain of the Coors ceramic compositions were developed specifically to meet the rigorous operating conditions and reliability requirements to which high power, high frequency tubes are subjected.

Illustrated here is one of the miniature ceramic envelopes in regular production. Coors regularly produces many other sizes up to 10" O.D. Larger sizes can be manufactured.

Coors ceramics have outstanding electrical and physical characteristics. These properties are not affected by high outgassing or high operating temperatures.

LOWER COSTS for Precision Ceramic Parts Through Quantity Production—Coors has been able to make substantial reductions in manufacturing costs by stepping up production of high precision parts through automation.

All this adds up to these advantages for you: 1. Faster delivery on large quantity orders. 2. Precision parts—uniform and interchangeable, permitting you to use them on a production basis. 3. Prices that are correspondingly low.

For further information about Coors Space Age Ceramics and for a complete description of physical properties, write for Bulletin 858.



Ceramic-to-Metal Standard Terminal Insulators

Standard Terminal Insulators

Coors furnishes standard terminal insulators—available from stock—in various ratings and, also, can manufacture custom made insulators to meet your specific requirements. In the range of standard sizes, metal parts are bonded to the ceramic by Coors High Temperature Metalizing Techniques, thus producing strong hermetic ceramic-to-metal seals. The result is standard terminal insulators available for a wide range of requirements—insulators that have superior electrical and mechanical characteristics. Production is on a large quantity basis—you do not pay a premium for high quality, precision terminals.

Coors

COORS PORCELAIN
COMPANY

600 Ninth Street, Golden, Colorado

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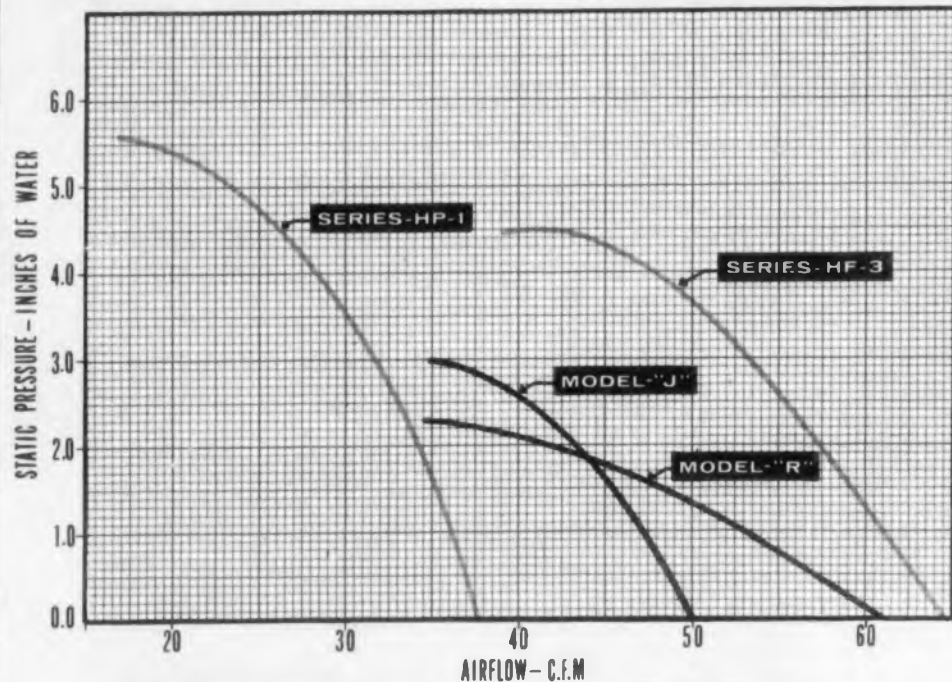
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PANY
Illinois
ARD
1959

NEW STANDARD 2" BLOWER POWAIR



Introduces New HP and HF Series

OUTPERFORMS ALL OTHERS

Available with 28 volt DC - 400 Cycle Single Phase or 3 Phase power. The D & B Powair Series offers a pressure, flow, size combination never before obtained. A completely new design approach can be taken to your electronic cooling problems, resulting in weight and size reductions. For additional information on performance and other models write us today.

CONSTRUCTION VERSATILITY
FOR —

- Square or round flange.
- Optional flange location over entire length of housing.
- AC or DC motors.
- Speeds from 8,000 to 22,000 RPM.



DEAN & BENSON
RESEARCH

Division of Benson Manufacturing Co., Kansas City 1, Mo.

Consult our Sales Engineering Staff for full information.

CIRCLE 80 ON READER-SERVICE CARD

NEW PRODUCTS

Variable Attenuator

Adjustable range is 0 to 40 db



Having an adjustable range of 0 to 40 db, model RDA-5811 variable attenuator is furnished in a waveguide measuring 2 x 1 in. Attenuation is accurate to 0.3 db at 4.8 kmc calibration frequency. The unit incorporates an anti-backlash gear train for holding original calibration over long periods of time. The insertion loss is 0.5 db and the maximum vswr is 1.15. All moving parts are housed in a sealed casting.

Radar Design Corp., Dept. ED, Picard Dr., Syracuse 11, N.Y.

CIRCLE 81 ON READER-SERVICE CARD

Transformer

Handles 235 w



Series 882 Thin-Tran transformer handles 235 w, mounts in an area measuring 1-29/64 x 2-29/64 x 3 in., and operates over the ambient temperature range of -55 to +100 C. Primary voltage on the standard unit is 115 v 400 cps; secondary voltages are available from 5 to 2000 cps. The terminals are arranged in rows of five pins: one for primary, three for secondaries, and one for use as a center tap on secondary windings. Regulation is 5% max, no load to full load. The unit weighs 1.44 lb and provides a power-to-weight ratio of 155 w per lb. Life expectancy is 10,000 hr. Fully encapsulated and hermetically sealed in a steel container, the transformer meets MIL-E-5272B and MIL-T-27A, class S.

Arnold Magnetics Corp., Dept. ED, 4613 W. Jefferson Blvd., Los Angeles, Calif.

CIRCLE 82 ON READER-SERVICE CARD

HERE'S A MANUAL FOR
QUALIFIED PERSONS

INTERESTED IN
**Reliable
Printed
Circuits...**



Where performance is critical and failure unforgivable, there is only one way to make printed circuits. It is with quality control in depth, as developed by the Bureau Of

Engraving, Inc., and as described in our new U.S. Air Force Approved QUALITY CONTROL MANUAL FOR PRINTED CIRCUIT BOARDS AND BOARD ASSEMBLIES.

For instance, it is not enough that every circuit be gaged to a very close tolerance. Consideration must also be given to the fact that the gage itself wears in use. Under GAGE CONTROL our manual states, "The Gage Control procedure insures that all gages, measuring and test equipment being used are within the tolerances required to maintain manufacturing specifications . . . gage is to be inspected according to the wear policy and frequency as specified on the gage control card."

Procedures, functions, definitions and maintenance of materials specifications are discussed in detail. Our QUALITY CONTROL MANUAL meets MIL-STD-105A and MIL-Q-5923C standards.

If you are a qualified person (engaged in the development or manufacture of products requiring printed circuits), write for our manual on your company letterhead. Copies will be sent out free as long as our limited supply lasts.

WRITE TO:

Member of the
Institute of Printed Circuits
BUREAU OF ENGRAVING, Inc.
Industrial Division
502 S. 4th St., Minneapolis 15, Minn.
Telephone FEderal 9-8721

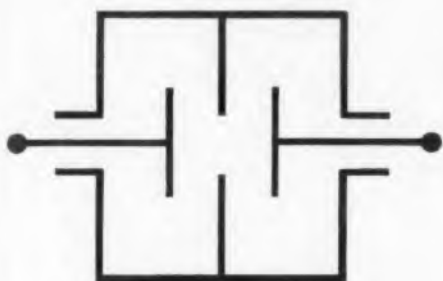
CIRCLE 83 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

MATCH WITS

with the

CRANKY CAPACITOR!



As soon as you're through the door at the NEREM show, grab a sharp pencil and head for Booth 928. You can win yourself a Wayne Kerr B-521 Component Bridge (3-terminal), and a reputation as the sharpest electronic wizard in the place.

All you have to do is estimate the magnitude of a 3-terminal capacitor set up in the Wayne Kerr booth. As per the schematic above, the device is made up of two circular discs, separated by a rectangular metal neutral plate. A circular hole is cut out of the center of the plate.

Capacitance is determined entirely by the aperture. Magnitude is established by the area of the opening and the spacing between the two active discs. In short, you'll be working with a direct application of the 3-terminal capacitor principle.

The challenge is to see how close you can come to the actual magnitude, as measured by the Wayne Kerr B-221 Universal Bridge (3-terminal, accurate to 0.1%).

NEREM show opens Tuesday, November 17 at 1 P.M. and closes the 19th at 6 P.M. Be there, at the Commonwealth Armory in Boston, Booth 928, and may the best man win. We hope it's you.

OTHER INSTRUMENTS: Audio to VHF Bridges; Oscillators; Attenuators; Microwave Equipment; Vibration and Distance Meters; Waveform Analyzer.

Send for complete W-K-02 catalog showing other instruments.

WAYNE KERR CORPORATION

1633 Race St., Philadelphia 3, Pa.

Electronics for Measurement and Control!

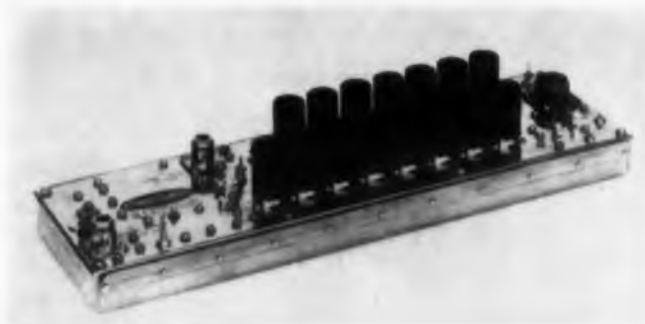
Sales, Stock and Service Facilities

CIRCLE 84 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

Amplifiers

For broadband use



Available in three standard models, these broadband amplifiers operate at impedance levels which permit convenient cascading of several amplifiers with standard 93-ohm interconnecting cables. Model 2220 has a voltage gain of 20 db; model 2230, shown here, has a 1-w power output. Both have a band pass of 100 kc to 300 mc with a 93-ohm input and output impedance. Model 2210 has a noise figure of 6 db over the same bandwidth. They can be furnished as separate units or rack mounted with integral power supplies. Modifications of the standard models can be supplied to cover different bandpass and gain requirements. Distributed and wideband amplifiers to meet Mil specs are also available.

RS Electronics Corp., Dept. ED, P. O. Box 368, Station A, Palo Alto, Calif.

CIRCLE 85 ON READER-SERVICE CARD

DC Null Detector

Input impedance is 40,000 ohms



For use with guarded and unguarded potentiometers and bridges in production testing and laboratory applications, type 9834 dc null detector has an input impedance of 40,000 ohms and will provide high sensitivities with source resistances up to 100,000 ohms. It has four degrees of sensitivity over the range of 1000 to 1 and has a noise level of less than ± 0.1 mv. It is housed in a metal case with vinyl finish and carrying handle. Panel mounting models are also available.

Leeds and Northrup Co., Dept. ED, 4934 Stenton Ave., Philadelphia, Pa.

CIRCLE 86 ON READER-SERVICE CARD

Not a worry in the world...



THIS IS ONE
SNAP-IN CONTACT THAT
WON'T PULL OUT!

...the Deutsch snap-in contact, of course—guaranteed to withstand 25 pounds pull. In Deutsch DS miniature connectors, each pin and socket is locked in place by an exclusive, patented spring mechanism.

WHAT'S MORE...Deutsch-designed tools whip the problem of fast, reliable crimping (hand or automatic)—insertion and removal.



And...just glance at these specs:

- Deutsch-designed crimp, stronger than the wire itself (AN #18 wire and smaller)
- 7 shell sizes, with alternate clocking and insert arrangements
- exclusive Deutsch ball-lock coupling
- superior interfacial seal
- silicone inserts; no shrinkage, bonding or reversion
- temperature range -67° to in excess of 300° F
- seal before electrical contact
- interchangeable with existing Deutsch DM (MS) miniatures and hermetics
- meet all applicable requirements of MIL-C-26482

So why worry? For details on completely reliable snap-in type connectors, contact your local Deutsch representative or write for data file C-11.



© THE DEUTSCH COMPANY



The Deutsch Company
ELECTRONIC COMPONENTS DIVISION
Municipal Airport • Banning, California

CIRCLE 87 ON READER-SERVICE CARD

Call FANSTEEL for High Temperature Metals

**TUNGSTEN
MOLYBDENUM
TANTALUM
COLUMBIUM**

FANSTEEL 82 METAL
(Columbium-Tantalum-Zirconium)

FANSTEEL 80 METAL
(Columbium-Zirconium)

FANSTEEL 99 METAL
(Tungsten-Nickel)

FANSTEEL TANTALOY
(Tantalum-Tungsten)



Need a high temperature metal in ingots, billets, sheet, rod, wire or foil? Call Fansteel. Want parts fabricated to your specifications? Call in Fansteel. Get the experience of men who know how to make the metal as well as machine and fabricate it.

IMMEDIATE DELIVERY
From Stock of Tantalum and Molybdenum Sheet

Five most used sizes of tantalum sheet—.002", .003", .005", .007", .010".

Seven sizes of ductile Moly "D" sheet—.005", .007", .010", .012", .015", .020", .025".

FANSTEEL

Fansteel Metallurgical Corporation
North Chicago, Illinois,
U.S.A.

CIRCLE 88 ON READER-SERVICE CARD

NEW PRODUCTS

Transducers

Linear and rotary motion



These linear and rotary motion transducers, called Transipot, have ac input and ac or dc output. Rated for operation to 125 C, they can be used for telemetry, indication, data reduction, and as transmitters or receivers for detecting any combination of linear or rotary motion as part of a feedback control system. The specifications for a typical unit, the size 15 linear motion ac-ac transducer, include: input range, 20, 50,

or 100 mils; sensitivity, 1 v rms per mil; input linearity, 0.5%; and frequency range, 300 to 3000 cps. All units are brushless and use modular construction with a standard servo-mounting.

Arnoux Corp., Dept. ED, 11924 W. Washington Blvd., Los Angeles 66, Calif.

CIRCLE 89 ON READER-SERVICE CARD

Turn Indicating Dials

For use with potentiometers

These ten-turn indicating dials provide readings of potentiometer full turns. The turn number stays in view while the dial registers partial turns in increments of 1/100. No gearing mechanisms are used and no disassembly or panel holes are required for mounting. Model 10 is a 1-in. unit and model 20 is 1-13/16 in. to fit 0.25 in. diam shafts. For 0.125-in. shafts, an adapter bushing can be supplied.

Spectrol Electronics Corp., Dept. ED, 1704 S. Del Mar Ave., San Gabriel, Calif.

CIRCLE 90 ON READER-SERVICE CARD

DIRECT USE—without auxiliary amplification

DIRECT WRITING—without servos or linkage drives



You get them both with the new **ESTERLINE-ANGUS**

RECORDING D.C. MICROAMMETER

Here's the recording instrument of a thousand-and-one uses in every field of research and production.

Ranges: 0 to 50 microamperes with approximately 200 ohms input resistance. Also 0-10/50/200 millivolts D.C.

Power Supply: 120 volts, 60 cycles.

Response: 1 second, independent of external circuit resistance.

It's ruggedly built for continuously reliable results in rough use. It's quickly and easily set up. Send for Catalog Section No. 41.

The Esterline-Angus Company

No. 1 in fine Graphic Instruments for more than 50 years.

DEPT. K, P. O. BOX 596, INDIANAPOLIS 6, INDIANA

CIRCLE 91 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

Volt Potentiometer

Ranges are 0 to 1.601 v and
0 to 0.1601 v



Type 8687 portable volt potentiometer has two operating ranges: 0 to 1.601 v and 0 to 0.1601 v. The instrument has limits of error of $\pm 0.05\% \pm 30 \mu\text{v}$ for the high range and $\pm 0.05\% \pm 3 \mu\text{v}$ for the low range. Typical laboratory applications of this compact, three-dial potentiometer include measurements of temperature, contact potentials, plus calibration of dc ammeters, voltmeters, and other instruments. In industrial use, it can calibrate thermal converters, and

strain gages. It is housed in a metal case with a removable lid.

Leeds and Northrup Co., Dept. ED, 4934 Stenton Ave., Philadelphia, Pa.

CIRCLE 92 ON READER-SERVICE CARD

Tape Reader Set

Is 5-7/8 x 7-1/2 x 9-1/2 in.

Including transmitter-distributor, motor, base, and cover, model 28 LXD punched-tape reader set measures 5-7/8 x 7-1/2 x 9-1/2 in. It provides for sequential output and 100 words per min transmission. Optional contacts are available for multi-wire output. Models are furnished to read five or six-level chadless or fully perforated tape. Applications include on-line data transmission over existing communications facilities and off-line control of tape-operated machines.

Teletype Corp., Dept. ED, 4100 Fullerton Ave., Chicago 39, Ill.

CIRCLE 93 ON READER-SERVICE CARD

MEASURE DELAY ACCURATELY

without
JITTER
WITH TLI's NEW
**PULSE
TIMER**



MODEL PT244 \$1895⁰⁰

WHAT IT IS —

... a paired trigger generator with fixed and delayed pulses. Combination of counters and digital dial provides direct reading delay to 9,999.99 microseconds accurate to better than 0.01 microsecond. Note that this instrument is a full size module of the TLI Modular Instrumentation System.

Incorporates design of Hazel-tine Electronics Corp. Model 1754 Precision Time Measuring Equipment.

HOW IT WORKS —

Delay controls position gates which select desired pulse from 100kc crystal controlled pulse chain to avoid jitter inherent in delay circuits. Phantastron circuit provides vernier control between 10 microsecond pulses. Jitter less than 0.001 microsecond.

Full specifications and application information available on request in Bulletin ED-82



TELETRONICS LABORATORY, INC.

54 KINKLE STREET
WESTBURY, L. I., N. Y.

CIRCLE 94 ON READER-SERVICE CARD



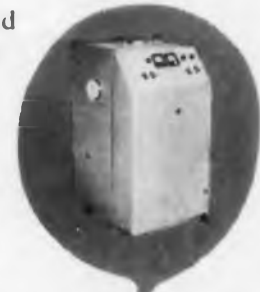
TROUBLED WITH LEAKS?

Aeronauts know, and so do scientists, engineers and designers... leaks are hazardous. You'll find sure-stop solutions to leakage problems in CEC's complete line of helium/mass spectrometer leak detectors... capable of locating and measuring leaks that pass

only 1 atm cc of air in 66 years!

Use them to calibrate leaks of 10^{-10} magnitude... for quality control and MIL spec checking

of both evacuated and pressurized components. For rapid response, increased sensitivity, and long trouble-free life, depend on the mobile Type 24-110A, above, or the portable Type 24-210A, shown with its mobile workstand. For complete information on these sensitive, trouble-free instruments, call your nearest CEC sales and service office or write for Bulletins CEC 1838-X22 and CEC 1830-X44.



Analytical & Control Instrument Division

CEC

CONSOLIDATED ELECTRODYNAMICS / 360 sierra madre villa, pasadena, california



CIRCLE 95 ON READER-SERVICE CARD

Webster was right! Rectify means make right

that's just what built-in rectification does for PIC Counters—makes alternating current right for efficient, reliable operation over a tremendous count life.



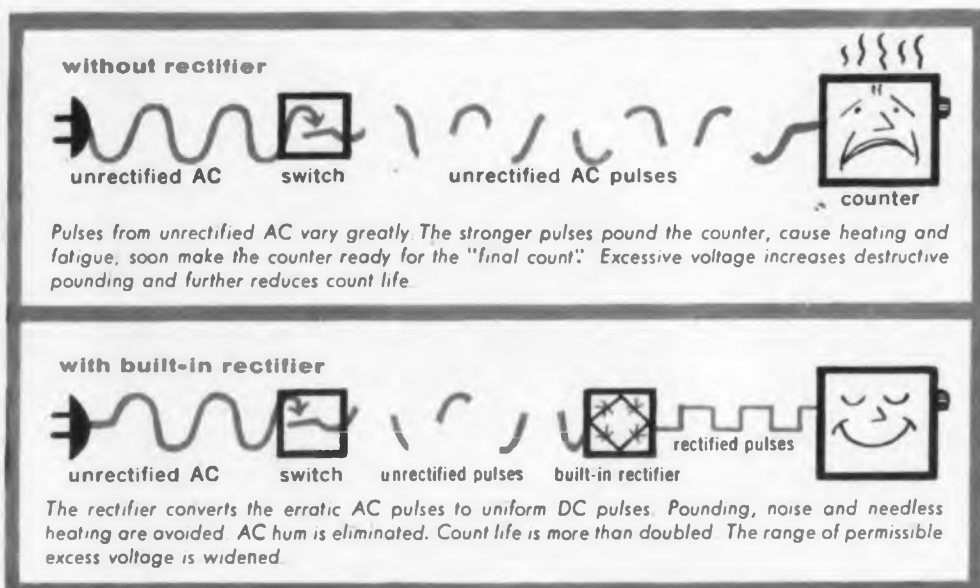
PIC-600 Electric Counter
50 million count life



CE-800 Electric Counter
200 million count life

When operating PIC-600 or CE-800 Counters from AC you get the long recognized advantages of DC operation *without adding any circuitry or components.*

You can hear the difference. Ask your PIC Distributor or Representative for a demonstration or write us.



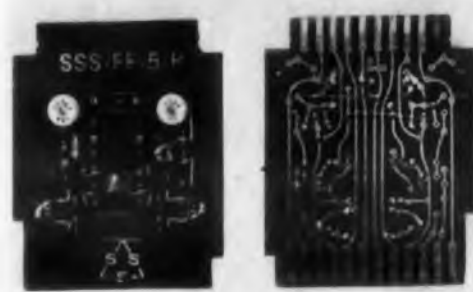
PIC
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Manufacturers of Counters, Switches, Relays, Actuators and Automatic Valves
AUTOMATION CONTROLS DIVISION
GENERAL CONTROLS CO.
8078D McCormick Boulevard, Skokie, Illinois

Representatives and Distributors in Principal Cities of United States and Canada
CIRCLE 96 ON READER-SERVICE CARD

NEW PRODUCTS

Control and Logic Modules Plug-in design



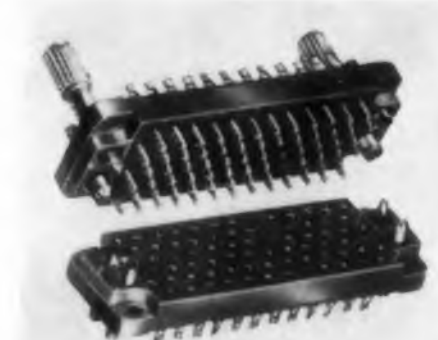
These transistorized, plug-in control and logic modules can be checked in place, without disturbing the normal operation of the circuit. Included in this line of compatible modules are flip-flops, gates, triggers, diode AND and OR logic units, power switching amplifiers, and devices for implementation of static control or computer systems accepting pulse repetition to 100,000 pulses per sec. The modules are 2-1/4 x 2-29/32 x 1/16 in. and fit 2 standard 12-terminal printed circuit connectors. All printed circuit conductors are hard gold alloy plated.

Solid State Systems, Inc., Dept. ED, 5716 Camille Ave., Culver City, Calif.

CIRCLE 97 ON READER-SERVICE CARD

Connectors

Have 20 and 75 contacts

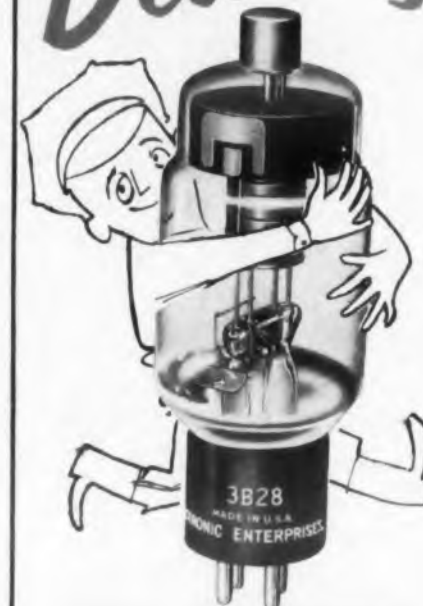


For aircraft and instrumentation applications these 29 and 75-contact units have reversed guides or polarizing screwlocks. They have a current rating of 5 amp. Voltage breakdown at sea level is 1900 v rms and at 60,000 ft, 700 v rms. The minimum creepage path between contacts is 5/64 in. and the minimum air space between contacts is 3/64 in. Contacts measure 1/8 in. center-to-center, the pin diameter is 0.04 in., and the solder cup fits a No. 20 awg wire.

DeJur-Amsco Corp., Dept., ED, 45-01 Northern Blvd., Long Island City 1, N.Y.

CIRCLE 98 ON READER-SERVICE CARD

Fast Delivery



ON MIL-TYPE TUBES!

You call, we quote, you verify—that's all it takes to get prompt delivery from Electronic Enterprises' vast selection of gas or mercury vapor rectifiers, vacuum rectifiers, grid controlled rectifiers, triodes, and hydrogen thyratrons. MIL-type tubes manufactured to military specifications include 576-A, 3B28, 371-B, 836, 811-A, 274-A, 274-B, 323-B, 3C23, FG-17, 394-A, 4B32. And every top quality E.E. tube is priced for extra economy. Short runs also available on virtually every tube type. Write or call your nearest E.E. rep, listed below, for prices and specs:

Richard L. Gysan Co.
12 Foster St., Wenham, Mass.
Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut.

Kittleson Co.
416 LaBrea Ave., Los Angeles 36, Calif.
California, Arizona, Nevada, New Mexico, and El Paso County, Texas

Blair Sales Co., Inc.
45 S. Broadway, Yonkers, New York
Metropolitan New York Area

Harry J. White Co., Inc.
121 Covered Bridge Rd., Barclay Farm
Haddonfield, New Jersey
Pennsylvania, Williamsport East, New Jersey,
Trenton South, Delaware, Maryland, Virginia,
West Virginia, North Carolina

DC
**ELECTRONIC
ENTERPRISES, INC.**

63 Seventh Avenue - Newark 4, New Jersey

CIRCLE 99 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

Wirewound Resistors

Temperature coefficient is ± 20 ppm



Available in five styles, these miniature wirewound resistors have a standard temperature coefficient of ± 20 ppm. They can be as small as 0.08 in. in diam and 0.375 in. long. The wattage rating starts at 0.05 w to 0.25 w at 125 C and is derated to zero at 150 C with accuracies to 0.025%. Designed to meet MIL-R-93B and MIL-R-9444, they can have axial wire terminals or dual wire terminals for printed circuit use. The units are encapsulated in epoxy.

Cinema Engineering Div., Dept. ED, 1100 Chestnut St., Burbank, Calif.

CIRCLE 108 ON READER-SERVICE CARD

Computer Diode

Recovery time is 4 μ sec max

These silicon mesa computer diodes have a maximum recovery time of 4 μ sec when switched from a forward bias with 10 ma current to a reverse bias of -5 v. Types 1N903, 1N904, and 1N905 have peak reverse voltage ratings at 25 C and 1 μ a or at 100 c and 10 μ a of 20, 30, and 40 v, respectively. The capacitance for all three types is 1 μ f and the forward voltage drop at 25 C and 10 ma is 1.1 v for type 1N903 and 1 v for 1N904 and 1N905. Also available, types 1N906, 1N907, and 1N908 have peak reverse voltages of 20, 30, and 40 v, respectively, a capacitance of 2.5 μ f, and a forward voltage drop of 1 v.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 109 ON READER-SERVICE CARD

CIRCLE 110 ON READER-SERVICE CARD



NOW
AVAILABLE IN
TRANSITRON'S
NEW
PACKAGE

SILICON CONTROLLED RECTIFIER

handling
10KW power

Transitron's Silicon Controlled Rectifier is a PNP high power bistable controlled switching device. It is analogous to a thyatron or ignitron, with far smaller triggering requirements and microsecond switching. The low forward voltage drop permits high current ratings and provides high efficiency with low cooling requirements. The PNP design permits higher voltage ratings and lower saturation resistance than power transistors. This permits the smallest packaging for high power control yet made possible.

Ratings currently available extend to 10 amperes at 100°C case temperature and up to 400 volts forward and inverse ratings. Operation at 125°C is now permissible with derating. Full ratings are possible at 35°C ambient with a 5" square heat sink. The peak control power is typically 1/200,000 of the output power!

Transitron's Silicon Controlled Rectifier has been designed into a new package for more rugged, convenient, and practical application. The 11/16" hex base and the general outline coincide with EIA standards for the 20-ampere rectifier.

TYPE	MINIMUM PEAK REVERSE VOLTAGE (Volts)	MINIMUM FORWARD BREAKDOWN VOLTAGE (Volts)	MAXIMUM AVERAGE FORWARD CURRENT (amps)	
			at T case = 100°C	at T case = 25°C
TCR 102	100	100	10	20
TCR 202	200	200	10	20
TCR 302	300	300	10	20
TCR 402	400	400	10	20

Maximum Storage Temperature Range — 65°C to +150°C
Maximum Operating Temperature Range — 65°C to +125°C
Send for Bulletin TE 1356

OTHER
TRANSITRON
SILICON
PRODUCTS
FOR
HIGH POWER
USE



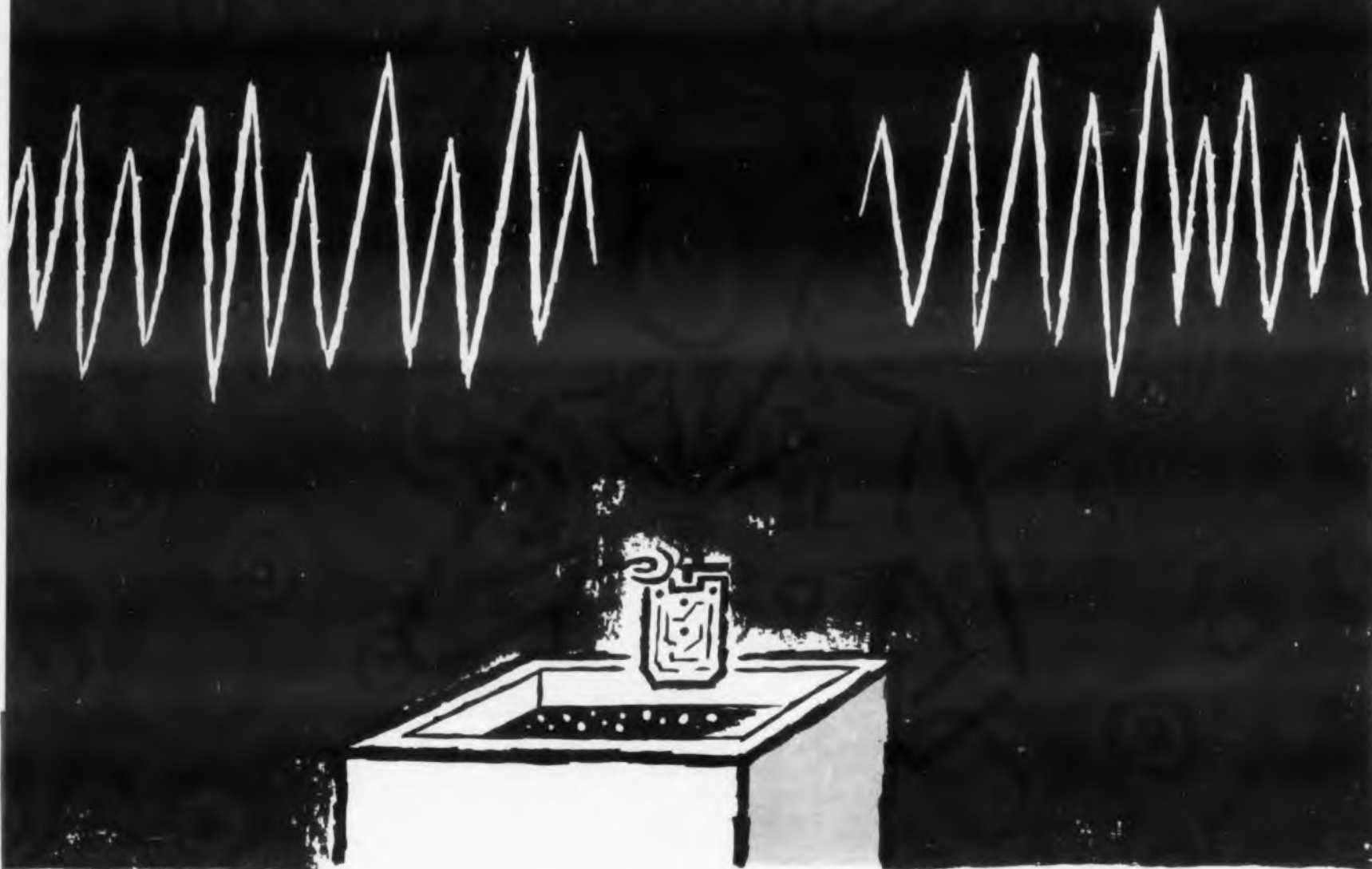
85 WATT
POWER
TRANSISTORS



Transitron

electronic corporation
wakefield, massachusetts

CLEAN ELECTRONIC PARTS CLEANER ULTRASONICALLY!



Save labor, save time—blast away dirt and dust by the remarkable ultrasonic method that Acoustica has developed to a fine point of efficiency. The hard-to-get-at parts in the most intricate electronic instruments are cleaned as easily as the most exposed parts. The powerful "cavitation" action of an Acoustica ultrasonic tank radiates to the innermost places, removes the most stubborn dirt or dust. Transistors, potentiometers, vacuum tubes, and scores of other products are thoroughly cleaned and decontaminated this modern, efficient way. Many leaders in the electronic industry have changed to Acoustica ultrasonic cleaning!

Acoustica is the recognized leader in quality ultrasonic cleaning equipment, the sole producer of the *Multipower* transducer. An Acoustica *certified* ultrasonic application is your assurance of maximum cleaning efficiency!

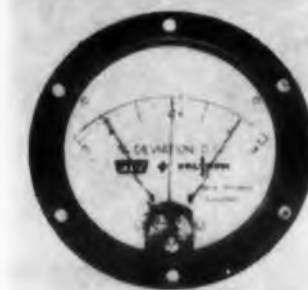
Acoustica Associates, Inc., Fairchild Court, Plainview, N. Y., 10402 Aviation Blvd., Los Angeles, Calif.


acoustica
THE GREATEST NAME IN ULTRASONICS

NEW PRODUCTS

Meter Relay

Accuracy is $\pm 0.15\%$ deviation



Designed to monitor per-cent deviation of voltages within predetermined limits over the range of 5 to 500 v, this meter relay has an accuracy of $\pm 0.15\%$ deviation at room temperature. Center scale voltage values may be programmed by switching external resistors. Contact closure will occur when the per-cent deviation of the programmed voltage exceeds the predetermined limits set on the movable contacts. Both ac and dc versions are available. Military units offer $\pm 0.3\%$ deviation accuracy from -55 to $+71$ C and meet vibration, shock, and humidity requirements of MIL-M-10304A. The ac meter relays maintain accuracy over the frequency range of 50 to 2000 cps. The relay contacts will give up to 10,000,000 make and break cycles without failure, and may be used to control corrective devices.

Voltron Products, Dept. ED,
1010 Mission St., S. Pasadena,
Calif.

CIRCLE 111 ON READER-SERVICE CARD

Ultrasonic Cleaners

Efficiency is 90%

These ultrasonic cleaners have an efficiency rating of 90%. Cleaning power is increased by means of the transducer which consists of piezoelectric ceramic material compressed between two solid metal sections. Model DR 252 generator with the T3 tank provides an average output power of 250 w and a tank capacity of 3 gal, model DR 520 generator with the T5 tank provides an average output power of 500 w and a tank capacity of 5

← CIRCLE 112 ON READER-SERVICE CARD

gal, and model DR 1020 generator with the T10 tank provides 1000 w and a tank capacity of 10 gal. All models operate at 20 kc. They are used to clean gyros, differentials, relays, semiconductors, vacuum tube components, printed circuit boards, and other products.

Acoustica Associates, Inc., Dept. ED, Fairchild Court, Plainview, L.I., N.Y.

CIRCLE 113 ON READER-SERVICE CARD

Toroid Inductors

Inductances are 0.01 mh to 4 h



Series M50 toroid inductors provide a high Q from 1 kc to 2 mc with inductances from 0.01 mh to 4 h. They have printed circuit mountings and measure 43/64 in. OD and 13/32 in. high. The units are housed in metal cases.

Torotel, Inc., Dept. ED, 5512 E. 110th St., Kansas City, Mo.

CIRCLE 114 ON READER-SERVICE CARD

Drive Unit

Dual Speed

Type DSD-2 dual speed drive unit is a gear reducer for positioning and indicating with an accuracy of 6 min of arc or better. It has an inner dial for coarse positioning, an outer dial for fine positioning, plus in-line input and output shafts. Having no backlash, units are available with ratios to 72:1. A vernier is available for the ratios 20:1 and 36:1. A modified version, type DSD-3, has an accuracy of 12 min of arc. The units pass Air Force requirements of MIL-E-4970, a high temperature test at +200 F, a low temperature test at -80 F, and shock tests at 100 g.

Acton Labs, Inc., Dept. ED, 533 Main St., Acton, Mass.

CIRCLE 115 ON READER-SERVICE CARD

CIRCLE 116 ON READER-SERVICE CARD ➤

THE 3/4" POT THAT FITS A 3/4" SLOT

DAYSTROM'S NEW MULTIPOT® ELIMINATES

PROTRUDING SIDE TERMINALS →



PROVIDES 25% BETTER PACKAGING DENSITY

For general test equipment and computer applications, there's no beating the low cost and easy access of Daystrom's miniature Series 450 MULTIPOT®. The rear-mounted terminals of this 20-turn potentiometer cut assembly time, reduce space requirements... and you pay no premium for miniaturization.

The Series 450 offers standard resistance from 100 to 250K... fits a 2 1/2 watt power rating... operates from -55°C to +100°C.

For complete specifications, write for Data Sheet ED-450-1.

Operating 21st for Quality Equipment

DAYSTROM PACIFIC
a division of DAYSTROM, INC.

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potentiometers • gyro instruments • airborne systems

Only NJE... at NO EXTRA COST

... offers 20
SAFETY Features
on High Voltage
Power Supplies

Only NJE offers the BASIC 20—safety and performance features—as standard equipment on Heavy Duty, Industrial High Voltage Power Supplies. There are 34 standard catalog units available on short delivery time and at economical cost. NJE guarantees quality construction, reliable performance and significant component derating.

Check the specs on just 2 of the 34 available.

Model	DC Voltage	Current	Ripple	Price	Size
H-60	0 to 50,000	5 MA	2% RMS	\$1300.	Control: 22" x 22" x 18" *Tank: 27" x 22" x 22"
H-80	0 to 120,000	5 MA	2% RMS	\$1850.	Control: 22" x 22" x 18" *Tank: 27" x 22" x 22"

*Oil not included



Write for full details in our complete catalog.

NJE

CORPORATION

20 Boright Avenue • Kenilworth, New Jersey

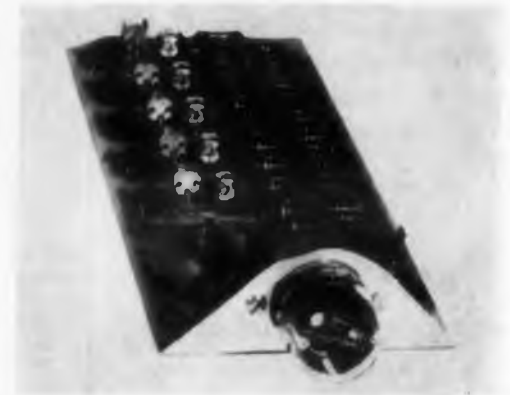
BR. 2-6000 • TWX Cranford, NJ 51 • FAX-FFP

CIRCLE 117 ON READER-SERVICE CARD

NEW PRODUCTS

Binary-to-Decimal Converter

For use with computers



Model 260 binary-to-decimal converter is for use with computers which require decimal display readout for any number of four-bit code inputs. Solid state techniques are used for conversion and memory functions. The converter activates a cold-cathode decimal display equal to a Nixie tube. The unit is available as a single plug-in module complete with illuminated display or as an assembly of a number of modules for rack mounting.

Hermes Electronics Co., Dept. ED, 75 Cambridge Parkway, Cambridge 42, Mass.

CIRCLE 118 ON READER-SERVICE CARD

Ultrasonic Cleaner

Tank is 9-1/4 x 5 x 6 in.



Model 100 ultrasonic cleaner has a tank measuring 9-1/4 x 5 x 6 in. with 25% of the tank bottom covered with driving elements. The radiating surface measures 12 sq. in. Made of heavy-gage stainless steel, the tank has rounded corners. A 115-v ac, 60-cps, single-phase generator, designed for continuous operation, delivers an average output of 60 w and a peak output of 240 w. The unit includes a one-tube oscillator, front panel switching which permits a choice of two transducers, and three-wire ground protection.

National Ultrasonic Corp., Dept. ED, 111 Montgomery Ave., Irvington, N.J.

CIRCLE 119 ON READER-SERVICE CARD

Tee Circulator

Insertion loss is 0.4 db



Model CX400 three-port tee circulator has 15 db isolation and 0.4 db insertion loss over the frequency range of 9.1 to 9.9 kmc. In the band center the insertion loss is about 0.1 db. The unit is rated at 1 kw peak and 100 w avg. The temperature range is -55 to $+71$ C. The circulator is 3.1 in. long, weighs 3/4 lb, and is useful for maser and parametric amplifier applications.

Rantec Corp., Dept. ED, Calabasas, Calif.

CIRCLE 120 ON READER-SERVICE CARD

Complex Ratio Bridge

For in-phase and quadrature voltage ratios



This complex ratio bridge measures both in-phase and quadrature voltage ratios. The unit is used to test three- and four-terminal networks such as transformers, synchros, resolvers, gyros, and transducers. The instrument cancels quadrature effects and the bridge has an in-phase accuracy of 0.001%. Quadrature voltage ratios are read as rectangular coordinates, tangent of phase-shift angle, or magnitude of phase-shift angle, directly in degrees. A self-contained phase-sensitive detector provides good sensitivity with 2-v reference. Harmonics and noise are rejected by a band-pass filter. The magnitude of the transformation ratios of $R + jX$ voltages are readable to six places. The bridge is available with a frequency range of 30 to 1000 cps or 50 to 3000 cps and in rack-mounting or cabinet models.

Gertsch Products, Inc., Dept. ED, 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

CIRCLE 121 ON READER-SERVICE CARD

Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines • Shift registers •

ESC EXTRA

Pulse transformers • Medium and low-power transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

ESC DEVELOPS DELAY LINE WITH 170 to 1 DELAY TIME/ RISE TIME RATIO

**Model 61-34 Perfected
For Specialized
Communications Application**

PALISADES PARK, N. J.—An entirely new Lumped-Constant Delay Line, with a proven 170 to 1 delay time/rise time ratio, has been announced by the ESC Corporation, Palisades Park, N. J. The new delay line, known as Model 61-34, was specifically designed for a specialized communications application calling for the exceptionally high delay time/rise time ratio.

ESC, the world's leading manufacturer of custom built and stock delay lines, is already widely recognized in the electronics industry for its exceptional engineering advances. In October, 1958, ESC broke through an existing design barrier and produced a delay line with a 145 to 1 delay time/rise time ratio. It had been thought, prior to the announcement of the Model 61-34, that ESC had reached the ultimate in this type of delay line.



SPECIFICATIONS OF NEW DELAY LINE MODEL 61-34

Delay time/rise time ratio: 170/1

Delay: 200 usec.

Rise time: 1.16 usec.

Attenuation: less than 2 db

Frequency response: 3 db = 325 KC

50 taps with an accuracy of ± 0.2 usec. at each tap.

Complete technical data on the new unit can be obtained by writing to

ESC Corporation, 534 Bergen Boulevard, Palisades Park, New Jersey.

CIRCLE 122 ON READER-SERVICE CARD

four-count 'em-four

Helipot builds four distinct lines of precision components. And each offers the most in design, production, delivery and value.

Beckman Rotating Components

Unique size 8's . . . plus 11's, 15's and 18's . . . in servomotors, rate generators, inertia and velocity dampers, gearheads and black box assemblies. Acceleration and response? Like heaven on earth!

Beckman Expanded Scale Meters

AC/DC Voltmeters with $\pm 0.1\%$ accuracy, ultrasensitivity, true rms indication. 126 standard and ∞ spec models. And there's more to meet your eye: expanded scale freq meters, linear scale ammeters, complete monitoring packages.

Beckman Standard Breadboard Parts

24-hour delivery . . . 1,139 items . . . myriads of precision gears, grid plates, hangers, shaft hardware, limit stops, dials, differentials, magnetic clutches, ball-and-disc integrators . . . but everything!

Helipot Precision Potentiometers

When it comes to pots, we do make the most! A full single-turn family: 15 series in 1/2" to 3" dia. A complete multi-turn line: 19 series in 7/8" to 3-5/16" dia. All metal or economy . . . linear and non-linear . . . spec pots, trimming pots, delay lines, turns-counting dials. This must be the place!

For a real cool list of catalogs, data sheets and tech papers . . . ask for Literature Selector C461.

Beckman
Helipot

Helipot Division of Beckman Instruments, Inc.
Fullerton, California
Engineering representatives in 29 cities

CIRCLE 123 ON READER-SERVICE CARD

NEW PRODUCTS

Modular DC Power Supplies

Outputs are 5 to 32 v



These transistorized dc power supply modules, designated models 22-211, 22-213, 22-214, and 22-217, have outputs of 5 to 7, 11 to 14, 14 to 17, and 25 to 32 v, respectively, and up to 6 amp. The input for all units is 105 to 125 v ac, 60 cps. Ripple is less than 2 mv rms, line regulation is 25 mv, and no-load regulation is 15 mv.

Dressen-Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena, Calif.

CIRCLE 124 ON READER-SERVICE CARD

Current Governor

Line and load regulation is 0.05%



Designed for transistor and semiconductor measurements, type CS-111 current governor has a range of 10 μ a to 500 ma from 0 to 200 v dc. Line and load regulation is better than 0.05%. Current is set to five places by decade knobs arranged to provide a digital inline readout. The current may be programmed or modulated by a remote signal. Transistor avalanche and Zener voltage measurements are easily made at controlled current. Dynamic measurements can be made by modulating the current. Other applications include measurement or testing of semiconductors, magnetic components, and other current sensitive devices.

North Hills Electric Co., Inc., Dept. ED, 402 Sagamore Ave., Mineola, N.Y.

CIRCLE 125 ON READER-SERVICE CARD

JOHNSON MINIATURE CAPACITORS

*Compact Design!
Rugged Construction!*



**Save valuable space
in RF equipment...**

Johnson miniature and sub-miniature air variable capacitors are available in a wide range of sizes, types, and capacities—perfect for use in compact RF applications. The 3 types described below have soldered plate construction, oversize bearing, and heavily anchored stator supports to provide extreme rigidity. Inductance path to both stator supports is extremely low with bridge-type stator terminal. Large compression rotor contact provides steady torque—rotor stays "put" where set. Rotor contact and all other metal parts are nickel-plated—steatite insulator is DC-200 treated.

SUB-MINIATURES—In addition to the miniature air variables described below, the new Johnson Type "T" and "U" sub-miniature capacitors are also available in production quantities. Write for our new components catalog 978 listing complete specifications.

TYPE "M"—Peak voltage 1250 volts on .017" plate spacing; 850 volts on .013" spaced units. Shaft slotted for fast screwdriver adjustment—mounting bushing threaded with flats to prevent turning—mounting nut furnished. Available in production quantities with the following features: locking bearings; 180° stop; various shaft extensions; high torque; silver or other platings. Single section, butterfly, and differential types available.

TYPE "S"—Midway in physical size between the Type "M" and "K" capacitors, the Type "S" has a plate spacing of .013" with a peak voltage rating of 850 volts. Other spacings, single hole mounting type, straight shaft, screwdriver shaft, or locking type screwdriver shaft available on special order in production quantities.

TYPE "K"—Widely used for many military and commercial applications, the Type "K" has a peak voltage rating of 1000 volts with a plate spacing of .015". Unit is available in production quantities to meet MIL-C-92A specifications—other capacities and variations for specialized military and commercial applications are also available in production quantities.

New Catalog

For detailed specifications, including engineering drawings, on Johnson miniature and sub-miniature capacitors, as well as other Johnson electronic components, write for your free copy of our new components catalog No. 978.



E. F. JOHNSON CO.

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CIRCLE 126 ON READER-SERVICE CARD

CIRCLE 139 ON READER-SERVICE CARD

Metallized Mylar

Has many electronic applications



Metallized mylar, sealed against weather and chemical changes, will not scratch, tarnish, or deteriorate with age.

It is available with or without pressure sensitive adhesive, laminated to other types of materials for such use as heat sealing, or Mylar-vinyl extrusions. With or without embossing, it can be used for nameplates or dials.

Forest City Products, Inc., Dept. ED, Cleveland 15, Ohio.

CIRCLE 138 ON READER-SERVICE CARD

Pressure Switch

Actuating pressure range is 5 to 30 psia

Type RR-58 absolute air pressure switch is available in an actuating pressure range of 5 to 30 psia. It has an accuracy of ± 0.5 psi from -85 to $+185$ F and ± 1.5 psi from 185 to 400 F. Difference in pressure between the on and off positions is 2 psi.

The switch can be spst or spdt and is rated at 28 v dc or 110 v ac with 5 amp resistive load. It meets the environmental specifications of MIL-E-5272 including ± 20 g shock and 75 to 500 cps at 10 g vibration. It weighs less than 1.8 oz and measures 1-27/32 in. in length and 7/8 in. in diam.

Suited to missile and aircraft applications, the switch can actuate at critical altitudes. It can actuate at critical pressures to prevent arc-over in high voltage equipment and to protect equipment in electronic assemblies.

Newark Controls Co., Dept. ED, 15 Ward St., Bloomfield, N.J.

CIRCLE 137 ON READER-SERVICE CARD

CIRCLE 139 ON READER-SERVICE CARD

CIRCLE 137, 139, 147, 548, 549 ON READER-SERVICE CARD

INTERNATIONAL RECTIFIER CORPORATION



RECTIFIER NEWS



644 Zener Diode Types Offer Advantages to Every Voltage Regulator Circuit

As compared to other voltage reference elements, the silicon diode regulator has a longer life expectancy because of its mechanical ruggedness. It does not deteriorate under storage nor age during its operating life. Small size and light weight make its use in airborne or portable equipment especially desirable from many standpoints.

International Rectifier Corporation now offers an extensive line of zener types numbering 644 in seven basic styles. From the miniature type rated at 750 milliwatts to the precision 1N430 reference element types, all are manufactured to meet the most rigid military requirements. See how these all-welded, hermetically sealed diodes can improve your circuit design.

CIRCLE 547 ON READER-SERVICE CARD

Miniature Voltage Reference Packs Maintain Voltage Regulation to within $\pm 0.01\%$!



REF-PAK MODEL 4RV8
Standard MIL Transformer Case

Designed around the highly stable 1N430 silicon reference element, these miniature reference supplies may be considered to be the solid state equivalent of the standard cell. A high degree of stability is attained by maintaining a precise constant current through the reference element, regardless of temperature or line voltage variations.

Ref-Paks will operate directly from



REF-PAK MODEL RV8-PC
Special Housing for insertion into printed circuit boards.

an unregulated power source... maintain voltage regulation to within $\pm 0.01\%$! Output voltages of either 8.4 or 16.8 volts dc are available in 5 distinct types that allow operation from 28 or 115 volt dc, 400 and 60 cycle power supplies. Temperature coefficient of these devices is $\pm 0.001\%/^{\circ}\text{C}$ from -55° to $+100^{\circ}\text{C}$.

For complete details ask for SR-401.

CIRCLE 548 ON READER-SERVICE CARD

ZENIAC Provides a Shortcut to the Application of Silicon Zener Diodes

A flip of the Zeniac selector switch quickly tells you the exact diode required in complex breadboard circuitry. This unique innovation — the first semiconductor substitution box in history — has been designed specifically to aid system design groups by saving valuable lab time in the application of zener diodes.

Two units are available, each housing 11 diodes in voltage steps from 3.9 thru 27 volts. Model A Zeniac is rated at 1-watt; Model B is rated at 10-watts. Both are now in stock at your Authorized Distributor. Ask for details on this time saver...



CIRCLE 549 ON READER-SERVICE CARD

Technical Service Provides XY Plot of Reverse Breakdown Characteristics of Each Diode in all Prototype Orders

To eliminate guesswork and tedious testing on your part, every zener diode sent on prototype orders will be accompanied by a specially plotted XY recording of its exact breakdown voltage point! This permanent record can come in mighty handy when it's time to match diodes or reorder to the same specs. This is just one of the many application engineering services we are prepared to extend to you at all times!

Write to the factory for Bulletin SR-250-A, a four page technical article describing the characteristics of zener diodes, how to select them, and application data with circuit schematics.

FOR SAME DAY SERVICE ON PRODUCT INFORMATION DESCRIBED ABOVE, SEND REQUEST ON YOUR COMPANY'S LETTERHEAD

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 6-6281 • CABLE RECTUSA
BRANCH OFFICES: NEW YORK CITY AREA OFFICE: 132 E. 70th St., TRafalgar 9-3330 • NEW YORK STATE AREA OFFICE: 2366 James St., Syracuse, N.Y., HOward 3-1441 • CHICAGO AREA OFFICE: 205 W. Wacker Dr., FRanklin 2-3888 • NEW ENGLAND AREA OFFICE: 17 Dunster St., Cambridge, Mass., UNiversity 4-6520 • PENNSYLVANIA AREA OFFICE: Suburban Square Bldg., Ardmore, Pa., HIghway 9-1428 • MICHIGAN AREA OFFICE: 1799 Coolidge Hwy., Berkley, Mich., LIncoln 3-1144 • IN CANADA: International Rectifier of Canada, Ltd., 1581 Bank St., Ottawa, Ontario, Regent 3-6880

WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS • SELENIUM • GERMANIUM • SILICON

NEW PRODUCTS

Radiator Tube Clamp

Weights 1 oz



For use with type 545, 554, 589, and 6339 external anode, miniature power diodes in air or oil cooled applications, this heat dissipating anode connector weighs 1 oz and occupies 1-1/8 cu in. Made of light weight aluminum, it maintains uniform anode contact to 300 C.

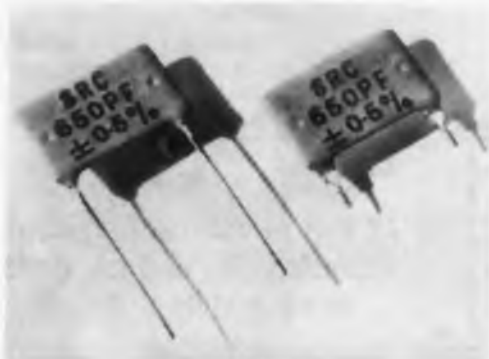
The requirements of MIL-C-5541 are met.

Trought Associates, Inc., Dept. ED, 116 Greylock Ave., Belleville 9, N.J.

CIRCLE 142 ON READER-SERVICE CARD

Capacitors

Range is 2 to 10,000 μf



Having capacitances from 2 to 10,000 μf , these cement-insulated silvered mica capacitors are less than 1/8 in. thick. They come in seven sizes and have conventional or printed circuit loads. Lead spacing is in modules of 0.1 in.

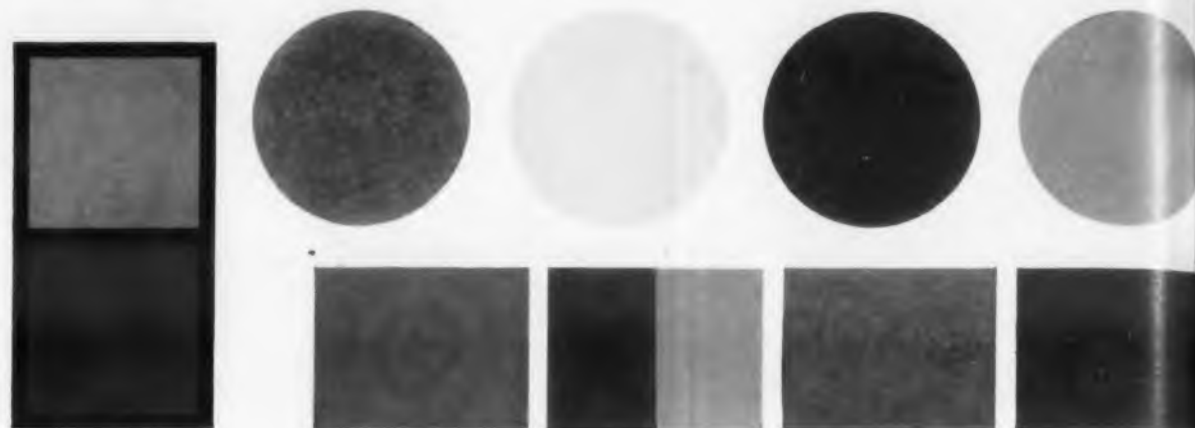
Tolerance is $\pm 0.5\%$ to $\pm 10\%$. Temperature range is -60 to $+100$ C or to $+135$ C for encapsulated units.

Average temperature coefficient is ± 25 ppm per deg C. The voltage rating is 500 wvdc and the long term stability is $\pm 0.05\%$.

British Radio Electronics Ltd., Dept. ED, 1833 Jefferson Place, N.W., Washington 6, D.C.

CIRCLE 143 ON READER-SERVICE CARD

COUNTDOWN · COMPUTERS · CONTROLS



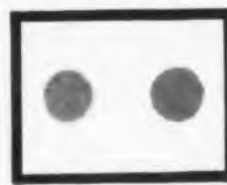
ROUND OR



UNILITE... single-color light with one-inch diameter round button.



TRILITE... lights in 3 colors. Round button is 1" in diameter.



TWINLITE... lights in 2 colors. Solid or split-color buttons $\frac{3}{4}$ " x 1". Mounts in rows or matrix using barriers.



BILITE... lights in 2 colors. Square button may be split-color. Mounts without barriers on .875" centers, both directions.

CIRCLE 144 ON READER-SERVICE CARD

DL S



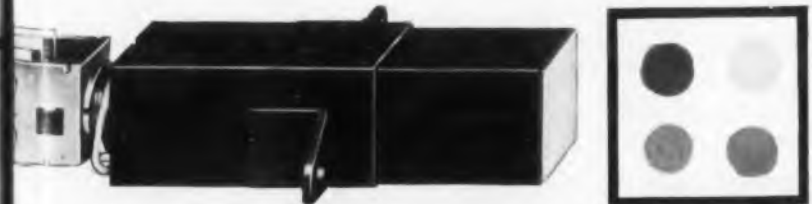
OR SQUARE...

FROM 1 TO 4 COLORS

LIGHTED PUSHBUTTON PANEL SWITCHES

Whatever your application requirement, we undoubtedly have a standard lighted pushbutton panel switch to fit your needs. If not, modification, or a complete custom design, can easily and quickly be produced.

The units shown are the five basic standard models. They all feature a pair of single pole, double throw subminiature, non-simultaneous switches. Models are available with positive-feel light-touch Momentary Action, or Alternate Action (push-on, push-off). Switches and lamps may be interwired or terminated independently. Choose from six standard illumination colors, plus white. All lamp and light filter assemblies are removable from the front of the panel. For indicating use only, any unit can be supplied without switches. Round-button models are available with square pushbutton caps. Models are available for either sub-panel, flush-panel, or matrix mounting.



QUADLITE ... four bulbs, lights in 4 colors. Designed for matrix use. mounts on 1/8" centers both directions. Mechanical interlocking for master resetting, mutual cancellation, or other special actions.

We would like to prepare a specification drawing to meet your requirements. For quotation or technical literature, please send application information to:



ELECTROSNAP CORPORATION

Switch Division
4216 West Lake Street • Chicago 24, Illinois
Telephone VAn Buren 6-3100 • TWX CG-1400



MOST EFFICIENT LINK BETWEEN MIND AND MACHINES

Revolutionary ASTROMATIC panel concept simplifies and reduces complex monitoring and control centers to small, efficient, pictorial lighted panels. ASTROMATIC control panels are made possible by Electro Snap's complete line of lighted push-buttons, switches, indicators, and other unique panel components. Electro Snap supplies components or complete panels. Ask about ASTROMATIC.

CIRCLE 141 ON READER-SERVICE CARD

Frequency Generator

Output is 2.5 v, 300 to 4000 cps



Model 6261 frequency generator has an output of 2.5 v with frequencies of 300 to 4000 cps. Accuracies are 0.1% to 0.01%. The oscillator circuit uses types 2N334 and 2N335 silicon transistors, precision wire wound resistors, and metallized Mylar capacitors. A bimetallic tuning fork is employed. The tuning fork and the oscillator circuit are in a hermetically sealed can measuring 1-1/2 x 1-1/2 x 3-1/4 in. Required operating power is 28 v dc.

Varo Manufacturing Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

CIRCLE 145 ON READER-SERVICE CARD

Power Supplies

Both ac and dc types



These ac and dc power supplies have voltage ranges from between 0 and 30 v to between 0 and 120 v. Maximum current ranges are 1 to 12 amp. The ac output is variable; the dc output is well-filtered and can be obtained with a very low ripple. A voltmeter indicates output. All outputs are available from both the front and the rear of the units; all input connections are located at the rear. Protection against overload and short circuits is provided. The units are designed for panel mounting.

Nutron Manufacturing Co., Inc., Dept. ED, 67 Monroe Ave., Staten Island 1, N.Y.

CIRCLE 146 ON READER-SERVICE CARD

crystal can size relays

by ADVANCE



ADVANCE MV SERIES
offered in 3 terminal
arrangements...6 mount-
ing arrangements, and 7
resistance values (30 to
10,000 ohms).
— AVAILABLE AT
ADVANCE DISTRIBUTORS



ADVANCE RELAYS

ELGIN

A PRODUCT OF ELECTRONICS DIVISION
ELGIN NATIONAL WATCH COMPANY
2435 N. NAOMI ST., BURBANK, CALIFORNIA

—these construction
features assure
exceptional reliability:

Positive sealing. Advance's use of induction heating cuts rejects from faulty soldering to a negligible figure. Soldering is accomplished at high speed, hence damage to the relay due to heat transfer is eliminated.

RADIFLO testing for leakage is used to detect leaks as small as 10^{-8} cc/sec. All relays that pass this test will function after long shelf life.

RIQAP* program approval. Under RIQAP, the Signal Corps constantly checks Advance's quality control and inspection, to insure military standards of reliability for all Advance customers, both military and industrial.

*Reduced Inspection Quality Assurance Plan of the U.S. Army Signal Corps.

SPECIFICATIONS

Coil resistance: Available in 7 values, from 30 to 10,000 ohms.
Shock: 50 G's for 11 milliseconds.
Vibration: 10 to 34 cycles per second at maximum excursions of .4". 34 to 2000 cps 20 G's acceleration.
Operating power: Pull in power 250 milliwatts at 25°C.
Contact rating: 2 amps resistive at 32 VDC or 115 VAC.
Life: 100,000 operations minimum at rated current.
Weight: 0.45 ounce.
Size: $\frac{7}{8}$ " high x $\frac{51}{64}$ " wide x $\frac{23}{64}$ " deep.

Our Applications Engineering Dept. will be pleased to work with you on your special application problems.

CIRCLE 147 ON READER-SERVICE CARD

NEW PRODUCTS

Parametric Amplifiers

Two models available



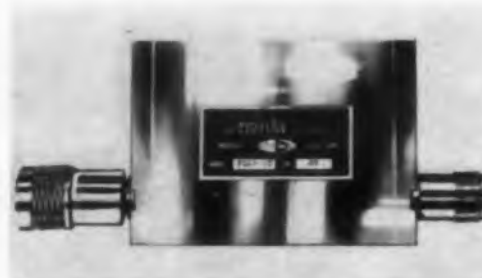
Model MA2-1000 parametric amplifier is used in the 950 to 1250 mc range and model MA2-1000L is used in radar receivers in the 1250 to 1350 mc range. Both models exhibit noise figures below 2 db with a bandwidth of 0.25%. The image rejection is better than 50 db down and the dynamic range is 80 db or better. The unit includes a Varactor diode, a low noise mixer, and a 1N21E or MA-412B diode for the down-converter stage. Complete amplifiers consist of the basic unit, a pump oscillator, a power supply, and waveguide accessories. The chassis is silver-plated brass and measures 6 x 3 x 2 in.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 140 ON READER-SERVICE CARD

Low-Pass Filters

Attenuation is 50 db



These low-pass filters are used in coaxial measurement set-ups to eliminate errors due to harmonics emitted by triode and klystron oscillators. They transmit frequencies up to the cut-off point of the filter. Attenuation is 50 db over most of the range, insertion loss is 1 db max, and vswr in the passband is 1.5 max. Units are available for frequencies of 500, 1000, 2100, and 4200 mc.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, N.Y.

CIRCLE 148 ON READER-SERVICE CARD



From the
NEW
convenience-style L
L&N line...

8686 POTENTIOMETER features central readout of -10.1 to 100.1 mv

With central readout (digits and scale) of measurements over the range -10.1 to +100.1 mv without input reversal, this portable millivolt potentiometer—one of a family of brand-new L&N instruments—brings marked operating convenience to industrial and lab measurements: thermocouple temperatures, calibration of millivoltmeters and potentiometer indicators and recorders, standard cell checking.

Ranges—(1) -10.1 to +100.1 mv; (2) 1010 to 1020 mv for standard cell calibration.

Limits of Error—Without ref. jct. compensation, $\pm(0.05\%$ of reading $+3 \mu v$). With ref. jct. compensation, $\pm(0.05\%$ of reading $+6 \mu v$).

Measuring Dials—"A" Switch: 9 x 10 mv plus additional dial step of 1010 mv and a "-" position. "B" Switch: 9 x 1 mv. "C" Slidewire: 0 to 1.1 mv on circular scale 12" long. Smallest division, 5 μv , adjustable to $\pm 1 \mu v$.

Galvanometer—Sensitivity, 0.06 μa per mm. Coil resistance, 25 ohms; CDRX, 100 ohms.

Function Switch—9-position switch selects (1) "Galv. OFF", (2) "STANDARDIZE", (3) "EMF MEASURE", (4) "EMF OUTPUT", (5) "STANDARDIZE", (6) "TC OUTPUT", (7) "TC MEASURE", (8) "STANDARDIZE", (9) "REF JCT".

Case—Metal with vinyl finish, 14 $\frac{3}{16}$ " x 11 $\frac{1}{32}$ " x 7 $\frac{3}{8}$ ". Weight, 21 lb.

Price—\$485 (subject to change without notice), f.o.b. Phila. or North Wales, Pa. Available for delivery after January 1, 1960. Specify List No. 8686 when ordering from nearest L&N Office or 4908 Stenton Ave., Phila. 44, Pa.

LEEDS NORTHROP
Instruments Automatic Controls • Furnaces

CIRCLE 149 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

ENGINEERS REALLY GROW AT EMERSON ELECTRIC



... AND YOU CAN GROW
AT EMERSON TOO!

- RADAR SYSTEMS ENGINEERS
- SERVO ENGINEERS
- COMPUTER ENGINEERS
(analog & digital)
- ELECTRONIC SUPPORT
EQUIPMENT DESIGN ENGINEERS
- INFORMATION THEORISTS
- COMMUNICATIONS SYSTEMS
ANALYSTS
- RELIABILITY ENGINEERS
- TECHNICAL WRITERS
(electronic background)

Emerson needs individuals who can make significant contributions in an initial stage concept-oriented program. Assignments in our radiation division, for example, involve radar development, parametric amplifiers, electronic scanning and complete radar fire control systems.

We emphasize the systems approach, which means Emerson engineers explore and contribute in many diversified areas. This climate of creative freedom has paid off in solid achievements.

If your talents can be better utilized by assuming greater responsibilities, you owe it to your future to contact us at once.

Send complete resume to R.L. Middleton.

EMERSON ELECTRIC



ELECTRONICS and AVIONICS
DIVISION
8100 W. FLORISSANT • ST. LOUIS 36, MO.

Engineers are a hardy breed... and the right *growing* conditions can make them flourish far beyond expectations.

Emerson Electric provides the most "fertile soil" available. Proof? So many of our engineers have come so far in so few years, with a research and development staff that is one of the finest in the entire industry.

We owe this achievement to many important considerations... not to a magic "green thumb". We provide our engineers with elbow room, they're not bogged down with non-technical details. Encouragement of original ideas, an unusually cooperative and close spirit, elimination of formalities... these and other factors are *real* at Emerson.

It has paid off exceedingly well for engineers and company alike: Emerson has grown from \$45 to \$90 million annually in just five years! *You* can easily become part of this "garden spot" for growing engineers. Just write us today for an interview at our expense.

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GROW...
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8100 FLORISSANT AVENUE



ELECTRIC

ST. LOUIS 36, MISSOURI

CIRCLE 926 ON CAREER INQUIRY FORM, PAGE 229

ELECTRONIC DESIGN • November 11, 1959

The New Ramo-Wooldridge Laboratories *in Canoga Park*

...an environment dedicated to
technological research and development

The new Ramo-Wooldridge Laboratories in Canoga Park, California, will provide an excellent environment for scientists and engineers engaged in technological research and development. Because of the high degree of scientific and engineering effort involved in Ramo-Wooldridge programs, technically trained people are assigned a more dominant role in the management of the organization than is customary.

The ninety-acre landscaped site, with modern buildings grouped around a central mall, contributes to the

academic environment necessary for creative work. The new Laboratories will be the West Coast headquarters of Thompson Ramo Wooldridge Inc. as well as house the Ramo-Wooldridge division of TRW.

The Ramo-Wooldridge Laboratories are engaged in the broad fields of electronic systems technology, computers, and data processing. Outstanding opportunities exist for scientists and engineers.

For specific information on current openings write to Mr. D. L. Pyke.



THE RAMO-WOOLDRIDGE LABORATORIES

8433 FALLBROOK AVENUE, CANOGA PARK, CALIFORNIA

Please write direct to advertiser mentioning *ELECTRONIC DESIGN*

NEW PRODUCTS

Voltmeter

Measures 1 mv to 1000 v dc



For use in instrumentation, telemetering, and monitoring applications, type DVM digital voltmeter measures bipolar dc voltages from 1 mv to 100 v. Accuracy is $\pm 0.1\%$ and speed is 100 conversions per sec. The output is automatically displayed as a three-decimal digit readout plus an overflow digit, sign, and decimal point. Electrical outputs include parallel BDC coded voltages and a serial pulse train for single wire telemetry use. This completely solid state instrument can also be used to measure elapsed time, measure events per unit of time, scale inputs into engineering units, and provide zero suppression signal conditioning.

Epsco Inc., Dept. ED, 275 Massachusetts Ave., Cambridge, Mass.

CIRCLE 152 ON READER-SERVICE CARD

Thermoelectric Generator Elements

Made of lead telluride



Made of lead telluride, these thermoelectric generator elements can operate at junction temperatures of 1100 F for several years. Type TEG #2P positive and type TEG #2N negative elements are available in six standard sizes and have prefinished hot junction surfaces and pretinned cold junction surfaces. They can be assembled directly into test fixtures.

Minnesota Mining and Mfg. Co., Dept. ED, 900 Bush Ave., St. Paul 6, Minn.

CIRCLE 153 ON READER-SERVICE CARD

THERMOMETER.—Made of stainless steel, it is designed for both laboratory and production use. The thermometer can be reset and recalibrated by the user. It has a range of from 0 to 220 F. Stem length is 6 in. with a diameter of 1/4 in. The diameter of the dial is 2 in. and the overall diameter is 2-1/8 in. Designated as model 142, the thermometer is waterproof for intermittent immersion and for continuously humid atmospheres.

The Pacific Transducer Corp., Dept. ED, 11836 W. Pico Blvd., Los Angeles 64, Calif.

CIRCLE 154 ON READER-SERVICE CARD

SOCKET CAP SCREWS.—Are made of cold forged stainless steel. The screws can be re-applied many times because of their long length. They are available in numerous sizes in the new ASA 60 series or the old series.

Set Screw & Mfg. Co., Dept. ED, Bartlett, Ill.

CIRCLE 155 ON READER-SERVICE CARD

RELAY MISS TESTER.—Cycles relays for testing under dry-circuit conditions. The relay contacts are tested dynamically at open circuit voltages as low as 1 mv with closed circuit currents as low as 1 μ a. An electronic gate is provided to eliminate erroneous miss indications.

Shasta Electronic Co., Dept. ED, P. O. Box 316, Palo Alto, Calif.

CIRCLE 156 ON READER-SERVICE CARD

AUTOMATIC MIXING DISPENSER.—Designed for flowable two-part compounds or adhesives, this unit is portable. Known as an Automatic Shot Meter, it is completely enclosed. It operates on 80 psi of airline pressure. It mixes and dispenses a uniform, air-free compound and is easily adjustable by means of a scale to any of fifty desired shot measurements from 2 to over 100 g.

Pyles Industries, Inc., Dept. ED, 20855 Telegraph Road, Detroit 41, Mich.

CIRCLE 157 ON READER-SERVICE CARD

TERMINAL BOXES.—Are built of cast iron or sheet steel with gasketed covers. The weatherproof multi-function thermocouple terminal boxes provide for the termination of from 6 to 100 thermocouple circuits. The cast iron boxes have either hinged or screw-down type covers, threaded openings for fittings, and external lugs for surface mounting.

Thermo Electric Co., Inc., Dept. ED, Saddle Brook, N. J.

CIRCLE 158 ON READER-SERVICE CARD

SERVO-MAGNETIC AMPLIFIERS.—This line is designed for 2-phase 400 cps servo motors. Voltage ratings are 26 and 115 v with power rating from 2.5 to 15 w. Weight of largest unit is under 2 lb.

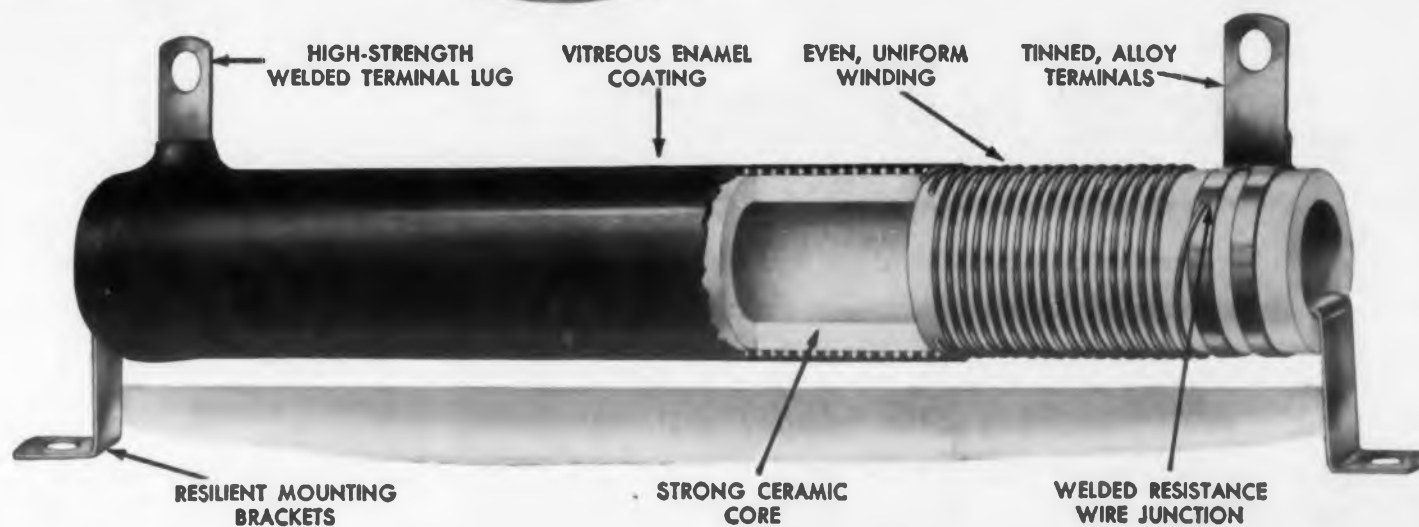
Torotel, Inc., Dept. ED, 5512 E. 110th St., Kansas City, Mo.

CIRCLE 159 ON READER-SERVICE CARD

Quality Features of

OHMITE[®]

VITREOUS ENAMELED RESISTORS



Balanced Thermal Expansion prevents crazing and moisture entrance

In Ohmite resistors, spot welding replaces soldering, brazing, and mechanical fastening. Spot welding produces strong connections that are not affected by vibration or high temperatures. Ohmite welded construction also produces an almost flush connection between the resistance wire and terminal. This prevents thin spots or bulges in the vitreous enamel coating which might cause future trouble and failure. Many different types of terminals are available besides the lug illustrated.

Ohmite can supply all of your resistor needs

some of the many types available

Axial Lead	Live Bracket Mounting Resistors
Brown Devil [®] Wire Lead	Edison Screw Base Mounting Resistors
Fixed, Lug Type	Riteohm [®] Wire-Wound Precision Resistors, Encapsulated; Vitreous Enameled; Molded Jacket; Hermetically Glass Sealed
Dividohm [®] Adjustable	Corrib [®] High Current, Corrugated, Edgewound Ribbon
Thin Type	Resistors with Heat Conducting Studs
Noninductive	Ferrule Mounting Resistors
Powr-Rib [®] , High Current, Round or Ribbon Wire, Open Wound	High-Shock Resistors
Resistors to meet MIL Specifications	

Write on company letterhead for Catalog 58

The almost endless variety of Ohmite resistors in many sizes and types—in a wide range of wattages and resistances—makes it possible to meet each individual need. Many of these can be supplied from the world's largest factory stock. Whatever your resistor requirements may be, chances are you will find exactly the type you need in industry's most complete line of high-quality resistors.

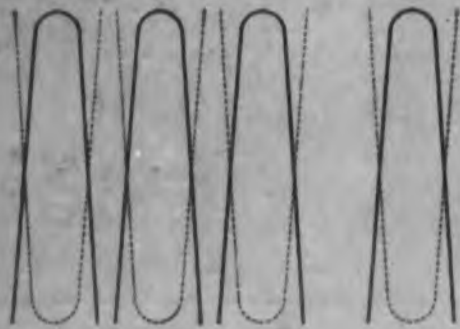
Be Right with



Ohmite Manufacturing Company
3643 Howard Street
Skokie, Illinois

RHEOSTATS RESISTORS RELAYS
TANTALUM CAPACITORS TAP SWITCHES
VARIABLE TRANSFORMERS DIODES R.F. CHOKES

CIRCLE 165 ON READER-SERVICE CARD



LEADERSHIP IN MEASUREMENT

Satham's leadership in measurement is exemplified by a family of products distinguished for their reliability in missile, aircraft, industrial and nuclear instrumentation.

Researched and fabricated by the pioneer of the unbonded strain gage, many of these sensing instruments have been privileged to help make the U. S. space and nuclear power programs a dynamic reality.

Recognizing that no one line can include the ideal instrument for every purpose, Satham has further exercised the responsibility that devolves upon leadership by preparing an objective, illustrated booklet entitled "Introduction to Transducers for Instrumentation." Brief but scholarly, it will aid instrumentation and project engineers in surveying all 16 major transduction principles, including but not limited to those used in Satham products.

Write for it on your company letterhead. Other information on specified instrumentation areas or problems will be included at your request.

For prompt attention, address requests to Dept. ED-864-1.



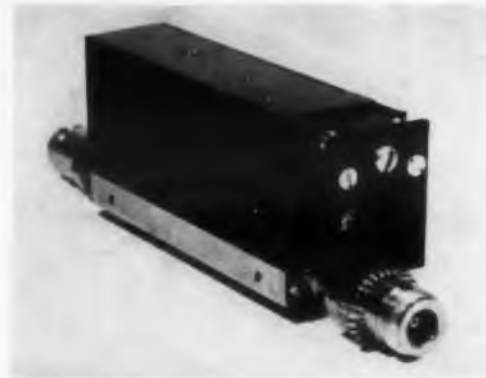
STATHAM INSTRUMENTS, INC.
12401 West Olympic Boulevard • Los Angeles 64, California

CIRCLE 160 ON READER-SERVICE CARD

NEW PRODUCTS

Coaxial Attenuators

Ranges are 4 to 7 kmc and 7 to 11 kmc



This variable coaxial attenuator is available with bandwidths of 4 to 7 kmc and 7 to 11 kmc and produces a maximum of 40 db attenuation. Attenuation variation is less than 5%. The vswr on all settings is less than 1.5. The unit handles 4 w. Units producing to 100 db attenuation with flat attenuation versus frequency characteristics can also be provided.

Merrimac Research and Development, Inc., Dept. ED, 137-28 Northern Blvd., Flushing 54, N.Y.

CIRCLE 161 ON READER-SERVICE CARD



Pressure Switches

Pressure range is 10 to 4000 psi

The series 1590 pressure switch has a pressure range of 10 to 4000 psi and an ambient temperature range of -65 to +300 F. The complete unit weighs 2-1/2 oz, and is 3 in. long and 0.937 in. in diam. All moving parts are sealed in an aluminum and steel housing. The entire assembly is resistant to corrosion. Accuracy is within 0.5 psi. The applications include pneumatic, hydraulic, lubricating, fuel, chemical, and gas pressure systems.

Haydon Switch, Inc., Dept. ED, Waterbury 20, Conn.

CIRCLE 162 ON READER-SERVICE CARD

SEE IT!



SHOOT IT!



SHOW IT!

...in only

2 MINUTES
on Polaroid® Land
Projection Film

Just a few minutes from the time you record oscilloscope traces with this new Beattie Oscillotron and Polaroid® Land Film Type 46, you can project a transparency. Also produces 60 sec. paper prints with the new, very fast Polaroid® 3000 Speed Film. Records up to 10 traces on a single frame and offers these many other advantages:

- Direct binocular view of CRT while recording.
- Non-reversed image.
- Camera swings back for easy access to lens and shutter, or lifts off completely. Can be rotated.
- Electric shutter-actuator available.
- Attaches easily to bezel of 5" CRT. Adaptable to other sizes. No special tools.

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C COLEMAN INC.

1000 N. Olive St., Anaheim, California
Branch: 437 Fifth Ave., New York, N.Y.

CIRCLE 163 ON READER-SERVICE CARD

CIRCLE 164 ON READER-SERVICE CARD

Transformer and Bobbin Winder

Permits fast wire change-over

This multiple transformer/bobbin winder permits fast change-over from one wire gage to another. The model 500-AM unit winds power, audio, and similar types of heavy duty transformer coils and all types of heavy duty field coils and bobbins.

The dial is calibrated in wire sizes from 10 to 31 AWG. Wire finer than 31 AWG can also be handled. Maximum coil OD is 16 in. and maximum winding stroke is 9 in. Loading distance for multiple winding is 24 in., max.

Winding width is adjusted by moving the slider on a calibrated scale to the desired winding width. The machine is furnished with an instant re-set automatic counter, a magnetic brake, and a motor and heavy duty tailstock. Winding speeds are up to 380 rpm.

Geo. Stevens Mfg. Co., Inc., Dept. ED, Pulaski Rd. at Peterson, Chicago 46, Ill.

CIRCLE 173 ON READER-SERVICE CARD

Indicator

For course, azimuth, and range

Combining the functions of a course indicator, an azimuth indicator, and a range indicator, this instrument, designated type 9814-02, measures 9-1/4 in. long and 3-1/8 in. in diameter and weighs 4-1/2 lb. The unit consists of three ac servo motors, four resolvers, one control transformer, one torque receiver, four potentiometers, and one servo amplifier.

The mechanical portion is hermetically sealed. A single indicator face presents compass information on a rotating compass card, distance information on a three-digit counter, and relative Tacan bearing information on a double-bar pointer. An auxiliary single bar pointer is provided for use with other navigational systems.

John Oster Mfg. Co., Avionic Div., Dept. ED, 1 Main St., Racine, Wis.

CIRCLE 174 ON READER-SERVICE CARD

CIRCLE 175 ON READER-SERVICE CARD

CIRCLE 172 ON READER-SERVICE CARD

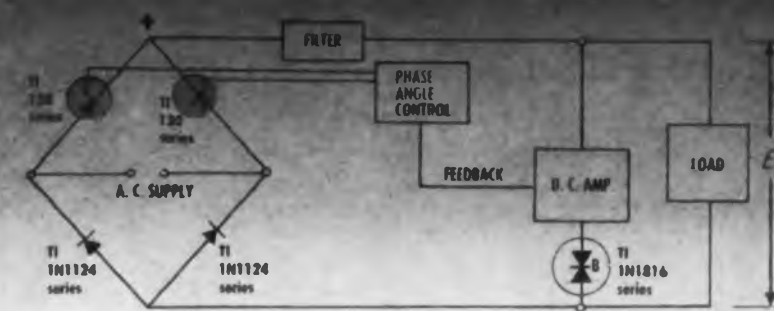
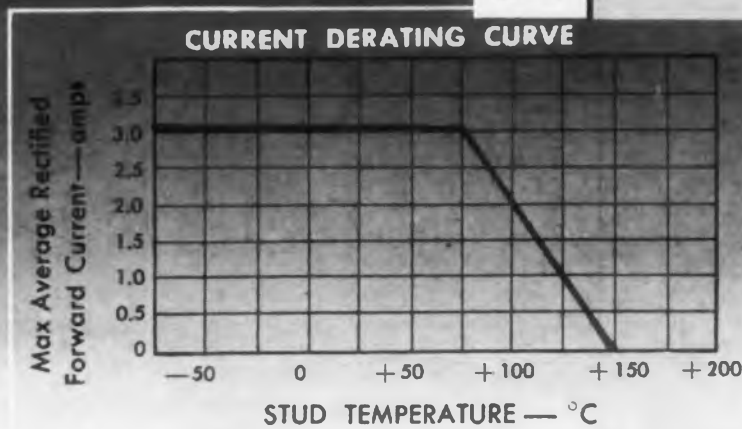
NOW FROM TI..

P
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ACTUAL SIZE

DIFFUSED SILICON CONTROLLED RECTIFIERS



TYPICAL CONTROLLED RECTIFIER BRIDGE REGULATED POWER SUPPLY

Switch 1-Ampere at 125°C Stud Temperature

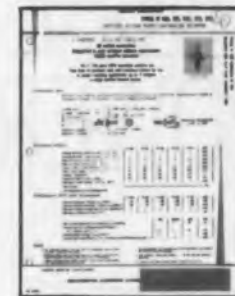
Now, the high current-high temperature capabilities and new small size of the TI 130-Series permits practical use of controlled rectifiers in such applications as relays and switches in regulated power supplies, light dimmers, servomotor controls, reversing drives and surge voltage suppression devices.

The TI diffused silicon P-N-P-N controlled rectifier has a third lead which controls current flow. A low 5-ma current fires the device which requires only 0.6 microsecond turn-on time. You get guaranteed PIV and breakover voltage ranges from 50 to 400 volts and an average rectified forward current of 3 amperes at 75°C and 1 ampere at 125°C stud temperature. Maximum operating temperature is 150°C!

You are assured of uniform reliability through *completely diffused silicon construction* which provides higher power dissipation and high sensitivity.

Contact your local TI representative for immediate delivery of TI P-N-P-N controlled rectifiers in production quantities!

Write for data folder containing complete parameters on Types TI 130, 131, 132, 133, 134 Diffused Silicon P-N-P-N Controlled Rectifiers.



Available In Hours from your local authorized TI distributor

germanium and silicon transistors
silicon diodes and rectifiers
tan-Ti-cap solid tantalum capacitors
precision carbon film resistors
silicon resistors

TEXAS



INSTRUMENTS

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WHY ENCAPSULATED?

Up to 250 KVA and no bulky case! Electro builds high reliability high power into half the size...half the weight. But this is no ordinary open coil construction—the coils are thin and solid...100% encapsulated with epoxy inside and out...sealed completely against dirt, damp and damage. One result: Fast cooling with high overload capacity for built-in reliability... temperature rise is 50% less! Another: Less size and weight simplifies equipment packaging...permits smaller cabinets and more efficient layout. Get the whole story of *Electro* encapsulateds for heavy-duty industrial applications (Class A or B); or on *HR/Epsal* ultracapsulateds for extreme environments (Mil-T-27A Grade 5 Class T). Electro engineers to your requirements... from microwatt to megawatt.

ENCAPSULATED HIGH POWER TRANSFORMERS

ELECTRO
high reliability transformers

ELECTRO ENGINEERING WORKS, 401 PEDA STREET, SAN LEANDRO, CALIFORNIA

Opportunities for Experienced Transformer Engineers. Write to Personnel Manager

CIRCLE 176 ON READER-SERVICE CARD

NEW PRODUCTS

One-hp Gearmotor

Has a 2-1/2 in. diam



This one-hp gearmotor, called model 70DC1R70, has a diameter of less than 2-1/2 in. The required input is 28 v dc at 65 amp. The output speed can be varied to meet customer specifications. The unit shown has an output shaft speed of 7000 rpm.

Western Gear Corp., Electro Products Div., Dept. ED, 132 W. Colorado Blvd., Pasadena, Calif.

CIRCLE 177 ON READER-SERVICE CARD

Epoxy Resin

Has low mix viscosity

ResinKast 709, a semi-rigid epoxy resin system has a two to four-day working life for a five gallon mass at 75 F. The mix viscosity is 4200 cps at 25 C. It is resistant to thermal and mechanical shock and is rated as class B electrical insulation material. The cure schedule is 16 hr at 175 F or 8 hr at 200 F.

Resin Formulators, Inc., Dept. ED, 8956 National Blvd., Los Angeles 34, Calif.

CIRCLE 178 ON READER-SERVICE CARD

DC Power Supply

Delivers 9 or 12 v



For the operation of transistorized equipment and for telephone systems, model TQ-4 dc power supply delivers 12 v at 500 ma or 9 v at 1 amp. The unit is fused, heavy filtering is provided, and a choke is used to obtain good regulation. It is enclosed in a heavy steel case and is supplied with cords.

Fisher Berkeley Corp., Dept. ED, 4224 Holden St., Emeryville 8, Calif.

CIRCLE 179 ON READER-SERVICE CARD

STRAITS TIN REPORT

News of developments
in the production
and uses of tin



Zircalloy 2 — containing 1.5% or more tin — was the cladding material used for the nuclear power unit which carried the submarine Nautilus across the North Pole. Zirconium alone couldn't do it. Addition of small quantities of tin strengthened the zirconium and reduced the variable effect of impurities. It also had a favorable effect on its corrosion resistance. This discovery led to development of Zircalloys containing 0.5 to 5% tin.

Factory fresh hosiery is now available to American consumers in tin cans. The manufacturers claim canning nylons reduces pilferage and handling costs, lets the lady select her nylons factory fresh from her grocer's shelf.

Foreign car manufacturers are capitalizing on latest developments in tin applications. Directional signals, subject to continuous wear and hard weather conditions, are electroplated with a tin-zinc coating. A tin-nickel electrodeposit shows good potential as a bright tarnish-resistant coating for automotive trim, bumpers and accessories. A tin-bronze coating of up to 12% tin and a tin-nickel coating of two-thirds tin are proving excellent undercoatings for chromium.



Write today for more data on these items or for a free subscription to **TIN NEWS**—a monthly bulletin on tin supply, prices and new uses.

The Malayan Tin Bureau
Dept. 12L, 1028 Connecticut Ave., Washington 6, D.C.

CIRCLE 180 ON READER-SERVICE CARD

Zener Diodes

Rated at 3/4 w

These 3/4 w Zener diodes come in an axial-lead, flangeless package. They are available in ratings from 6.3 to 200 v. The flangeless package is suited for insertion by automatic equipment in printed circuit boards. Designed to meet or exceed mechanical and environmental requirements of military specifications, the units can be used in both ac and dc circuits.

Types 3/4M6.8Z through 3/4M-200Z can be used for applications such as regulation of vacuum tube filaments, protection of transistors against surge voltages, and in other circuits where it is necessary to provide proper voltage regulation.

Motorola Semiconductor Div., Dept. ED, 5005 E. McDowell Rd., Phoenix, Ariz.

CIRCLE 181 ON READER-SERVICE CARD

Seam Welding Machines

Two models available

The model VTW 500 seam welding machine can handle materials that vary in gage from 0.001" up to 0.01 in. or more. The machine can be used to weld stainless steel, nickel alloys, Kovar, and other new metal alloys.

A phase shift heat control circuit is used and it is adjustable to extremely low heat settings for delicate materials. The unit operates at full power output, 2.8 kva, on a continuous duty cycle. Welding speed is adjustable to either 60 or 120 spots per second. The model VTW 501 machine is identical to the VTW 500 except for an additional control that makes it suitable for spotwelds timed from 2 to 20 cycles.

Thickness range of the VTW 501 is 0.0005 in. to 0.035 in. Both welders have: inputs of 220 or 440 v, 300 w input-standby power, and a power load of 30 amp max at 240 v. Hughes Aircraft Co., Vacuum Tube Products Div., Dept. ED, International Airport Station, Los Angeles 45, Calif.

CIRCLE 182 ON READER-SERVICE CARD

CIRCLE 183 ON READER-SERVICE CARD



**Reduce costs,
increase reliability**

...with

PRE-WIRED Daven switch assemblies

Daven has established a completely new Packaged Assembly Department. This group assembles various components on Daven rotary switches, does all internal wiring, any external cabling necessary, and pre-tests the entire package. In switch wiring, it is very often easier and less time consuming to wire and make connections to switch decks before they are stacked as a complete unit.

Thus, you can now have a completely tested sub-

assembly, instead of a mixed group of components and switches which ordinarily would have to be individually checked, assembled, soldered, and tested. Daven takes complete responsibility for the design, fabrication, testing and overall reliability of this assembly package.

For more information about Daven's new Packaged Assembly Service, write today.

THE **DAVEN** CO.



LIVINGSTON, NEW JERSEY

TODAY, MORE THAN EVER, THE DAVEN © STANDS FOR DEPENDABILITY

*Trimpot® Makes
Reliability a Reality*



General Purpose Wirewound Trimpot — Model 200. Operates at 105°C/L,S,P terminals/¼ watt/10 ohms to 100K. Available as rheostat, Model 201.

CIRCLE 736 ON READER-SERVICE CARD



High-Resistance Wirewound HI-R® Trimpot — Model 207. Operates at 175°C/L terminal/2 watts/100 ohms to 100K. Available as rheostat, Model 208 HI-R Trim R®.

CIRCLE 737 ON READER-SERVICE CARD



Dual-Element Wirewound Twinpot® — Model 209. Operates at 105°C/L terminal/¼ watt/10 ohms to 20K. Two potentiometer outputs with one adjustment shaft.

CIRCLE 738 ON READER-SERVICE CARD



General-Purpose Carbon Trimpot — Model 215. Operates at 125°C/L,S,P terminals/¼ watt/20K to 1 Meg. Available as Mil-Spec humidity-proof unit, Model 235 (1K to 10 Meg).

CIRCLE 739 ON READER-SERVICE CARD



Subminiature Wirewound Trimpot—Model 220. Operates at 175°C/L & W terminals/1 watt/100 ohms to 20K. Meets Mil-Specs for humidity.

CIRCLE 740 ON READER-SERVICE CARD



High-Temperature, Humidity-Proof Wirewound Trimpot—Model 224. Operates at 175°C/L,S,P terminals/1 watt/100 ohms to 100K. Meets Mil-Specs for humidity.

CIRCLE 741 ON READER-SERVICE CARD

Choose from among four terminal types: L—insulated stranded Leads; S—Solder lugs; P—printed circuit Pins; W—uninsulated Wire. Full range of standard resistances from 10 ohms to 1 megohm. Other resistances available.

TRIMPOT® RELIABILITY IS IN THE CARDS



Test information punched in these cards can provide detailed performance reliability statistics on Trimpot production. The cards summarize extensive environmental tests which Bourns regularly conducts above and beyond regular quality control. In Bourns' own Reliability Assurance Laboratory, monthly samples are taken at random from factory stocks and completely tested for conformance

to all environmental and electrical specifications on Trimpot catalog sheets. Results can then be fed into IBM computers which analyze performance data with corrective action taken immediately, if required!

This program is the only one of its kind in the industry. Only Trimpot potentiometers are tested so thoroughly, so frequently. In short, Trimpot reliability is a fact—one you can put in your next circuit.

PUNCHED CARDS ARE USED TO TABULATE BOURNS RELIABILITY DATA FROM -

Complete Quality Control Like This...



Trimpot reliability starts at the beginning. Here an incoming lot of potentiometer lead-screws undergoes a dimensional check.



From the time the element is wound until the lid of the potentiometer is installed, in-process inspection monitors quality.



100% final inspection is made possible by this exclusive high-speed system developed by Bourns to test all major electrical characteristics. Critical dimensions of each unit are also checked.

And Reliability Assurance Tests Like These...



This vibrator for measuring conformance to Mil-Specs is an important part of the extensive equipment in Bourns Reliability Assurance Laboratory.



This chamber subjects potentiometers to standard military tests for humidity, provides important feedback on product performance.



1000-hour load life testing per Mil-R-19A takes place in ovens like this, which hold temperatures at desired levels at full rated power.

When tests are completed and the results tabulated, Bourns engineers plot frequency distribution curves from the steady flow of test results. Analysis of these curves and other data from testing provides a continuing check on all models to see that they meet the most exacting standards of performance. This analysis and the constant flow of information between the Testing and Production departments is your assurance that the Trimpot potentiometers you specify and purchase will meet specifications.

Write for the new 8-page folder describing the Bourns Reliability Assurance Program and a copy of the Trimpot Summary Brochure.

Exclusive manufacturers of TRIMPOT®, TRIMIT®,. Pioneers in potentiometer transducers for position, pressure and acceleration.

CIRCLE 735 ON READER-SERVICE CARD

BOURNS Inc.

P.O. Box 2112R, Riverside, Calif.

Plants: Riverside, California
and Ames, Iowa

Trimpot® Makes Reliability a Reality



Humidity-Proof Wirewound Trimpot - Model 236. Operates at 135°C/L,S,P terminals/0.8 watt/10 ohms to 100K. Meets Mil-Specs for humidity.

CIRCLE 742 ON READER-SERVICE CARD



High-Temperature Wirewound Trimpot - Model 260. Operates at 175°C/L,S,P terminals/1 watt /10 ohms to 100K.

CIRCLE 743 ON READER-SERVICE CARD



High-Quality Commercial Wirewound Trimit® - Models 271, 273, 275. Operates at 85°C / L,S,P terminals/¼ watt/100 ohms to 10K.

CIRCLE 744 ON READER-SERVICE CARD



High-Quality Commercial Carbon Trimit - Models 272, 274, 276. Operates at 85°C/L,S,P terminals/0.2 watt/20K to 1 Meg.

CIRCLE 745 ON READER-SERVICE CARD



Panel-Mount Trimpot

All models are now available with the added convenience of panel mounting. Unique design permits quick factory attachment of rugged panel-mount assembly to standard "on-the-shelf" Trimpot potentiometers. The Panel Mount Trimpot takes as little as 1/12 sq. inch of panel space, meets Mil-Specs for vibration, shock, salt spray, etc. Recessed head prevents accidental changes of setting. Silicon rubber O-ring and Teflon washer provide moisture barrier.

CIRCLE 746 ON READER-SERVICE CARD

Choose from among four terminal types: L—insulated stranded Leads; S—Solder lugs; P—printed circuit Pins; W—uninsulated Wire. Full range of standard resistances from 10 ohms to 1 megohm. Other resistances available.

Trimpot
computers
taken

y. Only
so fre-
ou can

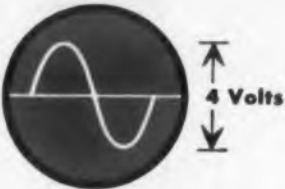
WHEN YOU HAVE
extraneous common mode signals



AND WANT TO MEASURE
0.1 to 100 millivolts full scale



AND THEN AMPLIFY



CHOOSE THE NEW HONEYWELL D-C AMPLIFIER



AccuData II

wide-band differential all-transistor D-C Amplifier for strain gages and thermocouples

- Full Scale Input: Unbalanced: $\pm 100 \mu\text{v}$ to $\pm 100 \text{mv}$
Differential: $\pm 3 \text{mv}$ to $\pm 100 \text{mv}$
Open Loop: Below drift level
- Full Scale Output: $\pm 2\text{v}$ at 50 ma, dc to 10 kc
- Frequency Response: to 20 kc
- Output Impedance: Less than 0.5 ohm at dc on all ranges
- Input Impedance: Unbalanced 3 to 100 mv ranges; greater than 20 megohms in parallel with 350 micromicrofarads.
Differential: Greater than ± 2 megohms
- Equivalent D-C Input Drift: Less than $2 \mu\text{v}/10^\circ\text{F}$ ambient temp. change on 0.1 to 30 mv input ranges
- Equivalent Input Noise: $4 \mu\text{v}$ peak-to-peak on 100 μv to 300 μv range (0-10 cps). $8 \mu\text{v}$ rms on 10 to 30 mv ranges (0 to 100 kc)
- Common Mode Rejection: 200,000 at 60 cps on 3 to 30mv ranges

The new Honeywell AccuData II is a completely transistorized D-C Amplifier designed for use in high accuracy data handling systems as a wide-band pre-amplifier for strain gages and thermocouples. Its output can be fed to electronic or electromechanical analog-to-digital converters and simultaneously recorded on galvanometer oscillographs or magnetic tape. Either differential or single-ended input modes can be selected by an eleven position range switch. This switch changes the gain in three-to-one steps. Intermediate gains with high resolution are provided by a ten-turn potentiometer. Write for AccuData II Bulletin to Minneapolis-Honeywell, Dept. 10, Boston Division, 40 Life Street, Boston 35, Mass.

Honeywell



First in Control

CIRCLE 184 ON READER-SERVICE CARD

NEW PRODUCTS

Trimmer Potentiometer

Case is 0.89 x 0.21 x 0.312 in.



Having a resistance range of 10 to 100,000 ohms with $\pm 5\%$ standard tolerance, type W-5 trimmer potentiometer has a case size of 0.89 x 0.21 x 0.312 in. and 0.75 mounting hole centers. The unit dissipates 2 w at 70 C, derating linearly to zero at 200 C. Extreme environmental conditions are provided for. The unit is available with side-mounted printed circuit configurations, flexible wire leads, solder-lugs or panel-mounting hardware.

Atohm Electronics, Dept. ED, 7648 San Fernando Rd., Sun Valley, Calif.

CIRCLE 185 ON READER-SERVICE CARD

Radiant Energy Standard

Source temperature kept within ± 1 deg Kelvin

This radiant energy standard is comprised of model 403 black body and model 100 temperature controller. Designed to emit black body radiation over the temperature range of 500 to 1000 Kelvin, the unit maintains its radiation source temperature within 1 deg Kelvin despite changes in ambient temperature, line voltage variations, transients, and tube aging. The selected temperature is maintained by a combination of vacuum-tube amplifier and thyatron circuitry.

Infrared Standards Lab., Dept. ED, 10555 Magnolia Ave., Riverside, Calif.

CIRCLE 186 ON READER-SERVICE CARD

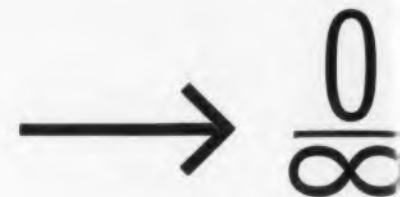
Power Supply

Provides to 60 v dc



Model ME 60-1M transistorized power supply is rated at 0 to 60 v dc at 0 to 1 amp continuously variable over the entire range. It has no external

IT'S NOT
"HOW THIN"



BUT
HOW EXACT!

With the recent trend in strip metal towards thinner and thinner gauges Somers, a pioneer in thin strip for nearly 50 years, is naturally among the leaders in rolling ultra-thin strip. But in addition to rolling production quantities of strip as thin as can be obtained anywhere in the world, Somers utilizes exclusive techniques and equipment to make sure that every foot of metal is up to the most exacting standards.



1. Accu-Ray nuclear gauging to assure of solute uniformity of thickness throughout



2. Unique rolling mill for strip from .001 down, makes possible extremely close control of the final anneal temper, uniform accuracy the final temper.

3. Experience exclusively with thin strip metals gives Somers an unmatched background in engineering ultra-thin strip to meet all special requirements.

NEARLY
FIFTY
YEARS

FOR EXACTING STANDARDS ONLY

Somers

Somers Brass Company, Inc.
116 BALDWIN AVE., WATERBURY, CONN.
CIRCLE 187 ON READER-SERVICE CARD

LEADERSHIP LINE



Westinghouse INSULATION REPORT NO.2

.....published by Micarta Division, Westinghouse Electric Corporation



Fostercast #26 Withstands Severest Tests

Today's engineers recognize the importance and need of good transformer protection. That's why they specify Fostercast #26—the Westinghouse resin that permits cast transformers to withstand even the severest flame and moisture tests.

Fostercast #26 resin has passed the flammability test #2021, as well as the thermal shock test, Type C, of Military Specification MIL-I-16923. Transformers treated with the resin have also passed the humidity and flammability tests of MIL-T-27A.

Gelation and curing of the resin can be accomplished at relatively low temperatures, although best results have been obtained at 60° to 80° C. Standard casting methods are used.

Design Engineers' Note: Fostercast #26 resin costs substantially less than epoxies!

For further information and data, check Box No. 2 in the coupon below, and mail.



Another Industry First

Now, from Westinghouse, comes an entirely new line of self-adhering, fully cured tapes for class "H" flexible insulation—self-adhering silicone rubber-treated glass cloth and tapes.

These new treated tapes, which are available coated on one or both sides, are ideal for cables, transformers, coils and lead wire because they offer these four insulation features:

1. Lower insulation costs due to absence of inter-leaf and separator.
2. Dielectric strength of tape greater than conventional semicured silicone rubber tapes and equal to fully cured silicone rubber tapes.
3. Good shelf life (three-month minimum)—this eliminates procurement and stocking problems.
4. Self-adhering characteristics enable the tape to stay in place with adequate bonding, thus forming a homogeneous structure impervious to moisture.

These features add up to longer insulation life and lower insulation costs for the user. Silicone tapes can be ordered in standard width in 36- and 72-yard rolls, and on special cores and pad diameters for use with cable wrapping machines. Get full details by checking Box No. 1 on reply card.

Mail to:

MICARTA DIVISION		ED 11-9
WESTINGHOUSE ELECTRIC CORPORATION		
MANOR, PA.		
Send Me Information on the Following:		
1 <input type="checkbox"/> Silicone Rubber-Treated Glass Cloth and Tapes		2 <input type="checkbox"/> Fostercast #26 Resin
Name _____		Title _____
Company _____		
Address _____		
City _____		Zone _____ State _____
J-06638		

YOU CAN BE SURE...IF IT'S **Westinghouse**

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS"
CBS TV FRIDAYS



CIRCLE 191 ON READER-SERVICE CARD

circuit breaker handle or fuses but can be operated at 120% of rated current. Under short circuit conditions the unit can be operated for long periods with 1/3 of the dissipation in the power transistors that occurs at normal full load. The current is cut off automatically when the output exceeds a preselected point, which is continuously variable from 20% to 120% of rated current. The output voltage may be regulated to 0.1% or 0.01%. Recovery time is less than 50 μ sec and overshoot is less than 1%. Ripple is 0.01% max. The unit mounts on a standard 19 in. rack with panel height of 5-1/4 in., or can be furnished in a portable bench-top housing.

Mid-Eastern Electronics, Inc.,
Dept. ED, 32 Commerce St., Springfield, N.J.

CIRCLE 188 ON READER-SERVICE CARD

Tester

For synchro torque receivers

Model RF-2 receiver test fixture automatically tests for dynamic error in accordance with BuOrd spec MIL-S-20708A. It can be used with aircraft indicators having sealed-in torque receivers. By pressing a button the indicator is driven with a three-wire electrical signal at the rate of 1 rpm. The variation in this signal is converted into a direct angular error indication without the aid of transducers. Specifications include frequency of 400 cps and synchro excitation of 10 to 115 v. The unit measures 21-3/4 x 9-3/4 x 4-3/4 in.

Theta Instrument Corp., Dept. ED,
40 Victor St., Saddle Brook, N.J.

CIRCLE 189 ON READER-SERVICE CARD

Multiplexers

Miniature type

The S series of miniature electro-mechanical telemetering multiplexers are available in all standard channel configurations and sampling rates for PAM and PDM applications. Containing no vacuum tubes, the amplifier is stabilized against drift during the master pulse interval by stabilizing segments on the mechanical commutator. The common mode rejection ratio is better than 100,000:1.

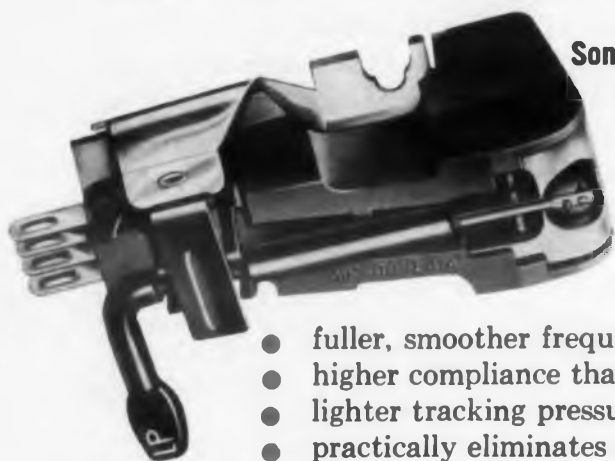
General Devices, Inc., Dept. ED,
Box 253, Princeton, N.J.

CIRCLE 190 ON READER-SERVICE CARD

Now... from Sonotone—

4 Big Improvements

in the quality stereo cartridge



Sonotone 8TA cartridge replaces 8T as industry standard

The new Sonotone 8TA cartridge gives greater than ever stereo performance... has 4 big extras:

- fuller, smoother frequency response
- higher compliance than ever before
- lighter tracking pressure
- practically eliminates dust pile-up

ONLY
\$1450*

Sonotone 10T unitized stereo at lowest price ever

New 10T cartridge sells at record low price of \$6.45.* And it covers the complete high fidelity range. 10T's unitized construction makes it easiest to install, easiest to replace. Low price means more sales—more profits.



SPECIFICATIONS

	8TA	10T
Frequency Response	Smooth 20 to 20,000 cycles. Flat to 15,000 with gradual rolloff beyond.	Flat from 20 to 15,000 cycles ± 2.5 db.
Channel Isolation	25 decibels	18 decibels
Compliance	3.0×10^{-6} cm/dyne	1.5×10^{-6} cm/dyne
Tracking Pressure	3-5 grams in professional arms 4-6 grams in changers	5-7 grams
Output Voltage	0.3 volt	0.5 volt
Cartridge Weight	7.5 grams	2.8 grams
Recommended Load	1-5 megohms	1-5 megohms
Stylus	Dual jewel tips, sapphire or diamond.	Dual jewel tips, sapphire or diamond.

*including mounting brackets

Sonotone makes only 6 basic ceramic cartridge models... yet has sold over 9 million units... used in over 662 different phonograph models. For finest performance, replace worn needles with genuine Sonotone needles.

Sonotone PRO P. Electronic Applications Division, Dept. CGG-119
ELMSFORD, NEW YORK



Leading makers of fine ceramic cartridges, speakers, tape heads, microphones, electronic tubes.
In Canada, contact Atlas Radio Corp., Ltd., Toronto

CIRCLE 192 ON READER-SERVICE CARD

NEW PRODUCTS



Temperature Control

For refrigeration or heating equipment

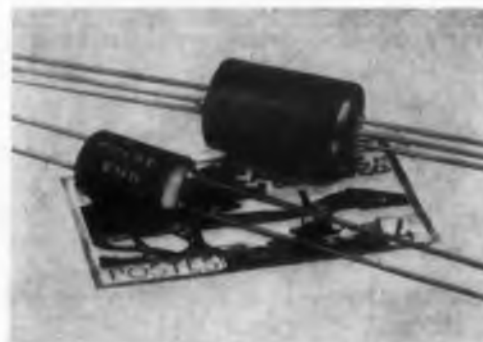
Designed for exterior use to control either refrigeration or heating equipment, model GWS, non-indicating, single-point temperature control, is resistant to weather conditions and to shock and vibration. Functioning as a limit control, it stops the flow of the refrigeration medium or of steam, oil, gas or electricity for heating applications. Dials can be calibrated or uncalibrated. The unit can have a normal sensitivity of 1% of scale range or a close sensitivity of 0.5% of scale range.

Partlow Corp., Dept. ED, 530 Campion Rd., New Hartford (Utica), N.Y.

CIRCLE 193 ON READER-SERVICE CARD

Pulse Transformer

Subminiature



This subminiature pulse transformer, called the Micro-Stat, has a hermetically sealed metal casing that is 0.57-in. long with a diameter of 0.51 in. It is also available with an epoxy casing that is 0.41-in. long with a diameter of 0.3 in. All applicable military specifications are met by the unit that comes in over 50 designs. The unit is constructed on an armite form for precise winding geometry to control leakage inductance and distributed capacity. Each unit has a polished gap which represents 1/2 mil of effective gap. Improved voltage breakdown and insulation resistance is claimed through use of core-gapped construction.

Pulse Engineering, Inc., Dept. ED, 560 Robert Ave., Santa Clara, Calif.

CIRCLE 194 ON READER-SERVICE CARD

WHO NEEDS FEED-BACK?

The patented chronometric governor of this standard DC Timing Motor is a tyrant: without any other circuitry, it holds the motor output speed within $\pm 0.1\%$ while driving charts, cams, contacts, actuators or other devices. It holds the rate even if output shaft load, line voltage, or ambient temperatures change. And that's just the standard model of this little gem: custom variations can do even better, under special conditions.

The A. W. Haydon Co. knows all about timers and timing. If you have a specific timing problem, you ought to have our literature.

Bulletin MO 802 is yours for the asking (5800 Series chronometrically governed DC Motor.)



AWHAYDON
THE COMPANY

227 North Elm Street, Waterbury 20, Connecticut

CIRCLE 195 ON READER-SERVICE CARD

CANNON PLUGS

Schweber

FOR
IMMEDIATE
LARGE
QUANTITY
DELIVERY
AT
FACTORY
PRICES

2500

Yes! You can now order up to 2500 each of such popular Cannon Connector types as Miniature D, KO, DPD, DPA, DPX, etc. Immediate shipment at factory prices.

Schweber

ELECTRONICS

100 RICKS ROAD, MINEOLA, L.I., N.Y.

TELEPHONE 6-6520 TWX G-CY-NY-580

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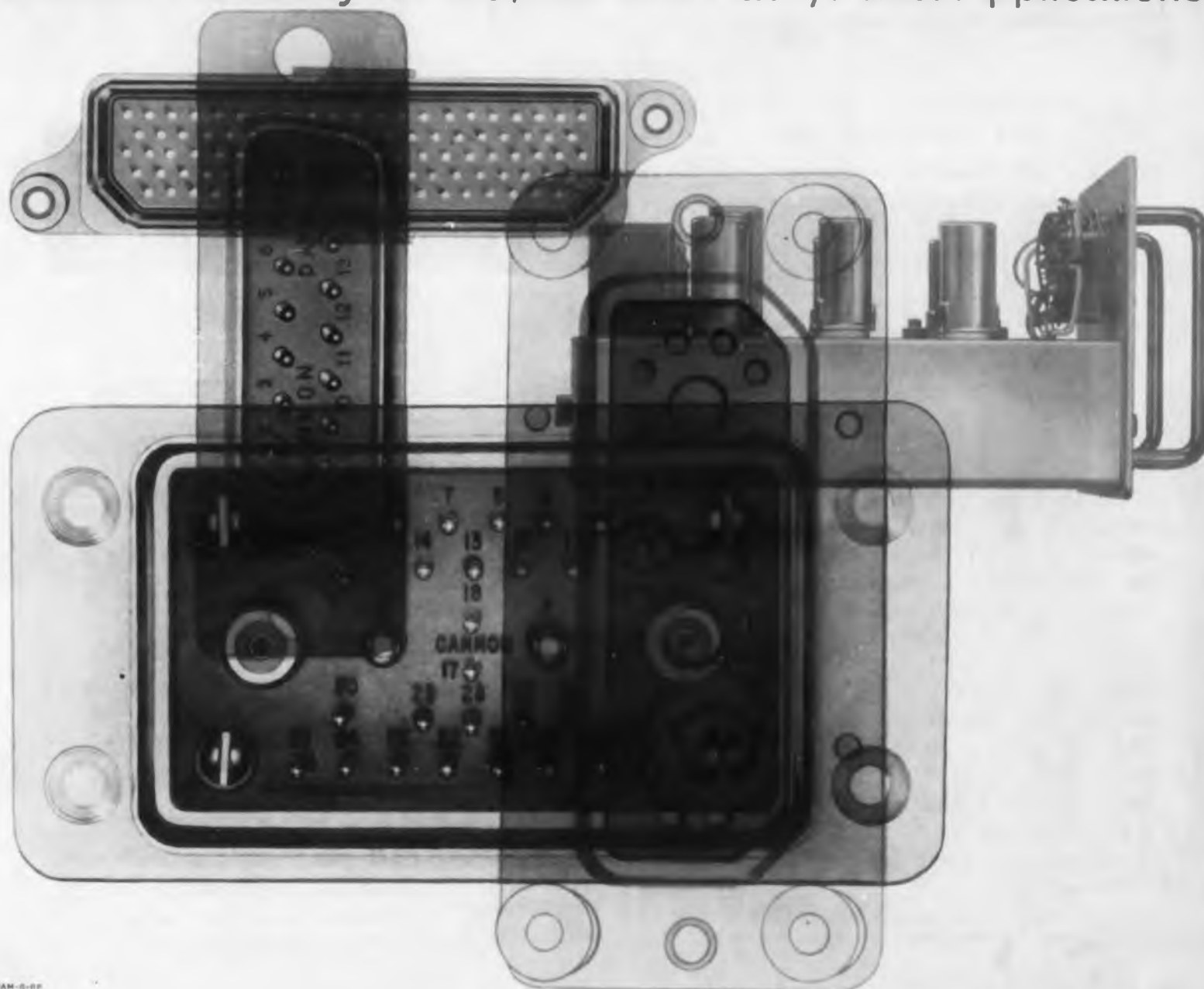
CIRCLE 197 ON READER-SERVICE CARD



The assembling of highly-flexible electronic systems and sub-systems into a modular package . . . for fast inspection, testing, service, and replacement of components . . . calls for standardized-type plugs throughout the system. Reliability and optimum flexibility in shell designs and types of layouts are the design criteria for the more than 18 different basic Cannon Modular and Rack/Panel Plug Series. This Series is available in standard, miniature, or subminiature sizes . . . for standard or printed circuitry. Up to 180 contacts and a varied combination of contacts for control, audio, thermocouple, co-ax, twin-ax, and pneumatic connections. Single or double-gang. With or without shells. The Rack/Panel Series ranges from the tiny "D" subminiature to the heavy-duty DPD Rack/Panel Plug. For further information on Cannon Modular and Rack/Panel Plugs write for Cannon DP Catalog, Cannon Electric Co., 3208 Humboldt St., Los Angeles 31. Please refer to Dept. 438 Factories in Los Angeles, Santa Ana, Salem, Toronto, London, Paris, Melbourne, Tokyo. Distributors and Representatives in the principal cities of the world.

CANNON PLUGS

Maximum Flexibility for Modular and Rack/Panel Applications



CAN-6-66

NEW PRODUCTS

Blowers

Corrosion-resistant



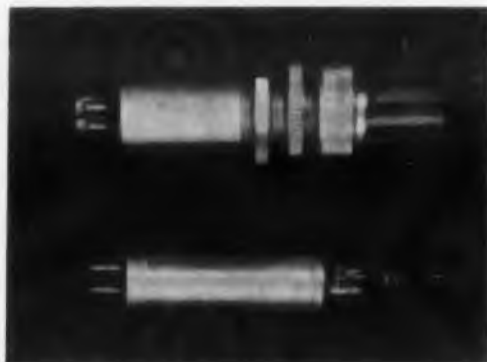
Series PVC direct-drive, corrosion-resistant utility blowers come with 1/3, 3/4, or 1 hp motors and capacities of 399 to 2000 cfm. Constructed of rigid unplasticized polyvinyl chloride, they can be used in such applications as laboratory hood exhaust systems. They withstand temperatures to 140 F at the blower inlet.

Industrial Plastic Fabricators, Inc., Dept. ED, Endicott St., Norwood, Mass.

CIRCLE 198 ON READER-SERVICE CARD

Gas Triode Indicator

For transistor monitoring



This gas triode indicator is a subminiature grid-controlled unit designed for transistor monitoring service. The 1GT7 with a plug-in KP-145A tube can be operated as a conventional thyratron and used in relay control circuits. Or it can be applied in circuits requiring electrical memory combined with visual readout. In typical ac operation the anode voltage is 120 v ac, the anode series resistance is 120 K, and the grid triggering voltage is from 1.5 to -6 v. In typical dc operation, the anode voltage is 85 ±15 v dc, the anode series resistance is 120 K, and the grid triggering voltage is from 0 to -4.5 v.

Eldema Corp., Dept. ED, 1805 Belcroft Ave., El Monte, Calif.

CIRCLE 199 ON READER-SERVICE CARD

Is your pot in armor, too?

Choose from SPECTROL's complete new line of METAL Multi-Turn Precision Potentiometers

At first you may wonder what in blazes our friend in armor, Sir Spectrol, is doing in a serious magazine like this. Well, it's just a bit of trickery on our part to call your attention to Spectrol's 8 new metal multi-turn pots. *The first complete line anywhere.* Also, to remind you Spectrol makes many other pots, special and standard. There will be more trickery with Sir Spectrol in future issues, but you can easily see through it and there will be plenty of accompanying facts, figures, photos and specs.



BOOST SPEED and EASE of Production Line Testing

End Calculation and Transcribing Errors



- 0.001% Ratio Accuracy at a 1000:1 step down; this is terminal linearity of 1 part in 10 million.
- Resolution: 1 part in 100 million of input—300 million discrete steps above and below unity.
- Ratios of 3-to-1 step up to 10⁻⁸ step down.
- Direct, in-line readout of numbers on sloping panel.

Transformers, synchros, resolvers, computers, and meters can be tested on a simple "go/no-go" basis.



MODEL NO. 7600



MODEL NO. 7500

RATIOFORMER

Ruggedly built. High input, low output impedance, extremely low phase shift make the OEKO Ratioformer a versatile and adaptable instrument.

DEVIAFORMER

Direct readout of percent of deviation from specified voltage ratios. Used with a ratio standard such as the OEKO Ratioformer, reduces measurement to extremely accurate % answer.

Write for descriptive folder.

OSBORNE electronic sales corp.

712 S. E. Hawthorne Blvd., Portland 14, Oregon
13105 S. Crenshaw, Hawthorne, California

CIRCLE 200 ON READER-SERVICE CARD

MOBILE-IZE YOUR ELECTRONIC EQUIPMENT



MODEL OC-2 WITH FORMICA SCOPE TRAY

PRICE ONLY \$54.50

1 o b Glendale Calif

TECHNIBILT
CORPORATION
905 AIR WAY, GLENDALE 1, CALIFORNIA

CIRCLE 201 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1968

The Metal Pots

Spectrol offers four 3-turn and four 10-turn models. All feature anodized aluminum cases with 3/16-inch thick walls. These 8 precision wire-wound pots absorb no moisture—dissipate heat fast and stay dimensionally stable. They operate from -55°C to $+125^{\circ}\text{C}$ and withstand relative humidity of 95%.

You can choose diameters of 7/8, 1, 1-5/16 and 1-13/16 inches in both 3 and 10-turn models. Resistance ranges to 1,000,000 ohms with standard linearity tolerances of $\pm 0.25\%$ (0.020% on special order). Like Sir Spectrol, the new multi-turns will take a respectable jolt. They function to 20g vibration from 55 to 2,000 cps and withstand 30g shocks.

Please write for literature, or consult the yellow pages of your phone book for your Spectrol engineering sales representative.

SPECTROL

ELECTRONICS CORPORATION
1704 SOUTH DEL MAR AVENUE • SAN GABRIEL, CALIFORNIA

17

CIRCLE 202 ON READER-SERVICE CARD

SPECIFICATIONS

MODEL	540	530	580	560	780	790	880	840
No. of coil turns	10	3	10	3	10	3	10	3
Diameter (Inches max.)	3/4	3/4	1	1	1 1/4	1 1/4	1 1/4	1 1/4
Standard resistance range in ohms ($\pm 3\%$)	25-125K	10-36K	25-150K	10-40K	30-300K	10-90K	50-400K	20-120K
Special resistance to	250K	75K	250K	75K	750K	240K	1 meg	330K



SPECIAL POTS

Spectrol can design and deliver the pot you need when you need it. Recent custom designs include pots for airborne computers, pots designed to be immersed in fuel, pots for high temperature application, pots with non-linear functions, and many others. Let us know your requirements.

STANDARD POTS

Popular single and multi-turn models and turns counting multi-dials are stocked in 30 electronics supply houses in the U. S. and Canada. Ten resistance ranges from 100 ohms to 200 k ohms with standard linearity tolerances of $\pm 0.3\%$ are available.

Terminal Blocks

With many types of terminals



These terminal blocks are supplied with either stud or turret terminals or a combination of both, as well as with screw type terminals. Possible configurations include threaded stud terminals on top of block so that two or more leads can be attached to a common terminal, and solder turret terminals on top of the block. Taper-pin terminals are also available. On double-row terminal blocks, a combination of terminal types can be used for the two rows and bus plates can be supplied to connect the two rows at any point between the barriers.

Kulka Electric Corp., Dept. ED, 633-643 S. Fulton Ave., Mt. Vernon, N.Y.

CIRCLE 205 ON READER-SERVICE CARD

MINIATURE THERMAL MAGNETIC CIRCUIT BREAKER

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VOLTAGE: 250 V A.C. 65 V D.C.

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Ideal as a dependable sensitive protection in communication equipment, telephone systems, electronic and electrical equipment. Available with auxiliary circuits to signal "Make" and "Break" position; features manual release for occasional disconnection of equipment from line.

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E-T-A

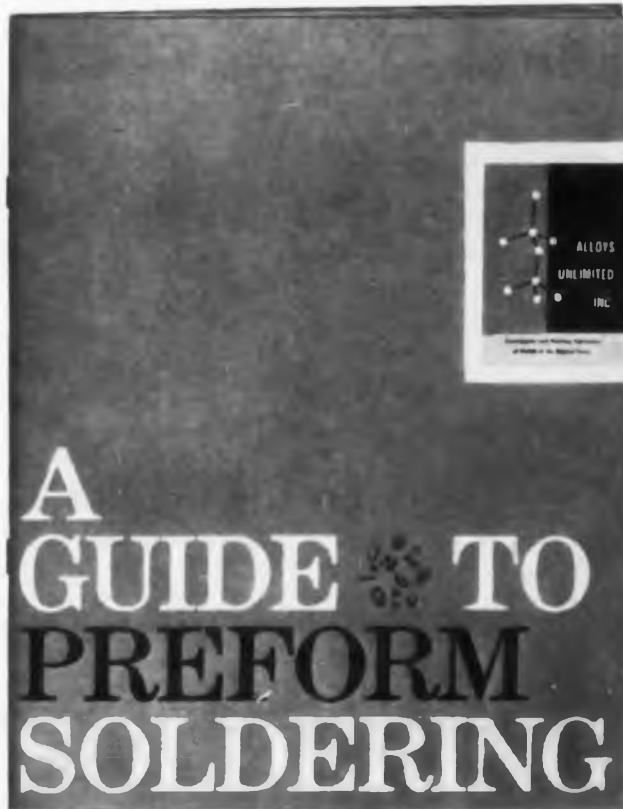
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FREE! NEW 8 PAGE GUIDE

Complete information on solder preforms, their selection and use. Technical diagrams. Send for your copy today.

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CIRCLE 204 ON READER-SERVICE CARD

Microwave Filter

Range is 3000 to 36,000 mc



Originally designed for C-band operation, this microwave filter can operate with any waveguide size or at any frequency from 3000 to 36,000 mc, and with larger or smaller pass and stop bands. Typical characteristics at the C-band are: 0.3 db maximum insertion loss in the pass band, 1.4 max vswr in the pass band, 30 db minimum rejection in the stop band, and a power capacity of 0.5 mw cw.

Litton Industries, Dept. ED, 336 N. Foothill Rd., Beverly Hills, Calif.

CIRCLE 206 ON READER-SERVICE CARD

NEW PRODUCTS

Potentiometer Wirewound type



Having a 3/4 in. diam, this wirewound potentiometer is especially designed for environmental conditions found in military applications. It has from 25 to 50,000 ohms resistance. The applicable parts of MIL-R-19A, MIL-E-5272A, MIL-R-19518, MIL-R-12934B, and NAS 710 are met. The unit has sealed-type construction for encapsulation.

Maurey Instrument Corp., Dept. ED, 7924 S. Exchange Ave., Chicago 17, Ill.

CIRCLE 207 ON READER-SERVICE CARD

Wavemeters

Can be read directly to 0.0001 in.



These secondary-standard, broadband wavemeters can be read directly to 0.0001 in. Large micrometer heads are used, eliminating the need for verniers. The line ranges from 2.6 to 140 kmc in 12 models, each covering the entire waveguide bandwidth. The units have high Q values, which are maintained by the sealed construction and inert gas pressurization. Changes in humidity, altitude, and barometric pressure are provided for. Each unit is individually calibrated and is supplied with a calibration chart.

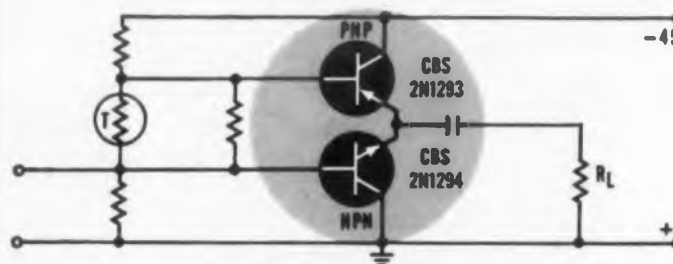
DeMornay-Bonardi, Dept. ED, 780 S. Arroyo Parkway, Pasadena, Calif.

CIRCLE 208 ON READER-SERVICE CARD

First of a series of
complementary power transistor lines

NEW CIRCUIT ECONOMIES THROUGH COMPLEMENTARY POWER TRANSISTOR PAIRS

Complementary pairs of CBS NPN and PNP power transistors eliminate input and output transformers in push-pull circuits. Resulting advantages are many: Economy. Miniaturization. Improved frequency response. Ease of applying negative feedback. Etc.



COMPLEMENTARY CLASS B AMPLIFIER

NOTE THE IDENTICAL DATA FOR THESE NPN-PNP PAIRS

NPN Type	Max. W. Diss.*	Max. V _{CEO} †	Max. V _{CEs} ‡	Min. h _{FE} (I _C =0.5A)	Max. Thermal Res. °C/W	PNP Type
2N326	7	35	35†	30	8	2N1291
2N1292	20	35	30‡	30	3	2N1291
2N1294	20	60	45‡	30	3	2N1293
2N1296	20	80	60‡	30	3	2N1295
2N1298	20	100	80‡	30	3	2N1297

All types have: Max. collector current, 3 amps; storage temperature, -65 to +85°C. *25°C base mounting temperature. †Polarity: NPN positive, PNP negative. ‡I_{CEs} = 1 ma max. †I_{CEs} = 10 ma.



A SURVEY of customer applications resulted in this line of five CBS NPN-PNP pairs that make possible new economies in complementary circuitry. Mounted in the popular TO-3 diamond package, they feature high voltages . . . up to 100 volts, and proven reliability (they exceed the MIL-19500A specification). They offer the first complete line of complementary power transistors . . . with more coming in future ranges of ratings and packages . . . for audio, control, voltage regulation, servo and computer applications. Check the simplicity of the circuit and the abbreviated data for this versatile and comprehensive CBS line. Write for complete technical Bulletin E-332A.

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CBS semiconductors

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

Sales Offices: Lowell, Massachusetts, 900 Chelmsford St., Glenview 4-0446 • Newark, N. J., 32 Green St., Market 3-5832 • Melrose Park, Ill., 1990 No. Mannheim

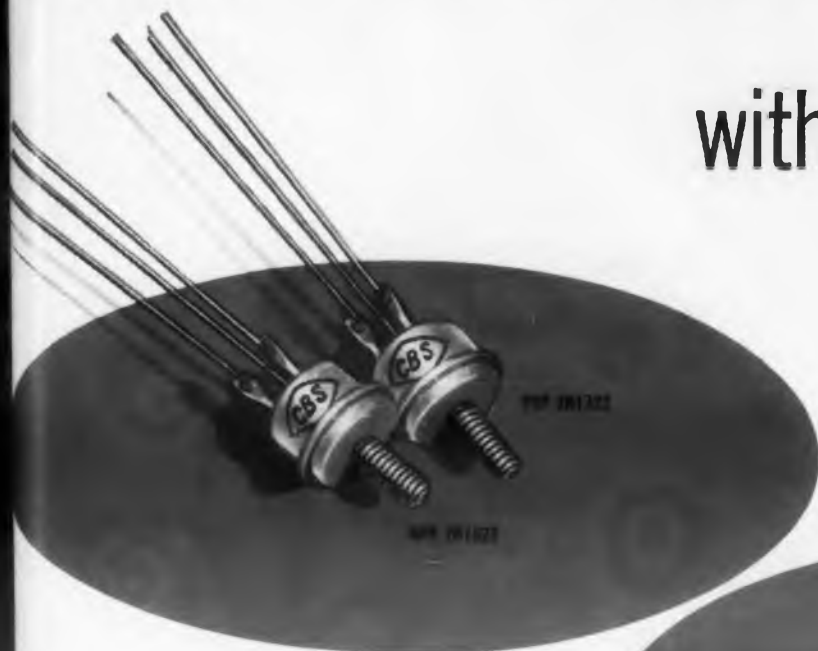
Eastbrook 9-2100 • Los Angeles, Calif., 2120 S. Garfield Ave., Raymond 3-9081

CIRCLE 209 ON READER-SERVICE CARD

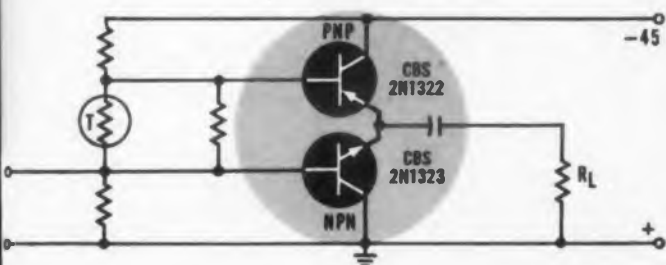
Second of a series of complementary power transistor lines

NOW... COMPLEMENTARY CIRCUIT ECONOMIES

with **INDUSTRIAL** NPN-PNP POWER TRANSISTOR PAIRS



Complementary pairs of CBS NPN and PNP power transistors eliminate input and output transformers in push-pull circuits. Resulting advantages are many: Economy. Miniaturization. Improved frequency response. Ease of applying negative feedback. Etc.



Typical Industrial Complementary Push-Pull Amplifier

INDUSTRIAL NPN-PNP POWER TRANSISTOR PAIRS

NPN Type	Package	Max. W. Diss.*	Max. $V_{CB0}†$	Max. $V_{CES}‡$	Min. h_{FE} ($I_C = 0.5A$)	Max. Thermal Res. °C/W	PNP Type
2N1321	Male	20	35	30 $‡$	30	3	2N1320
2N1329	Female	20	35	30 $‡$	30	3	2N1328
2N1323	Male	20	60	45 $‡$	30	3	2N1322
2N1330	Female	20	60	45 $‡$	30	3	2N1078
2N1325	Male	20	80	60 $‡$	30	3	2N1324
2N1332	Female	20	80	60 $‡$	30	3	2N1331
2N1327	Male	20	100	80 $‡$	30	3	2N1326
2N1334	Female	20	100	80 $‡$	30	3	2N1333

All types have: Max. collector current, 3 amps; storage temperature, -65 to +85°C. *5°C base mounting temperature. †Polarity: NPN positive, PNP negative. ‡ $I_{CES} = 10$ ma.

Enthusiastic acceptance of the diamond-package line of CBS NPN-PNP power transistors has disclosed a demand for additional pairs in industrial packages. These new industrial types make possible the same design economies of complementary circuitry. Mounted in TO-10 and TO-13 male and female packages, they are supplied with solder lugs or flying leads. And they feature high voltages (up to 100 volts) and proven quality (they exceed the MIL-T-19500A specification). The new units add another complete industrial line to the growing lines of CBS complementary power transistors for audio, control, voltage-regulation, servo and computer applications. Check circuit and abbreviated data. Write for complete data sheets: Industrial types, Bulletin E-360; diamond types, E-355. Order now from your local Manufacturers Warehousing Distributor. Watch for a higher power line soon.

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through Advanced Engineering

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Sales Offices: Lowell, Mass., 900 Chelmsford St., GLenview 4-0446 • Newark, N. J., 32 Green St., MARket 3-5832
Melrose Park, Ill., 1990 N. Mannheim Rd., EStbrook 9-2100 • Los Angeles, Calif., 2120 S. Garfield Ave., RAymond 3-9081

CIRCLE 210 ON READER-SERVICE CARD

Pulse Generator

Repetition rate is 2 mc



The model 3450C pulse generator is constructed entirely of plug-in wiring modules that allow extension to multiple pulse requirements and provide maximum accessibility for maintenance. Fast rise time pulses at repetition rates to 2 mc are provided. Features include: wide range variable pulse delay and duration, high resolution controls, and automatic overload protection. The output amplitude is stabilized by power regulators and pulse output is presented dc coupled with base line at chassis ground.

Electro-Pulse, Inc., Dept. ED, 11861 Teale St., Culver City, Calif.

CIRCLE 211 ON READER-SERVICE CARD



Crystal Oscillator

Stability is 0.001% to
0.0001%

Type DFO-12 crystal oscillator is available at any frequency from 10 kc to 100 mc and provides a stability of 0.001% to 0.0001%, depending on frequency. The standard operating temperature range is -55 to +75 C; special units for operation to +105 C are available. An input of 20 v or more provides an output of 100 mv into a 50-ohm load with corresponding power outputs into impedances as high as 500 ohms. The current required is 3 to 5 ma. Heater voltage may be dc or from 6.3 to 115 v ac with 4 w avg. Encapsulated in Silastic, the unit measures 1-1/4 in. diam and 3-1/2 in. long. It weighs 3-1/2 oz.

Delta-f, Inc., Dept. ED, 113 E. State St., Geneva, Ill.

CIRCLE 212 ON READER-SERVICE CARD





ELECTRONICS

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

ELECTRONICS: In the half century since the invention of the original audion tube by De Forest, the art of electronics has expanded to a fourteen billion dollar industry that is contributing in hundreds of ways to our knowledge of the universe and our understanding of life itself. At Lockheed, for example, over half the technical staff is engaged in electronics research and development.

Significant contributions to the advancement of the state of the art in electronics have been made by Lockheed engineers and scientists in such areas as: computer development; telemetry; radar and data link; transducers and instrumentation; microwave devices; antennas and electromagnetic propagation and radiation; ferrite and MASER research; solid state electronics, including devices, electrochemistry, infrared and optics; and data reduction and analysis.

Over one-fifth of the nation's missile-borne telemetering equipment was produced by Lockheed last year. Its PAM/FM miniaturized system provides increased efficiency at one-fourth the weight of FM/FM missile-borne systems.

Advanced development work in high-energy batteries and fuel cells has resulted in a method for converting chemical energy directly into electrical power that promises a fuel utilization of almost 100% and an energy conversion efficiency of 70% or better.

Areas of special capability in computer development include the design of large scale data handling systems; development of special purpose digital computing and analog-digital conversion devices; development of high-speed input-output equipment; and advanced research in computer technology, pattern recognition, self-organizing machines, and information retrieval.

Other major developments are: a digital flight data recorder able to record each of 24 channels every few seconds; digital telemetry conversion equipment to reduce telemetered test data to plotted form rapidly and inexpensively; advancements in the theory of sequential machines; and a high-speed digital plotter that can handle some four thousand points per second with the finished plot programmed into the data tape as a continuous curve.

Lockheed Missiles and Space Division is engaged in all fields of the art — from concept to operation. Its programs reach far into the future and deal with unknown environments. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, Dept. K-21, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed

MISSILES AND SPACE DIVISION

Systems Manager for Navy POLARIS FBM; DISCOVERER, MIDAS and SAMOS; Army KINGFISHER; Air Force Q-5 and X-7.

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for industrial and military applications

CIRCLE 213 ON READER-SERVICE CARD

NEW PRODUCTS

Power Supplies

Provide 110 to 325 v dc



The 300 series of transistorized power supplies furnishes 110 to 325 v dc variable output at 200, 400, 800, and 1500 ma with 0.1% load and 0.1% line regulation. The 200, 400, and 800-ma units require only convection cooling and occupy 3-1/2 in. of panel space. The 1500-ma power supply has a 5-1/4 in. panel height and uses forced air cooling. Remote programming is provided on all units.

Trygon Electronics, Inc., Dept. ED, Pleasant Ave., Roosevelt, L.I., N.Y.

CIRCLE 214 ON READER-SERVICE CARD

DC Signal Sources

For digital programming



Made for digital programming, these dc signal sources accept input signals from such program devices as paper tape recorders and keyboards. Typical uses are in automatic checkout equipment and precision testing applications. Standard units are for three binary-coded decimal digits; other codes can be supplied. The three digits may be fed serially or simultaneously. External contacts must remain closed for 3 sec to register. The unit has a clock closure circuit. The output voltage stability is 0.05% under these conditions: no load to full load, ± 10 deg C temperature change, and $\pm 10\%$ variation in line voltage. Recovery time for a 20% load change is 100 μ sec. The voltage is adjustable with an accuracy of $\pm 0.1\%$ and the output ripple is under 0.05%. The unit requires 8-3/4 in. of rack space.

Consolidated Avionics Corp., Dept. ED, 880 Canal St., Stamford, Conn.

CIRCLE 215 ON READER-SERVICE CARD

STRAPLOCK* CABLE CLAMPS

- SAVE TIME
- REDUCE INSTALLATION COSTS
- SIMPLIFY ASSEMBLY



Just push Straplocks into place and you're ready to lay cables or wires immediately—without time-consuming bundling or lacing. Straplocks require only a mounting hole for fast, easy manual installation, eliminate "blindspot" problems, quickly adjust to various sizes and align perfectly. They provide an ideal vibration-proof clamp for fastening cables or wires to cabinets, panels or sheet metal surfaces.

SPECIFIED AS ORIGINAL EQUIPMENT
IN AUTO INDUSTRY



Ford Motor Company now uses Straplocks for installing electrical cables in new autos and trucks. In typical application above, lighting cable is anchored quickly and economically. Straplocks resist engine heat, oil, grease and battery acid.

Molded from tough Nylon, Straplocks resist oils, greases, common solvents and severe temperatures from -65° to $+300^\circ$ F. Absence of any metal in their construction and mounting requirements assures complete insulation. They are especially suited for aircraft, missile, automotive and heavy appliance applications.

Request literature and technical data.

STRAPLOCK SAMPLE KIT

Prove to yourself how Straplocks save time, reduce installation costs. Special introductory kit containing 200 W-1 Straplock Cable Clamps and handy installation tool costs only \$4.50. Order today!

*Patented
WHITSO, INC.

9326 Byron Street, Schiller Park, Illinois
(Chicago Suburb)

CIRCLE 216 ON READER-SERVICE CARD

Voltage Divider

Six-decade type

Model VDR-106A six-decade voltage divider can be set to any one of 1,000,000 voltage divider ratios from 0.000001 to 1 with an absolute accuracy of 0.0002% of the input voltage from dc to 4000 cps. At 10 kc the absolute accuracy is better than 0.0005%. The resolution is 0.0001% and the over-all resistance of the divider is 10,000 ohms. The rated accuracy is maintained from 15 to 35 C. Suitable for rack mounting, the unit measures 19-1/2 x 14 in. A unit for bench use is also available.

Julie Research Labs., Inc., Dept. ED, 556 W. 168th St., New York 32, N.Y.

CIRCLE 253 ON READER-SERVICE CARD

Mercury Relays

Two- and three-pole types

These double- and triple-pole mercury relays, called Phaertltron, have Teflon bearing surfaces, heavy tungsten contacts, and mercury-to-mercury make and break. The plunger units are hermetically-sealed in glass. There is no exposed arc. Contacts are rated at 35 and 60 amp at 115 v ac. The triple-pole model measures 5-9/16 x 4-3/4 x 2-5/16 in.; the double-pole model is 4-1/8 in. wide.

Mack Electric Devices, Inc., Dept. ED, Wyncote, Pa.

CIRCLE 254 ON READER-SERVICE CARD

Magnetic Switch

Has plastic shell

Contained in a plastic shell, type MH-2-P magnetic switch is for mounting in areas of limited access and has a quick disconnect plug. A minimum magnetic field transient time of 8 msec is needed to activate the switch. The operating life is in excess of 1,000,000,000 operations. Post Machinery Co., Dept. ED, 175 Eliot St., Beverly, Mass.

CIRCLE 255 ON READER-SERVICE CARD

CIRCLE 218 ON READER-SERVICE CARD

READY
GET SET...
(3, 2, 1...)

ANDREW
HELIAX®

A truly flexible
air-dielectric cable

The advertisement features a large black and white photograph of a rocket launch. A man in a suit stands next to a large coil of cable, holding a section of it. The background is dark, and the rocket is illuminated. The text 'READY GET SET... (3, 2, 1...)' is positioned above the man. The Andrew Heliax logo, consisting of a stylized lightning bolt with the word 'ANDREW' inside it and 'HELIAX®' below, is placed on a white rectangular background. Below the logo, the text 'A truly flexible air-dielectric cable' is written in a smaller font.

At the zero second everything must function without failure. ANDREW HELIAX cable is used in postassembly and preflight checkouts of missile radio frequency systems. The cable forms a closed circuit over which interrogation and response signals are transmitted between checkout equipment and airborne radio frequency packages. The HELIAX cable runs from a mobile trailer to connecting points on the missile.

The ruggedness of HELIAX makes it well suited to this challenging task, where its low VSWR, low RF leakage and low attenuation give accurate measurement of systems performance. Flexibility permits the cable to be taken down, recoiled and subsequently reused many times.

If you require similar characteristics in a cable, consider the special advantages of HELIAX.

HELIAX is normally supplied as an assembly, complete with end fittings factory attached, reducing installation labor and improving quality.

Complete uniformity throughout its entire length gives HELIAX superior electrical characteristics.

HELIAX is always less difficult, less costly to install, easier to handle.

HELIAX is available in 7/8" size (Type H0) and 1 1/8" size (Type H1).

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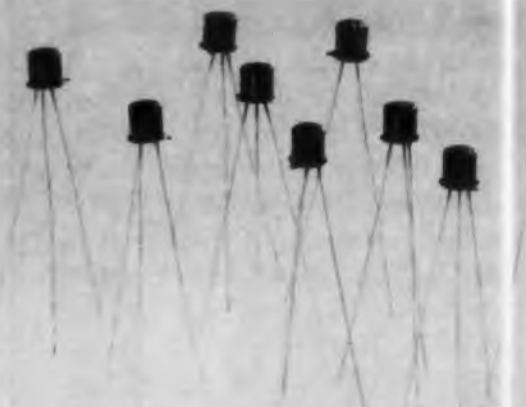


Fairchild Silicon Mesa
NPN and PNP Transistors
are available from stock
for same day shipment
in quantities up to
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pieces per type.

At factory prices
of course!

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NEW FAIRCHILD 2N706 provides TRANSISTOR LOGIC OF MAXIMUM

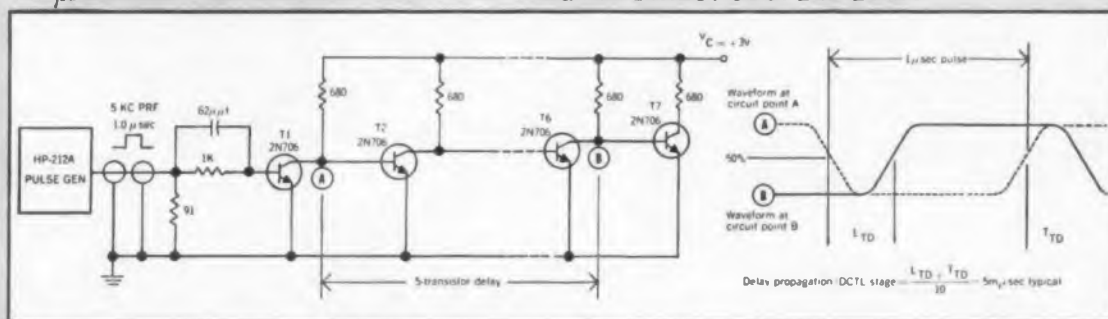
Saturating high-speed silicon logic ends the need to sacrifice one requirement in favor of another. The Fairchild 2N706 diffused silicon mesa transistor is as fast as the fastest germanium — and in addition has the inherent advantages of silicon. This combination fulfills all these logic-circuit design objectives:

SPEED	10 megapulse operation saturated 25 megapulse operation nonsaturated Guaranteed low storage
RELIABILITY	Large power reserve: 150 mW dissipation at 100° C ambient (no heat sink) 300° C stabilization of all units Rugged mesa construction
CIRCUIT SIMPLICITY	Saturating logic with fewer components 3 to 5 milliamperes current level Small JEDEC TO-18 outline

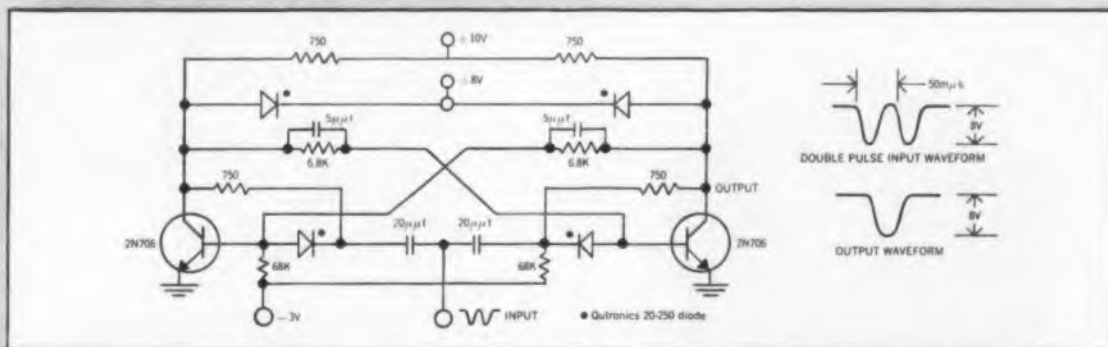
Fairchild's 2N706 provides optimum performance in the most-used logic circuit configurations and has a broad current and power range that covers many alternate approaches. It is ideally suited for high-density modular equipment because of its small size and its high performance in simple, low-power saturated circuits. The 10 megapulse speed is conservative, applying specifically to saturating logic and a 3 to 5 milliamperes current level.

FAST, RELIABILITY, SIMPLICITY

5 m μ SECOND PROPAGATION DELAY PER STAGE IN DIRECT COUPLED LOGIC



20 MEGACYCLE SATURATING FLIP-FLOP CIRCUIT



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

Symbol	Characteristics	Rating	Min.	Typ.	Max.	Test Conditions
V _{CB0}	Collector to base voltage	25 v				
V _{EB0}	Emitter to base voltage	3 v				
	Total dissipation, 100° C free air ambient	150 mw				
h _{FE}	D.C. pulse current gain		15			I _C = 10mA V _C = 10v
V _{BE(SAT)}	Base saturation voltage			0.9		I _C = 10mA I _B = 1mA
V _{CE(SAT)}	Collector saturation voltage		0.3	0.6		I _C = 10mA I _B = 1mA
h _{fe}	Small signal current gain at f = 100 mc		4			I _C = 20mA V _C = 10v
C _{ob}	Collector capacitance (140Kc)		3.5 pf	6 pf		I _E = 0mA V _C = 10v

For specification sheets, write Dept. B-11-11



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The following
Fairchild transistors
are available from stock
for same day shipment
in quantities up to
1000
pieces per type.

Standard NPN: 2N696,
2N697. High Voltage NPN:
2N699. High Beta NPN:
2N1420. Low Storage NPN:
2N1252, 2N1253. Standard
PNP: 2N1131, 2N1132.
Mesa: 2N706.

At factory prices
of course!



CIRCLE 220 ON READER-SERVICE CARD

CIRCLE 221 ON READER-SERVICE CARD

STANDARD MAGNETIC SHIFT REGISTERS the way you want them!



- **LOW** in Cost
- **LOW** in Weight and Size
- **LOW** in Power Consumption

Epsco is now volume-producing a complete line of magnetic Shift Registers . . . standard off-the-shelf units designed to meet an extensive application range.

Featuring extreme reliability under widely variable conditions, the units operate at rates up to 250 KC, from -55°C to $+85^{\circ}\text{C}$. The line offers very high packaging densities for signal storage and distribution in data processing systems. Each is fully compatible with the Epsco family of encapsulated Transistorized Digital Logic Circuits.

A new line of Shift Register Printed Circuit Card Assemblies is also available. Write for complete technical information.

Epsco, Incorporated, Components Division, SR, 275 Massachusetts Ave., Cambridge 39, Mass. UNiversity 4-4950.

Epsco 
COMPONENTS

CIRCLE 222 ON READER-SERVICE CARD

NEW PRODUCTS

Recording Systems

Four, six, and eight-channel types



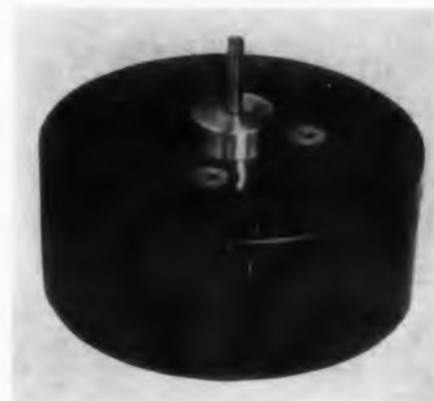
Available in four, six, and eight-channel types with a choice of five interchangeable preamplifiers, these modular graphic recording systems produce traces on standard roll chart or Z-fold paper. The basic unit consists of the recorder, master power panel, power supplies, and driver amplifiers; they are contained in a standard 19 in. relay rack which is mounted on casters.

Epsco Worchester, Div. of Epsco, Inc., Dept. ED, 588 Commonwealth Ave., Boston 15, Mass.

CIRCLE 223 ON READER-SERVICE CARD

Hysteresis Motors

Synchronous



These hysteresis synchronous electric motors are for use in ambient temperatures from -32 to $+135^{\circ}\text{C}$. The motor-induced flutter will not exceed 0.1 rms at 1200 rpm or 0.15 rms at 360 rpm. The stray external magnetic field is -47 dbm. Typical applications include tape transports, turnable drives, missile and aircraft instrumentation, computer drum drives, viscometers, flow meters, and dynamometers.

Telecomputing Corp., Hysyn Electromotive, Dept. ED, 915 N. Citrus Ave., Los Angeles 38, Calif.

CIRCLE 224 ON READER-SERVICE CARD

YOKE DISTORTION your problem?



Uniform magnetic fields
Produced in Celco

Precision
Deflection
Yokes
Minimize
**SPOT
DISTORTION**



Exclusive Celco core materials make it possible to achieve faster recovery times, minimum hysteresis, high linearities and maximum sensitivities.

Contact Celco Engineering Department for a fast solution to all your yoke problems.

Celco produces a complete line of standard or special commercial and military precision deflection yokes.

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CIRCLE 225 ON READER-SERVICE CARD

5-WAY RELIABILITY

IN YOUR CIRCUIT DESIGN

WITH

VITRAMON®

CAPACITORS

The latest additions to the growing line of "Vitramon" Capacitors feature smaller mounting area, lower inductance, and more versatility of application — plus all the phenomenal electrical characteristics for which "Vitramon" Capacitors are noted — fine silver electrodes fused to pure porcelain enamel, perfectly bonded to provide stability, wide temperature range, humidity immunity, low loss, low noise.

RADIAL SERIES

- Thin design — 5/64" to 7/64"
- Versatile mounting — can be used axially, radially, or on edge
- Ideal for minute circuit assemblies
- 0.5 to 1200 mmf; 500 to 50 vdc



PARALLEL SERIES

- Tiny mounting area — 11/64" x 9/32"
- Designed for automatic insertion
- Packed for cartridge feeding
- Capacitance through 1000 mmf. at 100 vdc



CO-AXIAL SERIES

- Compatible with MIL-C-10950B
- Very low inductance
- Flexible leads
- Maximum height from mounting surface 1/4"
- To 1000 mmf at 300 vdc



AXIAL SERIES

- Extremely rugged
- 4 case sizes from 3/8" to 29/32"
- 0.5 to 6800 mmf; 500 to 300 vdc



AXIAL-RADIAL SERIES

- Mounted axially or radially
- 4 case sizes from 3/8" to 27/32"
- 0.5 to 5600 mmf; 500 to 300 vdc



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Incorporated

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CIRCLE 226 ON READER-SERVICE CARD

HERMETIC CONNECTORS.—The DM5600 miniature series and the DHO2 AN series have eyelet or solder pot contacts fused into a single piece of white glass. They stand mechanical shock of 100 g, thermal shock from -100 to +500 F, operate at pressures to 1000 psi, and have a potential of over 2000 v. The DH series mates with MS and MS-E plugs from size 10SL to 32 AN; the DM5000 series mates with rack and panel, standard, and snap-in contact miniature plugs.

The Deutsch Co., Electronic Components Div., Dept. ED, Banning, Calif.

CIRCLE 227 ON READER-SERVICE CARD

DRAFTING EQUIPMENT.—Set No. 70,242 includes a French curve, an engineer's 6-in. scale-master, an architect's 6-in. scalemaster, a 6-in. slide rule, a 30 to 60 deg triangle, a 45 to 90 deg triangle, a ruler, a T-square, and protractor calibrated in 1/2 degrees.

Edmund Scientific Co., Dept. ED, Barrington, N.J.

CIRCLE 228 ON READER-SERVICE CARD

ANALOG TO DIGITAL CONVERTER.—Type 161 provides a punch paper tape processed in binary coded decimal form for use with special purpose digital computers. It measures from 3 mv to 1000 v dc with an accuracy of ±0.05%. Recording speed is 10 per sec.

Systron Corp., Dept. ED, 950 Galindo St., Concord, Calif.

CIRCLE 229 ON READER-SERVICE CARD

ADHESIVE.—Called Epox-Cement, it cures at room temperature and has a bond strength of 3000 lb per sq in. on metals, ceramics, plastics, and other materials. It is claimed to have excellent dielectric properties.

G-C Electronics Co., Div. of Textron Inc., Dept. ED, 400 S. Wyman St., Rockford, Ill.

CIRCLE 230 ON READER-SERVICE CARD

MOTOR-STARTING CAPACITORS.—Model 5992 is rated at 1 uf, 400 cps, and operates from -65 to +400 F. The unit has a 1-1/4 in. ID with 1/4 to 3/8 in. thickness, depending on the temperature range, and is 1/2 in. long.

Double E Products Co., Dept. ED, 208 Standard St., El Segundo, Calif.

CIRCLE 231 ON READER-SERVICE CARD

PLUG.—Type PR-300 is for easy insertion and withdrawal in Press-Fit jacks. The in-line plug takes the stripped wire end to the tip of the probe where it is soldered without interfering with the ready insertion or withdrawal.

Sealectro Corp., Dept. ED, 139 Hoyt St., Mamaroneck, N.Y.

CIRCLE 232 ON READER-SERVICE CARD

INSULATION SLEEVE.—Is designed to slip on and snap in place to prevent interference of the sleeve with the insertion of ground tap leads. This design also allows for maximum visibility during insertion.

Amp Inc., Dept. ED, Harrisburg, Pa.

CIRCLE 233 ON READER-SERVICE CARD

MEN

Basically, the rapid advances made by Bryant in the field of magnetic storage drums are due to the technical capability and long experience of Bryant's research, engineering and production men. Full details are in our new descriptive brochure.

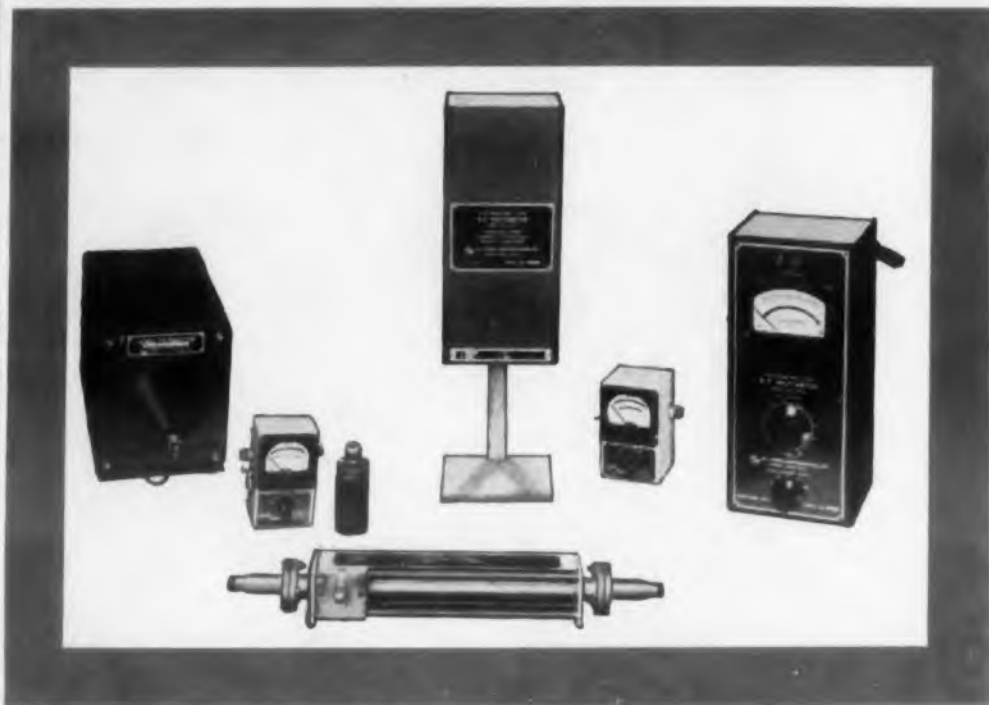
Write for your copy. Bryant Computer Products Division, a division of Bryant Chucking Grinder Company, P. O. Box 620, Springfield, Vermont.

See the New Bryant Line of Standard Drums at Booth 17, Eastern Joint Computer Conference Dec. 1-3, 1959.

CIRCLE 234 ON READER-SERVICE CARD

MicroMatch[®]

RF POWER STANDARDS LABORATORY



MicroMatch equipment is used to establish a reference standard of RF power to an accuracy of better than 1% of absolute.

THE 64IN CALORIMETRIC WATTMETER establishes RF power reference of an accuracy of 1% of value read, and is used to calibrate other wattmeters. Five power scales, 0-3, 3-10, 10-30, 30-100, and 100-300 watts, are incorporated in the wattmeters for use in the 0-3000 mcs range.

711N and 712N FEED-THROUGH WATTMETERS, after comparison with the 64IN, can be used continuously as secondary standards and over the same frequency range as covered by the primary standard. The MODEL 711N is a multirange instrument covering power levels from 0 to 300 watts in three ranges, 0-30, 30-75, and 75-300 watts. MODEL 712N covers power levels of 0 to 10 watts in three switch positions, 0-2.5, 2.5-5, and 5-10 watts full scale.

636N and 603N RF LOAD RESISTORS absorb incident power during measurements. MODEL 636N is rated at 600 watts, and MODEL 603N is rated at 20 watts. Both models perform satisfactorily over the entire frequency range to 3000 mcs. These loads, in conjunction with the MODELS 711N and 712N Feed-through Wattmeters, form excellent absorption type Wattmeters.

152N COAXIAL TUNER is used to decrease to 1.000 the residual VSWR in a load. The tuner is rated at 100 watts, and its frequency range is 500-4000 mcs.

For more information on Tuners, Directional Couplers, R. F. Loads, etc., write



M. C. JONES ELECTRONICS CO., INC.

185 N. MAIN STREET, BRISTOL, CONN.

SUBSIDIARY OF



CIRCLE 235 ON READER-SERVICE CARD

NEW PRODUCTS

Thermoelectric Transducers

Outputs are 0 to 5 v



Using a minimum of modular elements and replaceable, humidityproof sensing elements, these transducers have outputs from 0 to 5 v and ranges from -320 to +1000 F. Fluid-immersion types with 4500 psi to 100 F and gas-immersion types with 4500 psi at 77 F and 2000 psi at 1200 F are available. The sensing elements may be nickel-iron, platinum or thermistor, semiconductor oxides. The resistance tolerance is to 0.5%. Mounting permits variation in tube length or changing the element while the fitting is locked. Solder terminals are used.

Arnoux Corp., Dept. ED, 11924 W. Washington Blvd., Los Angeles 66, Calif.

CIRCLE 236 ON READER-SERVICE CARD

Telemetry Commutator

For airborne applications



For missile, rocket, and other airborne applications, type 500602 PDM telemetry commutator is a two-pole 45 break-before-make channel, 20 rps type. Weighing 1.8 lb, the unit provides 500 hr noise-free service. One pole is used to sample single-ended transducer data of 0 to 30 mv dc or 0 to 5 v dc signal levels at 900 samples per sec. Transducer loading is less than 1 ohm and inter-channel isolation is over 100 meg. The second pole is for timing according to IRIG. The sampling system is enclosed in a hermetically-sealed case. The switch withstands 20 g vibration at 20 to 2000 cps.

Instrument Development Labs., Inc., Dept. ED, 67 Mechanic St., Attleboro, Mass.

CIRCLE 237 ON READER-SERVICE CARD

Components and assemblies
ride high, wide and handsome

with **GHS** HERMETIC
SEALING

SURVIVAL IN INNER SPACE

Spanking new products off the drawing boards hold high promise... until their natural enemies "gun them down" with destructive environmental forces. Why not consider hermetic sealing — the proven technique that builds an impenetrable shield against 7 major causes of product failure? By use of inert gas filling, GHS Hermetic Sealing permanently rids your components and systems of any of the common hazards of corrosion, dust, fungus, altitude pressures, etc., which can seriously affect their rated performances. Let us show you how to preserve the quality reputation of your products with hermetic sealing.

RE-USABLE HERMETIC SEALS

Pressurized GASEALS for static sealing assure absolute protection against gases and liquids under severe conditions of temperature and environment.



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ELECTRONIC SUB-SYSTEMS ■ MEGPOTS ■ GASEALS
TOGGLE SWITCHES ■ HERMETIC SEALING SERVICES

CIRCLE 238 ON READER-SERVICE CARD

PNEUMATIC CRIMPING TOOL.—Loads 100 or more contacts, pins or sockets at once. They are automatically fed, one at a time, into the jaws of the tool and are fixed to the wire by pressing a button.

The Deutch Co., Electronic Components Div., Dept. ED, Banning, Calif.

CIRCLE 239 ON READER-SERVICE CARD

INSULATED SOLDERLESS TERMINALS.—This kit includes a type 1930 bolt cutter and crimping tool plus an assortment of terminals.

Vaco Products Co., Dept. ED, 317 E. Ontario St., Chicago 11, Ill.

CIRCLE 240 ON READER-SERVICE CARD

PRESSURE CALIBRATOR SYSTEM.—Measures and regulates pressure in a reservoir using a frequency comparator. The comparator indicates the magnitude and direction of the difference in frequencies. The accuracy is 0.05% full scale.

Wiancko Engineering Co., Dept. ED, 255 Halstead, Pasadena, Calif.

CIRCLE 241 ON READER-SERVICE CARD

DRAFTING EQUIPMENT.—Includes a portable drafting machine, a holometer with diameters of 3/8 to 1/2 in., and a protractor as well as vertical and horizontal scales calibrated in 1/32 in. increments. The brief case type holder permits drawing in a flat position or, by snapping the case together, provides an 8-deg inclined surface.

Charles W. Thrift Co., Dept. ED, 3312 W. Vermont Ave., Los Angeles, Calif.

CIRCLE 242 ON READER-SERVICE CARD

DRAFTING PEN.—Model 3065 has interchangeable point sections that provide these line widths: 00, 0, 1, 2, 2-1/2, 3, and 4. Each point section has its own cartridge.

Koh-I-Noor Pencil Co., Dept. ED, Bloomsbury, N.Y.

CIRCLE 243 ON READER-SERVICE CARD

HEATING CHAMBER.—Molybdenum heated, permits temperatures of 3400 F in a hydrogen atmosphere. Heating controlled by a saturable reactor and radiation thermometer controls. Cooling is controlled by refractory-lined water-cooled zones. The applications include aircraft, missile, ceramic, and metallurgical industries.

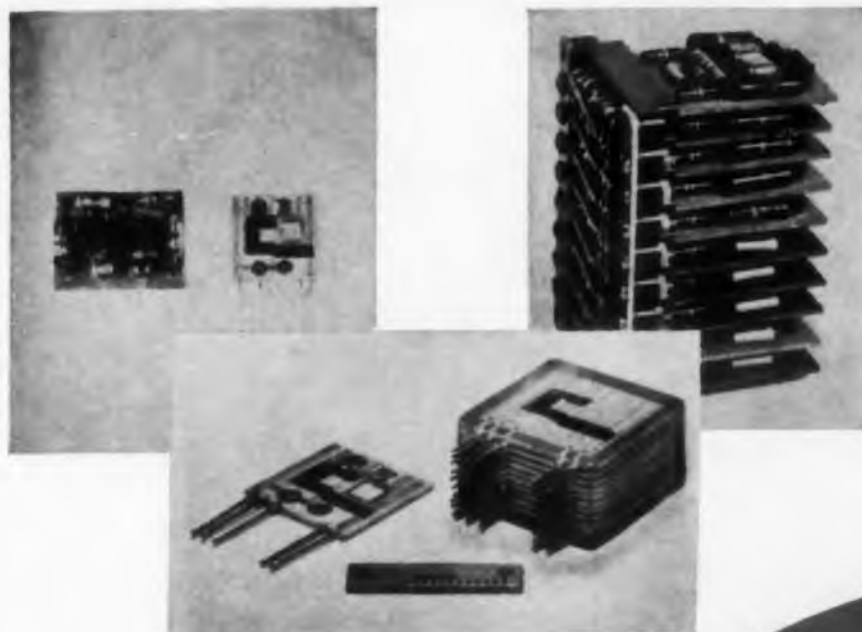
W. P. Keith Co., Dept. ED, 9128 S. Norwalk Blvd., Santa Fe Springs, Calif.

CIRCLE 244 ON READER-SERVICE CARD

LOCKWASHER NUTS.—Self-locking type, have high tensile strength. Type F19270 is made of A286 stainless steel for use to 1200 F. Type F19271 is made of 304 stainless steel for use to 1400 F.

Raynor Manufacturing Co., Inc., Dept. ED, Kay-Div., Box 2001, Terminal Annex, Los Angeles, Calif.

CIRCLE 245 ON READER-SERVICE CARD



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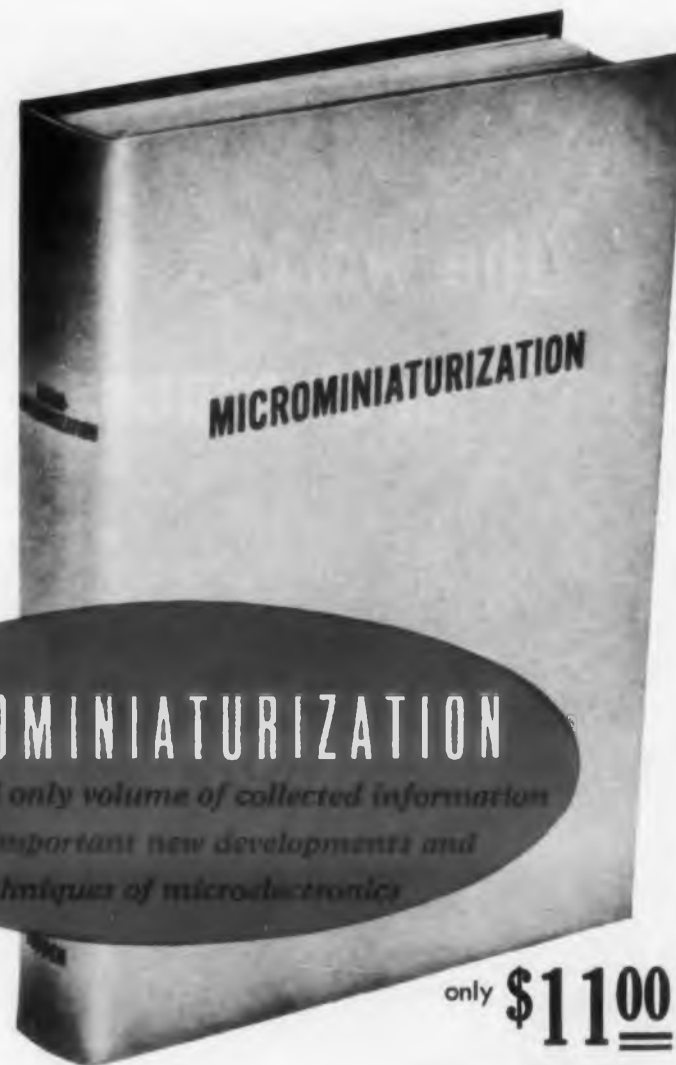
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the world's
most expensive

inch
of
recording tape

There's no question about it—if there were a dropout in this inch of tape it could cost you plenty. That's why our customers invariably demand perfection from our EP Audiotape—the *extra precision* magnetic recording tape for computers, automation, telemetry and seismography.

Audio Devices' battery of Automatic Certifiers is one of the unique means used to make sure EP Audiotape always meets customers specifications. The Automatic Certifier records and plays back every inch of the EP Audiotape under test. These tests can be so demanding that if the tape fails to reproduce just *one* test pulse out of the 40 million put on a single reel, the entire reel is rejected. There are no *if's*, *and's*, or *but's*.

This is just one of many special quality-control operations. From raw material to hermetically sealed containers, every reel of EP Audiotape gets individual attention.

For more information write for free Bulletin T112A. Write Dept. TD, Audio Devices, Inc., 444 Madison Avenue, New York 22, N. Y.

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Rectifier Division: 620 E. Dyer Rd., Santa Ana, Calif.

CIRCLE 249 ON READER-SERVICE CARD

NEW PRODUCTS



Terminal Boards
Taper pin type

Designed for use in computer and data process programming and multi-channel communications systems, these single row terminal boards have 10 or 20 feedthrough type taper receptacles with single and double feedthrough connections. They have nesting projections and recesses to aid stacking. Elongated holes facilitate mounting and barriers across both faces increase creepage path. Receptacles are silver-plated and gold-flashed. With standard solderless taper pins minimum pull out is 14 lb. The molding compound conforms to MIL-M-14E. The terminal boards pass the shock requirement of MIL-S-901B.

General Products Corp., Dept. ED, Union Springs, N.Y.

CIRCLE 250 ON READER-SERVICE CARD

Transducer

For radiation tracking



Type XY20 solid state radiation tracking transducer detects the position of visible to near infrared light sources. A linear functioning semiconductor device, this single element detects the angular position of the source. Having microsecond response characteristics, it can be used in tracking, instrumentation, automatic control, and computers. Detection occurs by means of a lateral photoeffect in a silicon pn junction.

Electro-Optical Systems, Inc., Dept. ED, 170 N. Daisy Ave., Pasadena, Calif.

CIRCLE 251 ON READER-SERVICE CARD

IN A SQUEEZE?



HERE'S YOUR ANSWER FOR PRECISION TUBING AT REGULAR TUBE PRICES

Quality specifications and profit margins have you in a squeeze on tubing? Precision Tubing assures you unsurpassed quality of temper, straightness, accuracy, finish and roundness at regular mill prices . . . and test results prove it.

Whatever the type of alloy tubing you need from .010" to 1.125" O.D. in copper, brass, aluminum, up to 3/4" O.D. in nickel and nickel alloys, Ni-Span "C", phosphor-bronze and nickel silver Precision can supply it. Whether you need Bourdon, round, rectangular, oval or square . . . preformed to special shapes . . . or Coaxitube-Precision can supply it to your specifications.

For improved quality at lower costs specify Precision Tubing. Write for technical data to Dept. 10, Precision Tube Company, Inc., North Wales, Pa.

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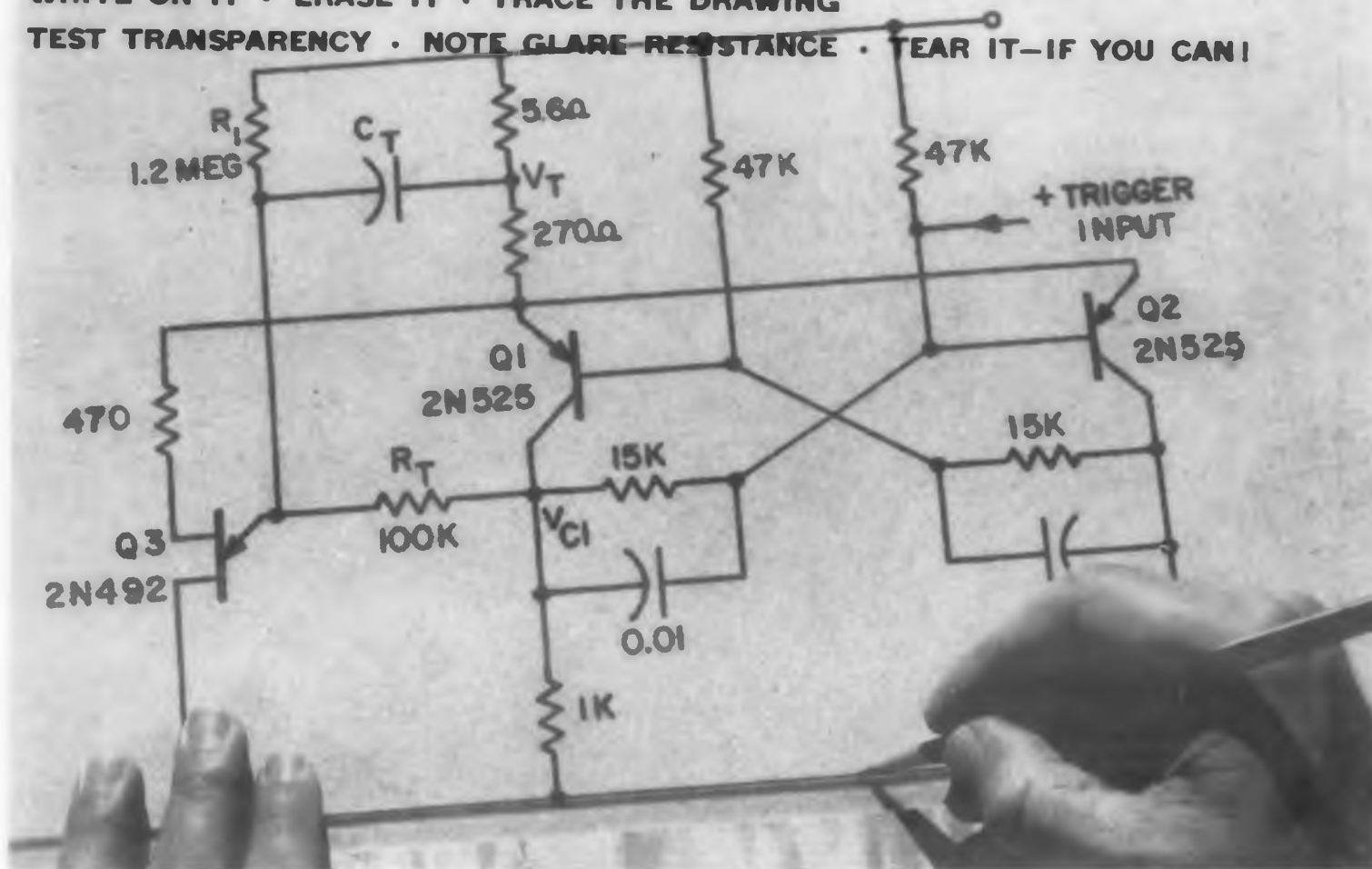
CIRCLE 252 ON READER-SERVICE CARD
CIRCLE 685 ON READER-SERVICE CARD

THIS IS CRONAFLEX[®] DRAFTING FILM (.004")

THICKNESS

WRITE ON IT • ERASE IT • TRACE THE DRAWING

TEST TRANSPARENCY • NOTE GLARE RESISTANCE • TEAR IT—IF YOU CAN!



NEW! CRONAFLEX Drafting Film offers best surface every time you use it

CRONAFLEX* is the only drafting film made entirely by Du Pont. It is an exclusive combination of a superior surface on Du Pont's unique CRONAR* polyester film base. Du Pont makes the surface and the base in one complete process that assures you of consistent quality. Every piece of CRONAFLEX Drafting Film has been subjected to the most careful supervision during its entire manufacturing cycle. The .004" thickness of this new drafting film makes it easy to handle and to file.

The surface: ideal for pencil... erases easily... smear-resistant... clearer than cloth—you get faster print-through speed with greater uniformity... accepts ink.

The base: holds size... flexible... unexcelled strength... moisture-resistant... easy to handle... lies flat.

CRONAFLEX Drafting Film is available *now* in many put-ups and sizes... in either roll or sheet form... matted one or two sides. For additional information, and the name of your nearest dealer, *clip* the coupon on the preceding page (you'll never be able to tear it!) and send it in.

E. I. du Pont de Nemours & Co. (Inc.) Photo Products Department, Wilmington 98, Delaware. In Canada: Du Pont of Canada Limited, Toronto.

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THIS IS ONE COUPON YOU CAN'T TEAR OUT.
BETTER USE SCISSORS OR A KNIFE.

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Please send me additional information about CRONAFLEX Drafting Film and a list of suppliers in my vicinity.

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Printed in U. S. A.

Telemetry System

Video type

Designed for missile applications, model 701 video telemetry system withstands 40 g shock for 11 μsec in three planes and 45 g acceleration. It has 525 lines and a 30-frame fully interlaced picture. The circuitry is transistorized and the EIA synchronization is crystal-controlled. The entire system occupies 118.8 cu in. and weighs 5.9 lb.

Lockheed Electronics and Avionics Div., Dept. ED, 6201 E. Randolph St., Los Angeles 22, Calif.

CIRCLE 263 ON READER-SERVICE CARD

Micro-Gage

Measures 0.5 micron or less

Designated the Dyna-Micro-Gage, this photoelectric instrument is capable of dynamic measurements down to 0.5 micron or less. Uses of the instrument include continuous gaging for diameter of wire and for width of sheets, measurement of small hole sizes and of variation in roundness in wire or thread. It can also be used as a strain gage to measure very small deflections. The output voltage can operate a meter, actuate a relay or be recorded to give a graphical record of variations.

Lindly & Co., Inc., Dept. ED, 248 Herricks Rd., Mineola, N.Y.

CIRCLE 264 ON READER-SERVICE CARD

Interference Filters

For ground support equipment

Made for military ground support equipment and conforming to MIL-F-15733C, these radio interference filters are hermetically-sealed and have stud type terminals for standard connectors. Ground terminals are provided on each side for grounding neutral power leads and harness shielding. The product line includes single and three-phase 120 and 240 v, 60 and 400 cps units with a current rating of 5 to 100 amp. Single and dual units for 28 v dc power lines are rated at 100 v dc and at 5 to 300 amp.

Genistron, Inc., Dept. ED, 2301 Federal Ave., Los Angeles 64, Calif.

CIRCLE 265 ON READER-SERVICE CARD

NEW PRODUCTS

Tension Control Spools fine gage wire

Called Auto-Tension Control No. 510-A-116, this unit spools and unspools fine gage wire and provides automatic control of tension. It is used for wire in the winding of electron tube grids, resistors, solenoids, potentiometers, and transformers.

The unit is comprised of an ac motor, controls, a sensing device, and an automatic brake. Controllable tension range is 1.5 to 140 g with winding speeds to 1000 ft per min for a spool with a 2 in. OD. Spool sizes to 4-1/2 in. OD can be accommodated. The unit is housed in a 12-3/4 x 4-13/16 x 8-11/16 in. anodized aluminum cabinet, is rated at 5 to 10 w, and operates from a 115 v ac, 60 cps, single-phase line.

Diehl Manufacturing Co., Dept. ED, Somerville, N.J.

CIRCLE 267 ON READER-SERVICE CARD

Function Generator Has a 34-chord accuracy



Operating as an adjustable nonlinear potentiometer, the Vernistat-adjustable function generator produces any empirical or mathematical curve with a 34-chord accuracy. The function adjusting assembly is a 34-pole, 101-position printed circuit switch. An integral voltage divider provides voltages to the switch positions in 1% increments. The 34 poles are sliding contacts which are used to select the voltage levels to $\pm 0.5\%$ of any desired value.

The interpolating unit accepts the selected voltages and performs linear interpolation between the voltages appearing at adjacent sliding contacts. Applications include ballistic wind computers, differential analyzers, air data computers, and environmental controllers.

Perkin-Elmer Corp., Dept. ED, Norwalk, Conn.

CIRCLE 268 ON READER-SERVICE CARD

General Electric Semiconductor News

Tests prove reliability of

Mass production of SCR's is now a reality. The experience, skill and manufacturing knowhow of General Electric's SCR production line is your assurance of dependable quality-controlled SCR's—an assurance unmatched by any other manufacturer.



WHAT THE SCR DOES

The SCR is a miniature semiconductor device that blocks positive forward voltage in its "off" or non-conducting state. However, by applying a small signal to the gate terminal it switches rapidly to a conducting state and acts like a single junction silicon rectifier. It is completely static, arcless and fast. It is almost 100% efficient. It contains no mechanisms subject to wear. As a result, the SCR can switch and control power either faster, more safely, less expensively or more reliably than the many devices it replaces: circuit breaker, relay, thyatron, magnetic amplifier, rotating amplifier and many others. Among the many hundreds of circuit designs are these:

Superior d-c motor operation from an a-c source. Eliminates motor generator sets, tubes or magnetic amplifiers to provide controlled d-c. Replaces mechanical speed and direction changers.

Superior a-c generation from a variable d-c source. First really practical method of using static inverters with ratings of several kilowatts.

Simpler conversion to high frequency. SCR converters are small and efficient. Extends use of high frequency power where desirable, as in fluorescent lighting systems.

Pulse modulators. Compact, yet rugged replacement for hydrogen thyratrons in radar and beacon modulators.

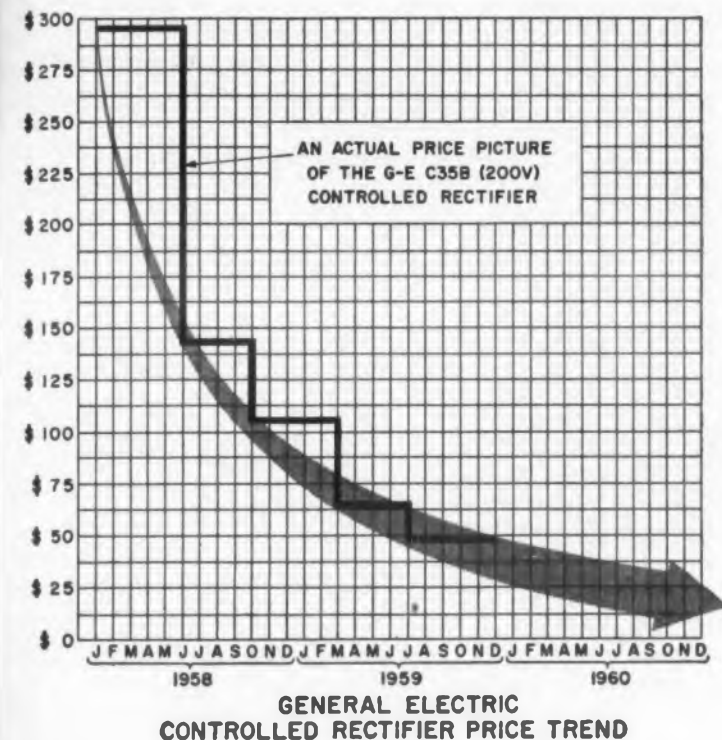
D-c regulation. Control large blocks of voltage with small losses by pulse width modulation. Eliminate bulky rheostats and adjustable d-c generators.

Other applications: Battery charging regulator, transient voltage protection, dynamic braking, constant current supply, static switching, regulated power supply, d-c to d-c conversion, temperature control.

silicon controlled rectifier

*Prices again reduced, new circuits developed,
customer designs move into manufacturing stage*

Prices again have been reduced an average of twenty percent on General Electric's Silicon Controlled Rectifier, providing greater values to users. These new prices have been made possible through expanding production and lower manufacturing costs.



TESTS AND FIELD REPORTS PROVE RELIABILITY

Reliability of General Electric SCR's has been steadily improved over two years of manufacturing experience. Typical test results point to the reliability achieved to date.

MAXIMUM ALLOWABLE RATINGS (Resistive or Inductive Load)

	C35U	C35F	C35A	C35G	C35B	C35H	C35C	C35D
Continuous Peak Inverse Voltage (PIV)	25	50	100	150	200	250	300	400 volts
Transient Peak Inverse Voltage (Non-Recurrent < 5 millise.)	35	75	150	225	300	350	400	500 volts
RMS Voltage (V _{RMS}), Sinusoidal	17.5	35	70	105	140	175	210	280 volts
Average Forward Current (I _F)	Up to 16 amperes							
Peak One Cycle Surge Current (I _{surge})	150 amperes							
Peak Gate Power	5 watts							
Average Gate Power	0.5 watts							
Peak Gate Current (I _G)	2 amperes							
Peak Gate Voltage (V _G) (forward)	10 volts							
Storage Temperature	-65°C to +150°C							
Operating Temperature	-65°C to +125°C							
CHARACTERISTICS (At Maximum Ratings)	C35U	C35F	C35A	C35G	C35B	C35H	C35C	C35D
Minimum Forward Breakover Voltage (V _{BO})	25	50	100	150	200	250	300	400 volts
Maximum Reverse (I _R) or Forward (I _S) Leakage Current (Full Cycle Average)	6.5	6.5	6.5	6.5	6.0	5.5	5.0	4.0 ma
Maximum Forward Voltage (V _{F AVG})	0.86 volts (Full Cycle Average)							
Maximum Gate Current To Fire (I _{GF})	25 ma							
Maximum Gate Voltage To Fire (V _{GF})	3 volts							
Typical Gate Current To Fire (I _{GF})	10 ma at +1.5 volts (Gate to Cathode Voltage)							

C-35 Series—lower cost series with ratings similar to above, but for use up to 100°C maximum, with forward current ratings up to 10 amperes.
ZJ-50 Series—a high-current series now in development, and available on a prototype-sample basis.

GENERAL ELECTRIC

Semiconductor Products Department

CIRCLE 269 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

Tape Reader

Reads to 48 lines simultaneously

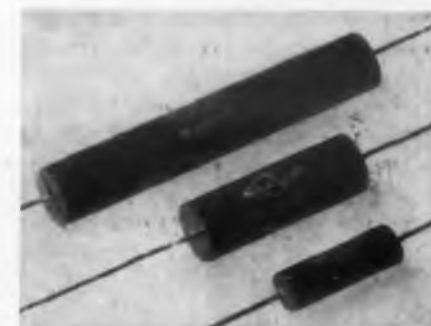
For standard 1-in. 5 to 8-hole paper or Mylar tapes, the series TR tape block reader can read a fixed block of information of up to 48 lines or 384 bits simultaneously. Output terminals are available for all bits through special alloy triple-wire brush contacts. The device is useful for numerically controlled systems, automatic programming, and automatic testing.

Wang Laboratories, Inc., Dept. ED, 12 Huron Dr., Natick, Mass.

CIRCLE 270 ON READER-SERVICE CARD

Resistors

Molded-carbon deposited type



Type CPM molded-carbon deposited resistors are encapsulated in moisture and heat resistant plastic. Called Carbomold, they are supplied in ranges of 10 ohms to 5 meg in the 0.5-w size, 10 ohms to 10 meg in the 1-w size, and 30 ohms to 20 meg in the 2-w size. Tolerance is $\pm 1\%$. Designed for full load at 70 C and derated to zero at 150 C, they exceed the insulation resistance requirements of MIL-R-1059C.

Aerovox Corp., H-Q Div., Dept. ED, Olean, N.Y.

CIRCLE 271 ON READER-SERVICE CARD

Spectrum Analyzers

Range is 1 to 200 cps

These real-time spectrum analyzers, called Simoramic, synthesize the equivalent of thousands of bandpass filters by means of a single delay line in a closed loop. The frequency location, impulsive response, and gain of all the synthesized filters are determined by the same network elements in the closed loop. The outputs are presented sequentially. Model 4A covers the band of 1 to 200 cps with about 1 cps resolution.

Federal Scientific Corp., Dept. ED, 615 W. 131 St., New York 27, N.Y.

CIRCLE 272 ON READER-SERVICE CARD

NEW PRODUCTS

Tension Control Spools fine gage wire

Called Auto-Tension Control No. 510-A-116, this unit spools and unspools fine gage wire and provides automatic control of tension. It is used for wire in the winding of electron tube grids, resistors, solenoids, potentiometers, and transformers.

The unit is comprised of an ac motor, controls, a sensing device, and an automatic brake. Controllable tension range is 1.5 to 140 g with winding speeds to 1000 ft per min for a spool with a 2 in. OD. Spool sizes to 4-1/2 in. OD can be accommodated. The unit is housed in a 12-3/4 x 4-13/16 x 8-11/16 in. anodized aluminum cabinet, is rated at 5 to 10 w, and operates from a 115 v ac, 60 cps, single-phase line.

Diehl Manufacturing Co., Dept. ED, Somerville, N.J.

CIRCLE 267 ON READER-SERVICE CARD

Function Generator Has a 34-chord accuracy



Operating as an adjustable nonlinear potentiometer, the Vernistat-adjustable function generator produces any empirical or mathematical curve with a 34-chord accuracy. The function adjusting assembly is a 34-pole, 101-position printed circuit switch. An integral voltage divider provides voltages to the switch positions in 1% increments. The 34 poles are sliding contacts which are used to select the voltage levels to $\pm 0.5\%$ of any desired value.

The interpolating unit accepts the selected voltages and performs linear interpolation between the voltages appearing at adjacent sliding contacts. Applications include ballistic wind computers, differential analyzers, air data computers, and environmental controllers.

Perkin-Elmer Corp., Dept. ED, Norwalk, Conn.

CIRCLE 268 ON READER-SERVICE CARD

General Electric Semiconductor News

Tests prove reliability of

Mass production of SCR's is now a reality. The experience, skill and manufacturing knowhow of General Electric's SCR production line is your assurance of dependable quality-controlled SCR's—an assurance unmatched by any other manufacturer.



WHAT THE SCR DOES

The SCR is a miniature semiconductor device that blocks positive forward voltage in its "off" or non-conducting state. However, by applying a small signal to the gate terminal it switches rapidly to a conducting state and acts like a single junction silicon rectifier. It is completely static, arcless and fast. It is almost 100% efficient. It contains no mechanisms subject to wear. As a result, the SCR can switch and control power either faster, more safely, less expensively or more reliably than the many devices it replaces: circuit breaker, relay, thyatron, magnetic amplifier, rotating amplifier and many others. Among the many hundreds of circuit designs are these:

Superior d-c motor operation from an a-c source. Eliminates motor generator sets, tubes or magnetic amplifiers to provide controlled d-c. Replaces mechanical speed and direction changers.

Superior a-c generation from a variable d-c source. First really practical method of using static inverters with ratings of several kilowatts.

Simpler conversion to high frequency. SCR converters are small and efficient. Extends use of high frequency power where desirable, as in fluorescent lighting systems.

Pulse modulators. Compact, yet rugged replacement for hydrogen thyratrons in radar and beacon modulators.

D-c regulation. Control large blocks of voltage with small losses by pulse width modulation. Eliminate bulky rheostats and adjustable d-c generators.

Other applications: Battery charging regulator, transient voltage protection, dynamic braking, constant current supply, static switching, regulated power supply, d-c to d-c conversion, temperature control.

silicon controlled rectifier

*Prices again reduced, new circuits developed,
customer designs move into manufacturing stage*

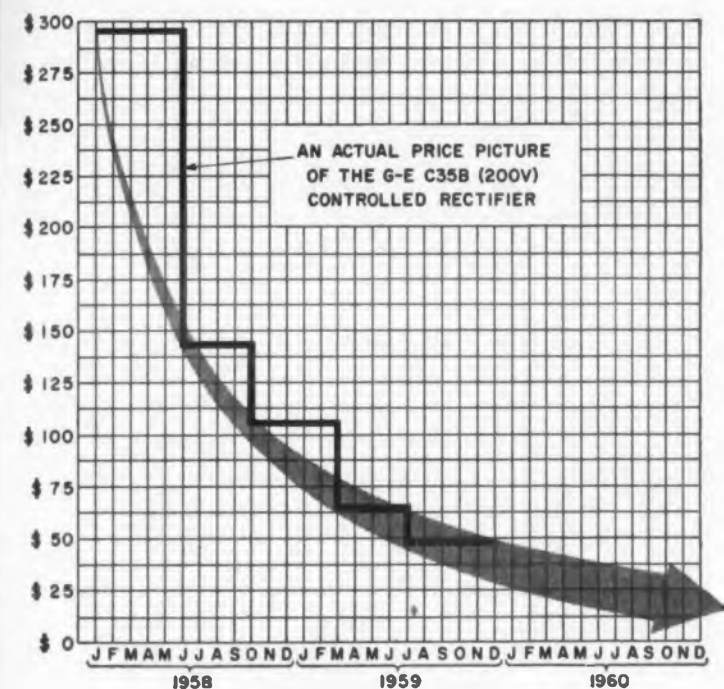
Prices again have been reduced an average of twenty percent on General Electric's Silicon Controlled Rectifier, providing greater values to users. These new prices have been made possible through expanding production and lower manufacturing costs.

98% survival after 1000 hours of storage at 125°.

97% survival after 1000 hours of operation at maximum ratings at 125°C.

No thermal fatigue failures after 30,000 cycles from 20°C to 135°C and return.

Less than one percent failures experienced by customers (many of which were traced to misapplication).



GENERAL ELECTRIC
CONTROLLED RECTIFIER PRICE TREND

TESTS AND FIELD REPORTS PROVE RELIABILITY

Reliability of General Electric SCR's has been steadily improved over two years of manufacturing experience. Typical test results point to the reliability achieved to date.

MAXIMUM ALLOWABLE RATINGS (Resistive or Inductive Load)

	C35U	C35F	C35A	C35G	C35B	C35H	C35C	C35D
Continuous Peak Inverse Voltage (PIV)	25	50	100	150	200	250	300	400 volts
Transient Peak Inverse Voltage (Non-Recurrent < 5 millisec.)	35	75	150	225	300	350	400	500 volts
RMS Voltage (V _{RMS}), Sinusoidal	17.5	35	70	105	140	175	210	280 volts
Average Forward Current (I _F)	Up to 16 amperes							
Peak One Cycle Surge Current (I _{surge})	150 amperes							
Peak Gate Power	5 watts							
Average Gate Power	0.5 watts							
Peak Gate Current (I _G)	2 amperes							
Peak Gate Voltage (V _G) (forward)	10 volts							
Storage Temperature	-65°C to +150°C							
Operating Temperature	-65°C to +125°C							
CHARACTERISTICS (At Maximum Ratings)	C35U	C35F	C35A	C35G	C35B	C35H	C35C	C35D
Minimum Forward Breakover Voltage (V _{BO})	25	50	100	150	200	250	300	400 volts
Maximum Reverse (I _R) or Forward (I _F) Leakage Current (Full Cycle Average)	6.5	6.5	6.5	6.5	6.0	5.5	5.0	4.0 ma
Maximum Forward Voltage (V _{F AVG})	0.86 volts (Full Cycle Average)							
Maximum Gate Current To Fire (I _{GF})	25 ma							
Maximum Gate Voltage To Fire (V _{GF})	3 volts							
Typical Gate Current To Fire (I _{GF})	10 ma at +1.5 volts (Gate to Cathode Voltage)							

C-35 Series—lower cost series with ratings similar to above, but for use up to 100°C maximum, with forward current ratings up to 10 amperes.
Z1-50 Series—a high-current series now in development, and available on a prototype-sample basis.

GENERAL ELECTRIC

Semiconductor Products Department

CIRCLE 269 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

Tape Reader

Reads to 48 lines simultaneously

For standard 1-in. 5 to 8-hole paper or Mylar tapes, the series TR tape block reader can read a fixed block of information of up to 48 lines or 384 bits simultaneously. Output terminals are available for all bits through special alloy triple-wire brush contacts. The device is useful for numerically controlled systems, automatic programming, and automatic testing.

Wang Laboratories, Inc., Dept. ED, 12 Huron Dr., Natick, Mass.

CIRCLE 270 ON READER-SERVICE CARD

Resistors

Molded-carbon deposited type



Type CPM molded-carbon deposited resistors are encapsulated in moisture and heat resistant plastic. Called Carbomold, they are supplied in ranges of 10 ohms to 5 meg in the 0.5-w size, 10 ohms to 10 meg in the 1-w size, and 30 ohms to 20 meg in the 2-w size. Tolerance is $\pm 1\%$. Designed for full load at 70 C and derated to zero at 150 C, they exceed the insulation resistance requirements of MIL-R-1059C.

Aerovox Corp., H-Q Div., Dept. ED, Olean, N.Y.

CIRCLE 271 ON READER-SERVICE CARD

Spectrum Analyzers

Range is 1 to 200 cps

These real-time spectrum analyzers, called Simoramic, synthesize the equivalent of thousands of bandpass filters by means of a single delay line in a closed loop. The frequency location, impulsive response, and gain of all the synthesized filters are determined by the same network elements in the closed loop. The outputs are presented sequentially. Model 4A covers the band of 1 to 200 cps with about 1 cps resolution.

Federal Scientific Corp., Dept. ED, 615 W. 131 St., New York 27, N.Y.

CIRCLE 272 ON READER-SERVICE CARD



BISHOP Tubular Products NEWS

"METALS FOR

PRECISION AND PERFORMANCE"

GOLD-CLAD STAINLESS TUBING CURBS CORROSION IN REACTOR

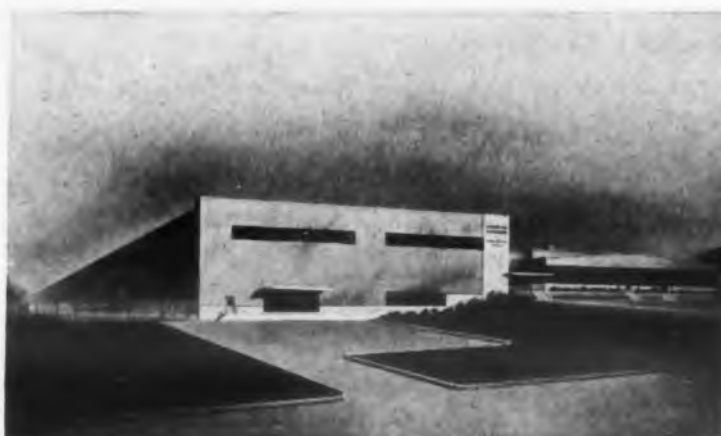
Photo pictures insertion of gold-clad stainless steel heat exchanger into gold-clad power reactor at AEC's Los Alamos Scientific Laboratory. Completely successful in recent operational tests, the unique reactor is designed to produce superheated steam in a single pass. This is the second experimental reactor using uranyl phosphate fuel—the first unit failed because of excessive corrosion in the heat exchanger. Gold-cladding now protects all structural parts in contact with the extremely corrosive solution.

Will clad metals solve your corrosion problems? Investigate the BISHOP line of clad metals. BISHOP was the first company to successfully produce gold-clad stainless tubing . . . coupon brings data. Use it.

CIRCLE 725 ON READER-SERVICE CARD



NEW BISHOP TUBE MILL OPENS



Sketch shows new BISHOP facilities adjacent to the present tube mill in East Whiteland Township, west of Paoli, Penna.—completing the first stage in BISHOP's long range expansion program. This two-story structure will contain over 165,000 square feet of floor space. BISHOP platinum mechanical manufacturing operations also move to the East Whiteland plant.

CIRCLE 726 ON READER-SERVICE CARD

BISHOP NOW DRAWING .002" WALL TANTALUM TUBING

Tantalum tubing with paper-thin wall thicknesses is now being supplied by BISHOP on special order. Sizes range from .062 in. OD x .002 in. wall to 1.5 in. OD x .125 in. wall. Columbium (niobium) tubing down to .002 in. wall has been produced and is also available. Can tubing of these "exotic" metals be the answer to any of your design problems? Check with BISHOP . . . use the coupon.

CIRCLE 727 ON READER-SERVICE CARD

J. BISHOP & CO.

platinum works

FOR HELPFUL DATA USE THIS HANDY COUPON

Tubular Products
Bulletin No. 12

Platinum Products
Catalog No. 4

Clad Metal Data

Special Tubing Data

Check information you'd like and mail to
J. BISHOP & CO.,
55 King St., Malvern, Penna.

Name _____

Position _____

Company _____

Address _____

City _____

Zone _____

State _____

Tubular Products Division

55 KING STREET, MALVERN, PENNA.

NIagara 4-3100

THIS IS THE BISHOP LINE:
Products of all the Platinum Metals...
Small diameter Stainless Steel,
nickel and special alloy tubing

CIRCLE 725 THROUGH 727 ON READER-SERVICE CARD

NEW PRODUCTS

INSULATED SOLDERLESS TERMINALS.—Included in this line are 13 ring tongue terminals with hole diameters from 9/64 to 13/32 in., five spade tongue terminals with hole diameters from 9/64 to 13/64 in., and three butt connectors for wire sizes 22-16, 16-14, and 12-10 gages. They are color-coded for size.

Vaco Products Co., Dept. ED, 317 E. Ontario St., Chicago 11, Ill.

CIRCLE 274 ON READER-SERVICE CARD

FASTENERS.—One-piece, right-angle, type are available in many configurations for lengths to 3 in. of instrument panels, shock-mounting of equipment in 0.02-in. increments. For such uses as attachment in package containers, tubing and wiring harnesses, they have been vibration tested to 43 g with amplitudes to 0.375 in., and at frequencies to 80 cps.

Western Sky Industries, Dept. ED, 21301 Cloud Way, Hayward, Calif.

CIRCLE 275 ON READER-SERVICE CARD

ALUMINUM NUTS.—Are self-locking type and have a stainless steel wire form. They meet the requirements of MIL-C-25027 for 550 F operation.

Waltham Precision Instrument Co., Dept. ED, 221 Crescent St., Waltham 54, Mass.

CIRCLE 276 ON READER-SERVICE CARD

LATITUDE COUNTER.—Reads directly in degrees and minutes. The characters are 0.125 x 0.075 in. and are furnished in standard or fluorescent enamels. The unit measures 1.725 x 0.5 x 0.75 in. The ball-bearing mounted shaft may be operated at 500 rpm constant or up to 1500 rpm intermittent. Mil specs for aircraft are met.

Veeder-Root Inc., Dept. ED, Hartford 2, Conn.

CIRCLE 277 ON READER-SERVICE CARD

ELECTRONIC ASSEMBLY AND MAINTENANCE TOOLS.—Set 5343-ET-B has special alloy steel tools that are heat treated. Screwdrivers for compact assemblies, pliers, diagonal cutters, drivers, and a pencil-type soldering iron are included in this set of 43 tools.

Snap-on Tools Corp., Dept. ED, 28th Ave., Kenosha, Wis.

CIRCLE 278 ON READER-SERVICE CARD

VIDEO MONITORS.—Have a resolution of 600 lines, 2% max nonlinearity, and an 8-mc frequency response. The modules are plug-in type and the aluminized picture tube has a nonglare face plate. The following picture tube sizes are available: type V-36 is 14 in., V-96 is 17 in., V-98 is 21 in., and V-92 is 24 in. They may be either cabinet or rack design.

Foto-Video Labs., Inc., Dept. ED, 36 Commerce Rd., Cedar Grove, N. J.

CIRCLE 279 ON READER-SERVICE CARD

Variable Resistors

Wirewound

These preset wirewound variable resistors have a resistance range of 1/2 to 5000 ohms and measure 3/4 in. in diameter. Positive contact with the resistance winding at every point of rotation is provided by a spring contactor. Continuous contact between contactor, rotor, and cover is also provided. Rotational torque is 2 to 8 oz-in., stop torque is 12 lb-in., and the angle of rotation is 240 ± 5 deg without fixed resistor stop. Type 110 has straight or snap-in mounting tabs and terminals for printed circuits and type 112 has a flange type cover for eye-let or rivet mounting.

Chicago Telephone Supply Corp., Dept. ED, Elkhart, Ind.

CIRCLE 280 ON READER-SERVICE CARD

Leak Detector

Detects 1×10^{-13} cc per sec

Model 700A leak detector is sensitive to a leak rate of 1×10^{-13} cc of air per sec. The attenuation settings are 1, 3, 10, 30, 100, 300, and 1000. The required input is 115 v, 60 cps, single-phase. Model 700B includes a pumping system in addition to the basic instrument. The over-all dimensions of these units are 52 x 45-1/2 x 25-1/2 in.

Crosby-Teletronics Corp., Vacuum Research Div., Dept. ED, 54 Kinkel St., Westbury 4, L.I., N.Y.

CIRCLE 281 ON READER-SERVICE CARD

Silicon Transistors

Saturation resistance under 5 ohms at $10 \mu\text{a}$

These symmetrical pnp silicon transistors have a saturation resistance of less than 5 ohms at $10 \mu\text{a}$. Leakage currents are held below $0.005 \mu\text{a}$. Like relay contacts, the transistors can switch current in both directions. They are used in choppers, demodulators, bilateral applications, and conventional switching circuits.

Crystalonics, Inc., Dept. ED, 249 Fifth St., Cambridge, Mass.

CIRCLE 282 ON READER-SERVICE CARD

CIRCLE 283 ON READER-SERVICE CARD

KEEPS *Total* COST DOWN



IF INSTALLED-COST IS A DESIGN PROBLEM

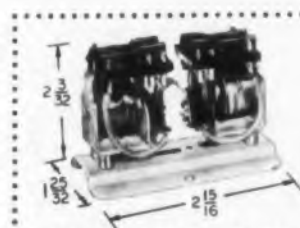
Look at the KA general purpose RELAY

What do your relays cost *installed*? Initial cost is never the whole story.

Our KA Relays are engineered for modern production methods. They're available with printed circuit, taper tab, quick-disconnect or hook solder terminals . . . are simple, economical to install. This fact, combined with low original cost, keeps your total cost down.

Another source for savings! All standard KA ac relays bear U/L and Canadian Standard Association seals of approval.

Write or call for more information or see the complete P&B catalog in Sweet's Product Design File.



KB LATCHING RELAY consists of two KA Relays, forming a mechanical latching relay, featuring a large number of contact arrangements.

KA ENGINEERING DATA

GENERAL:

Insulation Resistance: 100 megohms min.
Breakdown Voltage: 1500 V. rms between all elements.

Temperature Range:
-55° C. to +85° C. DC
-55° C. to +70° C. AC

Weight: 2.0 ozs.
Pull-in: DC 75% of nominal voltage.
AC 78% of nominal voltage.

Terminals: Taper tabs.
Printed circuit.
Quick-disconnect.
Pierced solder lugs.

Enclosures: Dust Cover
(max. 55° C. ambient for AC relays)
(max. 70° C. ambient for DC relays)

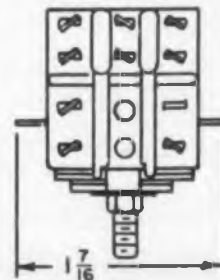
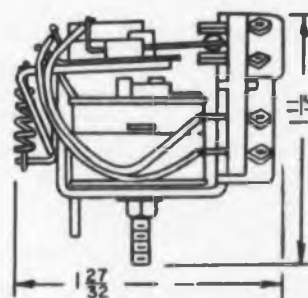
CONTACTS:

Arrangements: 3 Form C (3PDT) max.
Material: Movable—1/8" silver; stationary—1/2" wide silver overlay.

Lead: 5 amps @ 115 V. AC 60 cps res.

COILS:

Resistance: 16,500 ohms max.
Power: 1.2 watts (DC), 2 volt amps (AC)
Duty: Continuous AC or DC (DC coils will stand 4.5 watts at 25° C.)



P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

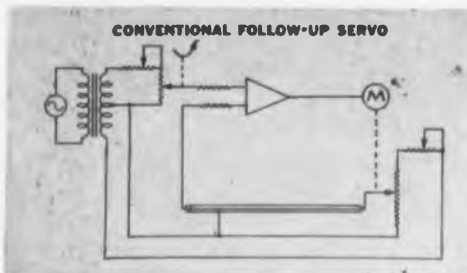
IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

How to improve servo performance with Vernistat* a. c. potentiometers

Typical example shows how they increase servo reliability and accuracy, reduce system complexity and cost

Servos which utilize resistance potentiometers must also include several other components to achieve high accuracy. In addition, these components may increase cost, create added problems in design, and add an element of unreliability.

FOR EXAMPLE, a simple follow-up servo:



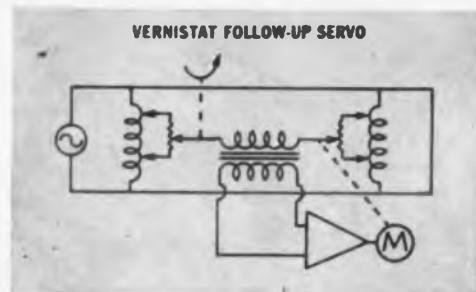
Here, to position a remote shaft in accordance with the position of the input shaft, resistance potentiometers and summing resistor networks are used. This requires an accurate center-tapped voltage source, so that the two potentiometers will be excited by equal voltages of opposite phase. When the shafts of the two potentiometers correspond, the input to the amplifier will be zero.

THIS TYPE OF CIRCUIT has inherent difficulties:

- 1) With usual high potentiometer impedances, pickup from stray electrostatic fields may necessitate shielding of the remote signal leads. Shielding and its capacitance increases phase shift.
- 2) In the summing resistor network, half of the error voltage appears across each resistor, so that only half of the error voltage appears at the amplifier input. This means a loss of gain of one-half, which must be made up by the amplifier.
- 3) To achieve terminal linearity and resulting servo accuracy, it is often necessary to end-trim conventional potentiometers.

CONTRAST THIS CIRCUIT WITH one which includes the Vernistat a.c. Potentiometer — a fundamentally new, compact device which combines several desirable features not available in standard potentiometers.

*vernistat®—a design concept that unites in one compact device the best features of the precision autotransformer and the multiturn potentiometer



Here, a null transformer provides gain and transmits the error signal directly to the amplifier. Because of this, the amplifier gain requirements are reduced. The error signal is zero when the two Vernistat shafts correspond.

IN THE VERNISTAT CIRCUIT, all signals are transmitted over low impedance leads. This reduces the circuit's susceptibility to pickup and quadrature due to stray capacity. This is particularly important in high gain servo systems.

FEWER COMPONENTS ARE NEEDED with the Vernistat approach, and this reduces the system's complexity. Summing resistors are not necessary. Where conventional potentiometers must be end-trimmed to achieve terminal linearity, the Vernistat inherently provides terminal linearity by means of its design.



IN SOLVING DESIGN PROBLEMS like these, the Vernistat a.c. Potentiometer offers such major features as: low output impedance (as low as 45 ohms) with high input impedance (as high as 200,000 ohms) — high resolution (up to 0.004%) — low phase shift (as low as 0.2 minutes) — and high terminal linearity (to 0.01%). Vernistat a.c. Potentiometers meet the requirements of MIL E 005272-B, and will operate at 125°C without derating.

WRITE TODAY for full description and specifications on Vernistat a.c. Potentiometers, Adjustable Function Generators, and Variable Ratio Transformers.



765 Main Ave., Norwalk, Conn.

Perkin-Elmer Corporation

CIRCLE 284 ON READER-SERVICE CARD

NEW PRODUCTS

Neon Indicator Unit

Mounts in 3/8-in. hole

This low-voltage neon indicator unit generates its own ignition voltage from any applied dc voltage of four or more volts. It mounts in a 3/8-in. hole and is available in a variety of lens shapes and colors. Called a Tec-Lite, and designated the LVN-Series, it may be operated directly from the source voltage. Or it may be additionally controlled by a low voltage, high impedance input signal. It is designed for portable, battery-operated equipment.

Transistor Electronics Corp., Dept. ED, 3357 Republic Ave., Minneapolis 26, Minn.

CIRCLE 285 ON READER-SERVICE CARD

Circulator Tee

Frequency range is 9 to 9.16 kmc



For missile applications, transponders, beacons, and other airborne radar systems, model 380864-1A three-port circulator tee has a frequency range of 9 to 9.16 kmc with isolation at 16 db min. The insertion loss from the transmitter to the antenna is 0.4 db max, and from the antenna to the receiver, 0.2 db max. The input vswr is 1.5 max, peak power is 50 kw, and average power is 50 w.

Kearfott Co. Inc., Microwave Div., Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

CIRCLE 286 ON READER-SERVICE CARD

Picture Tube

Needs no safety plate

Type 23KP4 square-cornered picture tube needs no safety plate, and has 114 deg deflection using standard 110 deg sweep components. The tube is 23 in. wide and uses a dark safety glass, called Ultra-Vision, which increases picture contrast and cuts reflected light.

General Electric Co., TV Receiver Dept., Dept. ED, Electronics Park, Syracuse, N.Y.

CIRCLE 287 ON READER-SERVICE CARD

PRECISION TEST RECEIVER



Sensitive Detection of Microwave Energy

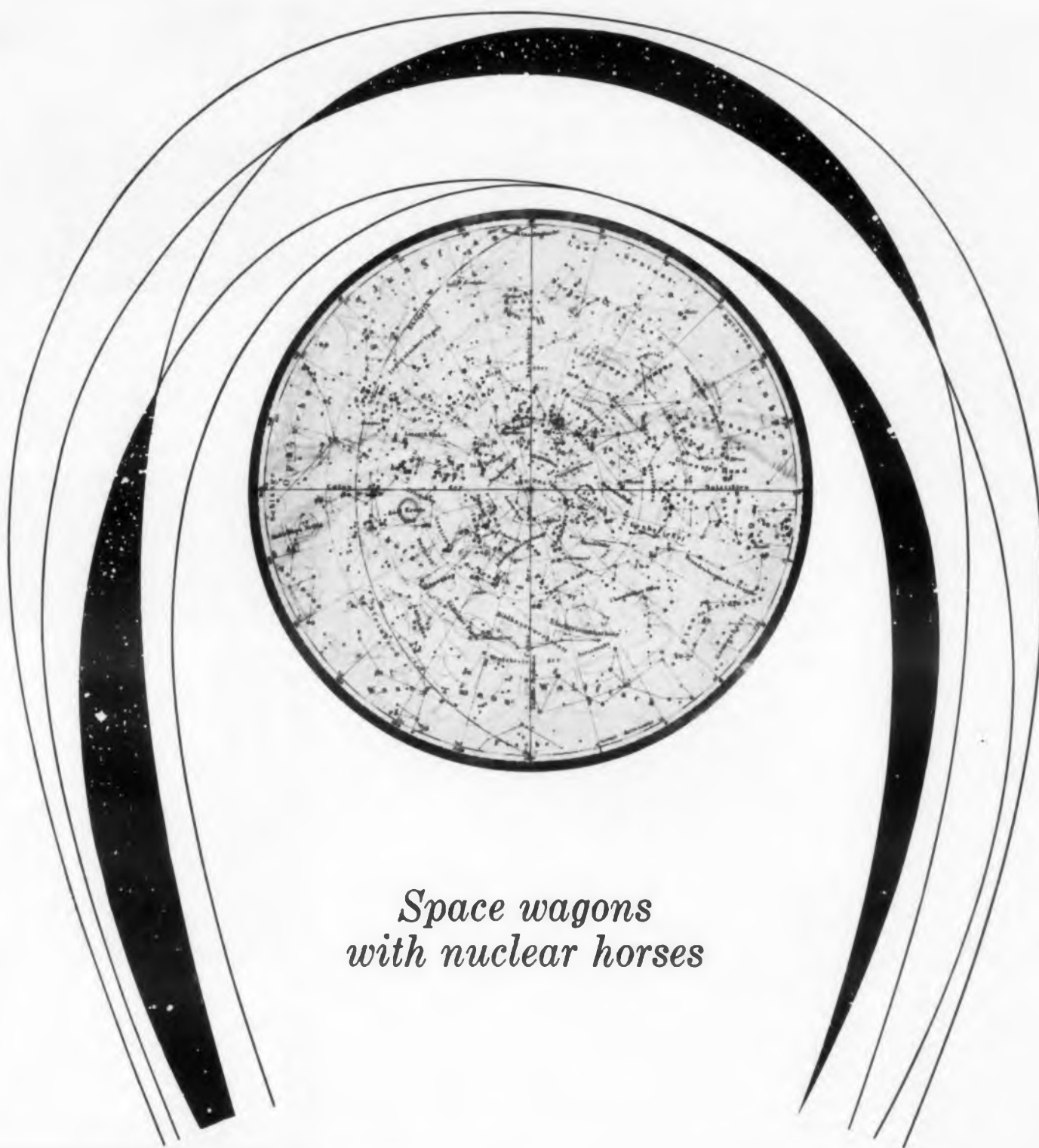
The AIL Type 130 Precision Test Receiver (30 and 60 Mc standard units available) is a versatile instrument combining a high gain, low-noise figure receiver and a secondary standard of attenuation. It can be used wherever accurate measurements of the differences of r-f and i-f power levels are required. A few typical applications are: noise - figure measurement, measuring characteristics of directional couplers, calibration of r-f attenuators and measurement of selectivity characteristics.

Detailed literature is available on request.



1345 NEW YORK AVENUE
HUNTINGTON STATION, L. I., N. Y.
A DIVISION OF CUTLER-HAMMER, INC.

CIRCLE 288 ON READER-SERVICE CARD

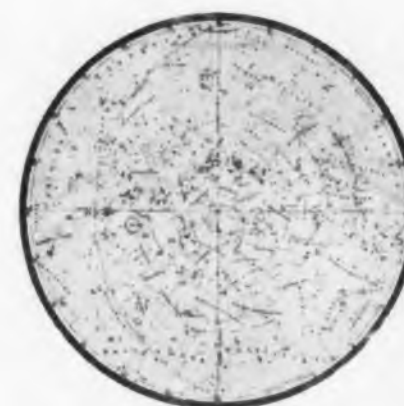


*Space wagons
with nuclear horses*



Space exploration will really come of age when manned rockets can leave earth, accomplish their missions and return without disposing of parts of themselves en route. This breakthrough depends on the rapid development of both nuclear rocket engines and the space vehicles capable of using them. Douglas is putting forth a major research effort in the area of manned nuclear space ships. Every environmental, propulsion, guidance and structural problem is being thoroughly explored. Results are so promising that even if the nuclear engine breakthrough comes within the next five years, Douglas will be ready to produce the vehicles to utilize this tremendous new source of space power! Douglas is seeking qualified scientists and engineers for this and other vital programs.

Elmer Wheaton, Engineering Vice President, Missiles and Space Systems, goes over new space objectives that will be made possible by nuclear propulsion with Arthur E. Raymond, Senior **DOUGLAS** Engineering Vice President of



Give your career
extra propulsion, tool

**DOUGLAS AIRCRAFT COMPANY
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has immediate openings
in the following fields—

Electrical and Electronics:

Control System Analysis & Design
Antenna & Radome Design
Radar System Analysis and Design
Instrumentation
Equipment Installation
Test Procedures
Logic Design
Power System Design

Mechanical Engineering —

Analysis and Design of the following:

Servo Units
Hydraulic Power Systems
Air Conditioning Systems
Missile Launcher Systems
Propulsion Units and Systems
Auxiliary Power Supplies

Aeronautical Engineering:

Aerodynamic Design
Advanced Aerodynamic Study
Aerodynamic Heating
Structural Analysis
Strength Testing
Dynamic Analysis of Flutter
and Vibration
Aeroelasticity
Design of Complex Structure
Trajectory Analysis
Space Mechanics
Welding
Metallurgy

Physics and Mathematics:

Experimental Thermodynamics
General Advanced Analysis in
all fields
Computer Application Analysis
Computer Programming and
Analysis
Mathematical Analysis

For full information
write to:

Mr. C. C. LaVene
Box 601-E
Douglas Aircraft Company, Inc.
Santa Monica, Calif.

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT

FAIRCHILD TA-400 ACCELEROMETER SMALLEST EVER MADE

high shock and vibration resistance...
0.5% accuracy... self-torquing for system testing.*

This hermetically sealed linear accelerometer for missile and aircraft applications has an extremely sensitive differential transformer pick-off. It will measure accelerations from $\frac{1}{4}g$ to 50g. Viscous fluid damping is provided over a wide temperature range. *The pick-off is wired with additional taps to allow a DC or AC excitation (Filterable from pick-off excitation) to be superimposed. This torques the restrained pendulum in either direction from null.

FAIRCHILD
CONTROLS CORPORATION

COMPONENTS DIVISION
225 Park Ave. 6111 E. Washington Blvd.
Hicksville, L. I., N. Y. Los Angeles, Cal.

A Subsidiary of Fairchild Camera and Instrument Corporation

GYROS
PRESSURE
TRANSDUCERS
POTENTIOMETERS
ACCELEROMETERS

Write
Dept 35ED

SHOCK: 100g EACH OF THREE AXES
VIBRATION: 20g TO 2000 CPS EACH OF THREE AXES



$\frac{7}{8}$ " Length
 $\frac{1}{2}$ " Diameter

General Characteristics

Range	$\pm\frac{1}{4}g$ to $\pm 50g$
Undamped natural frequency	10-175 cps
Output	Differential Transformer 6 volts into a 10K load. 400 cps phase sensitive
Null	15 to 50 MV
Accuracy	Including linearity, hysteresis, and repeatability after light tapping—0.5% of full scale to half scale.

CIRCLE 289 ON READER-SERVICE CARD

NEW PRODUCTS

Wire Tubing

For high temperature use

This aluminized, silicone-rubber impregnated glass cloth, called Zippertubing, is for use on wires and cables in high temperature areas. It has good chemical resistance and can be used on aircraft cables which are in contact with hydraulic fluids such as Skydrol. It is designed for easy installation.

Zippertubing Co., Dept. ED, 752 S. San Pedro St., Los Angeles 14, Calif.

CIRCLE 290 ON READER-SERVICE CARD

Servo Amplifier

Operates dc plus 2 and 3-phase motors



Designed to respond to 400 cps control signals obtained from synchro, induction-potentiometer, or resistance-potentiometer follow ups, model D-3320 servo amplifier operates dc, two-phase, and three-phase motors. The temperature range is -65 to $+160$ F. Positioning time is as low as 5 sec from travel stop-to-stop. The unit withstands 10 g vibration at frequencies to 2000 cps and 15 g shock. Solid state electronics are used. The unit is adaptable to aircraft, missile, ordnance, marine, and industrial applications.

Hoover Electric Co., Dept. ED, Hanger Two, Port Columbus Airport, Columbus 19, Ohio.

CIRCLE 291 ON READER-SERVICE CARD

Wire Cutter

Automatic

For short run productions, model AB-4 wire cutter can be operated by inexperienced personnel. Wire may be cut in lengths from 2-1/2 to 25 in. The counter, which determines the number of pieces to be cut, may be set from 0 to 500. Hook-up wire and sleeving is cut at the rate of 1000 ft per hr.

Electronic Industries, Dept. ED, 2624 Perliter St., N. Las Vegas, Nev.

CIRCLE 292 ON READER-SERVICE CARD



LOU: It's truly remarkable, Mac. The connector conforms to the highest standards under—

MAC: 'Conformity'! That's what's eating our society alive! What but decadence can ensue when every man wears the same tie, drives the same car—



LOU: —the most rigid tests ever devised, and it's capable of withstanding specified test voltage of Table 1 at sea level—

MAC: —lives in a house indistinguishable from his neighbor's—



LOU: —and again while undergoing the 50,000 feet—

MAC: —and sacrifices his soul to conform to The Organization Idea? What's become of the individualists, the bohemians, the pure literati and true intelligentsia?!



LOU: —altitude test. Did you dig the legs on that blond at the 16th?

AMPHENOL

MINNIE

As advertised on page 76.

Fast delivery at factory prices from

Schweber

ELECTRONICS

80 HERRICKS ROAD, MINEOLA, L. I., N. Y.
PIONEER 6-8820, TWX 6-CV-NY-880U

CIRCLE 293 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

SILIC
grade
boron
tals
lifetim
are a
Gr
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SILICON MONOCRYSTALS.—Semiconductor grade, are doped to customer specifications. The boron level is less than 1/2 ppb. Undoped monocrystals have resistivities of 800 ohm-cm or higher and lifetimes in excess of 200 μ sec. Polycrystalline rods are also available.

Grace Electronic Chemicals, Inc., Dept. ED, 101 N. Charles St., Baltimore 1, Md.

CIRCLE 294 ON READER-SERVICE CARD

SILICON DIODES.—For very fast computer switching applications, types RD2121 and RD2124 recover to 200 K in 0.2 μ sec. Typical capacitance is 1.5 μ f. Mil specs are met.

Rheem Semiconductor Corp., Dept. ED, 327 Moffett Blvd., Mountain View, Calif.

CIRCLE 295 ON READER-SERVICE CARD

JAR BATHS.—Called Magni-Whirl, are for ASTM kinematic viscosity tests and general laboratory use. Automatic pulsation of the agitator plate maintains temperatures constant to ± 0.1 deg C. The temperature range can be 70 C or to 100 C. The design allows for full visibility.

Blue M Electric Co., Dept. ED, 138th and Chatham St., Blue Island, Ill.

CIRCLE 296 ON READER-SERVICE CARD

SOLDERING TIP CLEANER.—Type 149 has brushes treated to withstand heat. Certified not to cause corrosion of solder joints, it is used in laboratories, industrial applications, and workshops.

Dickinson's Electronics, Dept. ED, Sacramento 24, Calif.

CIRCLE 297 ON READER-SERVICE CARD

SHIPPING CONTAINER.—Gives complete protection to electronic equipment and conforms to the Air Transportation Association category 1 standards. They are made in customer-specified sizes and are re-usable.

William Bal Corp., Dept. ED, 947 Newark Ave., Elizabeth, N. J.

CIRCLE 298 ON READER-SERVICE CARD

LAMP SHIELDS.—Spring-type brass, cadmium-plated, they fit directly on the glass part of the T-3 1/4 lamp. They come in straight or flared design.

Amatom Electronic Hardware Co., Inc., Dept. ED, 88 Drake Ave., New Rochelle, N. Y.

CIRCLE 299 ON READER-SERVICE CARD

BATTERY CHARGE CONTROL.—Type MP-3 automatically controls the battery charging equipment as it brings the battery to a full state of charge, and then automatically terminates the charge. Designed to control both regular daily charges and weekly equalizing charges, it requires no attendance or resetting. For controlling modified-constant potential battery charging, units are available for 6- to 60-cell batteries. Dimensions are 6-1/4 x 8-1/8 x 4-1/8 in.

The Electric Storage Battery Co., Exide Div., Dept. ED, Rising Sun and Adams Aves., Philadelphia 20, Pa.

CIRCLE 300 ON READER-SERVICE CARD

reads easily, at a glance . . .



This new General Electric Type KT time meter measures operating time of any electrical equipment, speeds routine checking with **"at-a-glance" readability**. Big numbers are more than twice the size of ordinary meter digits. New low cost, too—in square, round, portable and sealed models. Totally enclosed construction means extra years of dependable operation. Increased operating temperature range (minus 67F to plus 150F) extends meter life, reduces maintenance. What's more, a **new sixth digit**—standard on all G-E models—offers more accurate range of measurement at **no extra cost!** Pass on these important benefits to your customers with time meters from the complete KT line. Also, specify G.E.'s Type TSA interval or process timers for dependable service on your automatic time-control applications. New BIG LOOK panel meters are available, too! For the full story on any of these instruments, contact your nearby G-E Apparatus Sales Office; or, write to Section 593-306, General Electric Co., Schenectady 5, N. Y. In Canada, contact Canadian General Electric Company Limited, 940 Lansdowne Avenue, Toronto 4, Ontario.

Other General Electric Instruments for Original Equipment Manufacturers—Switchboard instruments; inking, inkless, switchboard and portable recorders; testing instruments; speed-measuring systems.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

CIRCLE 301 ON READER-SERVICE CARD



now available from G-L . . .

HIGH PERMEABILITY nickel alloy Magnetic Laminations

plus the *QUALITY,
UNIFORMITY and SERVICE*
that have made
G-L TAPE WOUND CORES
a standard in the industry

High permeability magnetic laminations, made to the most exacting standards in the industry, can now be obtained from G-L.

Transformer Laminations have the superior characteristics and uniformity-of-product associated with G-L magnetic tape wound cores. Controlled production techniques, careful selection of material, expert tooling and precision stamping assure you of the highest quality.

Magnetic Head Laminations are the result of improvements made by G-L on normal processing techniques to provide laminations with minimum burrs, improved stacking factors, reduced head dimensions.

Special Shapes are available from G-L for special applications. Our own tool and die shop is set up to do rapid prototype work.

Your inquiries are invited. Write, wire or call. Send us prints on your current requirements for an immediate quotation. Our illustrated magnetic laminations folder, TB-104, will be mailed upon request.

G-L ELECTRONICS

2921 Admiral Wilson Blvd., Camden 5, N. J.
Phone WOodlawn 6-2780
Teletype TWX 761, Camden, New Jersey

CIRCLE 302 ON READER-SERVICE CARD

NEW PRODUCTS

Potentiometer

Resistance range is 10 ohms to 100 K

Model 224 Trimpot potentiometer has a resistance range of 10 ohms to 100 K, a temperature range of -65 to $+175$ C, and a power rating of 1 w at 70 C. The resolution is as low as 0.17%. Three terminal configurations are available: insulated stranded leads, solder lugs, and printed circuit pins. The unit weighs 0.1 oz and measures 0.19 x 1.25 x 0.32 in. It meets MIL-STD-202A.

Bourns, Inc., Dept. ED, P.O. Box 2112, Riverside, Calif.

CIRCLE 303 ON READER-SERVICE CARD



Frequency Signal Source

Delivers 40 to 4000 cps

For aircraft, missile, and ground control equipment, model MJXO frequency signal source delivers from 400 to 4000 cps. The unit is available with accuracies of $\pm 0.05\%$, $\pm 0.02\%$, and $\pm 0.01\%$ for continuous operation from -55 to $+85$ C. Operating from a 28 v dc, 20 ma, it furnishes a 0.23 rms min sine wave into equal or more than 2 K load, or 6 v peak-to-peak min clipped sine wave into equal or more than 7.5 K load. The unit is potted in silicone rubber and is hermetically sealed. Variations in waveform, output, and input are available.

Philamon Laboratories, Inc., Dept. ED, 90 Hopper St., Westbury, N.Y.

CIRCLE 304 ON READER-SERVICE CARD

Active Cathode Alloy

For vacuum tubes

Type X-3012 active cathode alloy is available in the form of seamless, Weldrawn, disc, lock-seam, and lapseam cathodes for vacuum tube. Having a high emission rate and a low sublimation rate, this material is made by adding 0.1% zirconium and 2% tungsten to the nickel base. Cathodes made from it can be fired at 700 C without undue softening.

Superior Tube Co., Dept. ED, 1521 Germantown Ave., Norristown, Pa.

CIRCLE 305 ON READER-SERVICE CARD

Another **FIRST** from **ALI**



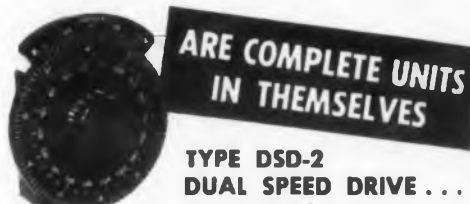
Now, for the first time you can obtain precision drive units complete in one package. ALI Drives save time, trouble and money—eliminate the need of procuring and assembling separate indicators, dials, knobs, gears, etc. And, with ALI Precision Drive Units you know you have a unit that will do the required job without a possibility of error. Use them with rotary components such as resolvers, syncros, potentiometers, inductors, capacitors, tuning coils, etc.



**REQUIRE NO
ADDITIONAL PARTS**

**TYPE PDW-1 PRECISION
DRIVE, WORM . . .**
Accuracy 1 min. of arc

A worm gear, shaft positioner for accurate repeatable positioning and indicating. Features: no backlash, compact design, long life, rugged construction. Mechanism utilizes a 180-1 ratio allowing direct dial readings of 1 minute of arc. Has hairline indicator, large engraved dials.



**ARE COMPLETE UNITS
IN THEMSELVES**

**TYPE DSD-2
DUAL SPEED DRIVE . . .**
Accuracy 6 mins. of arc

A precision gear reducer for highly-accurate repeatable positioning and indicating. Inner dial for coarse positioning, outer dial for fine positioning plus in-line input and output shafts and the availability of a wide range of ratios through 72-1. No backlash.



3 TYPES AVAILABLE
all meet MIL-E-4970 (USAF)

**TYPE DSD-3
DUAL SPEED DRIVE . . .**
Accuracy 12 mins. of arc

An economical precision gear reducer for positioning and indicating. Features: no backlash, in-line input and output shafts, compact design. Like Type DSD-2, it has inner dial for coarse positioning, outer dial for fine positioning.

Write for full details
ALI
**ACTON
LABORATORIES INC.**
Subsidiary of Technology Instrument Corp.
530 MAIN STREET, ACTON, MASS.
COLONIAL 3-7756

CIRCLE 306 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

CLINCH NUTS.—Types NKCFM are used in miniature components in aircraft, missiles, and industrial applications. They are effective to 350 F. The integral nylon cap seals pressures to 80 psi past the bolt threads. The installation may be by hand or by using a riveting or spinning technique. Shank lengths are 0.04 to 0.06 in. and minimum thickness is 0.03 in. Available in thread sizes 4-40 through 10-32, they are made of steel, cadmium plated, and stainless steel, plain finish. They meet AN-N-10 and MIL-N-25027 requirements.

Elastic Stop Nut Corp. of America, Dept. ED, 2330 Vauxhall Rd., Union, N. J.

CIRCLE 307 ON READER-SERVICE CARD

STRAIGHTENER AND ORIENTER.

—Type H-100 straightens diode leads and feeds packages into test equipment, taping machines, and marking machines. Typical operating speed is 3600 diodes per hr. Power required is 115 v ac.

Carman Labs., Inc., Dept. ED, 10 Carman Rd., Bedford, Mass.

CIRCLE 308 ON READER-SERVICE CARD

CASES.—For housing components or assemblies which must be easily accessible, three sizes of Minislides are available. They are made of aluminum.

Bud Radio, Inc., Dept. ED, 2118 E. 55th St., Cleveland 3, Ohio.

CIRCLE 309 ON READER-SERVICE CARD

CASES.—Designed for installation of more components than is possible with other cases of the same size, they have both snap lock and screw type fastening and are made of steel or aluminum. Called Miniboxes, they come in 18 sizes.

Bud Radio, Inc., Dept. ED, 2118 E. 55th St., Cleveland 3, Ohio.

CIRCLE 310 ON READER-SERVICE CARD

WIRE STRIPPERS.—Called Luco, they can strip plastic, polyethylene insulation, and Teflon. Several models are available for either hand or foot pedal operation. The model LT 4 can

be modified for solenoid operation, mounted on work tables.

Electronic Applications, Inc., Dept. ED, 194 Richmond Hill Ave., Stamford, Conn.

CIRCLE 311 ON READER-SERVICE CARD

WIRE STRIPPER.—Strips wire larger than No. 12 AWG and smaller than No. 36 AWG as well as coaxial cable. Called model F, it can be used with Teflon, vinyl, nylon, mylar, rayon, and polyethylene.

Western Electronic Products Co., Dept. ED, 655 Colman St., Altadena, Calif.

CIRCLE 312 ON READER-SERVICE CARD

SILICON DIODES.—Types RD1356 through RD1359 have a resistance to 50,000 meg at 25 C. Forward conductance is 100 ma at +1 v and breakdown voltages range is to 200 v. Mil requirements are met.

Rheem Semiconductor Corp., Dept. ED, 327 Moffett Blvd., Mountain View, Calif.

CIRCLE 313 ON READER-SERVICE CARD

GRID.—For drafting printed circuits, has a tolerance of ± 0.001 in. over a 36-in. dimension. The material used is Mylar.

Flexigraph Co., Inc., Dept. ED, 998 Farmington Ave., W. Hartford, Conn.

CIRCLE 481 ON READER-SERVICE CARD

RECORDING THERMOMETER.—Uses a dry stylus and will record in any position. Temperature ranges are +20 to +220 F or -40 to +160 F; time ranges are either 24 hr or 7 days. The unit weighs 14 oz and measures 3-15/16 x 2-7/8 x 3-3/8 in.

Pacific Transducer Corp., Dept. ED, 11838 W. Pico Blvd., Los Angeles 64, Calif.

CIRCLE 482 ON READER-SERVICE CARD

FREQUENCY CALIBRATOR.—For fm-fm telemetering systems model 520 has a calibration time of 30 sec per channel. External metering is provided and operation may be effected by inexperienced personnel.

Fenske, Fedrick & Miller, Inc., Dept. ED, 12820 Panama St., Los Angeles 66, Calif.

CIRCLE 483 ON READER-SERVICE CARD



If noise annoys you...

FORCE IT DOWN WITH

... and get typical receiver noise figures of 5.5 to 6.0 db!



UP TO A FULL DB BETTER THAN 1N21E'S
Used in conjunction with a 30 mc IF of 1.5 db noise contribution, these typical noise figures are attained in receivers operating from 300 to 4000 mc... up to 1 db less than Microwave's famous low-noise E-series diodes! The 1N21F diodes are directly interchangeable with other diodes of the 1N21 series.

WIDE APPLICATION

A major application is as a low-noise mixer diode following a low noise parametric amplifier in the 100 to 3000 mc range. Others include: UHF scatter, TV, telemetering, microwave links, radio navigation and astronomy, long range radar, and communications receivers.

COST REDUCTIONS

A significant cost reduction in UHF receiver RF front ends is possible by substituting this diode for the RF vacuum tube preamps, associated power supplies and other accessories

previously required for low-noise figure performance.

HOW TO GET BEST RESULTS

In receivers designed for 1N21C or 1N21E diodes, maximum noise figure improvement is obtained by retuning RF match, adjusting local oscillator injection for lowest noise figure and the IF matching transformer for optimum IF impedance match of the 1N21F. For minimum receiver noise the 1N21F should be matched into a low noise IF preamplifier using WE 5842 triodes or similar tubes.

AVAILABLE NOW in production quantities. Write or call for data and prices.



MICROWAVE ASSOCIATES, INC.
BURLINGTON, MASSACHUSETTS
BRowning 2-3000 — TWX 942

CIRCLE 314 ON READER-SERVICE CARD

FOR MAXIMUM MINIATURIZATION & LOWER COST...

Versatile Co-Netic and Netic Magnetic Shielding Foils



Facilitates positioning components closely without interference from damaging magnetic fields, making possible compact and less costly systems.



Cuts readily to any shape with ordinary scissors.



Wraps easily.



Easily fastens to walls for shielding entire rooms.



How Co-Netic and Netic foils lower your magnetic shielding costs:

- 1) You use less shielding material because (a) foil thickness is only .004" and (b) foils cut easily to exact shape required, minimizing waste.
- 2) Odd shaped and hard-to-get-at components are easily shielded, saving valuable time and eliminating tooling costs and inflexibility of rigid metals.

These foils are non-shock sensitive, non-retentive, require no periodic annealing. They effectively shield electrostatic and magnetic fields over a wide range of intensities. Both foils available from stock in any desired length in various widths.

Co-Netic & Netic foils are successfully solving many types of magnetic shielding problems in numerous critical satellite, missile, magnetic tape and other military, airborne, electronic and laboratory applications. These foils can help you solve your magnetic shielding problems.

MAGNETIC SHIELD DIVISION PERFECTION MICA CO.
1322 No. Elston Avenue • Chicago 22, Illinois

CIRCLE 315 ON READER-SERVICE CARD

NEW PRODUCTS

Phase Shifter

Produces 90 deg phase shift



Model 400 phase shift unit produces a 90 deg phase shift with a precision of 0.05 deg. The unit has a low phase gradient with respect to frequency, unity gain, low output impedance, and stable operation. Calibration adjustments are provided for. For operation at 400 cps, the unit has applications in tachometer testing, generating two-phase signals, and phase angle generation. It can be supplied in either full panel or half-panel sizes.

Dytronics, Dept. ED, P.O. Box 3676, Columbus 14, Ohio.

CIRCLE 316 ON READER-SERVICE CARD

Thermostat

Rated at 5.5 amp on 110 to 120 v ac



Type B thermostat operates on the principle of current flowing through the bimetal and generating heat which actuates the bimetal, breaking the circuit. As the device cools, the bimetal returns to the normal position and recloses the contacts. The blade and bimetal are supplied to give any desired performance. The unit is normally rated at 5.5 amp on 110 to 120 v ac. Both screw and quick disconnect terminals are standard; other types are available on special order. Adjustable and non-adjustable types can be furnished.

Clark and Bobertz, Inc., Hickok-Donnelley Div., Dept. ED, 1900 Euclid Ave., Cleveland 15, Ohio.

CIRCLE 317 ON READER-SERVICE CARD

NEW FROM NARDA



Model
10001
\$4700.

High Power

MICROWAVE MODULATOR

accepts over 40 magnetrons!

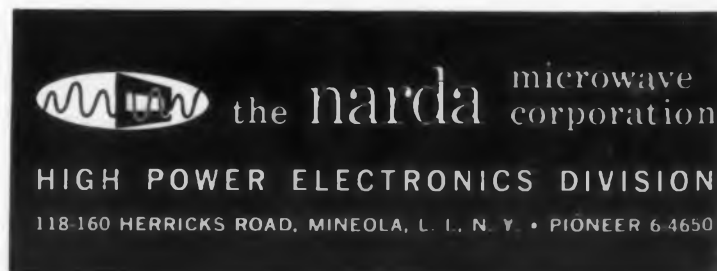
Here's the first of a series of new products from Narda's recently-established High Power Electronics Division! A high power Microwave Modulator that permits installation inside the unit of any of more than 40 magnetrons! Complete, compact and self-contained, it accepts magnetrons covering 3,200 mc to 35,000 mc, with peak outputs from 6 KW to 120 KW. Model 10001 features a completely interlocked circuit, with all high voltage leads and connections internal, for maximum safety; solid state high voltage bridge rectifiers for longer life and reduced heat output (prolonging life of other components, too); and built-in meters and viewing connectors for all principal parameters.

Other features are shown below. For complete specs and a list of at least 40 magnetrons suitable for use with the 10001, write Narda's High Power Electronics Division (HPED) at Dept. ED-7.

SPECIFICATIONS

High voltage supply: Continuously variable from 0 to 4 KV at 100 ma; **Pulse power:** 18 KV at 20 amps max.; **Magnetron filament supply:** Cont. variable from 0 to 13 volts at 3 A; **Rep. rate generator range:** Cont. variable from 180 to 3000 pps; **Pulse width:** 1 microsecond at 70% points, rise time 0.15 microseconds, max. slope 5% (other pulse widths available); **Size:** 38" h, 22" w, 18" d. **Weight:** 150 lbs.

Complete 1959 catalog available on request.



CIRCLE 318 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

SIX VSWR AMPLIFIER FEATURES

...available only from **NARDA**

1. Battery-operated (rechargeable nickel-cadmium).
2. Completely transistorized for low current drain.
3. Independent of line voltage variations.
4. Complete bolometer protection during switching.
5. Most compact unit available.
6. Completely portable.

Model 441B—\$225



Now you can get a completely portable battery-operated VSWR Amplifier offering complete protection against bolometer burnout at the same time!

Narda's Model 441B is supplied with nickel-cadmium batteries, providing complete freedom from line voltage deviations. Batteries recharge automatically when unit is plugged in; provision is built-in to show state of battery charge. A special protective circuit

permits switching and connect-disconnect with no danger of bolometer burnout. Provision is made for both crystals and high and low current bolometers.

Full sensitivity is provided over both normal and expanded scales; eliminates switching attenuation range. Other features are shown on this page; for complete information and a free copy of our latest catalog, write to us at: Department ED-10.

FEATURES:

- **SENSITIVITY:** 0.1 microvolts at 200 ohms for full scale.
- **FREQUENCY:** 1,000 cps \pm 1% (plug-in frequency networks available for 315-4,000 cps and broad-band applications)
- **BANDWIDTH:** 25-30 cps
- **RANGE:** 72 db (60 db in 10 db steps, 11 db continuous)
- **ACCURACY:** \pm 0.1 db per step • \pm 0.2 db maximum cumulative • meter linearity: 1% of full scale

SILICON MESA TRANSISTORS.—Are npn, double-diffused type with a switching time of 25 msec. Saturation resistance is 5 ohms. They conform to Mil specs and to JEDEC TO-5.

Rheem Semiconductor Corp., Dept. ED, 327 Moffett Blvd., Mountain View, Calif.

CIRCLE 320 ON READER-SERVICE CARD

NAME PLATES.—Are made from color-fast, anodized aluminum. They can be used for marking and decorating electrical equipment such as relays, transformers, regulators, and dial faces. Wiring and circuit diagrams can also be placed on them. They are custom-made in all sizes, designs, and in one or more colors. The name plates can be supplied with various types of adhesives and are resistant to organic solvents and extreme weather conditions.

Allied Decals, Inc., Dept. ED, 8100-35 Hough Ave., Cleveland, Ohio.

CIRCLE 321 ON READER-SERVICE CARD

MILLIWATTMETER.—Type U-381 is a portable, resistive film, bolometer wattmeter for the measurement of microwave power. It measures power in the 1 to 100 mw range with an accuracy of \pm 3% over the frequency band of 12 to 18 kmc. The unit has terminals provided for calibrating it against dc power. A micrometer adjustment permits a short-circuiting termination to be set for a vswr near unity at any frequency within the specified range.

Wayne Kerr Corp., Dept. ED, 1633 Race St., Philadelphia 3, Pa.

CIRCLE 322 ON READER-SERVICE CARD

TRAVELING WAVE TUBE.—Designed for microwave relay service. These tubes are available in models which cover frequency bands spanning 800 to 4800 mc.

International Telephone and Telegraph Co., Dept. ED, 67 Broad St., New York 4, N. Y.

CIRCLE 323 ON READER-SERVICE CARD

STEPPING RELAY.—Operates at a step rate of 8 per sec. It is a 12-position unit. Three of these relays have operated for more than 60 million revolutions with no indication of impending failure in life tests.

International Telephone and Telegraph Corp., Dept. ED, 67 Broad St., New York 4, N. Y.

CIRCLE 324 ON READER-SERVICE CARD

DPDT CHOPPER.—Model C1430-1 is a 9-pin plug-in unit with make-before-break-after action. Excitation frequency is 260 to 440 cps. The unit operates in temperatures from -65 to $+125$ C and will take 30 g of shock. The case measures $1/4 \times 1-3/8$ in. Model C1430 is a 9-pin general purpose unit that also has an excitation frequency of 360 to 440 cps. Other specifications are the same as for the C1430-1.

The Bristol Co., Aircraft Equipment Div., Dept. ED, Waterbury 20, Conn.

CIRCLE 325 ON READER-SERVICE CARD



the **narda** microwave corporation

118-160 HERRICKS ROAD, MINEOLA, L. I., N. Y. • PIONEER 6-4650

CIRCLE 319 ON READER-SERVICE CARD



Binswinger on Progress

Count Vladimir Butts Binswinger (1745-1810), inventor of the mnemonic alarm clock, said it: "All progress comes from man's desire to live beyond his income." A shocking thought, which devotees of Poor Richard's Almanac will indignantly reject with a frisson of well-bred horror.

We at HOOVER ELECTRONICS think Vladimir had something. Who doesn't want something better, even if it costs the earth with a platinum fence around it? The hopeful note in all this (optimists that we are) is that HOOVER is constantly trying to provide the *ultimate* . . . at the *reasonable* price. And (nobody'll say it if we don't) with fair success, too.

A fair example, to put it modestly, is the gismo shown below, which considerably lets existing FM/FM telemetering systems now in use at missile bases "live beyond their income" on a Scot's purse.

This Mixer Amplifier, no bigger than a baby's hand, is a part of the HOOVER Vernitel system, which improves accuracy of FM/FM telemetering systems by a whole order of magnitude, prolonging their lives in as humanitarian an effort as ever came out of a supposedly soulless corporation. Ask us for spec sheets.



HOOVER

ELECTRONICS COMPANY

SUBSIDIARY OF THE HOOVER COMPANY

110 WEST TIMONIUM ROAD • TIMONIUM, MARYLAND

Field Liaison Engineers
Los Angeles, California

CIRCLE 326 ON READER-SERVICE CARD

NEW PRODUCTS

Wavemeters

Absorption type



This series of absorption wavemeters offers the following frequency ranges: model RDW-5R, 1 to 2 kmc; model RDW-6R, 2 to 4 kmc; and model RDW-7R, 4 to 8 kmc. All models have a built-in crystal detector and a micrometer movement which is readable to 0.0001 in. The off-resonance insertion loss is less than 1 db and the insertion loss at resonance is about 2 db. The vswr is below 1.5; the loaded Q is greater than 2000. Each unit is furnished with a calibrated chart activated to 0.1%. Electrical foreshortening results in a maximum length of 14 in. for the largest unit.

Radar Design Corp., Dept. ED, Pickard Drive, Syracuse 11, N.Y.

CIRCLE 327 ON READER-SERVICE CARD



Frequency Generator

Provides 60 to 4000 cps

Model TFGX frequency generator, incorporating a tuning fork oscillator, provides from 60 to 4000 cps and a variety of output waveforms and voltages. It operates from 28 v dc to furnish 6 v peak-to-peak square wave or pulse into equal or more than 7.5 K load, or alternately a 1 rms filtered sine wave into equal or more than 10 K with less than 1% distortion. Binary frequency dividers offer lower frequencies with over-all accuracy and stability ranges from 0.001% to 0.05%. The unit is potted in silicone rubber and hermetically sealed.

Philamon Laboratories, Inc., Dept. ED, 90 Hopper St., Westbury, N.Y.

CIRCLE 328 ON READER-SERVICE CARD



AMPEX: turning point for tape

Magnetic recording has reached the point where a better tape, by itself, can significantly improve the performance of your equipment. Anticipating this, Ampex has developed its Instrumentation Tape to assure the highest capability that the state of the art requires.

Precision tape reliability comes principally from the properties of its coating. And Ampex combines oxide preparation and careful coating techniques with the exclusive Ferro-Sheen process to produce the smoothest, most cohesive, most uniform of precision tapes. The result is measurable higher signal-to-noise ratios, and much less tape wear.

This, with its squared-up hysteresis curve, makes Ampex Instrumentation Tape ideal for all recording systems: direct, FM-carrier, PDM, and NRZ-digital.

Ampex Instrumentation Tape is available on hubs, NAB-type die-cast magnesium-alloy Precision Reels. Widths of 1/4", 1/2", and 1" are standard on either Mylar* or acetate base, in the following lengths, reel diameters and base thicknesses:

REEL DIAMETER	AMPEX STANDARD TAPE LENGTHS (feet)	
	BASE THICKNESS (mils) 1.0	1.5
7"	1800	1250
10 1/2"	3600	2500
14"	7200	5000

*DU PONT TRADEMARK

For complete specifications and additional tape literature, write

AMPEX MAGNETIC TAPES

934 CHARTER STREET, REDWOOD CITY, CALIF.

Microammeter

Range is 0 to 50 μ a

This recording type dc microammeter has a range of 0 to 50 μ a with an input resistance of about 200 ohms. Ranges of 0 to 10, 50 and 200 mv dc are also included. A magnetic amplifier, powered by 120 v, 60 cps, is combined with a permanent-magnet moving-coil movement. Accuracy is within 2% of full scale. The instrument can be used in series with or as a substitute for indicating instruments that give only instantaneous readings. Chart speeds are 3/4 in. per hr through 12 in. per min. Portable or mounting type models with motor or spring driven chart drives are offered.

Esterline-Angus Co., Dept. ED,
Indianapolis 6, Ind.

CIRCLE 329 ON READER-SERVICE CARD

Solenoids

Coils are encapsulated

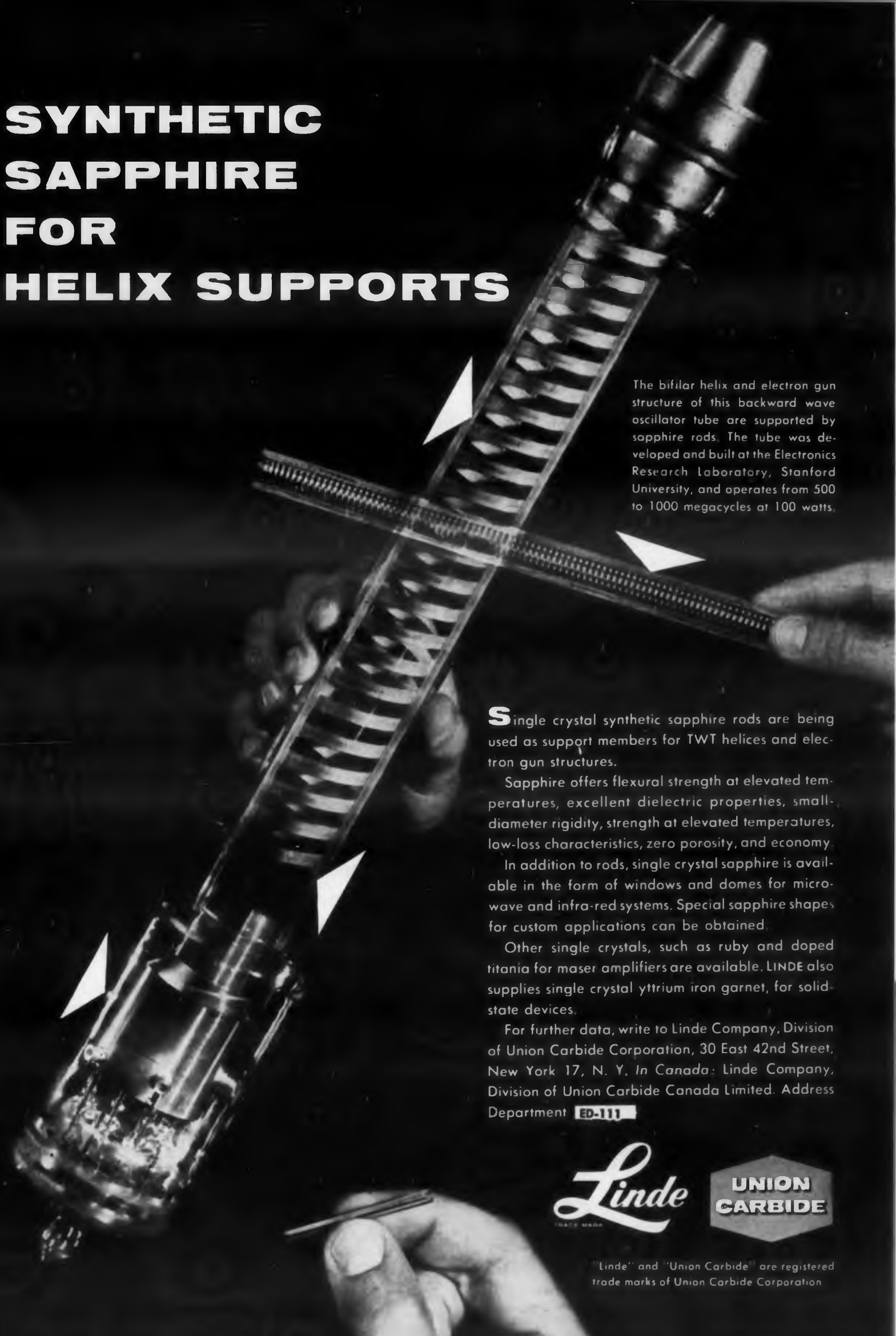
Series 801 double-T solenoids have a layer of epoxy resin for protection from moisture, water, machine oils, diluted acids, and harmful alkalies. The double-T design provides almost level pull characteristics throughout the plunger stroke. As the plunger decreases, the gap in the frame is bridged by the extra T-section on the plunger, providing additional pull and preventing a drop in power. Type 801 has a maximum stroke of 5/8 in., a formed pull-bar, and a 1/2-in. stack. Type 812 has a maximum stroke of 1-1/16 in., a straight pull-bar with reinforced slugs, and a 3/4 or 1-in. stack. Type 821 has a maximum stroke of 1-3/8 in., a formed pull-bar, and a 1-in. stack. Each is available for either constant or intermittent duty at 110 or 220 v, 60 cps. Units for dc may be ordered.

Controls Co. of America, Industrial and Commercial Controls Div., Dept. ED, 9555 Soreng Ave., Schiller Park, Ill.

CIRCLE 330 ON READER-SERVICE CARD

CIRCLE 331 ON READER-SERVICE CARD

SYNTHETIC SAPPHIRE FOR HELIX SUPPORTS



The bifilar helix and electron gun structure of this backward wave oscillator tube are supported by sapphire rods. The tube was developed and built at the Electronics Research Laboratory, Stanford University, and operates from 500 to 1000 megacycles at 100 watts.

Single crystal synthetic sapphire rods are being used as support members for TWT helices and electron gun structures.

Sapphire offers flexural strength at elevated temperatures, excellent dielectric properties, small-diameter rigidity, strength at elevated temperatures, low-loss characteristics, zero porosity, and economy.

In addition to rods, single crystal sapphire is available in the form of windows and domes for microwave and infra-red systems. Special sapphire shapes for custom applications can be obtained.

Other single crystals, such as ruby and doped titania for maser amplifiers are available. LINDE also supplies single crystal yttrium iron garnet, for solid-state devices.

For further data, write to Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. In Canada: Linde Company, Division of Union Carbide Canada Limited. Address Department **ED-111**

Linde
TRADE MARK

**UNION
CARBIDE**

"Linde" and "Union Carbide" are registered trade marks of Union Carbide Corporation

NEW PRODUCTS

DC Motors

Have constant speed



These constant speed dc motors are for such uses as controlling circuits from a battery. With operating voltages from 3 to 110 v dc and from 0.06 to 2 w input power, up to 150 oz-in. of torque can be produced at 1 rpm. Speeds from 900 rpm to 1 revolution in 24 hr can be provided. Severe environmental conditions, including vibration, gravity, and temperature, are provided for.

Amglo Corp., Dept. ED, 4325 N. Ravenswood Ave., Chicago 13, Ill.

CIRCLE 332 ON READER-SERVICE CARD

Counter

Has selectable digital time base



Equipped with a highly variable counting interval, model 5311 counter provides indications of flow, pressure, and speed in units such as psi, rpm, and gal per sec. The counting interval may be varied in steps of 10 μ sec from 10 μ sec to 1 sec. The frequency counting range is 10 cps to 200 kc. The counter makes period measurements by timing the duration of 1 to 100,000 cycles in 10- μ sec units. It is possible to produce a percentage indication of deviation from any given frequency by timing the number of input cycles. The internal time standard has a stability of 3 parts in 10^7 per day at a constant temperature. The ambient temperature range is -5 to $+150$ F.

Beckman Instruments, Inc., Berkeley Div., Dept. ED, 2200 Wright Ave., Richmond 3, Calif.

CIRCLE 333 ON READER-SERVICE CARD



THE RAW MATERIALS OF PROGRESS



FLUOROCHEMICALS, STABLE BELOW 0°

Polar cold! "Hot Spot" heat! To meet environmental and operational extremes like these, the RCA high-output transmitting tube shown above, needed a coolant superior to water. That coolant is FC 75, an inert fluid, one of the 3M Fluorochemicals. RCA found that FC 75 safely cooled tubes with plate dissipations in the order of 1,000 watts per sq. cm., and permitted essentially the same power output to be obtained at temperatures below 32° F. as that obtained with water cooling at temperatures above 32° F. The most stable fluid ever offered to electronics, FC 75 properties make it excel as a coolant and insulating fluid.

It has high dielectric strength, high heat transfer capability, is self-healing. It has wide liquid range with a pour point of -148° F. and low viscosity. It is thermally stable in excess of 800° F. As an evaporative coolant it is all these: nonexplosive, nonflammable, nontoxic, odorless, non-corrosive. Check the other properties at the right—then investigate FC 75, as well as other 3M Chemicals for the electronics industry: KEL-F® Molding Powders, KEL-F® Dispersions, KEL-F® Elastomers, Cardolite® NC 513, KEL-F® Oils, Waxes and Greases, Acids and Alkanes.

CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW



CIRCLE 334 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959



3M FLUORO-CHEMICAL FC 76 pours at -148°F . It has a wide liquid range of -148°F . to 212°F . at atmospheric pressure, with low viscosity. In addition, it offers these useful properties: high dielectric strength of 37KV; self-healing, maintaining dielectric strength after repeated high voltage arcing. Compatible with most materials used in high temperature equipment. Thermally stable in excess of 800°F ., it prevents development of hot spots in equipment. Prevents sludge formation due to hydrolysis or oxidation.

or at 800°F .

For free literature, write on your company letterhead, specifying product interest to 3M Chemical Division, Dept. KAP-119, St. Paul 6, Minn.



3M CHEMICAL DIVISION, MANUFACTURERS OF:
Acids • Resins • Elastomers • Plastics •
Oils, Waxes and Greases • Dispersion
Coatings • Functional Fluorochemicals •
Inert Liquids and Surfactants

COATING.—For spray coating of metal parts to provide anti-stick properties or for corrosion resistance or electrical insulation. The coating is made from Teflon and Kel-F. Custom coatings of from one to 20 mils in thickness can be applied to specification.

R. S. Hughes Co., Inc., Dept ED, 4515 Alger St, Los Angeles 39, Calif.

CIRCLE 335 ON READER-SERVICE CARD

INSERT.—Meets fastener requirements in electronic equipment. The S110 insert requires hole drilling only and can be used in open or blind applications. The insert provides load bearing, wear resistant, self-locking threads for holes in materials such as plate or cast aluminum, magnesium and cast iron. It can be used to temperatures as high as 450 F.

Rivet Tool Co., Dept. ED, 2600 W. 247th St., Torrance, Calif.

CIRCLE 336 ON READER-SERVICE CARD

CRADLE HEAD.—Permits tilting and panning television cameras by remote control. This makes possible positioning of cameras in inaccessible and dangerous locations. The control cradle head is powered by two separate motors which tilt the camera 30 deg up and 38 deg down and rotate it 370 deg. They are housed in soundproof housings for silent operation. Manual operation is also possible.

Houston Fearless Corp., Dept. ED, 11849 W. Olympic Blvd., Los Angeles 64, Calif.

CIRCLE 337 ON READER-SERVICE CARD

PROTECTIVE COMPOUND.—For protecting electric motor stator windings against moisture, dirt, abrasives, chemicals and other contaminants. Called Hysol 10-55, it is a two-component system which is mixed 1 to 1 by volume. The usual curing oven temperatures are used for preheating the motor and for curing the compound.

Houghton Laboratories Inc., Dept. ED, Olean, N. Y.

CIRCLE 338 ON READER-SERVICE CARD

POTTING COMPOUND.—For power transformers, the B-1317 material has a coefficient of shrinkage of 0.0002 in. per in. It offers adhesion to metal and a +265 F cold flow resistance. Good pour characteristics are obtained at +330 to +350 C.

Biwax Corp., Dept. ED, 3445 Howard St., Skokie, Ill.

CIRCLE 339 ON READER-SERVICE CARD

POWER SUPPLIES.—Chopper stabilization is now available as an optional accessory on Regatron power supplies. The chopper stabilizer raises the stability and regulation fixtures for the Regatron units by a factor of from 10 to 50.

Electronic Measurements Co. Inc., Dept. ED, Eatontown, N. J.

CIRCLE 340 ON READER-SERVICE CARD

For accurate, reliable acceleration measurement...

Pacific's

PRECISION LINEAR ACCELEROMETERS

are rugged
and right!

Pacific's family of accelerometers are designed, developed and tested to meet almost any acceleration measurement requirement. Their custom design provides excellent reliability and accuracy for many critical applications—combining features of lightness with high precision characteristics.

To save you time and money, many of Pacific's accelerometers can be incorporated into your own designs at an early stage.

Each of the basic models illustrated at the right is representative of a series of similar units which vary only in output characteristics. They are available and were developed to satisfy a special requirement but can now be considered as standard production items...completely tooled, qualified, proved in actual use...ready for immediate order.

For complete information on a Pacific accelerometer designed to your own requirements...or on a modification of these units, WRITE TODAY. The engineering skill and creative ability of Pacific Scientific are at your service.



For High Response Systems... Series 4204
Linear accelerometer provides extreme sensitivity, large output AC signal. Maintains a high natural frequency and low cross talk. Temperature compensated fluid damping provides exceptional dynamic characteristics without heater.



Highly Accurate... Series 4202
Unique torsion-bar suspension gives very low hysteresis with exceptionally rugged, long life. Single or dual pot and/or switch pick-off provides versatility. Automatic caging mechanism.



Light and little... Series 4201
This miniature accelerometer is a versatile, high production instrument with unusual flexibility of design and performance characteristics. Maintains accurate signals thru long service life. Potentiometer pick-off.



Creative
Manufacturing
and Development
in Aircraft Safety

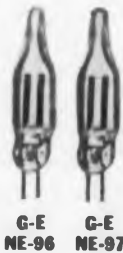


CIRCLE 341 ON READER-SERVICE CARD



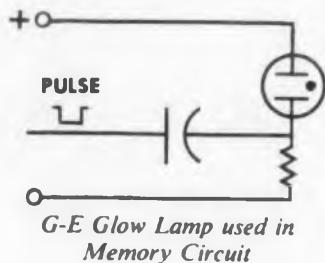
PACIFIC SCIENTIFIC COMPANY
P.O. Box 22019, Los Angeles 22, California
San Francisco • Seattle
Arlington, Texas • San Diego
Representatives: Eastern U.S.—Aero Eng. Co.
Canada—Garrett Mfg. Corp.

4 ways to use General Electric Glow Lamps as Circuit Components



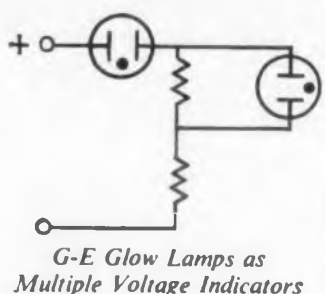
G-E
NE-96 G-E
NE-97

1. As a MEMORY DEVICE, because of the differential between starting and operating voltages. Both the General Electric NE-96 and NE-97 are well suited for switching circuits and counters where they can function as transfer elements and as indicators of state or sequence.



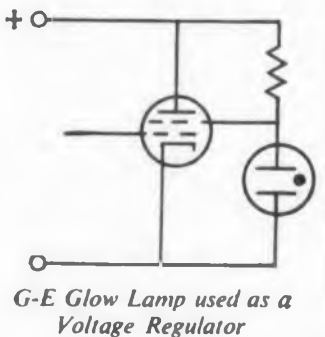
G-E
NE-76 G-E
NE-81

2. As a VOLTAGE INDICATOR, because of their critical starting voltage. The G-E NE-76 and the NE-81 are stabilized and selected for close tolerance on starting voltage. Both find use in gating circuits, logic matrices, switching circuits or as an indicator of input or output levels.



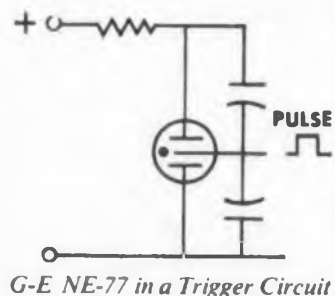
G-E
NE-68 G-E
NE-80

3. As a VOLTAGE REGULATOR, because of their constant operating voltage range. The General Electric NE-68 and its "first cousin", the G-E NE-80 (closer tolerance), function effectively wherever voltage regulation is required. (Glow Lamps for higher current applications are also available.)



G-E
NE-77

4. As a TRIGGERED SWITCH. A low current signal applied to the trigger (third electrode) starts this lamp, permitting conduction of peak current surges up to 100 m.a. in the power circuit. It can be used in counting circuits or as a control device with photocells, thermostats or moisture sensors in trigger circuit.



Choose the General Electric Glow Lamp best for your circuit requirements. For further information, write for "Glow Lamps as Circuit Control Components". General Electric Co., Miniature Lamp Dept. M-909, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC

NEW PRODUCTS

Wirewound Potentiometer

Rating is 4 w at 40 C



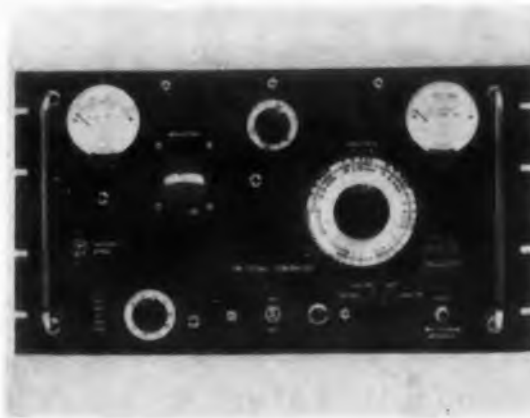
Type 45 wirewound potentiometer has a power rating of 4 w at 40 c, derated to zero at 135 C. The unit has a 1-1/8 in. diam. The resistance range is from 1 ohm to 10 K, linear; resistance tolerances are $\pm 10\%$ or closer. It is available with one tap at $50\% \pm 2\%$ resistance, at any position electrically. Series 45M, made to meet Mil specs, can also be supplied. Mechanical and electrical rotation is 300 deg, 280 deg effective. Torque is 1.2 to 6 oz-in.

Clarostat Manufacturing Co., Inc., Dept. ED, Dover, N.H.

CIRCLE 342 ON READER-SERVICE CARD

Signal Generator

Covers 150 to 280 mc



Designed for telemetry applications, model 100 TM fm signal generator has a total range of 150 to 280 mc. It can be used with beating units to provide lower carrier frequencies. Its 300-kc deviation permits direct sweeping of if stages. Spurious outputs are harmonics of the oscillator only. The unit conforms to JCEC specs and meets all telemetry requirements for carrier frequency, deviation, and modulating frequency. It occupies 10-1/2 in. of panel space.

Waltham Electronics Corp., Dept. ED, Waltham, Mass.

CIRCLE 343 ON READER-SERVICE CARD



TODAY-
he can escape

Rheumatic Heart Disease

Tommy had an attack of rheumatic fever, frequent forerunner of rheumatic heart disease. Fortunately for him, his heart was not damaged.

Rheumatic fever, usually preceded by a "strep" infection, often strikes the same victim more than once. With each attack comes a new danger of heart damage.

Tommy's parents no longer live in fear of rheumatic heart disease, however. Through research, medical science has developed new methods of controlling "strep" infection and preventing recurrences of rheumatic fever.

For more facts about prevention, see your physician or ask your Heart Association.

For more research progress against the heart diseases . . .

Give
HEART FUND

Recording System

For use with computers

This recording system, called Dacom, reads magnetic tape from a computer and records characters on microfilm. The unit operates at 16,500 characters per sec. As many as 66 lines of 130 characters can appear as a page; these are micro-filmed at more than 2 frames per sec. A roll of 1000 ft of 16-mm film contains the decoded information from more than 35 reels of 2400-ft magnetic tape.

Eastman Kodak Co., Dept. ED,
343 State St., Rochester 4, N.Y.

CIRCLE 344 ON READER-SERVICE CARD

Oscillograph Recording System

Has eight channels



Model 958-1500 direct wiring oscillograph recording system accepts up to eight floating or grounded inputs. It has a maximum sensitivity of 10 μ v per chart division. All circuitry is transistorized and features include up to eight channels of amplification, and a common power supply. Plug-in printed circuit units are used and the system can be adapted for use with other readout devices. The system has a linearity of $\pm 0.4\%$. Frequency response is from 0 to 100 cps within 3 db at 10 divisions peak-to-peak amplitude. There is a choice of eight switch-selected sensitivities. The enclosed galvanometers have velocity feedback damping.

Sanborn Co., Industrial Div.,
Dept. ED, 175 Wyman St., Waltham
5, Mass.

CIRCLE 345 ON READER-SERVICE CARD

CIRCLE 346 ON READER-SERVICE CARD >

SMALLEST LIGHTEST CARCINOTRONS



with wide band sole tuning

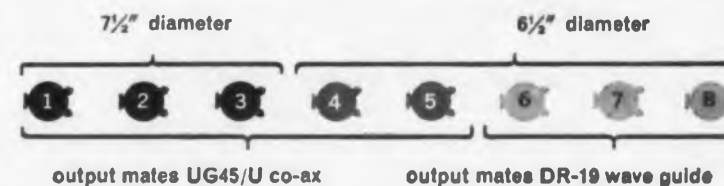
Though it has just recently made its debut into the high society of Litton microwave tubes, this carcinotron (our model L-3298) has already been commended by the military for its exceptionally clean design. Every engineer concerned with upgrading the performance of ECM equipment will surely find much of interest in this medium-power tube, with which Litton takes a major stride toward truly simultaneous noise-jamming capability by affording faster tuning rates than any previously attainable.

The Litton family of eight electrically-compatible carcinotrons is the first to incorporate the critical capability of wide band sole tuning without frequency or power holes when the tube is operated into as much as a 1.5-to-1 mismatch. Litton carcinotrons are the first to use wider-than-normal-band RF output couplers, minimizing many system components such as antennae, waveguide plumbing, and load isolators.

We cite these firsts not for glory's sake, but rather for their meaningful contribution to more efficient system design, smaller size and lighter weight.

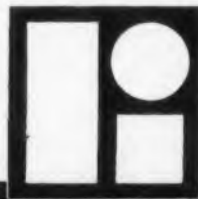
The notable suitability of these carcinotrons is not limited to ECM. You can also consider them for other military applications such as drivers for communications links—in fact, wherever medium-power tubes with extremely rapid tuning and low tuning power are required.

Because of their mechanical and electrical compatibility the eight tubes in the family are interchangeable, as shown.



These versatile tubes are not just drawingboard products — you can order them now.

Write concerning voltage-tuned power oscillators of whatever nature to Litton Industries, Electron Tube Division, Office E23, 960 Industrial Road, San Carlos, California. Your request for our Carcinotron Catalog or for answers to your specific questions will be honored promptly.



LITTON INDUSTRIES Electron Tube Division

BARRATRON TRANSMITTING TUBES • MAGNETRONS • KLYSTRONS • TRAVELING WAVE TUBES • BACKWARD WAVE OSCILLATORS • CARCINOTRONS • GAS DISCHARGE TUBES • NOISE SOURCES • CROSSED-FIELD AMPLIFIERS • HIGH DEFINITION CRT • DIRECT-WRITING CRT • STORAGE TUBES • MICROWAVE FILTERS • DUPLEXERS • TR TUBES

CAPABILITY THAT CAN CHANGE YOUR PLANNING





NEW... DIRECT-READING TRANSISTOR TEST SET MEASURES

β in ranges of 0 to 30/100/300
 h_{11} } 0.5 to 20 K at 1 KC
 h_{1e} }
 I_{co} 0 to 50 microamperes
 I_e 0 to 3/10/30 milliamperes

Quickly and accurately the new Metronix Model 545-B Transistor Test Set measures all the essential parameters of transistor performance and gives a direct presentation of the test data.

This versatile instrument can be operated either on its own 5.2-volt collector voltage supply or on any externally supplied potential up to 50 volts DC... can accommodate a wide test frequency range of from 200 cps to 50 kc... has an output jack to permit oscilloscope display of AC collector waveforms. And it's fully protected against meter overload.

Price \$225.00, f.o.b. factory.

Call or write for Specification Sheet No. 545-B

Metronix INC

A SUBSIDIARY OF

ASSEMBLY PRODUCTS, INC.

Chesterland 17, Ohio

CIRCLE 347 ON READER-SERVICE CARD



U.S.A. 2086

relays designed especially for

**VIBRATION
and SHOCK**

The rotary-balanced armature design of Hi-G relays assures efficient operation of these important components even under severe vibration and shock — up to 20 or 30G out to 2000 cps. By design, very little momentum is built up in moving parts. For more complete information on the complete line of Hi-G relays, send for New 1959 Hi-G CATALOG.



HI-G THE ONLY COMPLETE LINE OF ROTARY BALANCED RELAYS

Hi-G offers complete engineering and production facilities to manufacture relays for specific applications. Your inquiries are invited.



S & R TYPES



SL TYPES



SM TYPES

BALANCED
HI-G
ROTARY

HI-G INC.,

BRADLEY FIELD/WINDSOR LOCKS, CONN.

CIRCLE 348 ON READER-SERVICE CARD

NEW PRODUCTS

Epoxy Resin

Flame-proof, semi-flexible

Type XR-5019 Scotchcast semi-flexible epoxy resin meets and exceeds the flammability and thermal shock requirements of MIL-I-16923C and MIL-T-27A. It is a two part, thermosetting resin with a mixed pot life of 3 or 4 days at room temperature. The initial viscosity is 100 cps at 76 C, and the moisture absorption is 0.76% after 240 hr immersion. The electrical strength is 600 v per mil in 50-mil thickness. The dielectric constant is 7.24 at 1000 cps, —130 C. The dissipation factor is 0.199. Three cure cycles are recommended: 120 C for 2 to 3 hr, 95 C for 8 to 12 hr, and 75 C for 16 to 24 hr.

Minnesota Mining and Manufacturing Co., Dept. ED, 900 Bush Ave., St. Paul 6, Minn.

CIRCLE 349 ON READER-SERVICE CARD

High Voltage Tester

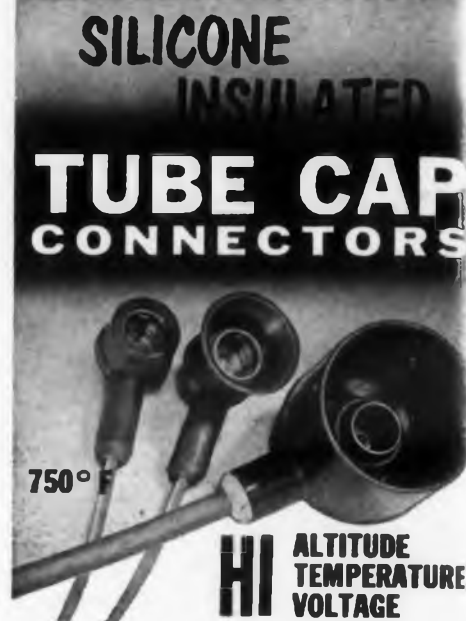
For automated production testing



Model 8514 high voltage tester, called Hypot, provides sensing and control circuits for automated production testing of motors, controls, capacitors, and transformers. It also makes breakdown tests of insulation in controls, cables, bushings, and other components. The unit has an automatic rate of rise on high voltage dc test potential and an adjustable automatic shutoff of voltage and leakage current meter. The timer shunts the leakage current microammeter for 0 to 5 min while capacitance loads draw to 10 ma for rapid charging. The unit provides automatic shorting of internal and external circuits upon release of high potential test voltage. A selector switch may be set for manual, semi-automatic, or fully automatic operation.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

CIRCLE 350 ON READER-SERVICE CARD



750°

**HI ALTITUDE
TEMPERATURE
VOLTAGE**

This is a new series of Tube Cap Connectors using special silicone components for high reliability applications. They provide the highest degree of resistance to temperature extremes and are virtually unaffected by ozone and corona. The excellent dielectric characteristics make them ideal for high voltage. Skirts and sealed-in leads guard against flashover at high altitudes. Additional features include anti-corona cup and long-life spring contacts.

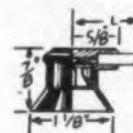
Clip this out — keep handy for part numbers and specs on connectors below for either 1/4" or 3/8" top caps. Prefix 90 for 1/4"; 91 for 3/8". Lead wire 18" long from center of cap or length to your specs.



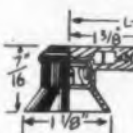
#90 or 91SCCSL beryllium copper contact, cadmium plated nests in anti-corona cup. Silicone rubber insulation throughout.



#90 or 91SCCRSL beryllium copper contact, cadmium plated nests in anti-corona cup. Silicone rubber insulation throughout. Takes up to one watt resistor — specify value and tolerance.



#90 or 91SCCDSL beryllium copper contact, cadmium plated nests in anti-corona cup. Skirt clings to tube — guards against flash-over. Silicone rubber insulation throughout.



#90 or 91SCCDRL beryllium copper contact, cadmium plated enclosed in anti-corona cup. Skirt clings to tube — helps suppress corona — guards against arc-over. Takes up to one watt resistor. Specify value and tolerance.



#90 or 91CCSTLRL beryllium copper contact, cadmium plated nests in anti-corona cup. Glass-filled silicone insulation on cap; silicone rubber on lead. Long skirt for arc-over. Takes up to 2 watt resistor. Specify value and tolerance.

Besides new silicone types — Alden provides a complete series of connectors for 1/4", 3/8" and 1/2" cap in your choice of phenolic, mica, polyethylene, nylon and Kel-F. Complete hi-voltage cable assemblies are available using Alden hi-voltage disconnects and tube cap connectors.

TELL US ABOUT YOUR CONNECTING PROBLEM. FOR PROMPT RECOMMENDATIONS — WRITE OR PHONE JACK POLLARD NOW.

ALDEN PRODUCTS CO.

11139 North Main Street, Brockton 64, Mass.

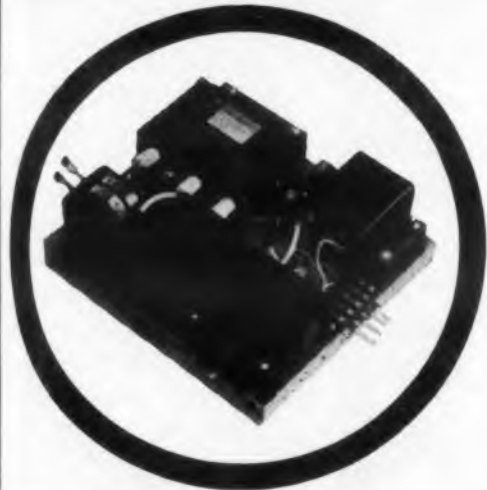
CIRCLE 351 ON READER-SERVICE CARD



Speaking of longevity...

M.R.C. offers a new series of Solid State Pulse Modulators for timing circuits, search radar, airborne radar and missile guidance.

One outstanding member of this group is the Model MP505 Airborne Pulse Modulator. This unit is used as a pulse modulator for high power missile beacons. Using only 250 watts of power, this effi-



cient unit provides 15KV pulses into a MA206 magnetron load. The pulse width is .25 microseconds at a repetition rate of 2000 pps.

The MP505 is hermetically sealed and weighs less than 7.5 lbs. Solid state-magnetic pulse generator systems are available in ranges from .1 to 10 megawatts, with repetition rates as high as 10,000 pps.

For complete information on the entire pulser series, write for Data File MP1100.



MAGNETIC RESEARCH CORP.
Pacing the Industry in Astro-Magnetics
3160 WEST EL SEGUNDO BOULEVARD
HAWTHORNE, CALIFORNIA

CIRCLE 352 ON READER-SERVICE CARD

STOP CLOCKS.—Designed for ac and dc operation, the clocks measure time intervals over wide voltage and ambient temperature variations. The digital ac stop clocks may be used for 60 and 400 cps operation. The digital dc stop clocks are used for 20 to 30 v operation. Electrical reset permits local or remote control or automatic operation where successive time intervals must be measured. Series numbers for the ac units are L15100 and L15200. Series number for the dc units is L15300.

The A. W. Haydon Co., Dept ED, Waterbury 20, Conn.

CIRCLE 353 ON READER-SERVICE CARD

ETCHANT.—Provides a method for bonding Teflon to itself and to other materials. Called Tetra-Etch, it is an activated form of sodium in solution. It reacts with Teflon to form a carbonaceous film on the treated surface which serves as a means of anchoring adhesives. The compound has proved compatible with a variety of adhesives, including epoxies, phenol formaldehydes, and most of the rubber and silicone types.

W. L. Gore & Associates, Inc., Dept. ED, 487 Papermill Road, Newark, Del.

CIRCLE 354 ON READER-SERVICE CARD

SCREW COVER PULL BOXES.—For wiring installation, these units are available in two types. Type FC is for flush installations and type SC is for surface mounting. They are available in standard sizes ranging from 4 x 4 x 4 in. to 24 x 24 x 6 in. They are formed of heavy gage one-piece sheet steel with all corners folded in and welded. All standard stock boxes are furnished with or without standard knockouts. Standard finish is a corrosion-resistant gray baked enamel.

Keystone Manufacturing Co., Dept. ED, Warren, Mich.

CIRCLE 355 ON READER-SERVICE CARD

MIXER-PREAMPLIFIER.—This line of matched mixer-preamplifier units covers the 8.5 to 9.6 kmc range. It has a minimum gain of 25 db, a maximum noise figure of 7.5 db and a 50-ohm if output at 30 or 60 mc. Model MMX-2 is available with or without an integral variable attenuator in the LO arm.

Lel, Inc., Dept. ED, 380 Oak St., Copiague, L. I., N. Y.

CIRCLE 356 ON READER-SERVICE CARD

FASTENER.—Self-retained type, eliminates the possibility of screws falling into electronic circuitry. It mates with any standard internally threaded member and can be adjusted to panel thickness over an 1/8 in. range. No special tools are required for installation.

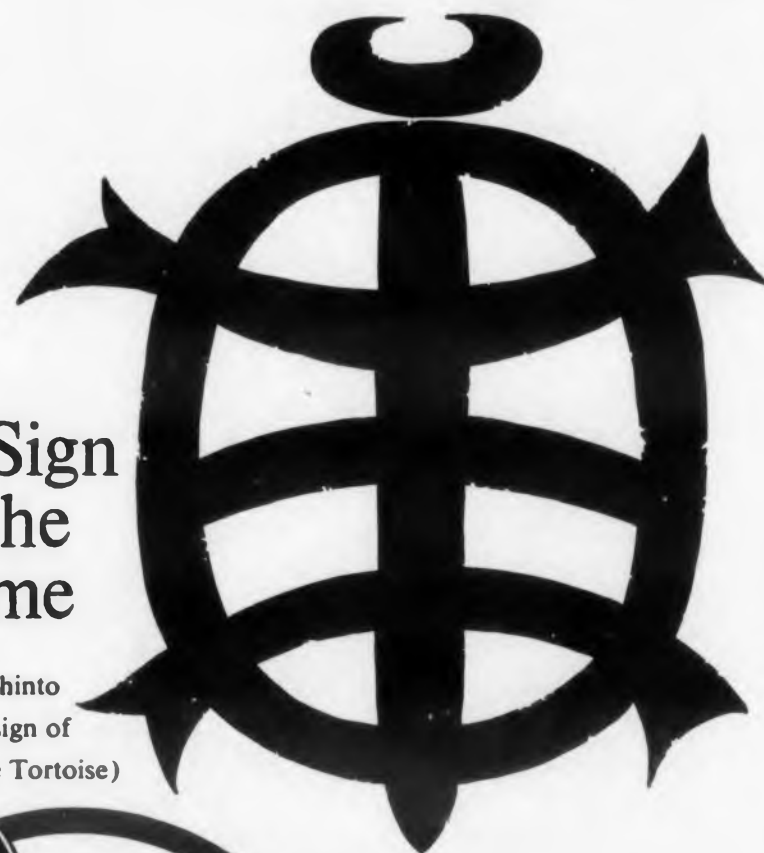
Illinois Tool Works, Calinoy Div., Dept. ED, 12917 Cerise Ave., Hawthorne, Calif.

CIRCLE 357 ON READER-SERVICE CARD

Number One of a simple series on symbology...

The Sign of the Kame

In the Japanese Shinto religion the sign of Kame (the Tortoise)



is the symbol of longevity. On the contemporary scene, the letters M.R.C. also mean longevity... longevity guaranteed by creative design and precision manufacturing. The all-new, wide band D.C. Amplifier fulfills a critical need of missile and aircraft design engineers for a stable, drift-free and multipurpose amplifier with a wide range of response. The M.R.C. D.C. Amplifier utilizes static, magnetic modulation instead of the usual electro-mechanical chopper. This results in an inherently rugged design.

SPECIFICATIONS

Input (nominal).....0 to 5 millivolts D.C.
Output.....0 to 5 V D.C.
Excitation.....28 V D.C. (unregulated)
Linearity.....± 1%
Total Gain.....0-1000
Pass Band.....flat beyond 100 cps
Gain Stability & Zero Drift....better than 1%

For additional information on M.R.C.'s complete line of magnetic and transistor amplifiers, write for Data File MA-1000.

MAGNETIC RESEARCH CORPORATION
Pacing the Industry in Astro-Magnetics

3160 WEST EL SEGUNDO BOULEVARD, HAWTHORNE, CALIFORNIA

CIRCLE 358 ON READER-SERVICE CARD



Carry a
PI
 recorder
 anywhere

Now you can record test data on-the-spot. In both lab and field you get accuracies equal to or better than big, rack mounted units. Just pick up and move a multi-channel (up to 14) PI recorder/reproducer as you would any other item of test equipment.

Instead of 1,000-lb. cabinets, requiring 1000 watts, you're working with recorders 10 times smaller and lighter, using 250 watts or less.

In the field, you get laboratory performance under the most difficult environments. PI fits many places where 19-inch racks won't go. One man can carry a rugged PI recorder to virtually any test site.

How did PI put precision in a small package? By combining transistorized electronics with unique stacked reel tape magazines. PI recorders use standard tapes and heads, are compatible in every way with standard recording practices and other recording equipment.

KEY SPECIFICATIONS (Model PS-207 Series unit)

FM SYSTEM: Frequency response $\pm 1/2$ db 0-10 kc, S/N ratio 43 db, better than 1.5% total harmonic distortion, less than 2% drift 40° to 120°F., linearity 1%.

DIRECT SYSTEM: Response ± 3 db 50-100,000 cps.

POWER: 115 vac, 48-62 cps or 24 vdc.

FLUTTER: Less than 0.1% rms dc to 300 cps or .5% peak-to-peak at 30 ips.

PS-207 shown contains electronics for 7 record/reproduce channels.

After you note these key specs, may we suggest you call your PI representative to arrange a demonstration? If you are uncertain who he is, please write direct. Address Dept. 1911.

Precision Is Portable



PRECISION INSTRUMENT COMPANY

1011 COMMERCIAL STREET • SAN CARLOS, CALIFORNIA • PHONE: LYTELL 1-4441

CIRCLE 359 ON READER-SERVICE CARD

NEW PRODUCTS

Sweep Generators

Output is from 20 to 1000 mc



Model SP-103, SP-104, SP-105 and SP-106 cover center-frequency ranges of 20 to 100 mc, 100 to 250 mc, 250 to 500 mc and 500 to 1000 mc, respectively. Sweep widths are variable from near zero to over 20% of the center frequency. The two low frequency units use inductively tuned oscillators. The other two are designed with cavity-tuned oscillator circuits. All oscillators produce the specified output of over 15 v rms into 50 ohms, which is equivalent to 4 to 5 w. The output is held constant within $\pm 5\%$ over the maximum sweep width by use of agc circuits controlling the oscillator's B+ voltage. For load isolation, a 3 db pad is provided between the oscillator and the output jack. There is a vernier attenuator with a range of about 0 to 10 db. Display linearity is better than 1.2 to 1. Source vswr for the instruments is normally below 1.3 to 1.

Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.

CIRCLE 360 ON READER-SERVICE CARD

Audio-Video Amplifier

Range is to 20 mc

Called the Transifier, this transistorized, wide-band, audio-video amplifier has a gain that is 3 db down at 20 mc in the 10 db position. The gain is down 3 db at 15 mc in the 20 db position. A voltage amplification of 30 and 100 is realized when two are used in series. The input impedance in the 10 db position is 15 μ f and 20,000 ohms; output impedance is about 75 ohms. In the 20 db position, the inherent noise is less than 10 mv. The maximum voltage output is 0.2 v rms in the 10 db position and 0.3 v in the 20 db position. The gain, in the 10 db position is no more than 3 db down at 15 cycles and, in the 20 db position, no more than 3 db down at 20 cycles. Dimensions are 2.25 x 1.15 x 4.5 in., and the weight is 15 oz.

Kay Electric Co., Dept. ED, Maple Ave., Pine Brook, N.J.

CIRCLE 361 ON READER-SERVICE CARD

VITREOSIL® FUSED QUARTZ



**OFFERS THE FINEST
 PROPERTY VALUES
 FOR FINER PRODUCTS**

- Absolute Chemical Purity
- Extreme Heat Resistance
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- Chemical Inertness
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In laboratories and other applications where critical requirements must be met, there is no room for second best. Vitreosil possesses properties of greatest value for: ultra-violet applications, metallurgical investigations, chemical research, photochemistry, spectroscopy, and many uses in physical, optical and electrical research as well as product operations.

Vitreosil is available in an unusually wide variety of types and sizes—Or, we'll be happy to fabricate to your specifications. Write us about your requirements today. For your convenience, use the coupon below. See our ad in Chemical Engineering Catalog.



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 FUSED QUARTZ CO., INC.**
 18-20 Salem Street,
 Dover, New Jersey

Please send technical data on

Company _____
 Name _____
 Street _____
 City _____

Zone _____ State _____

CIRCLE 362 ON READER-SERVICE CARD

Hi-Fi Tube

For 20 to 30 w range



For hi-fi equipment in the 20 to 30 w range, type 7355 octal-based beam pentode incorporates a five-plate dissipation per tube, a pair of tubes is rated to deliver 28.5 w with 2% harmonic distortion without feedback in a class AB1 push-pull hi-fi amplifier. The maximum ratings include: plate, 440 v; screen, 400 v; screen dissipation, 2.5 w continuous and 5 w on speech and music peaks; and cathode current, 100 ma. The 6.3 heater draws 0.8 amp. In typical single-ended class A1 amplifier service at 250 plate v, transconductance is 7600 μ mhos and maximum signal power output is 9 w.

General Electric Co., Receiving Tube Dept., Dept. ED, Owensboro, Ky.

CIRCLE 363 ON READER-SERVICE CARD

Cross-Guide Coupler

Covers 7 to 10 kmc

Model RDC-710 cross-guide coupler, having one arm terminated in a matched load, provides 20 and 30 db coupling with a frequency sensitivity of 1 db over the range of 7 to 10 kmc. The average coupling is a nominal ± 0.5 db, directivity is 18 db min, and vswr is 1.05 max. The unit is also available with a fourth flange replacing the matched load. Applications include scaling high power to the level of ordinary instruments.

Radar Design Corp., Dept. ED, Pickard Drive, Syracuse 11, N.Y.

CIRCLE 364 ON READER-SERVICE CARD

CIRCLE 365 ON READER-SERVICE CARD



CONSIDER...

Products shown are
twice actual size

Lockheed for electronic ceramics

The research, development and manufacture of miniature electronic ceramic components is centered in the new Electronic Ceramics Laboratory at Lockheed Electronics and Avionics Division (LEAD).

This facility is fully able to provide electronic ceramics to meet your particular specifications: MEMORY CORES, a whole family of square loop cores to suit computer and shift register applications; MULTI-APERTURE DEVICES (MAD), Cavitron equipment for the volume production of any geometry of MAD; RECORDING HEADS, of very dense materials with high flux

density ground to a micro-finish; GARNETS, poly-crystalline yttrium-iron garnets with minimum line width and loss tangent; ALUMINA SUBSTRATES, of high mechanical strength, high electrical resistivity and low dielectric loss; CUP CORES, in any size to specified inductance and minimum temperature coefficient; HIGH "Q" MATERIALS, for use as inductors, tuning slugs, transformers—frequency ranges from 1 to 50 megacycles.

What are your requirements? Write... Marketing Branch, 6201 E. Randolph Street, Los Angeles 22, California. Telephone Overbrook 5-7070.

Look to Lockheed for LEADership in Electronics

LOCKHEED ELECTRONICS & AVIONICS DIVISION

Requirements exist for staff and supervisory engineers

1 *REGATRON POWER SUPPLY DOES THE WORK OF 3 ORDINARY POWER SUPPLIES

a case history



(Model 212AM,
0-100 V dc, 0-100 ma,
\$129.00 unmetred)

A MANUFACTURER required three different regulated voltages. The voltages, which were to be used alternately, could be furnished by three separate power supplies or by a single power supply and a voltage divider. But, three power supplies were expensive. On the other hand, a voltage divider meant a loss of power and regulation plus the expense of high-wattage components.

THE SOLUTION: Three 1-watt resistors and a *Regatron Programmable Power Supply. An exclusive programming feature permits changing output voltage by shunting two terminals with a resistor. For each 1000 ohms, the Regatron delivers one volt . . . at rated current and regulation.

IN THE PROBLEM quoted here, the required voltages were 14.5, 28, and 45 V dc. The three resistors were 14.5K, 28K, and 45K. Regatron Programmable Power Supplies are available in many ranges up to 600 V dc and 3 amperes. Bulletin 765A tells more about how Programmable Regatrons solve d-c problems. Write for your copy.

TRANSISTOR TYPES

MODEL NUMBER	OUTPUT		REGULATION				MAXIMUM RIPPLE IN MV
	Voltage	Current	LINE 105-125 V AC 50-60 CPS		NO LOAD TO FULL LOAD		
			%	V	%	V	
212A ¹	0-100 V DC	0-100 MA	0.15	0.05	0.1	0.05	1/2
2-212A ¹	EQUIVALENT TO TWO MODEL 212A's. OUTPUTS MAY BE USED IN SERIES, PARALLEL, OR INDEPENDENTLY.						
224A ¹	0-100 V DC	0-200 MA	0.15	0.05	0.1	0.05	1
220A	0-50 V DC	0-500 MA	0.1	0.05	0.1	0.05	1
221A	0-100 V DC	0-500 MA	0.1	0.05	0.1	0.05	1
213A	0-50 V DC	0-1 AMP	0.1	0.05	0.1	0.05	1
214A	0-100 V DC	0-1 AMP	0.1	0.05	0.1	0.05	1
215A	0-50 V DC	0-3 AMP	0.1	0.05	0.1	0.05	1
218A	0-100 V DC	0-3 AMP	0.1	0.05	0.1	0.05	1

¹. Modulation input provided for measurement of transistor parameters by small signal method.

* Registered U.S. Patent Office. U.S. Patents Issued and Pending.



**ELECTRONIC
MEASUREMENTS**
COMPANY, INCORPORATED
EATONTOWN • NEW JERSEY

CIRCLE 366 ON READER-SERVICE CARD

NEW PRODUCTS



Vibration Instrument

For testing accelerometers

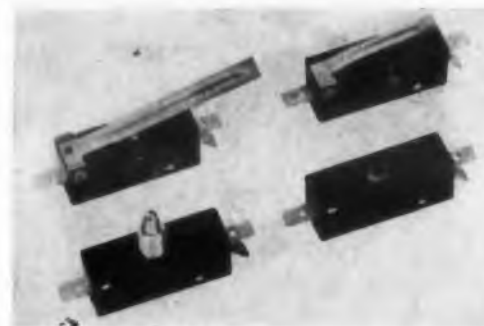
This accelerometer sensitivity standardizer, called Dial-a-gain, converts all accelerometer sensitivities to 1 v per g to allow direct reading of acceleration on any vtm. The unit includes a cathode follower input and a precision amplifier with a continuously variable gain control dial, calibrated directly in accelerometer sensitivities.

Unholtz-Dickie Corp., Dept. ED, 2994 Whitney Ave., Hamden 18, Conn.

CIRCLE 367 ON READER-SERVICE CARD

Snap Action Switches

Come in three types



These three types of snap action switches have molded phenolic cases, brass switch blades, and 1/4-in. terminals with holes for soldering. Type 750-150 pin plunger switch is suited to applications requiring limited overtravel where the actuating device can be accurately controlled. It is designed for limit, safety interlocking, and control switch requirements. Types 750-250 and 750-251 lever action switches have a maximum travel of 1/4 and 3/4 in., respectively. Panel mounting type 750-350 is for use where the actuating motion cannot be accurately controlled. The switches have the following ratings: 15 amp, 125 v ac; 10 amp, 250 v ac; and 1/2 hp, 125 to 250 v ac.

Controls Co. of America, Industrial and Commercial Controls Div., Dept. ED, 9555 Soreng Ave., Schiller Park, Ill.

CIRCLE 368 ON READER-SERVICE CARD

HOW ABOUT YOU?

Do you know that many cancers can be cured if detected early? That an annual health checkup is your best protection against cancer?

Are you giving yourself this big advantage? Or are you taking chances with your life because of foolish attitudes about cancer like these?



**DON'T
EVEN
MENTION
THAT
WORD!**

Fear keeps some people from even learning cancer facts that can save their lives.

**NEVER FELT
BETTER!**



Checkups help to detect cancer in its "silent" stage before you notice any symptom.



**COSTS
TOO
MUCH!**

Dollars you spend for the protection of your health can mean years of life.

Millions of Americans have made an annual checkup a habit... for life. How about you?

AMERICAN CANCER SOCIETY

CIRCLE 248 ON READER-SERVICE CARD

RC-RL Curves and Nomograms — 1

Donald Moffat

Motorola, Inc.

Western Military Electronics Center

Phoenix, Ariz.

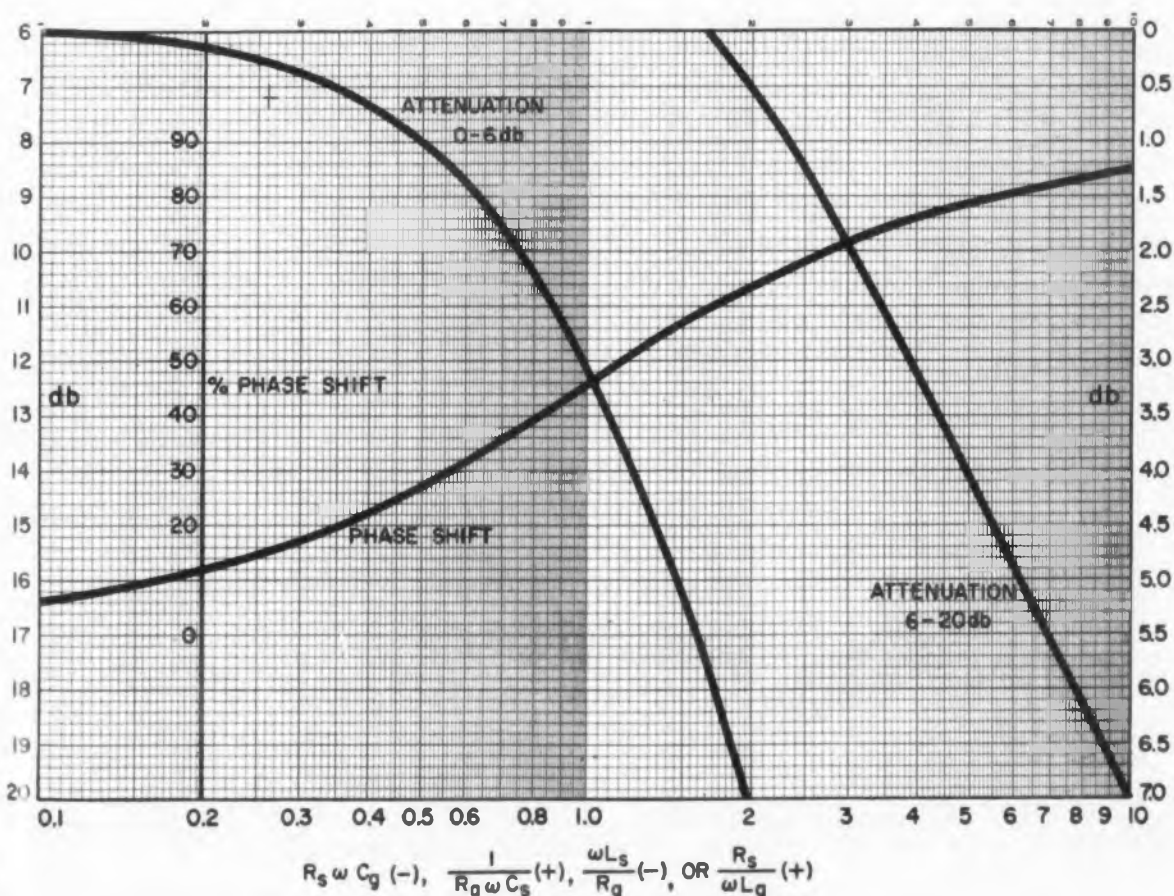
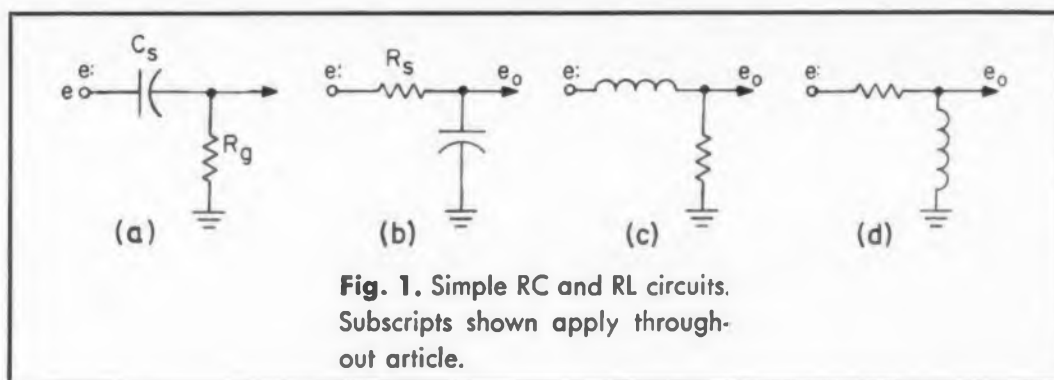


Fig. 2. Universal curve for the four single-section configurations shown in Fig. 1. Plus and minus signs on abscissa indicate the direction of phase shift (Abbreviations in abscissa: S, series element; G, element to ground; Plus, e_o leads e_i ; minus, e_o lags e_i).

◀ CIRCLE 248 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

Calculating transfer functions for even simple RC and RL circuits can be time-consuming. To simplify the designer's task, Mr. Moffat has analyzed many of the most common circuits and here presents their transfer functions, curves and nomograms. Some discussion is included on the effects of loading, so that exact equations can be used where approximations are not valid.

In Part I an analysis of single sections is made. Part II, in a future issue of ELECTRONIC DESIGN, will discuss phase manipulation in single sections. Part III will analyze multiple sections and discuss the optimum number of sections for achieving a desired phase shift. RC differentiation, with nomograms, will be covered in the same part.

FOUR COMMON RC-RL circuits of interest are shown in Fig. 1. If loading is negligible, the transfer functions for the circuits are:

Fig. 1a

$$\frac{e_o}{e_i} = \frac{R_g}{R_g + \frac{1}{j\omega C_s}} = \frac{1 \angle -\arctan \frac{1}{\omega R_g C_s}}{\sqrt{1 + \frac{1}{\omega^2 R_g^2 C_s^2}}} \quad (1)$$

Fig. 1b

$$\frac{e_o}{e_i} = \frac{\frac{1}{j\omega C_g}}{R_s + \frac{1}{j\omega C_g}} = \frac{1 \angle -\arctan \omega R_s C_g}{\sqrt{1 + \omega^2 R_s^2 C_g^2}} \quad (2)$$

Fig. 1c

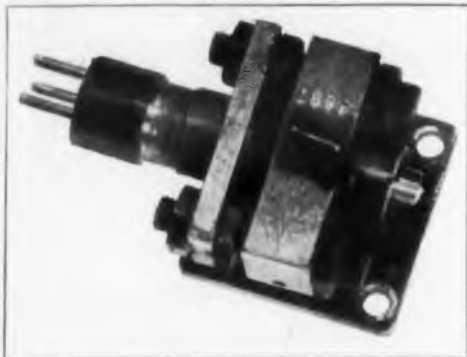
$$\frac{e_o}{e_i} = \frac{R_g}{R_g + j\omega L_s} = \frac{1 \angle -\arctan \frac{\omega L_s}{R_g}}{\sqrt{1 + \frac{\omega^2 L_s^2}{R_g^2}}} \quad (3)$$

(Continued on page 154)

Nickelectric News



DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS



Works after impact! This klystron dropped 158 miles in a Viking rocket — was recovered after impact in operating condition! Nickel alloy materials contribute to rugged performance of this and other klystrons made by Varian Associates, 611 Hansen Way, Palo Alto, Calif.

Klystron drops 158 miles ...still works!

PALO ALTO, CAL. This Varian V-55 klystron has soared up 158 miles in a Viking missile — dropped to earth. Recovered after impact, it still works!

Rugged klystrons like this don't just happen. They're designed and built for top performance under extreme shock, severe G-loads, supersonic vibration. Nickel alloy materials do much to overcome these problems and provide reliability.

Take weld splash particles, for instance — the very smallest particles, bounced around in missile klystrons by heavy forces, can cause a misguided missile. Fortunately, the Nickel-to-Nickel spot welds in this klystron's electron gun are consistently free from weld splashes. In addition, the oxidation resistance of Electronic Grade "A" Nickel improves parts cleanliness and insures better welds. What's more, the ductility of Electronic Grade "A" Nickel lends itself to the deep-drawing of the precise contours that focus klystron electron beams.

Pertinent literature: Bulletin T-15 — "Engineering Properties of Nickel." (Circle R.S. # 563)

Booklet — "Nickel Alloys for Electronic Uses" gives you latest facts on 17 freely available nickel alloys useful in the electronics industry . . . facts on physical and chemical properties, typical applications. Ask us for your copy. On specific metal problems, write to us at Huntington Alloy Products Division.

New! Spaced-lamination "A" Nickel transducer! ...Proclaimed to be first magnetostrictive ultrasonic generator able to compete with electrostrictive units on cost.



Spaced Electronic Grade "A" Nickel laminations lower cost in this ultrasonic transducer, match performance of similar piezoelectric transducers. Maker, Westinghouse Electric Corporation, states that the laminations are easily formed, annealed, brazed.

TV camera tube "sees" better than you! ... helped by

200 nickel-containing parts

HARRISON, N. J. This RCA image orthicon camera tube has a spectral response better than that of the human eye! To help convert what it "sees" into an electrical signal for transmission, approximately 200 nickel-containing parts are used in its electron gun, target and electron-multiplier.

Electronic Grade "A" Nickel cathodes improve emission, provide ample support strength and conductivity, plus good outgassing properties. In production, Electronic Grade "A" Nickel is easily drawn, welded, brazed . . . and it promotes cleanliness.

Inconel* nickel-chromium alloy is used for some parts of this tube because of its high hot-strength (strength retained up to 2000°F). Additional

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

... "Much more rugged," says maker

BALTIMORE, MD. Greater shock resistance and easier cooling that permits higher power loadings are features claimed for a unique new ultrasonic transducer now in production by Westinghouse Electric Corporation. Transducer is designed specifically for ultrasonic agitation of cleaning solutions, electroplating solutions and similar liquids having an acoustic impedance near that of water.

Spaced Electronic Grade "A" Nickel laminations (see illustration) reduce transducer cost to a level comparable to that of piezoelectric units. At the same time, this spaced construction (1) strengthens the device, (2) allows higher power loadings by speeding heat dissipation to circulating coolant.

According to Westinghouse engineers, Electronic Grade "A" Nickel improves transducer lamination production in 3 ways — (1) it's easily stamped, punched, formed to desired shape (2) the laminations don't warp in annealing (3) laminations are readily brazed to the mounting plate.

Pertinent literature: "Design of Nickel Magnetostrictive Transducers." (Circle R.S. # 564)

factors in the selection of Inconel alloy are its non-magnetic properties and its oxidation resistance.

Pertinent literature: "Nickel Alloys for Electronic Uses." (Circle R.S. # 565)



Better vision with Nickel. This famous 5820 image orthicon sees better than the human eye. Made by Radio Corporation of America, Electron Tube Division, Harrison, N. J. *Inco trademark

ELECTRONIC DESIGN DATA

(Continued from page 153)

Fig. 1d

$$\frac{e_o}{e_i} = \frac{j \omega L_o}{R_s + j \omega L_o} = \frac{1}{\sqrt{1 + \frac{R_s^2}{\omega^2 L_o^2}}} \angle \text{arc tan } \frac{R_s}{\omega L_o} \quad (4)$$

Because these four simple circuits are so commonly used in all frequency bands, a universal curve is given in Fig. 2, where attenuation is expressed in decibels. The abscissa is normalized impedance ratio and is written in four ways; the applicable one can be determined by comparing the subscripts with those of Fig. 1. Whenever possible, the subscript *s* will be used to designate an element that is in series with the signal, and *g* will go with an element that is grounded. Plus and minus signs on the abscissa of Fig. 2 indicate the direction of phase shift.

Loading

The circuit of Fig. 1a is often seen in inter-stage coupling, with the output going to a tube. Under certain conditions there will then be a shunt capacitance across R_o that cannot be neglected. The equivalent circuit then is like that in Fig. 3a.

Analysis of this circuit shows that except at dc, there will always be more attenuation than there was with no loading. The fractional amount of difference—error—is

$$\delta = 1 - \sqrt{\frac{1 + 1/\omega^2 R_o^2 C_s^2}{(1 + C_o/C_s)^2 + 1/\omega^2 R_o^2 C_s^2}} \quad (5)$$

Note that error is not constant, but is a function of both capacitance ratio and frequency, with any particular capacitance ratio having increasing error with increasing frequency. Eq. 5 is plotted

(Continued on page 156)

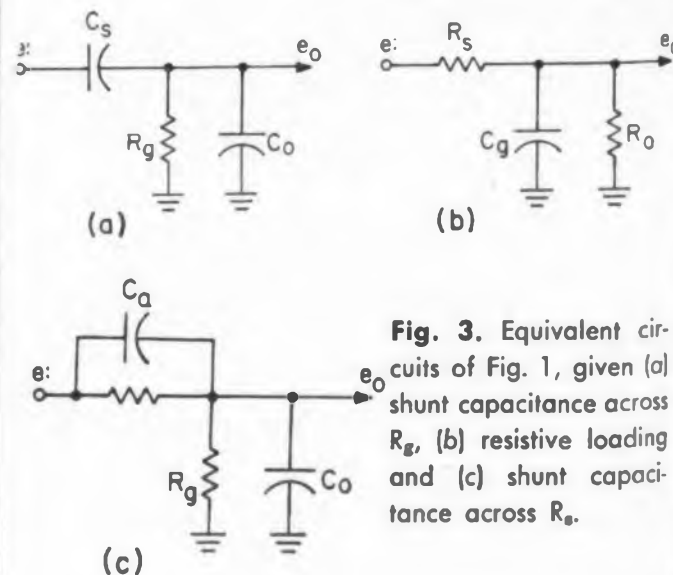


Fig. 3. Equivalent circuits of Fig. 1, given (a) shunt capacitance across R_o , (b) resistive loading and (c) shunt capacitance across R_s .



INCO ALLOY PRODUCTS

CIRCLE 563 THROUGH 565 ON READER-SERVICE CARD

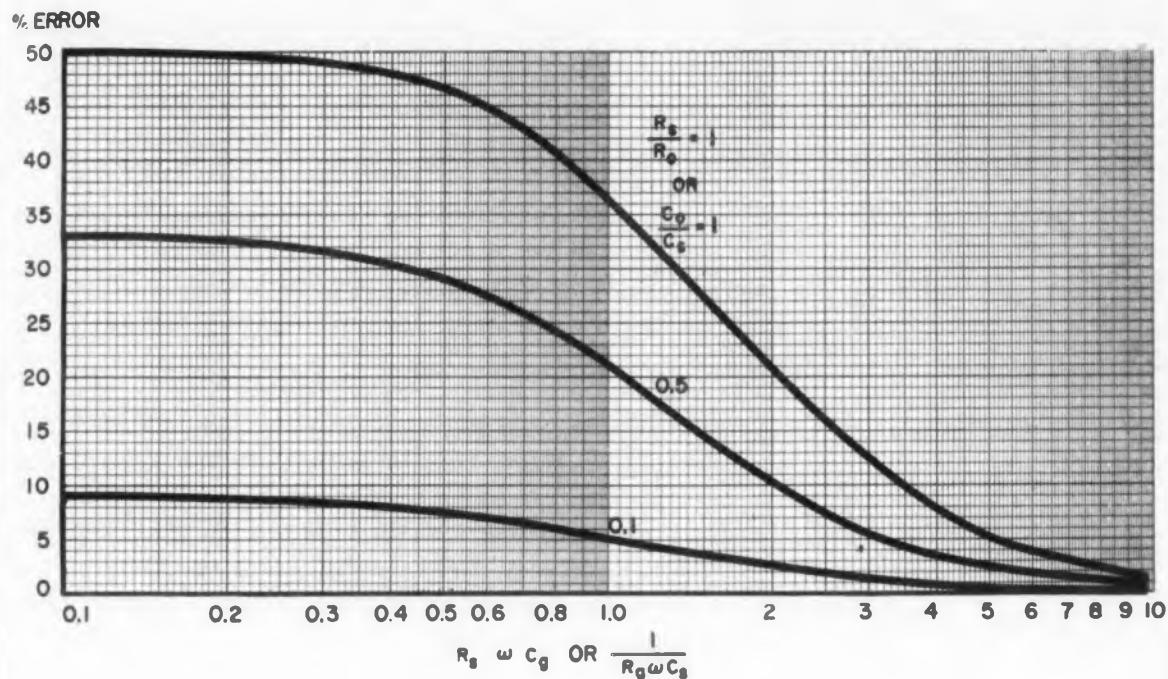
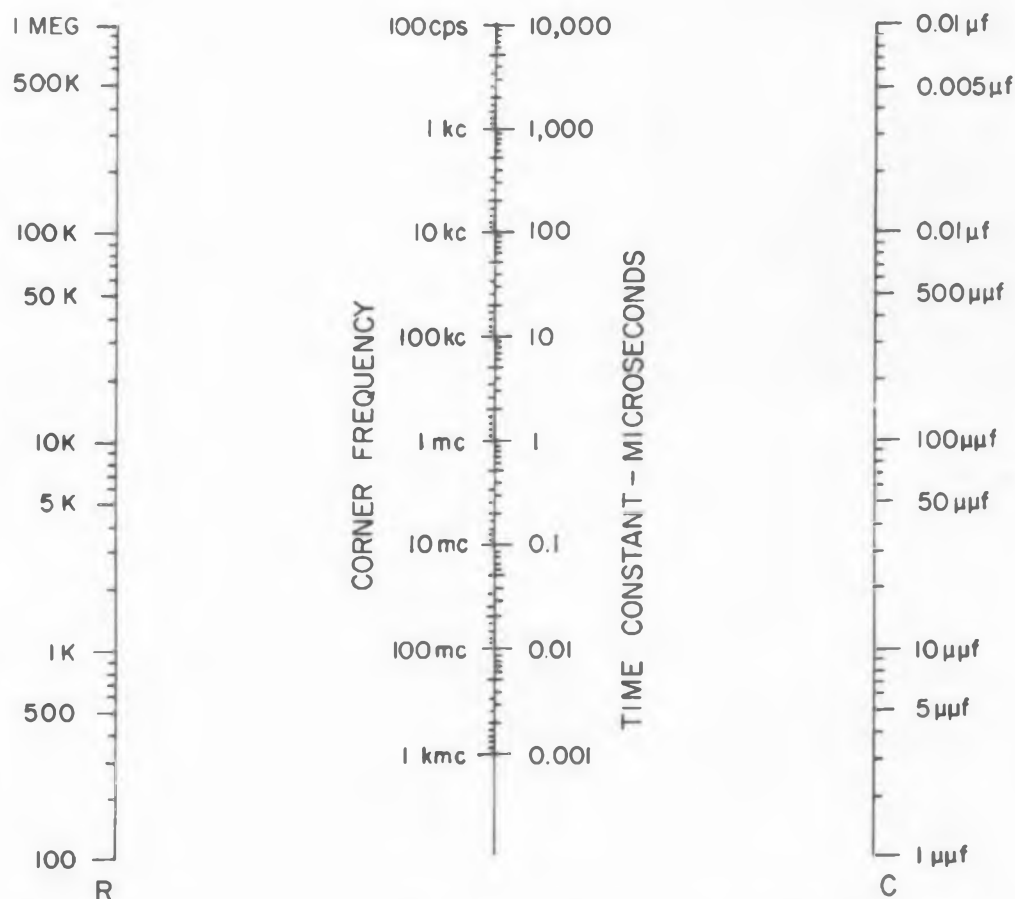


Fig. 4. Plot of error in circuit of Fig. 3(a). Error is a function of both capacitance ratio and frequency. Abscissa is normalized impedance ratio, and the parameter is capacitance ratio.



Nomogram of $R_s C_g = R_g C_s$. Both scales correspond to both sides of the equation.

BUILD ON ...

EASTERN

TEMPERATURE CONTROL EXPERIENCE REFRIGERATION COOLING



Sensitive aircraft and missile components and systems often require temperature control within close limits — while ambient temperatures fluctuate widely. Eastern refrigeration-type cooling systems are ideal for such conditions.

Designed for the strictest military requirements, these vapor-cycle closed-system packages are built around a highly efficient compressor powered by a special 400-cycle motor. Unique condensing and special cooling methods are called upon to meet the most unusual operating requirements, the most demanding specifications.

Capacities range from 100 to 6000 watts; operating altitudes extend to 100,000 feet. Some units, of the "boil-off" type, perform almost without regard for extremes in altitude and temperature.

Call on Eastern for imaginative solutions to *all* avionic cooling problems . . . and write for new Bulletin 360.



other refrigeration units for aircraft and missile electronics



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INDUSTRIES
INCORPORATED**
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HAMDEN 14, CONN.



CIRCLE 413 ON READER-SERVICE CARD



from 0.010 to 100 amperes
with just a turn of the wire



Simple ampere-turns of the overload coil accurately determine the current rating of a Heinemann Hydraulic-Magnetic Circuit Breaker.

For this reason, Heinemann circuit breakers offer you tremendous flexibility in specifying overload and short circuit protection for your products. They are available with tiny ratings down to ten milliamperes; or higher ratings, up to 100 amperes. Included are odd and fractional ratings such as 0.20, 23 or 18.7 amperes.

In any rating, you have the choice of at least four

different time-delay characteristics . . . or instantaneous trip. And Heinemann ratings are stable ratings . . . remain constant through any ambient temperature range.

With Heinemann, you can match protection precisely to the safe operating limits of any equipment.



A GREAT HELP TO ENGINEERS . . . the "Circuit Breaker Engineering Guide" is a valuable aid to anyone applying protection to electrical or electronic equipment. Ask for Bulletin 201.

HEINEMANN

HEINEMANN ELECTRIC COMPANY
156 Plum Street, Trenton 2, N. J.

Circuit breakers

CIRCLE 414 ON READER-SERVICE CARD

ELECTRONIC DESIGN DATA

(Continued from page 154)

in Fig. 4, where the abscissa is again normalized impedance ratio, and the parameter is capacitance ratio.

Nomogram

To reduce the high-frequency discrimination of capacitive loading, the series resistor can be shunted with a capacitor, as in Fig. 3c. For best results, the time constants are made equal:

$$R_s C_s = R_o C_o \quad (6)$$

The nomogram is a convenient tool to work out Eq. 6. Note that no subscripts are used on the nomogram: both scales correspond to both sides of the equation. First use the $R_o C_o$ time constant and draw a line through the proper values on the R and C scales. Next use the point where this line crosses the *Turning Scale* as a pivot about which to rotate a straight edge. Every combination of R and C that the straight edge joins is a valid combination of R_s and C_s to compensate R_o and C_o .

The range of the scales can be extended by multiplying either of both scales by any order of magnitude before drawing the first line. After the first line is drawn, the scales can be changed for the second time by multiplying the R scale by any power of ten, and the C scale by the reciprocal of the same power of ten.

Resistive Error

The circuit of Fig. 1b is not subject to error through capacitive loading, because any shunt capacitance can be simply added to C_o . The circuit might, however, have undesirable resistive loading—such as a grid return resistor. In the region above tens of megacycles, the tube itself may present a resistive input as low as 1000 ohms.

The resultant equivalent circuit is shown in Fig. 3b, and the error is given by

$$\delta = 1 - \sqrt{\frac{1 + \omega^2 R_s^2 C_o^2}{(1 + R_s/R_o)^2 + \omega^2 R_s^2 C_o^2}} \quad (7)$$

Error is now a function of both resistance ratio and frequency, decreasing with increasing frequency. When R_o is much larger than R_s , Eq. 7 approaches zero and Eq. 2 can be used with negligible error. By using resistance ratio as the parameter, the designer can use Fig. 4 to evaluate Eq. 7.

Part II of this series will discuss manipulation of the phase response of a single section. Three nomograms will be included to find ϕ_{max} , a value of capacitance to place ϕ_{max} at a given frequency and to select values to locate the phase maximum at any given frequency for another circuit. ■ ■

NEW LITERATURE

Analog To Digital Processor 415

Details of MicroSadic, a high-speed analog to digital processor are presented in this illustrated, four-page bulletin, No. 3004. The machine acquires, digitizes, and stores data at a maximum rate of 10,000 samples per second. Operations, design details, and specifications are given. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Amplifier Measurements

This booklet, entitled "Standard Methods of Measurement for Amplifiers" is the second of a series designed to establish comprehensive measurement standards for high fidelity components. The standard defines terms and test conditions and lists tests and ratings for amplifier output, sensitivity, frequency response, distortion, hum and noise, and damping factor. Send \$1.00 to Institute of High Fidelity Manufacturers, 125 E. 23rd St., New York, N.Y.

Digital Subsystems 417

Functionally packaged digital subsystems are described in this four-page, illustrated folder. The folder describes the versatility of the units as elements of digital subsystems. Included are photographs and specifications of available digital modules, such as a: forward-backward counter, bistable multivibrator, exclusive OR gate, AND gate, Schmitt trigger, and monostable multivibrator. Servomechanisms, Inc., 12500 Aviation Blvd., Hawthorne, Calif.

Microwave Measurements 418

Measurement of impedance and its associated parameters in waveguide systems through use of a sliding termination with specific reflection characteristics is discussed in this report entitled "Waveguide Sliding Shorts, Sliding Terminations, and Standard Mismatches." Use of sliding shorts for precision measurement of impedance (scattering matrix), insertion loss, attenuation and propagation constants, dielectric constant, slotted section curves, wavelength, and frequency are also covered. The article covers ways in which standard mismatches can be employed as reference standards of reflection—and therefore, vswr—against which various microwave test components may be calibrated. Photographs are included in Vol. 6, No. 2 of "PRD Reports." Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N.Y.

FREQUENCY STANDARDS

 <p>PRECISION FORK UNIT TYPE 50 Size 1" dia. x 3 3/4" H.* Wght., 4 oz. Frequencies: 240 to 1000 cycles Accuracies:— Type 50 ($\pm 0.02\%$ at -65° to 85°C) Type R50 ($\pm 0.002\%$ at 15° to 35°C) Double triode and 5 pigtail parts required Input, Tube heater voltage and B voltage Output, approx. 5V into 200,000 ohms</p> <p>*3 1/2" high 400 - 1000 cy.</p>	<p>FREQUENCY STANDARD TYPE 50L Size 3 3/4" x 4 1/2" x 5 1/2" High Weight, 2 lbs.</p>  <p>Frequencies: 50, 60, 75 or 100 cycles Accuracies:— Type 50L ($\pm 0.02\%$ at -65° to 85°C) Type R50L ($\pm 0.002\%$ at 15° to 35°C) Output, 3V into 200,000 ohms Input, 150 to 300V, B (6V at .6 amps.)</p>
 <p>PRECISION FORK UNIT TYPE 2003 Size 1 1/2" dia. x 4 1/2" H.* Wght. 8 oz. Frequencies: 200 to 4000 cycles Accuracies:— Type 2003 ($\pm 0.02\%$ at -65° to 85°C) Type R2003 ($\pm 0.002\%$ at 15° to 35°C) Type W2003 ($\pm 0.005\%$ at -65° to 85°C) Double triode and 5 pigtail parts required Input and output same as Type 50, above</p> <p>*3 1/2" high 400 to 500 cy. optional</p>	<p>FREQUENCY STANDARD TYPE 2005 Size, 8" x 8" x 7 1/4" High Weight, 14 lbs.</p>  <p>Frequencies: 50 to 400 cycles (Specify) Accuracy: $\pm 0.001\%$ from 20° to 30°C Output, 10 Watts at 115 Volts Input, 115V. (50 to 400 cycles)</p>
 <p>FREQUENCY STANDARD TYPE 2007-6 NEW TRANSISTORIZED, Silicon Type Size 1 1/2" dia. x 3 1/2" H. Wght. 7 ozs. Frequencies: 400 — 500 or 1000 cycles Accuracies: 2007-6 ($\pm 0.02\%$ at -50° to $+85^{\circ}\text{C}$) R2007-6 ($\pm 0.002\%$ at $+15^{\circ}$ to $+35^{\circ}\text{C}$) W2007-6 ($\pm 0.005\%$ at -65° to $+125^{\circ}\text{C}$) Input: 10 to 30 Volts, D. C., at 6 ma. Output: Multitap, 75 to 100,000 ohms</p>	<p>FREQUENCY STANDARD TYPE 2121A Size 8 3/4" x 19" panel Weight, 25 lbs.</p>  <p>Output: 115V 60 cycles, 10 Watt Accuracy: $\pm 0.001\%$ from 20° to 30°C Input, 115V (50 to 400 cycles)</p>
 <p>FREQUENCY STANDARD TYPE 2001-2 Size 3 3/4" x 4 1/2" x 6" H., Wght. 26 oz. Frequencies: 200 to 3000 cycles Accuracy: $\pm 0.001\%$ at 20° to 30°C Output: 5V. at 250,000 ohms Input: Heater voltage, 6.3 - 12 - 28 B voltage, 100 to 300 V., at 5 to 10 ma.</p>	<p>FREQUENCY STANDARD TYPE 2111C Size, with cover 10" x 17" x 9" H. Panel model 10" x 19" x 8 3/4" H. Weight, 25 lbs.</p>  <p>Frequencies: 50 to 1000 cycles Accuracy: ($\pm 0.002\%$ at 15° to 35°C) Output: 115V, 75W. Input: 115V, 50 to 75 cycles.</p>
 <p>ACCESSORY UNITS for TYPE 2001-2</p> <p>L—For low frequencies multi-vibrator type, 40-200 cy. D—For low frequencies counter type, 40-200 cy. H—For high freqs, up to 20 KC. M—Power Amplifier, 2W output. P—Power supply.</p>	<p><i>This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.</i></p> <p>WHEN REQUESTING INFORMATION PLEASE SPECIFY TYPE NUMBER</p>

American Time Products, Inc.

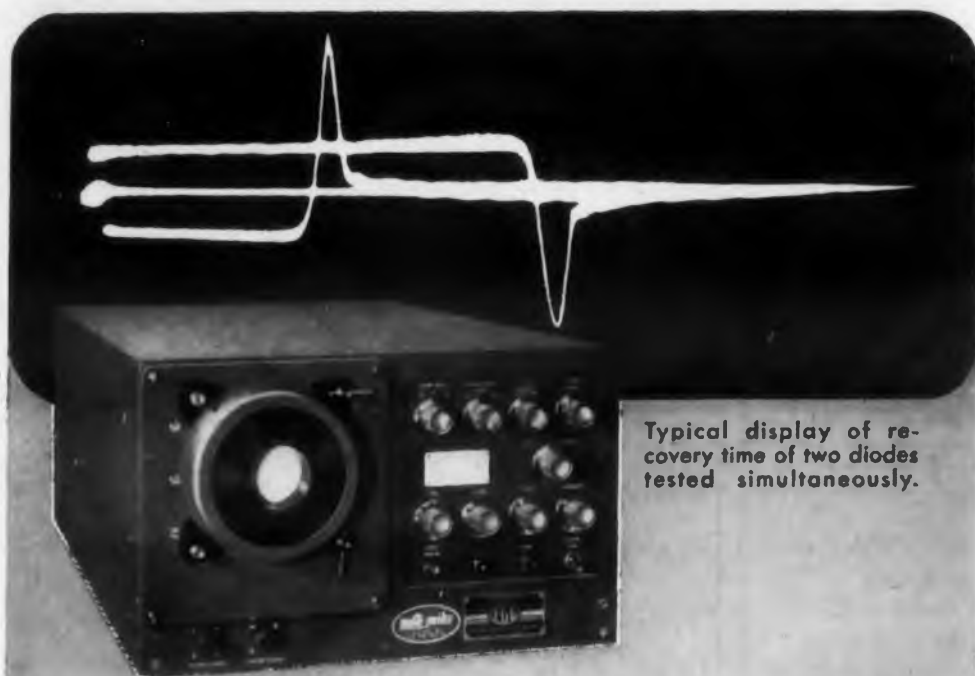


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Typical display of recovery time of two diodes tested simultaneously.

2 FROM 1

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TYPE 2236A PERFORMANCE DATA

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Nominal Spot Size (trace width)	0.002 inch	
Deflection	27 v/inch (nominal)	150 v/inch
Frequency Response	DC to greater than 3,000 mc (-3db at approx. 2,000 mc)	
Input Impedance	50 or 100 ohms	
Writing Speed	3 x 10 ¹¹ trace widths/sec.	

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CIRCLE 420 ON READER-SERVICE CARD

NEW LITERATURE

Pulse Instrumentation 421

The 48-page, 1959-60 general catalog includes complete technical data on a broad range of pulse instrumentation, including general purpose pulse generators, word generators, time delay generators and electronic counters. Factors in instrument selection and application are covered in the catalog. Photographs of the equipment are provided. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.

Semiconductor Diodes 422

This replacement characteristics and guide for semiconductor diodes contains complete data on the firm's diodes as well as replacement information on all EIA registered diodes. A digital automatic tester and classifier is also described in the 12-page brochure. Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N.Y.

Capacitors 423

Bulletin GEA-7008, four pages, provides detailed information on wet-type, sintered porous-anode tantalum capacitors used where extremely high capacitance values are required in the smallest possible space. The bulletin explains performance characteristics and advantages of the units and includes four tables, five graphs, outline drawings and complete ratings and dimensions. Actual size photographs are included. General Electric Co., Schenectady 5, N.Y.

Accelerometers 424

Accelerometer methods and techniques are described in this 20-page, illustrated manual "Series 2200 Accelerometers." Application information, mounting techniques, fixtures, and use of piezoelectric accelerometers for shock measurements are included in this booklet. Endevco Corp., 161 E. California Blvd., Pasadena, Calif.

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Associates: Canadian Cutler-Hammer Ltd., Cutler-Hammer Mexicana, S. A., Intercontinental Electronics Corporation

CIRCLE 425 ON READER-SERVICE CARD

Digital Voltmeters 426

This 20-page illustrated bulletin describes the NLS series 30 digital voltmeters. Complete specifications, operating instructions, information on input and output accessories, and complete wiring diagrams to convert the instruments into data logging and measurements systems are included. Non-Linear Systems, Inc., Del Mar, Calif.

Microwave Instruments 427

Detailed information is given in this 120-page catalog on slotted lines and tapered reducers, automatic impedance plotters, coaxial switches, transmission line hybrids, instrument loads, adjustable matching networks and impedance standard lines. In addition to technical descriptions, pictures, outline dimensions, circuit diagrams, and electrical and mechanical characteristics, the catalog includes a summary of data on transmission line connectors, complete price lists and suggestions for ordering. Alford Manufacturing Co., 299 Atlantic Ave., Boston, Mass.

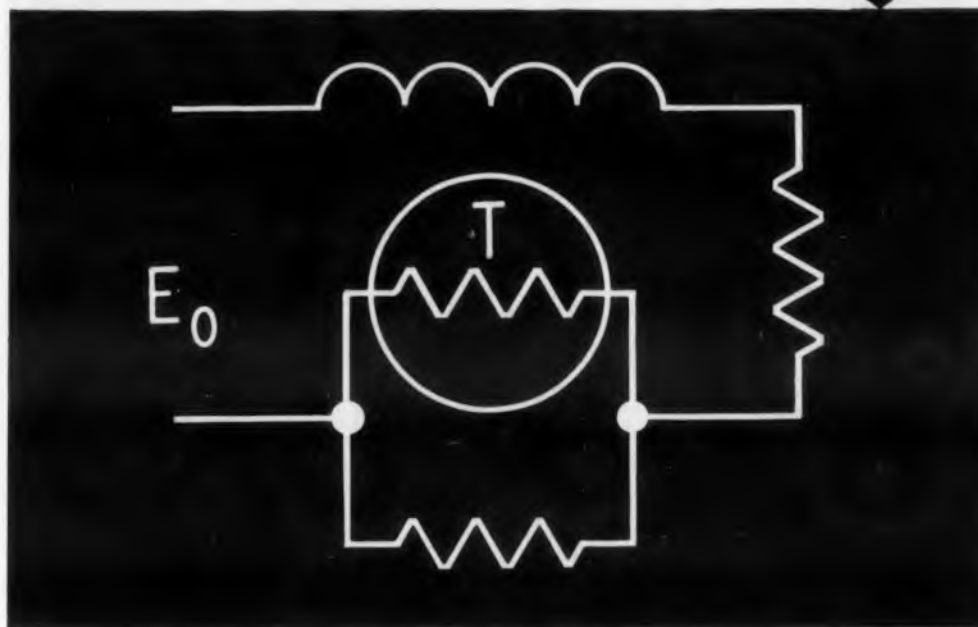
Miniaturization 428

This brochure describes the Miniaturization Awards Competition now in progress. The Award is presented annually to the individual or organization judged to have the greatest contribution to the field of miniaturization. The Award for 1959 will be presented in the Spring of 1960. Deadline for receiving entries is January 20, 1960. Sponsor for the Awards is Miniature Precision Bearings, Inc., Miniaturization Awards Committee, Box 604, Precision Park, Keene, N.H.

Components Catalog 429

The Fall issue of Helinews, eight pages, provides information on the firm's all-metal single-turn potentiometers, cermet trimming potentiometers, and includes test reports on ac voltmeters. Also mentioned is the technical information available from the firm. A zany glossary of German missile terms is given. Beckman Instruments, Inc., Helipot Information Service, 2500 Fullerton Road, Fullerton, Calif.

GLENNITE® THERMISTOR DESIGN IDEAS NO. 10



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Temperature changes can seriously affect tachometer output in aircraft and guided missile servo control systems. For example, errors in excess of 2% over an extended temperature range are not uncommon on uncompensated tachometers.

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Glennite wafer, bead and rod thermistors are available in a variety of resistance values, temperature coefficients and sizes to help you evaluate circuit problems. They may be obtained from your local distributor, or from Gulton Industries in bulk quantities.



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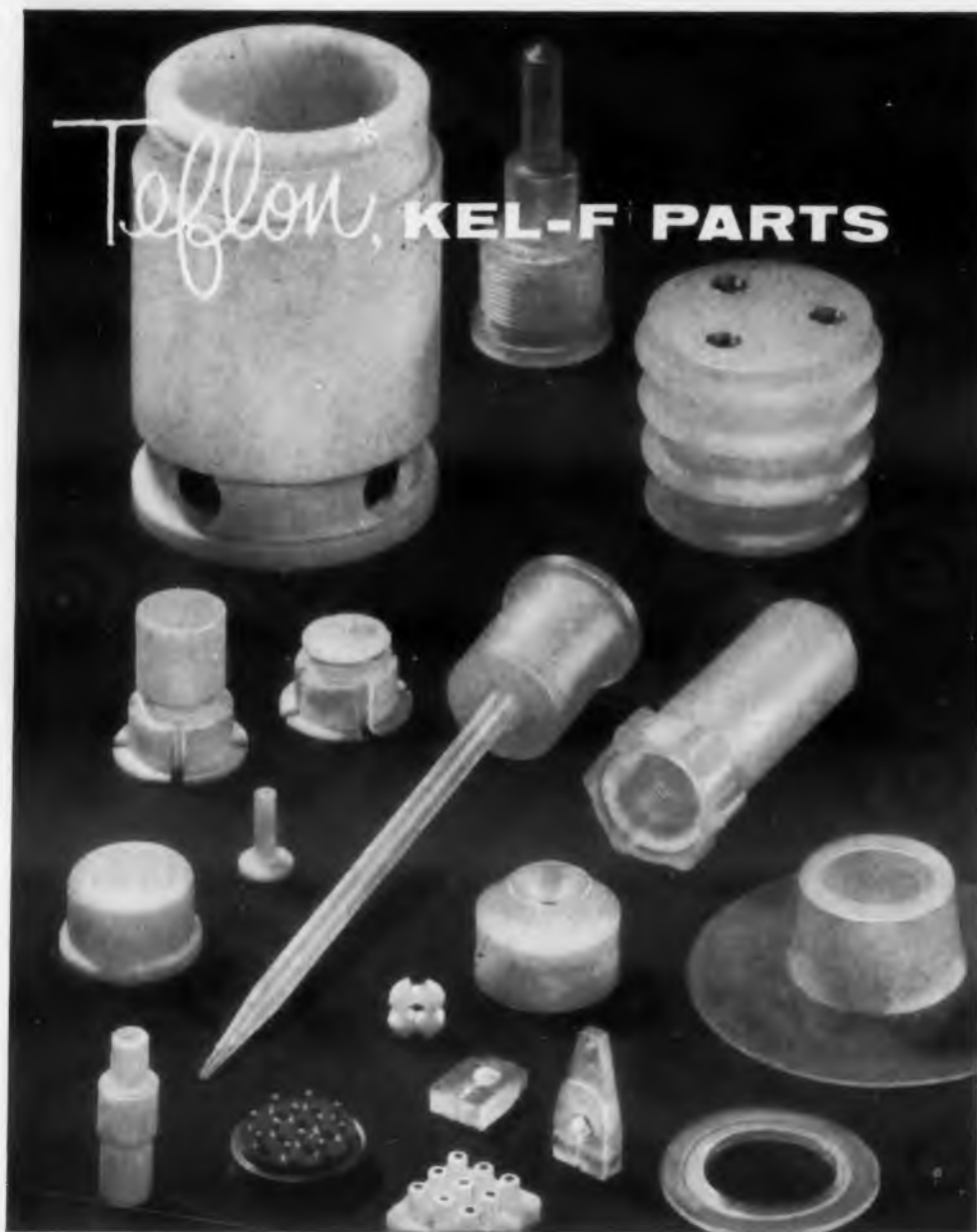
CIRCLE 430 ON READER-SERVICE CARD

MATERIALS & CERAMICS DIVISION, Metuchen, New Jersey
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In Canada: Titania Electric Corp. of Canada Ltd., Gananoque, Ont.



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CIRCLE 432 ON READER-SERVICE CARD

NEW LITERATURE

Indicators and Controls 433

A line of indicators and controllers is described in 10-page bulletin GEZ-2898. Instruments discussed are a dc millivoltmeter, bridge-type controllers, temperature scanner systems, and saturable reactor control systems. Typical measurement applications, principles of operation, control forms, and electrical specifications are given. General Electric Co., Schenectady 5, N.Y.

Magnetic Components 434

"Magnetic Components for Computers, Business Machines and Electronic Systems," 16 pages, describes the basic operating mechanism of magnetic cores used in logic, shift registers, and magnetic memories. Included is a section describing their use in typical applications such as computers, business machines, and data handling systems. Magnetics Research Co., Inc., 255 Grove St., White Plains, N.Y.

Resistors 435

The 1959-60 edition of the firm's catalog covers their complete line of resistors. Complete specifications on the units and other pertinent data are included. Tech-Ohm Resistor Corp., 36-11-33rd St., Long Island City 6, N.Y.

Slide Rule

This reactance computer slide rule permits designers to determine the resonant frequency of a circuit knowing inductance and capacitance. Or they can select various inductances and capacitances for a desired frequency. The slide rule also has provisions for computing inductive and capacitive reactances as well as inductances and capacitances of resonant circuits from 1 mc to 1000 mc. Constructed of plastic, the slide rule is 9.5 in. long. Send \$1.00 to JFD Electronics Corp., 6101 Sixteenth Ave., Brooklyn 4, N.Y.

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CIRCLE 436 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

Ceramic Capacitors

437

This two-page bulletin describes the VK line of ceramic capacitors. These miniature units operate at 200 v dc and to 150 C without derating. Electrical and physical characteristics of the capacitors are described with accompanying charts and drawings that cover capacity values to 10,000 μ mf. The line is also offered without cases for complete circuit assembly encapsulation. Vitramon Inc., Box 544, Bridgeport 1, Conn.

Zener Diode Slide Rule

This slide rule is designed to simplify the calculations that are necessary to design Zener diode circuits. Among the calculations that can be made are: value of the ballast resistor; maximum Zener dissipation; required thermal dissipator or heat sink area; and change in regulated voltage with ambient temperature. The various scales eliminate the need for using several curves. Design information such as basic regulator circuit, various relationships, and tabular design data

have been included as part of the calculator. Send \$1.00 to Motorola, Inc., Dept. ED, Semiconductor Products Div., 5005 E. McDowell Rd., Phoenix, Ariz.

Silicon Triguistors

438

Applications and circuit design notes for silicon trigistors appear in this 16-page booklet. Operation, trigistor biasing, a one shot multivibrator, a memory circuit, and a flip flop binary counter are discussed with the aid of diagrams. Solid State Products, Inc., 1 Pingree St., Salem, Mass.

Power Amplifier

439

A three-channel amplifier designed for driving recording oscillographs from low-level accelerometer signals is described in this two-page, illustrated bulletin. Features, operating specifications, operating curves, and circuit description are included. Columbia Research Labs, MacDade Blvd. & Bullens Lane, Woodlyn, Pa.

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2 Channel

PORTABLE RECORDING SYSTEM



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Basic System Assembly
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Outstanding Features

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CIRCLE 442 ON READER-SERVICE CARD

NEW LITERATURE

Zener Diode Handbook

The basic theory, design characteristics and applications for Zener (voltage limiting) diodes are covered in this 130-page manual. Chapter headings include: Characteristics of Silicon Zener Diodes, Design Considerations, Regulated Power Supplies, Surge Protection, AC and DC Amplifiers, Temperature Compensation and Impedance Cancellation, New Approaches in Zener Diode Applications, and Specifications and Testing Methods. How the Zener diode can be used as a coupling device in ac to dc amplifiers and as a biasing element is discussed fully. The book contains numerous schematic drawings, tables and curves, all based on actual circuits that were designed and tested. References that have appeared in previous literature have been checked and incorporated into the manual. Send \$1.00 to Motorola, Inc., Semiconductor Products Div., Dept. ED, 5005 E. McDowell Rd., Phoenix, Ariz.

Silver-Zinc Batteries

443

The performance features of second (rechargeable) silver-zinc batteries for electronic equipment, underwater apparatus, and industrial communications systems are explained in this four-page brochure. Battery discharge cycle capability, shelf life, reliability, weight, and output factors are covered in specification charts and dimensional tables. Photographs of various models are included. Cook Batteries, Subsidiary of Telecomputing Corp., 3850 Olive St., Denver 7, Colo.

Video Transformation Tube

444

The firm's video transformation tube which accepts a radar (rho-theta) signal and converts it to a television (rectilinear) display, is described in this illustrated four-page catalog. Characteristics and diagrams for the reading gun and the writing gun are included. Intercontinental Electronics Corp., Mineola, N.Y.



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CIRCLE 445 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

Pulse Transformer Parameters 446

Bulletins PT-204, PT-205, and PT-206, each four pages, discuss blocking oscillator applications, interstage coupling applications, and specific applications where transformer parameters are known. In each bulletin a section is devoted to the characteristics of the pulse transformer which distinguish it from other circuit elements. An illustrated waveform of a typical pulse transformer output pulse showing two cases of damping is included. Transformer parameters are indicated on the waveform. Technitrol Engineering Co., 1952 E. Allegheny Ave., Philadelphia, Pa.

Decade Counters 447

Modular plug-in decade counters are featured in bulletin 826A, 12 pages. Each of the ten counters in the line is illustrated with photographs, outline drawings, and circuit diagrams. Circuits showing the units operating as variable scale and preset counters are included. Burroughs Corp., Electronic Tube Div., Plainfield, N.J.

Voltage Regulators 448

Features of automatic voltage regulators of the instantaneous electronic transistorized series are covered in this eight-page bulletin. In addition to dimensional diagrams, photos of the various types also appear. The Superior Electric Co., 83 Laurel St., Bristol, Conn.

Coil Form Chart 449

Information on ceramic, phenolic, shielded, and printed circuit coil forms is given on this 22 x 34 in. reference chart. Military specs and materials for coil forms are included; scale drawings give dimensions. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.

Radio Remote Control Units 450

This data sheet provides specifications, applications and a description of radio remote control units. Diagrams of the transmitter and receiver are included. Regent Electronics Manufacturing Co., 15321 Rayen St., Sepulveda, Calif.

JENNINGS VACUUM RELAYS



RA4B



RE6B



RB7A

what would you look for in the ideal relay?

- High insulation resistance
- Very low contact resistance
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And where will you find a relay that embodies all these desirable characteristics? Examine the ratings achieved by these typical Jennings vacuum relays and see how well they meet the requirements of many specialized applications.

HIGH VOLTAGE	RE6B (5PDT)	Rated operating voltage dc or 60 cycle	25 kv 15 kv
		Peak test voltage	35 kv
		Continuous rms current dc or 60 cycle	25 amps 9 amps
		Actuating coil	16 mc 26.5 vdc
MINIMUM SIZE	RB7A (2PDT)	Rated operating voltage dc or 60 cycle	4 kv 2.5 kv
		Peak test voltage dc or 60 cycle	6 kv
		Continuous rms current dc or 60 cycle	6 amps 3 amps
		Actuating coil	16 mc 26.5 vdc
		Overall length	1 3/8 inch
HIGH CURRENT	RA4B (4PDT)	Rated operating voltage	300 v
		Continuous rms current	40 amps
		Interrupting rating (100,000 ops)	28 vdc-25 amps
		Shock	50 G
		Vibration	30 G from 10 to 2000 cps
		Actuating coil	26.5 vdc

Jennings vacuum relays are unequalled for solving difficult problems of antenna switching, pulse forming networks, or similar rf and dc circuits where reliability is of utmost importance.

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SPECIFICATIONS

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a. 10 db position, no more than 3 db down at 15 cycles and 20 mc.
b. 20 db position, no more than 3 db down at 20 cycles and 15 mc.
Input Impedance: 10 db position, capacitive component, 15 micromicrofarads; resistive component, 20,000 ohms at 1 mc to 15,000 ohms at 10 mc.
Output Impedance: 75 ohms, approximately.
Inherent Noise: Less than 10 microvolts referred to shorted input in 20 db position.
Maximum Output Voltage: 0.2 V. rms, 10 db position; 0.3 V. rms, 20 db position.
Battery Life: Approximately 1000 hours with mercury cells, 8-hour days.
Dimensions: 2 1/4" x 1 3/4" x 4 1/2".
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Price: \$95.00 f.o.b. factory.

Designed for use as a wide-band audio-video amplifier, the *Transifier* provides 10 db or 20 db gain in low level circuits, from audio to 20 mc. It can be used to replace full-size, noisy, narrow-band decade amplifiers, and when two are used in series, voltage amplification of 30 and 100 will be provided.

The *Transifier* may be used as a line amplifier for telemetering audio-video, as a pre-amp for wide-band oscilloscopes, hi-fi audio and ultra-sonic amplifiers, and in the laboratory for amplification of weak heterodyned signals and to amplify audio hum noise as an aid in tracing its source.

The unit includes a feed-back amplifier for stable operation which is compensated for unit of high frequency gain. Mercury batteries provide constant voltage output throughout their life.

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CIRCLE 452 ON READER-SERVICE CARD

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MICROPOTS • MICRODIALS • INSTRUMENT MOTORS • FREQUENCY STANDARDS
CIRCLE 453 ON READER-SERVICE CARD

NEW LITERATURE

Transfer Switches 454

Relay control features of automatic transfer switches are discussed in four-page bulletin 07500-G. A narrow control center model is illustrated. Specifications and schematic diagrams also appear. Lake Shore Electric Corp., 205 Willis St., Bedford, Ohio.

Graphite Properties 455

"Graphite—How It Compares with Metals, Ceramics," is a four-page reprint of an article presented before the Electrochemical Society. Comparative data on electrical resistivity, tensile strength and modulus, strength-to-weight ratio and thermal conductivity are shown graphically. One table relates the properties of graphite with its industrial uses and its applications in the nuclear and missile fields. Another table lists the coefficients of thermal expansion. Speer Carbon Co., St. Marys, Pa.

Semiconductor Graphites 456

Graphite usage in semiconductor production is the subject of illustrated catalog SC-659. Sections cover unique semiconductor graphites, specialized graphite machining problems, methods of graphite quality control, means of planning, scheduling and expediting orders, typical physical properties of various grades of graphite, stock sizes and prices. United Carbon Products Co., P. O. Box 747, Bay City, Mich.

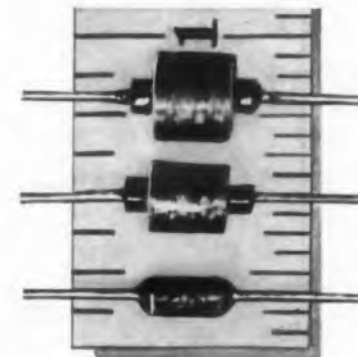
Hook-on Volt Ammeter 457

Descriptions, specifications and construction details of pocket-size, hook-on volt ammeters for testing ac voltages is given in Bulletin GEA-6292C, four pages. The bulletin lists applications, current ranges, accuracy percentage and operating instructions. Photographs are included. General Electric Co., Schenectady 5, N.Y.

MILLER Subminiature R.F. chokes

— smallest chokes available

These units have a 50 ma current rating, and an inductance range of 100 uh to 10 mh. Ratings are conservative, with a wide safety factor. Miller chokes can be encapsulated to meet military specifications.



Part No.	L ± 5%	R @ F	F ₀	DHMS ± 10%	Dimensions
70F104AI	100 uh	50 @ 790 Kc	4.40 Mc	6.70	3/4 x 1/4
70F154AI	150 uh	55 @ 790 Kc	3.60 Mc	8.20	3/4 x 1/4
70F224AI	220 uh	57 @ 790 Kc	3.00 Mc	10.0	3/4 x 1/4
70F334AI	330 uh	59 @ 790 Kc	2.50 Mc	12.8	3/2 x 1/4
70F474AI	470 uh	59 @ 790 Kc	2.30 Mc	15.0	3/2 x 1/4
70F684AI	680 uh	55 @ 790 Kc	2.03 Mc	18.0	1 1/4 x 1/4
70F824AI	820 uh	53 @ 790 Kc	1.93 Mc	20.0	1 1/4 x 1/4
70F103AI	1.00 mh	50 @ 790 Kc	1.76 Mc	21.5	1 1/4 x 1/4
70F153AI	1.50 mh	50 @ 250 Kc	1.38 Mc	32.0	1 3/4 x 1/4
70F223AI	2.20 mh	50 @ 250 Kc	1.08 Mc	41.0	1 3/4 x 1/4
70F333AI	3.30 mh	70 @ 250 Kc	1.05 Mc	43.0	1 3/4 x 3/8
70F473AI	4.70 mh	68 @ 250 Kc	930 Kc	52.0	1 7/8 x 3/8
70F683AI	6.80 mh	64 @ 250 Kc	750 Kc	66.0	3/2 x 3/8
70F823AI	8.20 mh	60 @ 250 Kc	720 Kc	73.0	1 3/4 x 3/8
70F102AI	10.0 mh	60 @ 250 Kc	690 Kc	84.0	3/16 x 3/8

Send for the MILLER industrial catalog

It lists over 1300 chokes, filters, transformers and coils, available for immediate delivery. Includes 260 new coil items—many conforming to military specifications. Request Miller Catalog No. 60.



J.W. MILLER COMPANY

5917 S. Main St., Los Angeles 3, Calif.

CIRCLE 458 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

Microwave Components 459

Resonance isolators, circulators, switches, tee circulators, phase shifters, and modulators are discussed in "Microwave Ferrite Components," a four-page catalog. Subgroups of coax and test equipment isolators, high power, miniature and microwave relay isolators, faraday rotators and differential phase shift circulators are also included. Ferrotec, Inc., 217 California St., Newton, Mass.

Time Delay Relays 460

Bulletin 5903, eight pages, describes and illustrates time delay relays. Manufacturing and assembly processes, standard and special type specifications, data on sizes, available mounting arrangements, weights and terminal styles, and a description of circuit design are included. Circuit application notes and a discussion of special types available for accuracies as good as 0.01 per cent also appear. Tempo Instrument Inc., P. O. Box 338, Hicksville, N.Y.

Inertial Guidance Platform 461

This eight-page bulletin illustrates and describes a gimbal platform which operates from -55 to $+100$ C. In addition to a description of the platform and associated electronic components, dip brazing fabrication features, configuration details of nine platform versions, and application information are included. General Electric Co., 600 Main St., Johnson City, N.J.

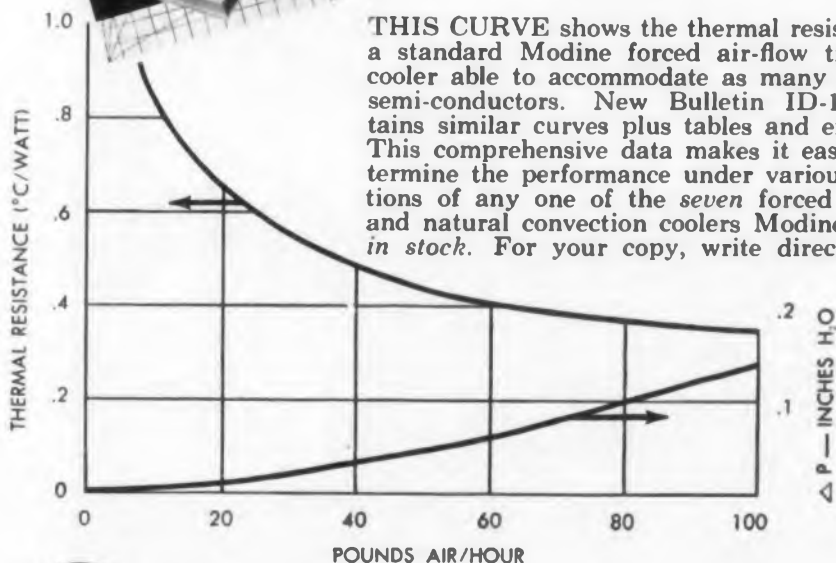
Precision Potentiometers 462

This catalog discusses box type and rotary trimmers, panel controls, precision servo type potentiometers, non-standard function pots, special non-linear pots, pressure and displacement transducers, unitized clutch modules with syncros, servo motors, spring returns, brakes, commutator switches, magnetic clutches and single or multiturn potentiometers. Technology Instrument Corp., 531 Main St., Acton, Mass.

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Modine Manufacturing Company

1608 DeKoven Ave., Racine, Wisconsin

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*Dunco's answer to the
problem of "over-relayed"
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AN IMPORTANT

RELAY

for industrial control

219 Frame Relays, using heavy duty 12-pin plugs and sturdy industrial-type phenolic sockets, are Dunco's answer to the need for industrial control relays that are large enough, but not too large; fully dependable, but moderately priced. Designed for long, reliable contact life on relaying loads, they have proved outstandingly successful on laboratory-type "tail chasing" circuits and on machine control installations.

Dunco 219 Frame Relays have 10-ampere current carrying parts; 150-volt electrical spacings of $\frac{1}{4}$ " over surface and $\frac{1}{8}$ " through air; and withstand 1500-volt dielectric test. Three standard contact arrangements available at *minimum* prices facilitate control circuitry standardization and simplify field maintenance replacement problems.

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CIRCLE 464 ON READER-SERVICE CARD

INSURE TUBE START-UP WITH ISOTOPE SOURCES FROM U.S. RADIUM



Leading electron tube manufacturers now rely on isotopic ionization sources from U. S. Radium to insure quick start-up and maintain firing stability.

U. S. Radium now offers plated electrodes and radium foil in required configurations for incorporation in electron tube envelope design. Use of such isotopes as Ni⁶³ eliminates problems associated with improper firing due to prolonged storage or extreme environmental conditions.

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MORRISTOWN, N. J. | Offices: Chicago, Illinois and North Hollywood, Calif. Subsidiaries: Radelin Ltd., Port Credit, Ont., Canada and U.S. Radium Corp. (Europe), Geneva, Switzerland.

CIRCLE 465 ON READER-SERVICE CARD

NEW LITERATURE

Microwave Tubes

466

Principal electrical characteristics for 22 klystron tubes and nine planar triodes are listed in this four-page catalog. Tube applications include microwave communication transmitters and receivers, test equipment, beacons, and missiles. Frequency coverage of the klystron line is 500 to 7500 mc, with cw output power ranging from 20 mw to 2 w. The klystrons are divided into five basic outline styles, each illustrated by a proportionally scaled photograph. Rocket planar triodes are designed for oscillator or amplifier applications and are available in either pulsed or cw versions with a frequency coverage from 500 to 3300 mc. The catalog lists amplification factors as high as 90, and peak power outputs to 200 w for oscillator operation. Sylvania Electric Products Inc., Central Advertising Distribution Dept., 1100 Main St., Buffalo, N.Y.

Magnetic Tape

467

Magnetic tape for digital and analog recording is described in this four-page, illustrated bulletin. Information includes performance qualities of the new tape, production techniques, and specifications. Photographs are included in bulletin 1619. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

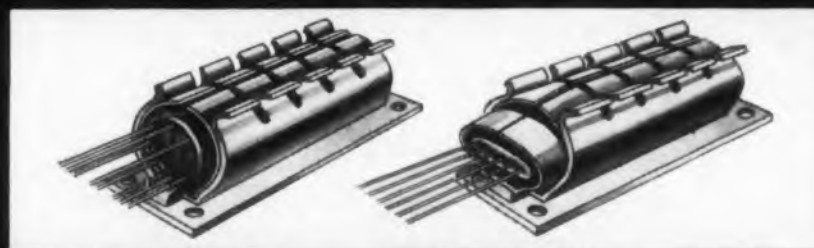
Tape Tension Gage

468

Type 5-050 dynamic tape tension gage for magnetic tape recorder/reproducers is described in bulletin 1621. The gage permits accurate tension measurement and adjustment to be made quickly and easily on fixed or mobile tape transports. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

AUGAT'S REVOLUTIONARY ELASTACLAMP*

The answer to more effective
cooling of subminiature tubes!



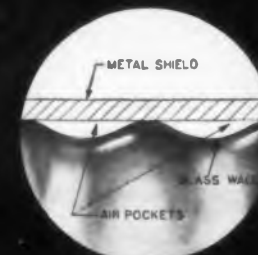
Heat-dissipating subminiature tube shield with elastic thermal conductor



Enlarged section of Elasta clamp's inner cartridge.

Resilient elastomer will completely conform to pronounced irregularities of glass surface thus reducing dangerous hot spots.

Tubes protected from severe shock and vibration by rubber-like elastomer which cushions glass.



Enlarged section conventional heat-dissipating tube shield.

For additional information write for bulletin No. 559.

AUGAT BROS., INC.

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CIRCLE 469 ON READER-SERVICE CARD

Automatic Test Equipment 470

The firm's preprogrammed automatic test system which employs only solid-state devices in computer circuit modules is discussed in this 24-page, illustrated booklet. Features, objectives, applications, and a general description of the system appear. Stromberg-Carlson, Electronics Div., 1400 N. Goodman St., Rochester 3, N.Y.

Thermocouples 471

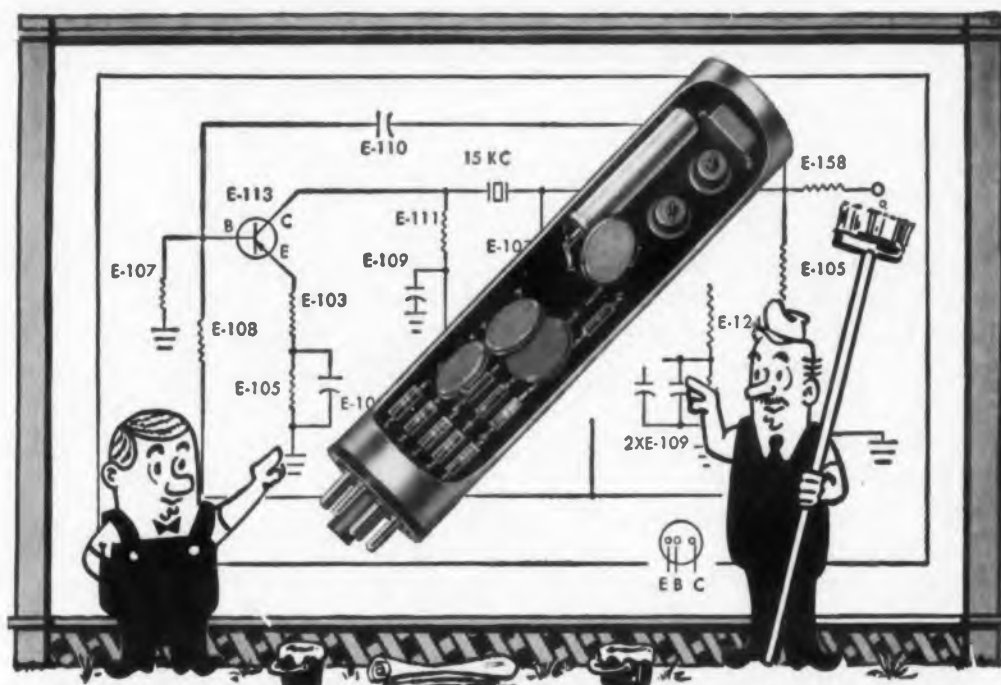
Illustrated catalog EN-S2, 52 pages, covers thermocouples and thermocouple components and accessories. It describes standard assemblies in protecting tubes and wells for general applications, specialized thermocouples and assemblies for laboratory and industrial applications, and a line of bare and insulated thermocouple wires, ceramic insulators, metal and ceramic protecting tubes, wells, and terminal heads. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Cathode-Ray Tubes 472

Information on over 75 types of standard (JEDEC registered) cathode-ray tubes is tabulated in this short-form catalog. Sections discuss the latest crt's suitable for new equipment designs, replacement tubes, special design services, screens, and accessories for crt's. Physical and electrical parameters are tabulated for such crt categories as electrostatic deflection and electrostatic focus, magnetic deflection and electrostatic focus, and magnetic deflection and magnetic focus. Allen B. Du Mont Labs, Inc., Electronic Tube Div., Clifton, N.J.

Coolers 473

Tables and performance curves in this eight-page bulletin aid the engineer in selecting coolers that will maintain junction temperatures of semiconductors within design conditions. Diagrams and photos illustrate the units. Modine Manufacturing Co., Racine, Wis.



"They're sure compact, K.C." "You bet, M.C., only 1 1/4 by 6 1/2 inches!"

NEW REEVES-HOFFMAN TRANSISTOR OSCILLATORS

WRITE FOR
BULLETIN RH-OS.



New Reeves-Hoffman oscillators are transistorized for compactness and crystal controlled for unerring accuracy. Each oscillator is produced and tested with exacting care by skilled craftsmen using the most modern equipment and facilities available. Reeves-Hoffman will manufacture these units in volume to your specifications.

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CARLISLE, PENNSYLVANIA

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TO SERVE YOUR EXACT NEED...

HIGH POWER
LOW POWER
BROAD BAND
LOW INSERTION LOSS
HIGH ISOLATION
SMALL SIZE
LIGHTWEIGHT

Added to the broad range of current Ferrite Isolators is an intensive program to conduct research and development in advanced ferrite devices for the frequency bands proposed for space navigation and communication.

Our design and engineering group will welcome an opportunity to work on your microwave problems.

TYPICAL SPECIFICATIONS

MODEL	FREQ. RANGE	ISOLATION	INSERTION LOSS	V. S. W. R.
W-568-3A-2	12.5-18.0 KMC	20 DB Min.	1.0 DB MAX	1.15 MAX
W-177-1K-1	9.5 KMC \pm 100 MC	25 DB Min.	.7 DB MAX	1.15 MAX
W-277-3A-3	5.2-5.9 KMC	17 DB Min.	1.0 DB MAX	1.15 MAX
W-859-11A-1	930 \pm 60 MC	25 DB Min.	2.0 DB MAX	1.25 MAX
W-668-1A-2	8.5 - 9.6 KMC	10 DB Min.	0.4 DB MAX	1.10 MAX

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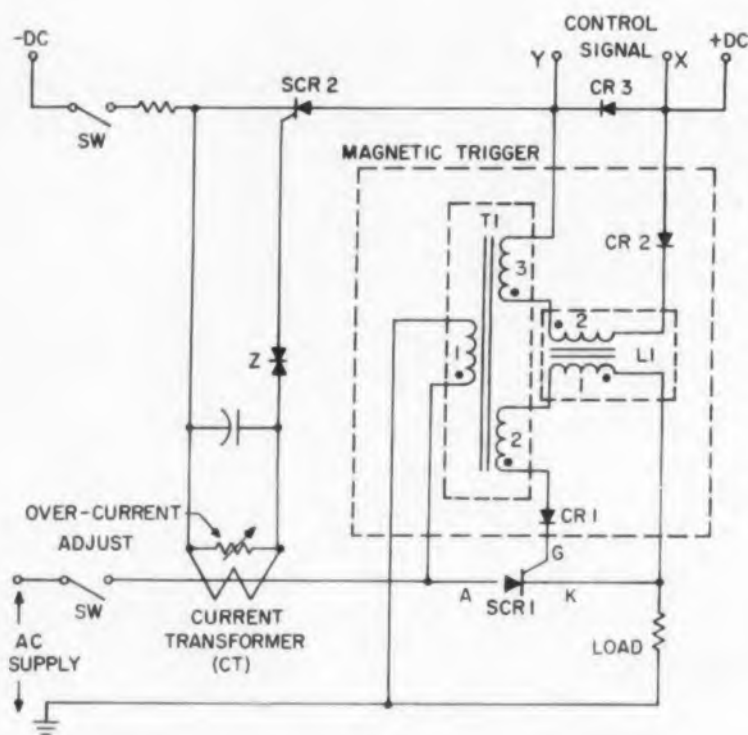
CIRCLE 475 ON READER-SERVICE CARD

Controlled Rectifier Power Supply Is Short-Circuit Protected

DESIGNING AN all solid-state power supply that is light, rugged and delivers high power per pound, is problem enough. Short-circuit protecting the power supply where no fuses are allowed is quite another thing. Here is a circuit, Fig. 1, based on a silicon controlled rectifier that accomplishes the job.

The Silicon controlled rectifier SCR is connected in series with the input power and the load in a half-wave configuration. A full wave configuration may be obtained very simply by adding one SCR and a properly rated center tap transformer. For simplicity, only the half wave circuit is discussed here.

A fast-response magnetic trigger operating on the reset principle (Avion Model 408 or equal) is used to control the firing angle of the SCR during normal operation.



Short circuit protection is provided through a silicon controlled rectifier in this all-solid state power supply circuit.

An isolation transformer *T1* is connected across the input. This transformer steps down (or, when a low-voltage supply is involved, steps up) the voltage level, to provide a proper supply to the reactor *L1*. The phasing of the transformer *T1* outputs is important and is indicated by dots.

During the first half cycle of supply frequency, when the anode of *SCR1* is positive, rectifier *CR1* is forward-biased and will allow current to flow into the gate *G* of the SCR. The angle at which this current will flow into the gate is determined by the saturation level of the reactor *L1*.

Rectifier *CR2* insures that during the first half cycle, no current will flow into the control winding #2 of *L1*. Winding #1 of the trigger reactor *L1* is the gate winding through which the current for the gate-cathode junction of the SCR flows.

Rectifiers *CR3* and *SCR2* form part of the short circuit protection network.

Normal Control

During normal operation, proportional control of the output is achieved by varying the control signal, or the impedance in the control circuit. This control may be implemented by various means. Some are listed below:

1. Potentiometer for manual control
2. Transistor or SCR
3. Ac signal from synchros in phase opposition to voltage of *T1* winding #3
4. Half-wave variable signals buck-impedance of *CR3*, through forward biasing, to a very low value. Rectifier *CR3*, thus biased, will pass the current necessary to reset the reactor core to cut off.

A current transformer (*CT*) is connected in series with the load. The secondary of the *CT* is in series with a Zener diode and a gate cathode junction of *SCR2*. An over-current adjusting rheostat is connected across the current transformer *CT*.

Under normal conditions the secondary current flowing out of the *CT* can flow only through the rheostat. The voltage developed across the rheostat is lower than the breakdown voltage of the

Zener diode. *SCR2* remains open, and does not allow current from the auxiliary dc supply to flow through it, diode *CR3* and a limiting resistor, to ground.

As soon as the load current exceeds a predetermined level, the secondary voltage drop across the *CT* exceeds the Zener voltage and triggers *SCR2*; *SCR2* fires and allows the auxiliary supply to forward-bias *CR3*.

Full reset current now flows through *CR3* and winding #2 of *L1* is subjected to full reset voltage. *L1* and *SCR1* cut off and the loading winding #3 voltage.

The firing angle of *SCR1* is determined by the firing angle of *L1*. When all the voltage is absorbed by winding #1 of the reactor *L1*, no output, except for very low exciting current, appears across the gate-cathode junction of the SCR. The amount of volt-second absorbed by the windings #1 of *L1* is determined by the voltage which is applied to winding #2 during the second half cycle of the supply frequency. If no voltage at all is applied to winding #2, then winding #1 allows load current to flow during the third half cycle, due to self-saturation. However if the full voltage is impressed on winding #2 during the second half cycle, no output current will flow during the following half cycle in the gate winding #1. Partial control voltage will allow firing of the SCR.

Short Circuit Protection

In order to cut off *SCR1*, then, the output of *L1* must also be cut off. One obvious way to achieve this is to allow the full voltage, induced in winding #3 of *T1*, to be impressed on winding #2 of *L1*. This is accomplished by reducing the current falls to zero. No telegraphing of *SCR2* occurs because once it is triggered it remains "on" due to the holding current supplied by the auxiliary supply. Resetting the supply to normal operation again is accomplished by opening and closing the switch *SW*.

Baruch Berman, Avion Division ACF, Paramus, N.J.

"never-fail" performance in electronic, missile, and aircraft applications

LEACH BALANCED ARMATURE RELAYS



For "never-fail" reliability... highest resistance to shock and vibration... significant reduction in size and weight... look to Balanced-Armature Relays from Leach.

These patented Balanced-Armature Relays can solve critical circuit control problems in 5-, 10- and 15-amp applications requiring 2, 4 or 6 poles. They are rectified for AC operation and meet or exceed military specifications MIL-R-25018, MIL-R-5757C, MIL-R-6106C (including the minimum current test requirements.) And Leach relays offer outstanding environmental characteristics:

Shock	50 G's
Vibration	15 G's to 2000 cps
Ambient Temperature Range	-70°C. to +125°C.
Acceleration	15 G's
Altitude	100,000 feet +

Leach relays can be tested to specific customer requirements—up to 100% of the total production run—in the Leach Production Reliability Center, the only reliability testing laboratory of its kind in the industry.

Leach "know-how" results from 40 years of designing and manufacturing for electronics—30 of these years spent in relay specialization. Today, many Leach designs are considered standard industry configurations. The Balanced-Armature series alone includes over 4,000 variations of 20 basic hermetically sealed, contaminant-free relays... standard designs and Magnetic Latch types... all available in a wide variety of mountings and terminals... a relay for nearly every electronic, missile, and aircraft application where components *must not fail*.

Write today for the new Leach Balanced-Armature Relays brochure containing specifications, typical ratings, and other information on these unusually reliable relays! Or contact your nearest Leach sales representative to discuss your specific relay requirements.



RELIABILITY → **LOOK TO LEACH**
RELAY DIVISION...LEACH CORPORATION
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CIRCLE 530 ON READER-SERVICE CARD

Just what you're looking for!



New!
**JEFFERS
 MINI-STAB
 INDUCTORS
 MINIature! STABLE!**

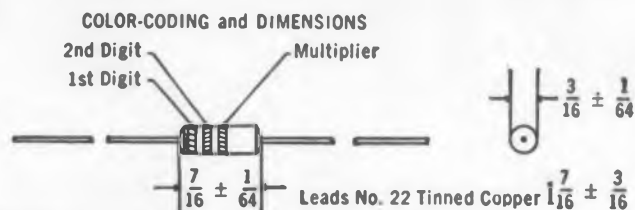
PACK OVER 60 TIMES MORE INDUCTANCE IN THE SAME SPACE!

THE MOST IMPORTANT ADVANCE IN DECADES! Now—in miniature size—you can get maximum inductance to 1000 μ h (more than 60 times the 15 μ h previously available). The revolutionary MINI-STAB line supplements the Jeffers Type 101 Inductor line to provide you with stable inductance values from 0.15 to 1000 μ h!

MINIATURIZATION WITHOUT LOSS OF STABILITY! Jeffers MINI-STAB inductors give you both stability and miniaturization.

Miniaturization is achieved through more efficient use of coil winding space.

Stability comes from using an open magnetic circuit as obtained with a conventional powdered iron coil form.



PART NUMBER	INDUCTANCE (Microhenries)	MEAS. FREQ. (MC)	Q MIN.	SRF MIN. (MC)	D.C. RES. MAX. at 25°C (OHMS)	CURRENT RATING (MA)	COLOR-CODING		
							1st	2nd	3rd
1311-1	18 ± 10%	2.5	50	25	1.8	315	BRN	GRY	BLK
1311-2	22 ± 10%	2.5	50	24	2.0	300	RED	RED	BLK
1311-3	27 ± 10%	2.5	50	20	2.8	255	RED	VLT	BLK
1321-1	33 ± 10%	2.5	50	19	2.5	270	ORG	ORG	BLK
1321-2	39 ± 10%	2.5	50	18	3.0	245	ORG	WHT	BLK
1321-3	47 ± 10%	2.5	50	17	3.5	225	YEL	VLT	BLK
1321-4	56 ± 10%	2.5	50	15	4.2	205	GRN	BLU	BLK
1321-5	68 ± 10%	2.5	50	14	5.0	190	BLU	GRY	BLK
1321-6	82 ± 10%	2.5	50	12	5.5	180	GRY	RED	BLK
1321-7	100 ± 10%	2.5	50	11	6.0	170	BRN	BLK	BRN
1321-8	120 ± 10%	0.79	50	9.0	7.0	160	BRN	RED	BRN
1321-9	150 ± 10%	0.79	50	8.6	8.0	150	BRN	GRN	BRN
1321-10	180 ± 10%	0.79	50	8.0	9.0	140	BRN	GRY	BRN
1321-11	220 ± 10%	0.79	50	6.6	10.0	130	RED	RED	BRN
1331-1	270 ± 10%	0.79	45	4.0	6.8	165	RED	VLT	BRN
1331-2	330 ± 10%	0.79	45	3.6	7.4	155	ORG	ORG	BRN
1331-3	390 ± 10%	0.79	45	3.4	10.6	130	ORG	WHT	BRN
1331-4	470 ± 10%	0.79	45	3.1	11.5	125	YEL	VLT	BRN
1331-5	560 ± 10%	0.79	55	2.9	15.2	110	GRN	BLU	BRN
1331-6	680 ± 10%	0.79	50	2.6	17.0	105	BLU	GRY	BRN
1331-7	820 ± 10%	0.79	50	2.4	19.0	100	GRY	RED	BRN
1331-8	1000 ± 10%	0.79	45	2.2	21.3	90	BRN	BLK	RED

TYPICAL CHARACTERISTICS OF INDUCTOR DESIGNS BASED ON 1000 μ H VALUE

INDUCTOR CHARACTERISTICS	JEFFERS MINI-STAB DESIGN	CONVENTIONAL DESIGNS	
		MINIATURIZED*	NON-MINIATURIZED
MINIATURIZATION (WT. IN GRAMS)	1.0	0.5 to 2	2 to 10
STABILITY OF INDUCTANCE WITH TEMP. -55 to +125°C	± 2%	± 10%	± 2%
WITH APPLIED CURRENT (ZERO to 90 MA)	- 1%	- 30%	NIL
WITH APPLIED VOLTAGE (TEST OR SIGNAL)	GOOD	POOR	GOOD

*UTILIZING CLOSED MAGNETIC CIRCUITS SUCH AS TOROIDS, CUP-CORES, ETC.

The MINI-STAB design is in contrast to conventional inductor designs in which miniaturization is usually achieved at the sacrifice of stability (i.e., inductor designs of the closed magnetic circuit type such as toroids, cup cores, etc., tend to be inherently unstable). A comparison of these inductor characteristics is presented in the chart at the left.

MINI-STAB Inductors can be furnished as being capable of meeting requirements of MIL-C-15305A. (Details on request.)



JEFFERS ELECTRONICS DIVISION
 SPEER CARBON COMPANY
 Du Bois, Pennsylvania

CIRCLE 531 ON READER-SERVICE CARD

IDEAS FOR DESIGN

Slide-Rule Solution
 For $|1 + j(f/f_0)|$

The quantity $|1 + j(f/f_0)|$ can pop up in design work so often that a short-cut solution in decibels would be a boon. Here is a simple slide rule solution that yields the answer in db quickly and with reasonable accuracy.

To evaluate $|1 + j(f/f_0)|$ in db on the slide rule, just follow these four steps:

1. Set f on the D scale opposite f_0 on the C scale. Read $(f/f_0)^2$ on the A scale opposite the B index.

2. Mentally add 1 to that value and set the hairline to $(f/f_0)^2 + 1$ on the A scale.

3. Multiply this value by itself, i.e., set the B index to $(f/f_0)^2 + 1$ on the A scale and move the hairline to the same quantity on the B scale.

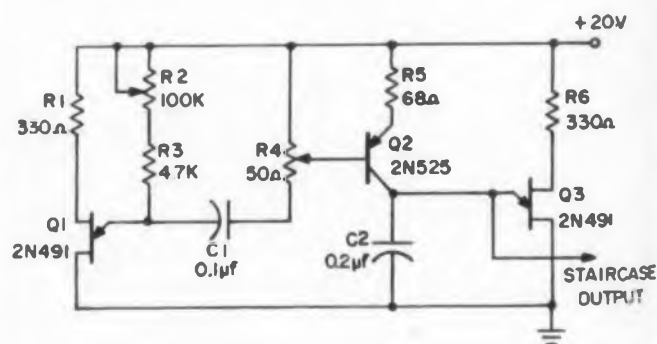
4. Look under the hairline on the L scale for the answer. If (f/f_0) is less than 3, read the answer in db directly. If (f/f_0) is between 3 and 10, add 10 db to the value on the L scale. (Ignore the decimal point for these readings.) If (f/f_0) is greater than 10, $|1 + j(f/f_0)| \cong f/f_0$.

For example, find $|1 + j(4/5)|$. Setting 4 on D opposite 5 on C gives 0.64 on A opposite the B index. Set the B index to $1 + 0.64 = 1.64$ on A , and then move the hairline to 1.64 on B . Read 2.15 db as the answer on L .

Jesse Roth, Sr. Engineer, Avion Div., ACF, Paramus, N.J.

A Simple Staircase Wave Generator

A staircase generator having good stability and a wide operating range may be constructed as shown in the circuit diagram. Transistor Q_1 operates as a free-running oscillator generating negative pulses across R_4 . These pulses produce current pulses from the collector of Q_2 which charge



Schematic diagram of a simple staircase generator.

FROM GENERAL INSTRUMENT CORPORATION

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HIGH
RELIABILITY
FOR PENNIES!



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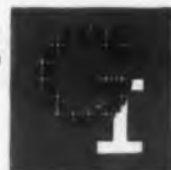
small size... μ a leakage

TYPICAL
UNITS

- 1XH — Half wave — 50 PIV, 12.5 Ma
- 2XH — Half wave — 100 PIV, 12.5 Ma
- 4XH — Half wave — 200 PIV, 12.5 Ma
- 5XH — Half wave — 250 PIV, 12.5 Ma
- 8XH — Half wave — 400 PIV, 12.5 Ma

Also available as doubler, center tap, 4-way bridge and special circuits.

For complete information, write today to Section ED-3



RADIO RECEPTOR COMPANY, INC.
Subsidiary of General Instrument Corporation
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General Instrument Corporation includes F. W. Sicles Division,
Automatic Manufacturing Division, Radio Receptor Co., Inc.,
Micamold Electronics Manufacturing Corporation and
Harris Transducer Corporation (Subsidiaries)

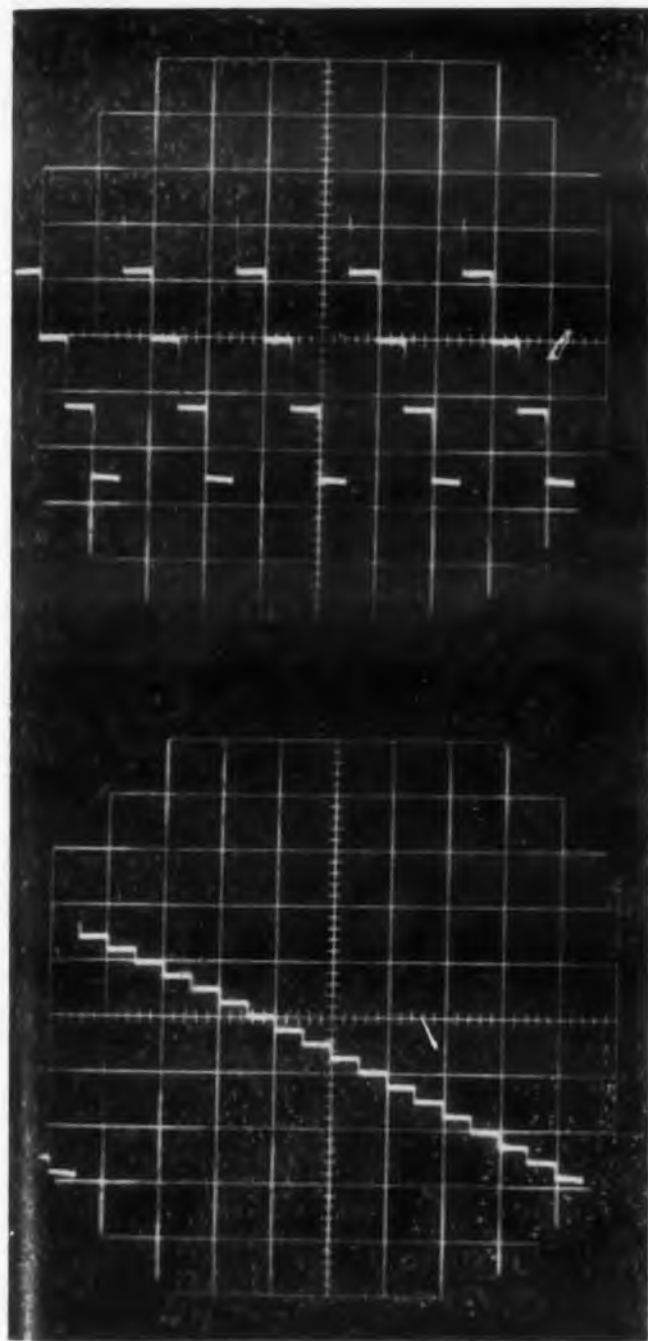
CIRCLE 532 ON READER-SERVICE CARD

capacitor C_2 in steps. When the voltage across C_2 reaches the peak point voltage of Q_3 , this transistor fires and discharges C_2 .

Resistor R_2 determines the frequency of oscillation of Q_1 and thus determines the period of the individual step without affecting the number of steps per cycle. The setting of R_4 determines the amplitude of the collector current pulse from Q_2 and thus determines the number of steps per cycle without affecting the period of the individual step. The waveforms show operation at two different settings of R_4 which give four steps per cycle and 18 steps per cycle.

This circuit can easily be adapted to operate as a wide range frequency divider by cascading stages similar to the stage formed by Q_2 and Q_3 .

T. P. Sylvan, Application Engineer, General Electric Co., Syracuse, N.Y.



Typical output waveforms. Vertical scale is two volts per division. Horizontal scale is one millisecond per division (right to left).

Waters has a watertight case!



Waters APW $\frac{1}{2}$ Sealed Potentiometer is so watertight and so heat resistant that it operates reliably even in boiling water! The APW $\frac{1}{2}$ is completely unaffected by humidity and water vapor, the two common causes of potentiometer failures in aircraft and missiles, where pressure and altitude changes allow equipment "to breathe". Naturally, the watertight construction of the APW $\frac{1}{2}$ also seals out dust and other minute particles which might cause failure. Meets MIL-E-5272A immersion specifications by means of a double "O" ring shaft seal. The glass-to-metal terminal board is solder-sealed to the case. Available with 125°C or 150°C construction, mechanical rotation stops, special winding angles, values to 100K and tighter linearity tolerances. Can be supplied with optional split bushings and various shaft lengths. (Waters WPW $\frac{1}{2}$ Sealed Potentiometer features the same construction as the APW $\frac{1}{2}$, but with a servo face.) Write for Bulletin APW-359.



POTENTIOMETERS
SLUG TUNED COIL FORMS
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IDEAS FOR DESIGN

Zener Diode Expands Telemetry Monitor Scale

The circuit used for monitoring, via telemetry, the B+ voltage of the tracking beacon in the X-7A RJTV (Ram Jet Test Vehicle) is shown in Fig. 1. This circuit provided a check of the B+ voltage to the beacon and in addition was an indication of beacon triggering.

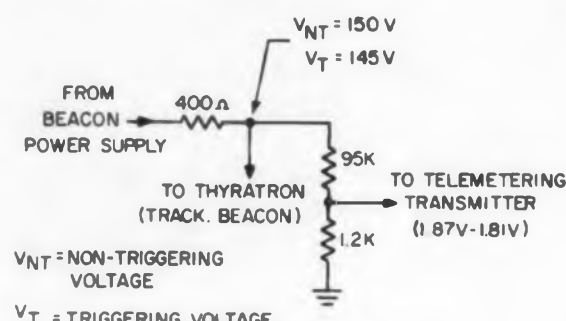


Fig. 1. Small voltage change in B+ telemetry circuit left room for doubt.

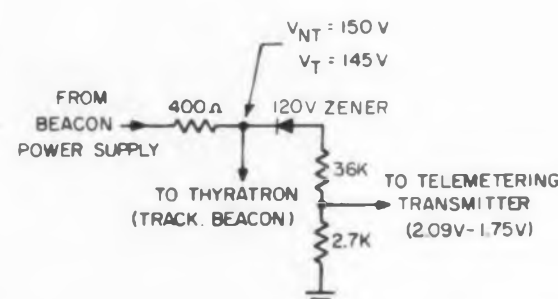


Fig. 2. Zener diode in circuit increase output range to transmitter from 0.06 v to 0.34 v.

The difficulty encountered in the circuit of Fig. 1 was that the voltage change from trigger to no-trigger, when divided down for telemetering, was so small that the beacon's state of operation was often questionable.

Fig. 2 shows the change that was incorporated in the telemetering monitor circuit which clearly defines the trigger/no-trigger state of the beacon. The zener diode provides a constant 120 v drop so that the voltage divider now reflects the change of 25 to 30 v. The change to telemetry transmitter is now 0.34 v instead of 0.06 v as in Fig. 1.

P. A. Walter and R. U. Moody, Lockheed Aircraft Corp., Missile & Space Division, Van Nuys, Calif.

100 pps Pulse Train Synched From 10 pps Source

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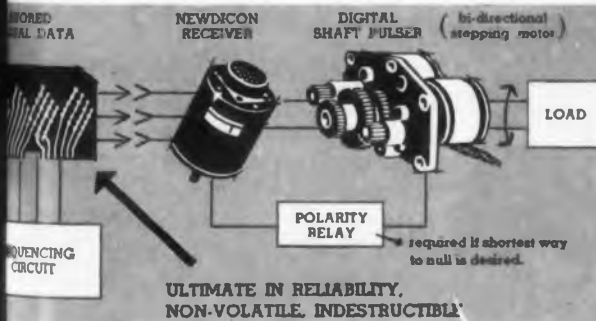
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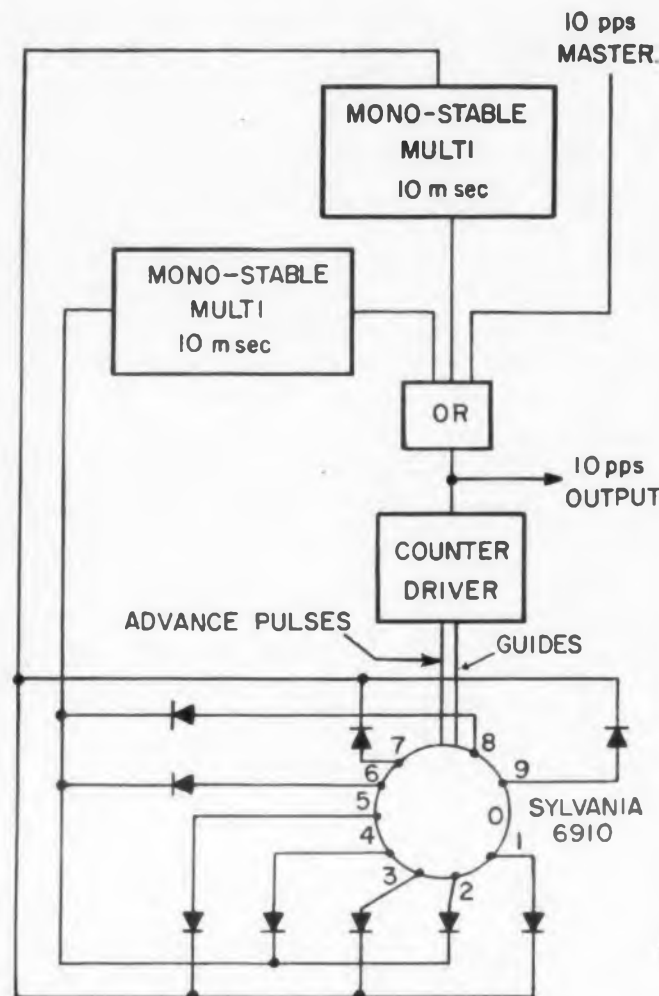
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ELECTRONIC DESIGN • November 11, 1959



100 pps pulse train output is generated in this synchronized, fail-safe circuit.

also remain in absolute synchronization, with the source pulse becoming every tenth output pulse. Fail-safe properties must be incorporated in the system so that the output pulses cease if the source pulses are interrupted.

The solution utilizes the decade properties of a cold cathode glow transfer counting tube, Sylvania 6910. With the glow normally at cathode "zero," the master pulse advances the count to cathode "one." When the glow arrives at cathode "one," monostable multivibrator (MMV)-A is triggered which advances the glow to cathode "two" after a 10 ms delay. When the glow arrives at cathode "two," a positive transient is developed, triggering MMV-B which advances the glow to cathode "three" after another 10 ms delay.

This cycle continues until the glow reaches cathode "zero" where it remains until another master pulse arrives. The staggered arrangement of the MMV's is used to reduce the individual duty cycle to approximately 50%.

The system parameters can be modified to generate 1000 pps from a 100 pps source. The fill-in generators can be cascaded if desired. The counter driver and MMV's are transistorized. Circuit details may be obtained by contacting the authors.

Jack Star and Edgar H. Fischer, Applied Physics Lab, J.H.U., Silver Springs, Md.

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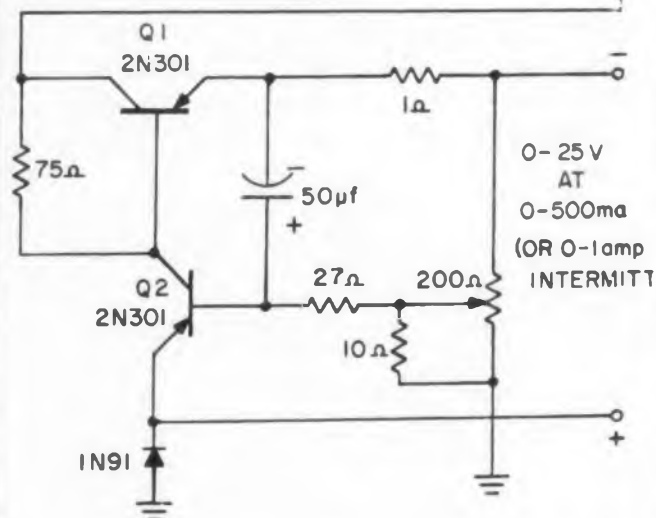
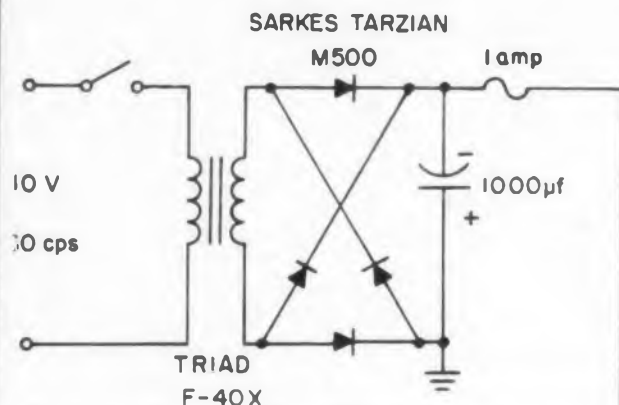
IDEAS FOR DESIGN

Power Supply Delivers Low, High I, Low Cost

This circuit fulfills the need for a high-current low-output impedance supply over an adjustable voltage range with a minimum of complexity and cost. The regulator is composed of two inexpensive power transistors and one 1N91 diode.

A 0-25-v adjustment over a 0-1/2-amp current output is featured. Output impedance varies from 0.5 ohm to -2 ohms. Ripple voltage is 100 mv p-p maximum over the entire output voltage and current range.

The regulator is conventional except for the



Two inexpensive transistors and a diode from the basis of this power supply.

negative current feedback effect from the dc output ground return. Instead of returning to ground directly, load current lowers the bias on Q2 by increasing the forward drop on the emitter diode. This in turn lowers the bias on Q1, maintaining the load current constant. A number of diodes may be tried to get the correct "over-compounding" to balance out the inherent regulation.

Charles T. Gage, Sigma Instruments, Inc., South Braintree 85, Mass.

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ELECTRONIC DESIGN • November 11, 1959

Mix Two Oscillators Without Lock

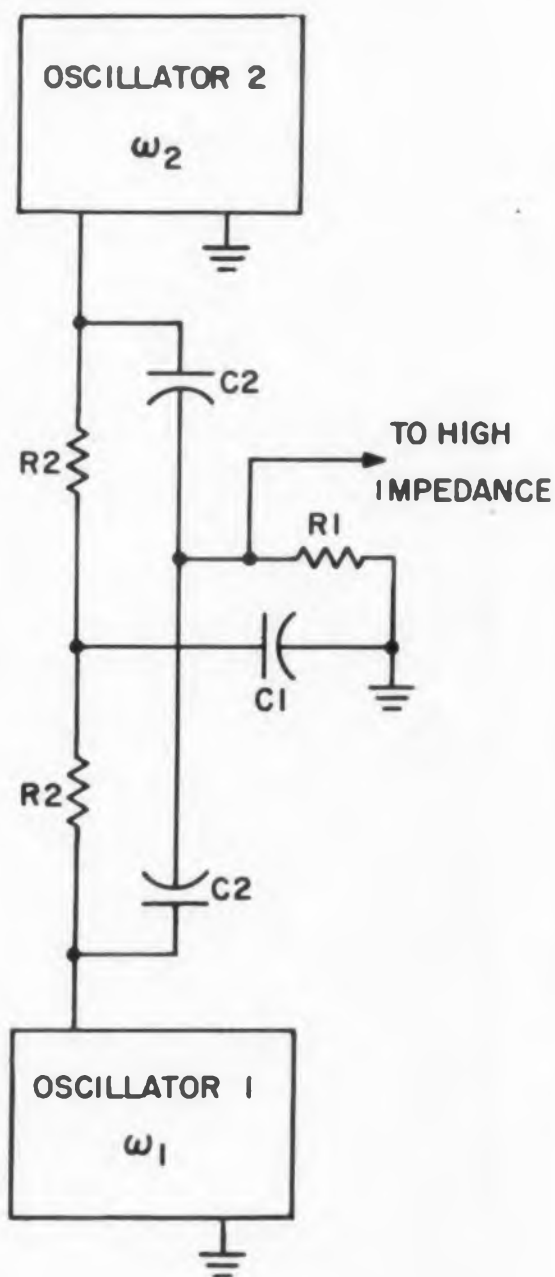
The outputs of two free-running-sine wave oscillators whose frequencies were only slightly different, had to be mixed without allowing them to lock together. The solution was provided by a parallel "T" circuit between the two oscillators.

The output is taken from R_1 and fed to a high impedance circuit. The values of the components are chosen so that there is zero transfer for one of the frequencies. This circuit was used in a beat frequency metal detector operating at about 3 mc.

The formulas for the circuit are as follows:

$$\begin{aligned}\omega_1 &\approx \omega_2 \\ \omega^2 C_1 C_2 &= 2/R_2^2 \\ \omega^2 C_2^2 &= 1/2 R_1 R_2 \\ C_1 R_2 &= 4 C_2 R_1\end{aligned}$$

Jack Brotzman, Naval Research Lab., Washington 25, D.C.



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176

Increase Input Impedance Of Emitter Follower

An emitter follower such as might be used for the input stage of an amplifier often has its input impedance lowered by the loading effect of the bias resistors. A typical case is that shown in Fig. 1.

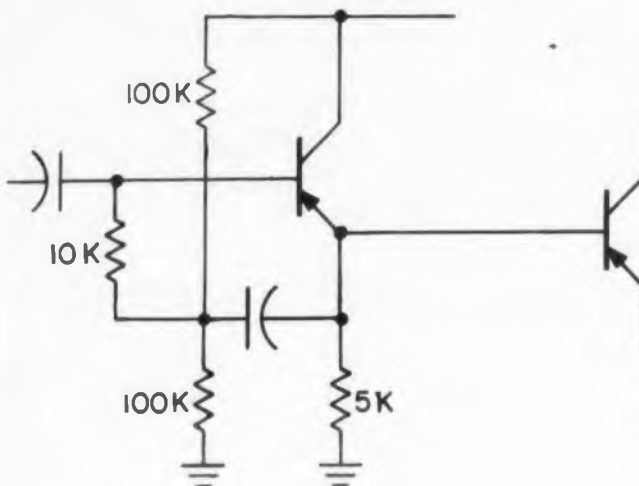


Fig. 1. Conventional emitter follower circuit parallels bias impedance with base impedance.

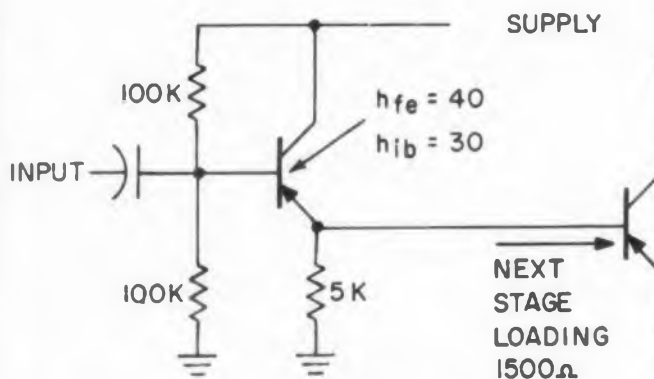


Fig. 2. Modified circuit transfers the bias resistor load to emitter circuit and almost doubles input impedance.

In this case the input impedance is the 47.3 K of the emitter follower base in parallel with the 50 K bias resistor impedance or 24.2 K.

The circuit of Fig. 2 transfers the bias resistor load to the emitter and raises the input impedance to 41 K.

The input device sees the 10 K resistor increased by a factor of $1/1 - A_v$, where A_v = the voltage gain of the emitter follower from base to emitter.

James G. Barr, The Martin Co., Denver 1, Colo.

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ELECTRONIC DESIGN • November 11, 1959

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binary number. In this case it would be $2^8+2^7+2^6+2^4+2^2+2^1$ or $256+128+32+16+4+2$ which totals 438.

This method is long and tedious, and becomes much worse as the binary numbers become longer. The method presented here was tried and found to save considerable time in repetitious mental conversions. The method involves the use of a hexi-decimal system, which is a system using radix 16.

The binary number is broken into groups of four starting from the right so the above number would be 0001 1011 0110. The groups of four are then the coefficients of 16 raised to the appropriate power. The coefficients are evaluated by the ordinary method, mentioned above, for evaluating a binary number. However, this is a very simple mental calculation since the number must be between zero and fifteen. After some use, the values of the groups would be automatically recognized without calculation.

These coefficients are usually called 0,1,2,3,4,5,6,7,8,9,u,v,w,x,y,z, in order that only one character be used to represent one coefficient. The use of 12 instead of w, for example, might be mistaken to be 1,2. To simplify the completion of the calculation, the accompanying table gives the values of the coefficient times 16 to various powers.

To find the answer to the problem, we see that there are three groups of four, representing 16^2 , 16^1 , and 16^0 . The coefficient of the first group is 1. Looking at the table on the horizontal line corresponding to coefficient 1, it is seen that 16^2 gives 256. For coefficient v, 16^1 gives 176; and for coefficient 6, 16^0 gives 6. 256, 176, and 6 are added to give the answer 438.

Robert Banow, Ford Instrument Co., Bldg. 2, Division of Sperry Rand Corp., Long Island City, N.Y.

Table of Values for Radix 16

COEFF.	16^0	16^1	16^2	16^3	16^4
1	1	16	256	4096	65,536
2	2	32	512	8192	131,072
3	3	48	768	12288	196,608
4	4	64	1024	16384	262,144
5	5	80	1280	20480	327,680
6	6	96	1536	24576	393,216
7	7	112	1792	28672	458,752
8	8	128	2048	32768	524,288
9	9	144	2204	36864	589,824
(10) u	10	160	2560	40960	655,360
(11) v	11	176	2816	45056	720,896
(12) w	12	192	3072	49152	786,432
(13) x	13	208	3328	53248	851,968
(14) y	14	224	3584	57344	917,504
(15) z	15	240	3840	61440	983,040



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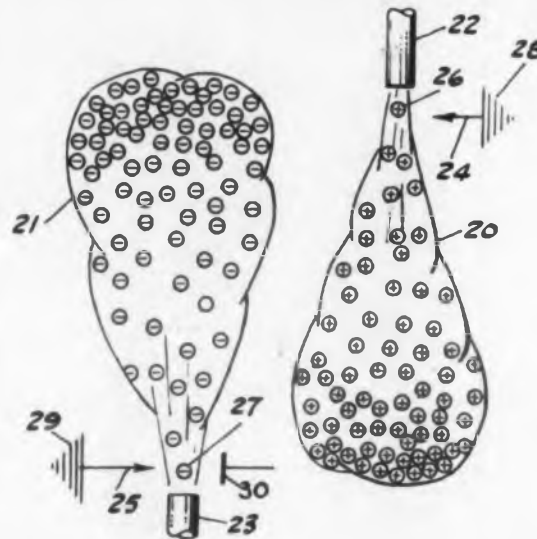
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PATENTS

Generation of Electrical Fields

Patent No. 2,881,335. Bernard Vonnegut.
 (Assigned to Arthur D. Little, Inc.)

A self regenerating means to produce separate dense charge formations is ap-



plicable to the creation and control of thunderstorms. Likewise it is possible by this means to transport particles to areas inaccessible by spraying, brushing or rolling.

Initially, a positive voltage is applied to plate 30 to cause a corona discharge from point 25. Negative ions moving towards plate 30 will become attached to cloud particles and the moving air will cause the negatively charged particles to accumulate at the top of cloud plume 21. As a result, point 21 will discharge and the moving air will assist the accumulation of positively charged particles in plume 20. With sufficient charge piled up in plume 20, the discharge from point 25 is self-exciting and the potential difference between the clouds builds up sufficiently to produce lightning across the clouds.



Potentiometers wound with our #479 Platinum Alloy Wire have exceptionally low noise level, even after extended periods of shelf life . . .

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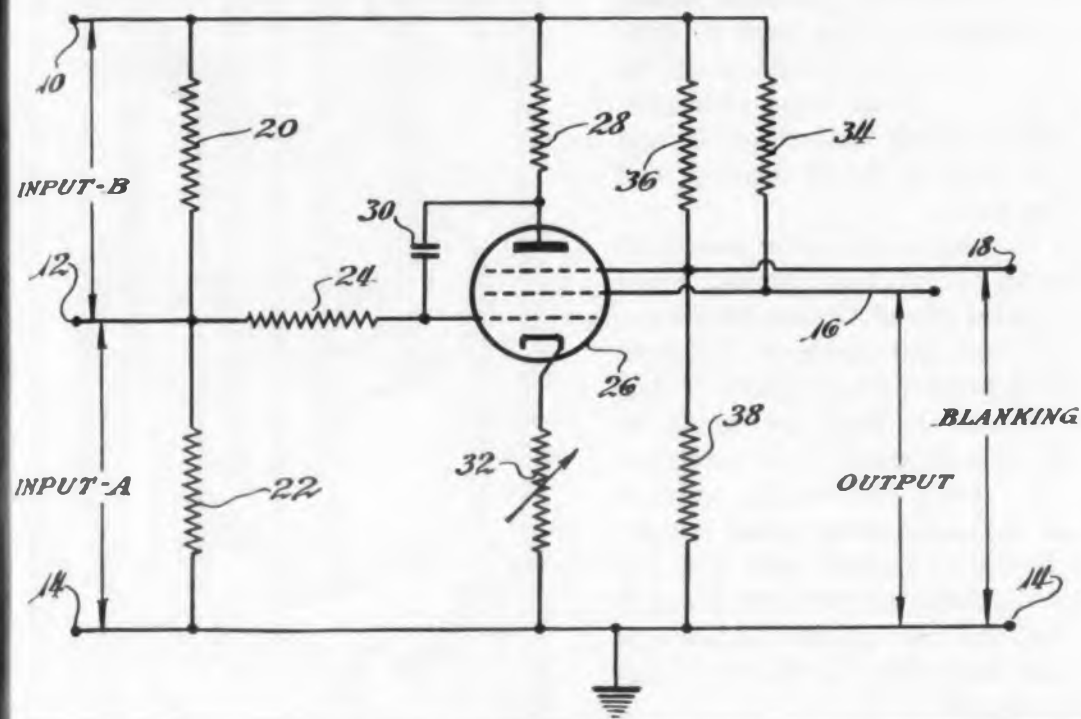
Deviation Oscillator

Patent No. 2,898,554. Gale W. Crampton.
(Assigned to Victor Adding Machine Co.)

Inputs A and B set the voltage on the control grid of a 6AS6 pentode phantatron and thereby determine the rundown time.

Initially capacitor 30 is charged to line

voltage with the tube cut off. The capacitor discharges until control grid and plate voltages are equal at which time the pentode is cut off. The capacitor again charges to line voltage and the cycle repeats according to the voltage between the two inputs.



The 6116/TE-39 ruggedized Reflex Klystron thermally tunes a band of 8500 to 9660 MC by means of a diode within the vacuum envelope. Tuning speed over the required frequency range is 0.7 seconds min. to 3.0 seconds max.

The 6940/TE-58 is identical to the 6116, but has special characteristics limiting spectrum width and spectrum continuity under adverse load conditions.

The 6845/TE-59 is similar in electrical and mechanical characteristics to the 6116 but may be operated under pulsed conditions with minimum frequency modulation.

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repeatedly cycled throughout its tuning range without damage or deterioration.

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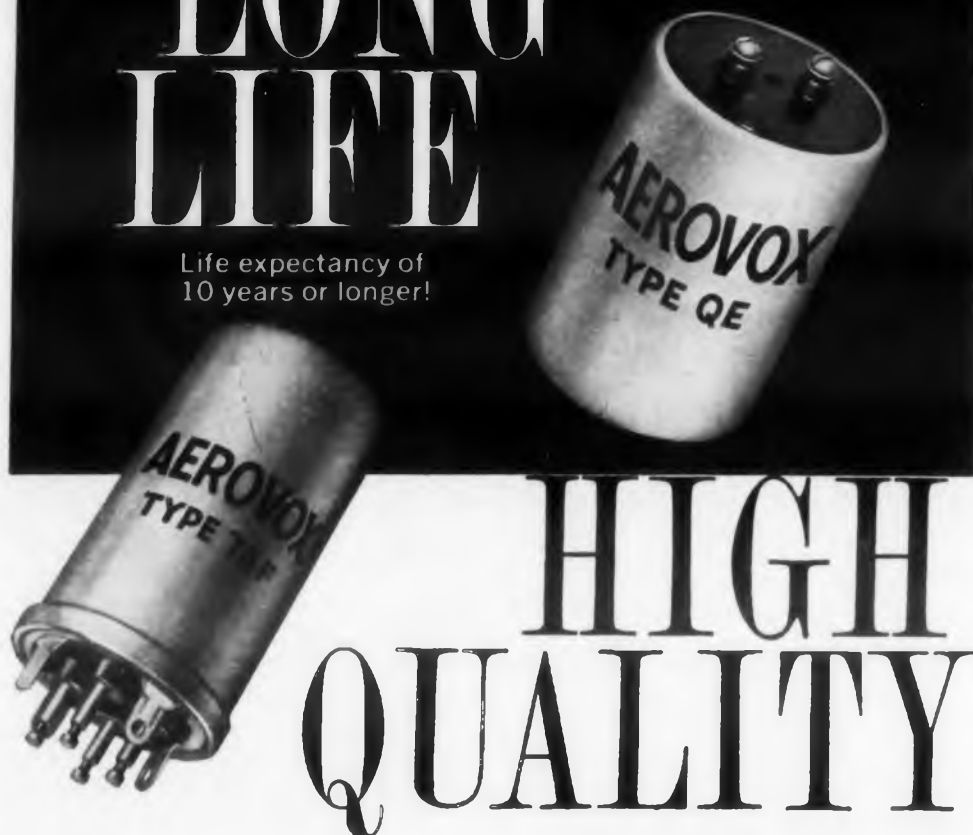
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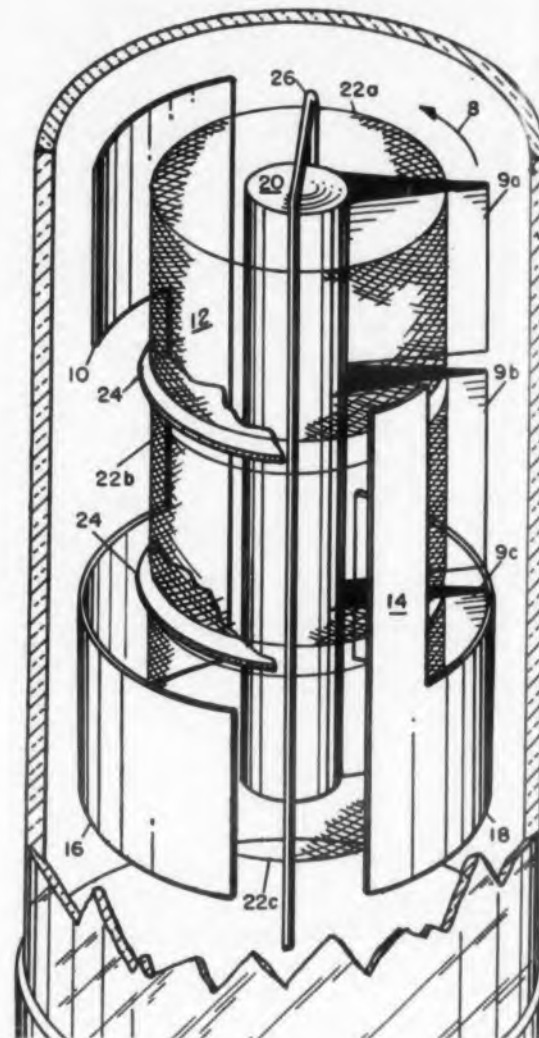
PATENTS

Synchronizing Signal Generator

Patent No. 2,884,561. Harold E. Beste.
(Assigned to Allen B. Du Mont Labs.,
Inc.)

A single-sheet beam tube is used to generate the standard television timing pulses. Electrons emitted from an axial cathode are caused to rotate at 15,750 cps so as to impinge upon electrodes which are properly shaped, sized and located to produce the H, serrated, and equalizing pulses.

Sheet 9a rotates the strike anode 10 once during 5 μsec (H-scan period). Sheet 9b hits anodes 12 and 14 each revolution; the dwell time per anode is 2.54 μsec (equalizing pulse period). Sheet 9c hits anodes 16 and 18 once per revolution dwelling on each anode 24.75 μsec (serrated pulse time.) The requisite gaps in the train of synchronizing pulses are obtained by gating control grids 22a, 22b and 22c. Initiation of the pulse series is prescribed by the narrow 31,500 cps pulses produced when the sheets impinge on wire loop 26.



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ELECTRONIC DESIGN • November 11, 1959

Binary Half Adder

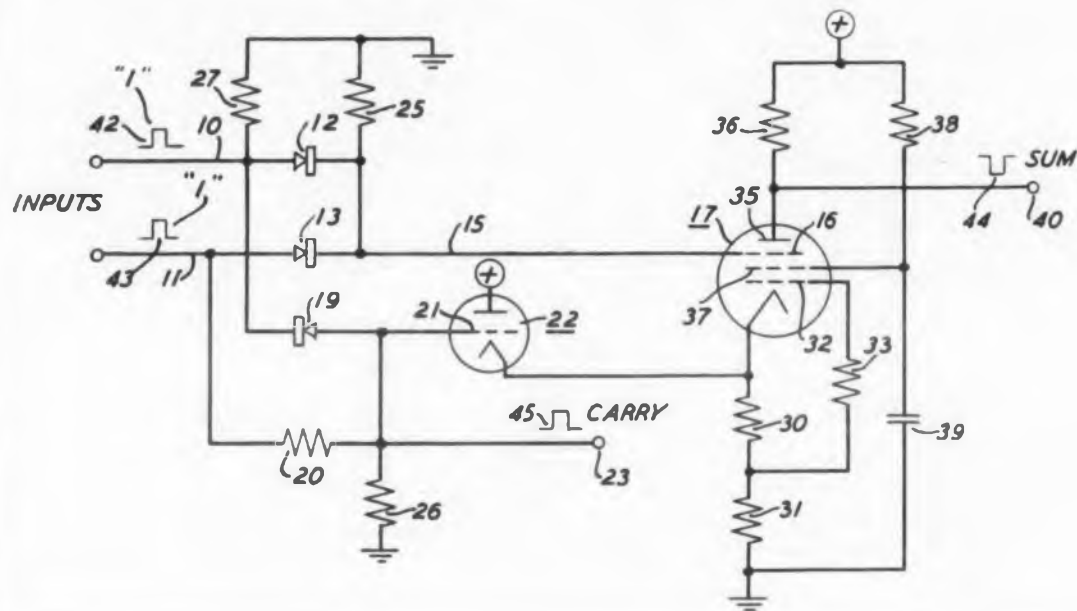
Patent No. 2,901,602. Elmer L. Younker.
(Assigned to Bell Telephone Labs, Inc.)

The logical circuit produces two outputs—a "sum" when the inputs are applied separately and a "carry" when the pulses are applied simultaneously.

Initially pentode 17 is conducting on the screen with zero plate 35 current due to suppressor 16 cut off. A positive pulse applied to the suppressor causes the plate

to conduct the "sum" output. By contrast, if the positive pulses are applied simultaneously to the suppressor and the cathode, the suppressor-to-cathode voltage does not change and plate conduction is zero.

Note, however, that the simultaneous application of the positive pulses to inputs 10 and 11 causes diode 19 to cut off and a "carry" pulse is available at terminal 23.



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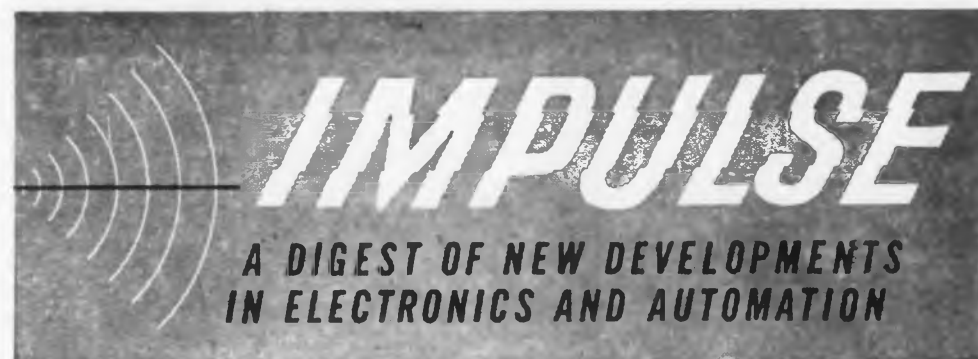
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A DIGEST OF NEW DEVELOPMENTS IN ELECTRONICS AND AUTOMATION

PUBLISHED BY ROME CABLE CORPORATION, ROME, N. Y.
PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

GLEAM IN ELECTRONIC EYE. There's more than one way to distinguish male from female, but the Army's newly developed ultra-sensitive radar system is certainly the most up to date! It's so sensitive it can spot even the slightest movement behind enemy lines—and distinguish between a walking man and woman! The blips provide the tip-off: a woman walks differently than a man and produces a different wave on the radar. This ground-to-ground system operates in fog or darkness, enabling the Army to detect moving targets at long range. Vehicles can be spotted 10 miles away and, in tests under ideal conditions, a walking soldier has been spotted 15 miles away.

WATCH OUT FOR THE MOHOLE! Watch for a new geophysical race between American and Soviet scientists: drilling through the earth's crust and the mantle around the earth's core. A variety of electronic instrumentation will be used in the drilling of a "Mohole"—so named because the boundary between crust and core mantle is called the Mohrovicic Discontinuity. American scientists propose to go down 18,000 feet below the ocean floor to measure a number of physical and chemical properties, including density, radioactivity, elasticity, magnetism, electrical properties, thermal gradient, porosity, permeability, and pressure. Existing instrumentation can be used if the hole is not smaller than 4 inches in diameter. Steps are being taken to develop a satisfactory low-frequency seismometer.

WHAT'S NEW IN INSTRUMENTATION CABLE? This 8-page illustrated bulletin discusses cable insulation and jacketing material and lists typical multi-conductor cable constructions available for use with telemetering equipment, data recording equipment, circuit control testing and electronic computers. Every design engineer working with electrical cable should have a copy. To obtain your free copy, write to IMPULSE, c/o Rome Cable Corporation, Dept. 1111, Rome, New York.

REAL-LIFE FLYING SAUCERS. Plans have already been made for saucer-like platforms to be stationed miles above the earth, powered by microwave energy beamed from the earth to the sky. A new scientific breakthrough—the development of a high-frequency, high-power microwave tube—makes this project feasible. Ergo, a previous engineering vice becomes a virtue: in communications, generated heat must be kept to a minimum; on the platform, the more heat generated, the more propulsion power is made available. It may not be long before there will be no question as to the authenticity of reported "flying saucers."

CABLEMAN'S CORNER. An important phase in multi-conductor cable manufacture is the manner and equipment used to "cable," or "twist," the various components together. The end use of the cable becomes an important factor in the assembly of a cable. Where flexibility is important, the length of lay, direction of lay, and the internal components all play important roles. Where connector fittings are employed, the sequential arrangement of the components may be important. Because of differing machine capabilities, even the selection of the specific piece of equipment for assembling your cable becomes important. To obtain the best results, consult a cable specialist—a man familiar with all the aspects of cable manufacture—your Rome Cable salesman.

These news items represent a digest of information found in many of the publications and periodicals of the electronics industry or related industries. They appear in brief here for easy and concentrated reading. Further information on each can be found in the original source material. Sources will be forwarded on request.

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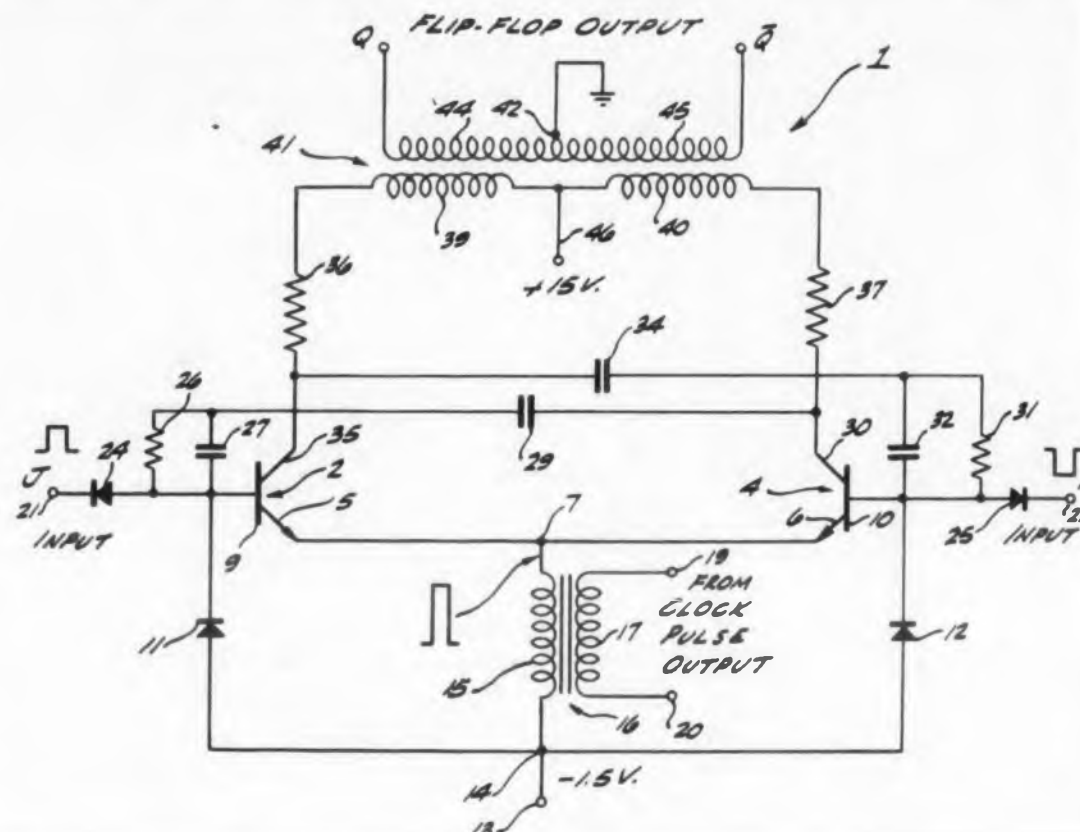
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PATENTS

Clock Pulse Circuit For Transistor Flip-Flop

Patent No. 2,898,479. Melvin R. Elroy.
(Assigned to Hughes Aircraft Co.)

An improved transistor flip-flop circuit reduces the required clock pulse power and allows the application of relatively inexpensive components; 50 flip-flops re-



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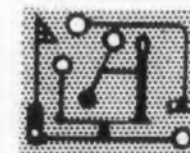
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quire only about 200 ma of clock triggering current. An npn transistor flip-flop obeys the illustrated truth table as the clock pulses shift the common emitter voltage from -1.5 v to 0.5 v.

Assume, as shown, that the J input is at $+1$ v and the K input is held at -1 v; transistor 4 conducts while transistor 2 is cut off. Now, let the clock pulse shift the common emitter (terminal 7) potential to $+0.5$ v.

Transistor 2 remains cut off but the emitter 6-base 10 voltage is sufficient to cut off transistor 4. A pulse couples back through capacitor 34 to flip transistor 2 to conduction. It is obvious that when both J and K inputs are simultaneously at $+1$ v, the flip-flop will be insensitive to the clock pulses and no change will occur.

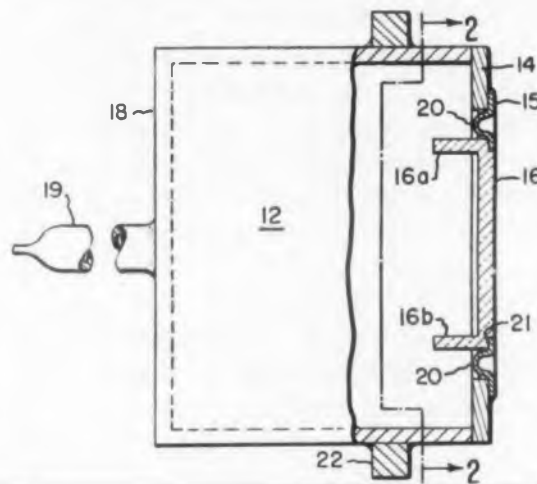
J	K	Q	\bar{Q}
$+1V$	$+1V$	NO CHANGE	NO CHANGE
$-1V$	$+1V$	T	F
$+1V$	$-1V$	F	T
$-1V$	$-1V$	CHANGES STATE	CHANGES STATE

Microwave Switching Device

Patent No. 2,900,568. Dudley N. Brewster. (Assigned to Sylvania Electric Products, Inc.)

A high-power discharge in a resonant TR device ordinarily causes sputtered metal to deposit on the iris or window. This tends to short-circuit the window, detune the cavity or make the window opaque to microwave transmission.

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BOOKS

Foundations for Bioelectronics for Human Engineering

A. Ford, U. S. Navy Electronics Laboratory, San Diego, California NEL Report 761, OTS Publication, PB 151291, Distributed by U. S. Dept. of Commerce, Office of Technical Services, 119 pp, \$2.75

Bioelectronics represents a union of electronics with physiology and psychology, for the purpose of measuring the electrical changes associated with the bodily functions of human beings. At its present stage, bioelectronics does offer great promise in human engineering. Dr. A. M. Small, Sr., formerly Head of the Human Factors Division, U. S. Navy Electronics Laboratory, saw the possibility of applying bioelectronics to several NEL problems. Dr. Small also saw that, with-

out a survey, it would be impossible to know whether the new projects would overlap work being done elsewhere, and it might even be impossible to emphasize the safe bioelectrical techniques and avoid the unsafe ones. He therefore assigned the writer of this book the task of making a survey of 614 studies covered in the book. These 614 were selected from almost 800 studies by eliminating those which were obviously only slightly significant.

The presentation takes the form of an annotated description of work cited by author, title, and location. To secure complete data on work elsewhere, every form of research communication, informal as well as formal, has been considered and is listed herein. The papers include



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unpublished doctoral and masters dissertations and, in some cases, even informal mimeographed notes of a research worker sent to his colleagues in other places. Sometimes the citation is that of a progress report on a military contract, or the abstract of a proposed paper to be read before a scientific meeting.

The information has been collected by reading original reports, insofar as possible, which has been facilitated by correspondence with the authors and directors of bioelectronic research in other places. Many of these men provided copies of hard-to-get reports and memoranda not listed in any library. In a few instances it has been necessary to use abstracts of work written by other reviewers, but usually only in minor citations.

Source Book of the New Plastics

Herbert R. Simonds, Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y., 362 pp, \$10.00

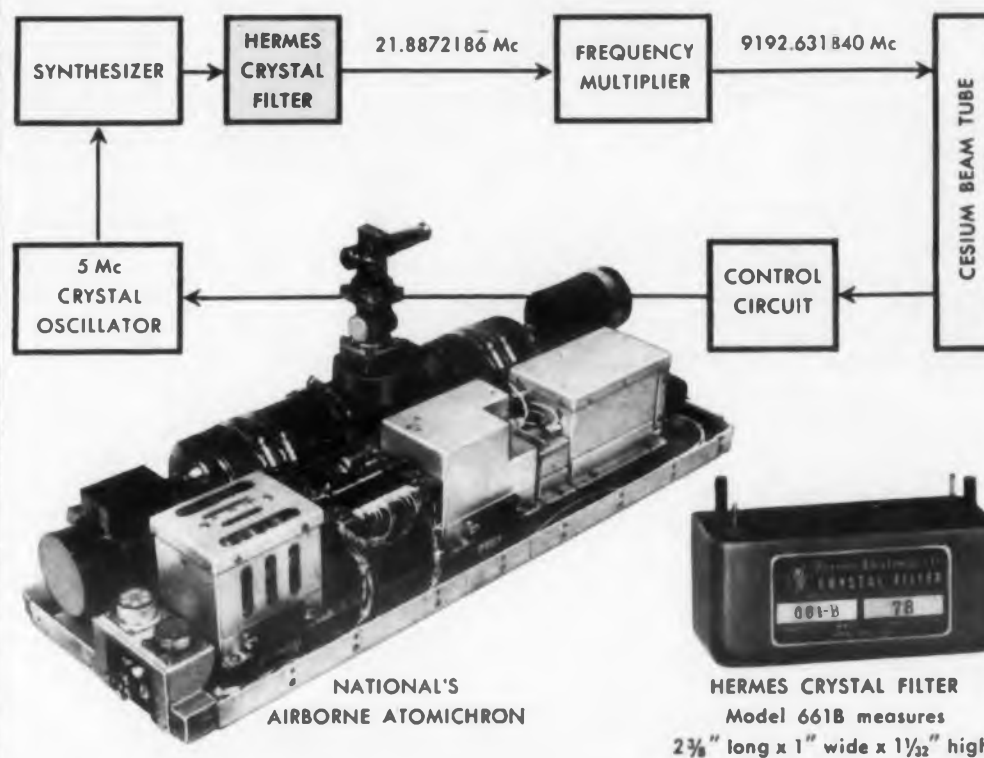
Included here are the new plastics,

their properties, production, price, applications and selection. Sixty plastics producing companies contribute articles describing their own materials. These materials include the seven new primary plastics of 1958.

The book also describes the significant recent improvements in established plastics, and the 100 most important patents issued in the plastics field for 1958. An "Introduction to Polypropylene" explains Professor Natta's work and the earlier German development of stereospecific catalysts. The book also gives complete information about polypropylene and polycarbonate. A section on graft copolymers describes the use of that technique in modifying plastics properties.

This book is a unique approach to plastics that concerns itself almost exclusively with latest developments. It contains the first and only survey of federal-sponsored research in plastics, and was made by James Kanegis of the Department of Commerce. It continues the practical presentation begun in the author's famous "Concise Guide to Plastics."

FIRST Airborne Atomic Frequency Standard Uses HERMES CRYSTAL FILTER



The National Company's Atomichron is the world's most accurate and stable instrument of its kind. It compares the precise unvarying resonance of the cesium atom which occurs at exactly 9192.631840 Mc with the output of a Crystal Oscillator. One of the critical problems in the development of the Atomichron was the elimination of spurious responses which occurred while generating the cesium frequency by a complex synthesis technique. The use of a Hermes Crystal Filter, Model 661B, between the Synthesizer and the Multiplier (see block diagram above) removed all spurious responses and allowed exactly 21.8872186 Mc to pass to the Multiplier.

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BOOKS

Video Speed Servicing

Samuel L. Marshall, Howard W. Sams & Co. Inc., and the Bobbs-Merrill Co. Inc., Indianapolis, Ind., 160 pp, \$2.95

This book contains a compilation of the troubles and repair procedures in specific TV receivers. It includes common breakdowns, troubles that cause unusual symptoms, and circuit changes that provide improved performance. Background material has been obtained directly from the manufacturers, from field service engineers, and from highly-skilled technicians. The book pinpoints the faults and describes in simplified detail the symptoms and the necessary repairs—the primary objective being the saving of your valuable time in diagnosing the trouble and making the repair.

The servicing information is presented in a straightforward and easy-to-follow manner. Accompanying each item is a simplified diagram of the section affected, to help the service technician identify and locate the defective component. A

complete index of receiver chassis and models is provided, and a logical method of identifying and classifying receiver troubles is used.

Relays

Collection of Papers given at the Seventh National Conference on Electro-Magnetic Relays, 1959, reprinted by Potter & Brumfield, Division of American Machine & Foundry Co., Princeton, Ind., 134 pp.

Thirty-three papers are reprinted in this book. The subjects covered fall into these categories: contacts, environments, general design, operating characteristics, specifications, testing, and testing equipment. Most of the papers discuss topics that interest designers of relays. But there are papers covering areas that would also interest relay users. These areas include how to specify relays realistically, factors that affect the selection of contacts, relays vs. semiconductors as switching devices, understanding relay pull-in, and effects of shunting circuits on relay operation.



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ELECTRONIC DESIGN • November 11, 1959

Recorder Survey: Recording Surfaces and Marking Methods

George Keinath, U. S. Government Printing Office, Washington 25, D.C., 41 pp. 30¢

This publication surveys and compares the characteristics of continuous traces, dotted traces, and printed characters produced by inking, incision, impression, indentation, deposition, heat, light, electric discharge, electron beam, magnetism, chemical action, or fluid streamlines. Descriptive and reference materials are included on three physical components of the recording system—the reservoir of material or energy, the marking point or matrix positioned by the measuring element, and the chart surface which preserves the record. Recorders are used for many purposes, but most frequently to supervise industrial processes and to carry out mechanical, electrical, and chemical testing of materials and products.

This survey was undertaken to bring together available information on the various methods and problems of recording scientific and technical data. The sur-

vey covers some of the physical principles either currently or potentially available for recording variable measurands in laboratory experimentation or industrial production.

Many recording principles have found practical application in commercially available recorders, and both illustrations and performance information have therefore been drawn largely from manufacturers' literature. Information obtained from commercial sources has been carefully reviewed, but no test program was carried out to verify performance claims. The omission of any method or device does not imply that it is considered unsuitable or unsatisfactory. Conversely, inclusion of descriptive material on any proprietary instrument, product or process does not constitute endorsement.

This first volume deals with marking methods and recording surfaces. Work under way in the reviewing of recorder actuating mechanisms, special recording problems, and data presentation may result in the issuance of a later report on these aspects of recording systems and marking methods.

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Multichannel Electron Multipliers

L. I. Andreeva B. M. Stepanov

ATTEMPTS to obtain higher pulsed currents from electron multipliers by "forcing" the power supply to the output stages date back some time.^{1,2} Coaxial photocells³ and electron multipliers with coaxial collectors⁴ have yielded pulsed output currents of several amperes with a time resolution of up to 2×10^{-9} second.

Unlike these single-channel systems, the multichannel electron multipliers described here yield pulse outputs of up to seven amps, with a time resolution of up to 2.5×10^{-9} sec and a gain of 10^8 to 10^9 . They can have from two to eight channels operating in parallel into one coaxial collector.

Fig. 1 shows a four-channel electron-optical system based on this principle. Each channel has a ten-stage electron multiplier with trough-like emitters. The collector is a short segment of 75 ohm coaxial line with slots in the outer conductor to permit passage of the electrons to the inner conductor.

The electron optics of the input to the

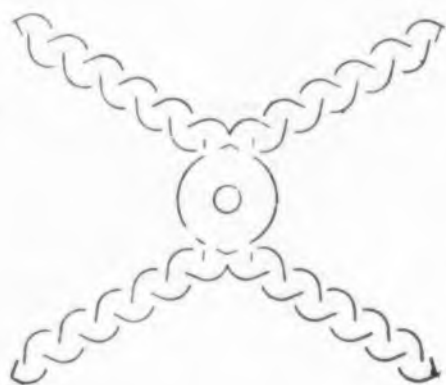


Fig. 1. (right) A four-channel electron-optical electron multiplier.

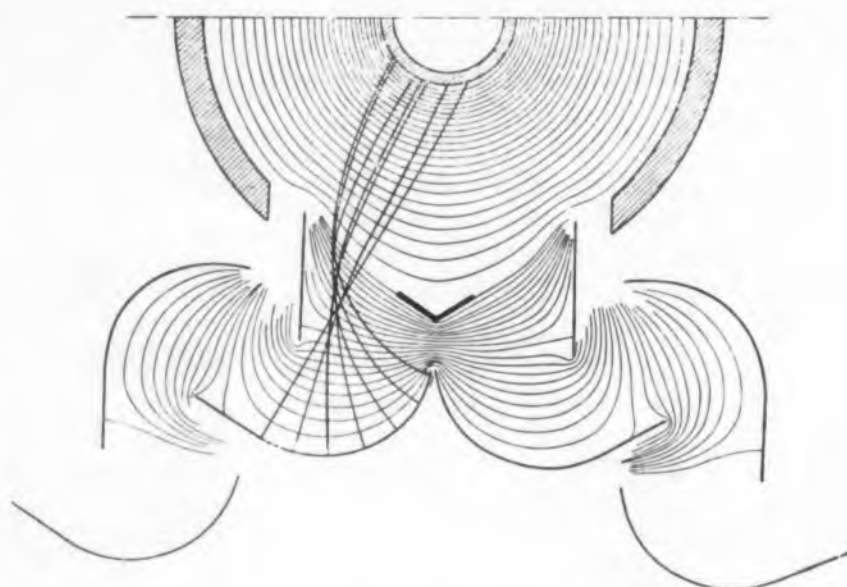


Fig. 2. The electron optics of the 75-ohm coaxial line which serves as the collector for the electron multiplier of Fig. 1.

coaxial collector is illustrated in Fig. 2, and again in Fig. 4.

Fig. 2 shows that this coaxial-collector construction provides good shielding between the collector field and the fields of the output emitters. This construction makes it possible to exclude the influence

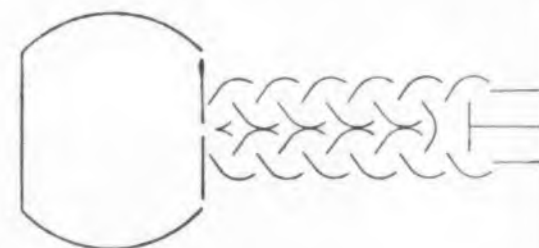


Fig. 3. A two-channel electron multiplier in which the collector is used in the form of a capacitor operating directly into a coax line.

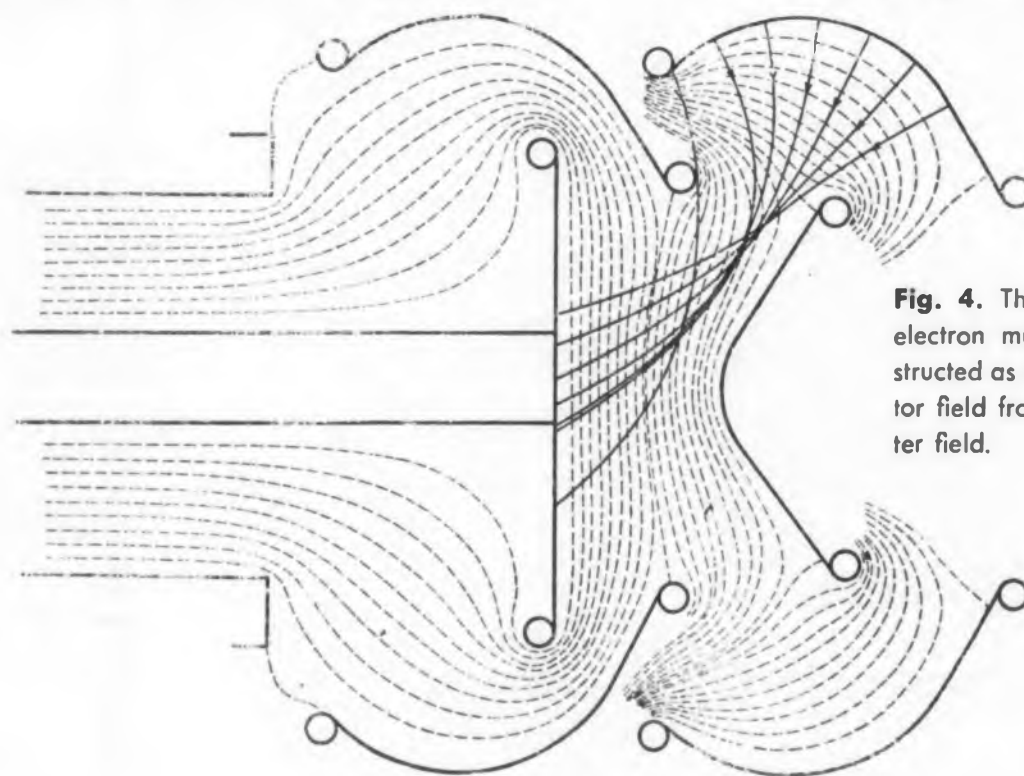


Fig. 4. The collector in this electron multiplier is so constructed as to shield the collector field from the output emitter field.

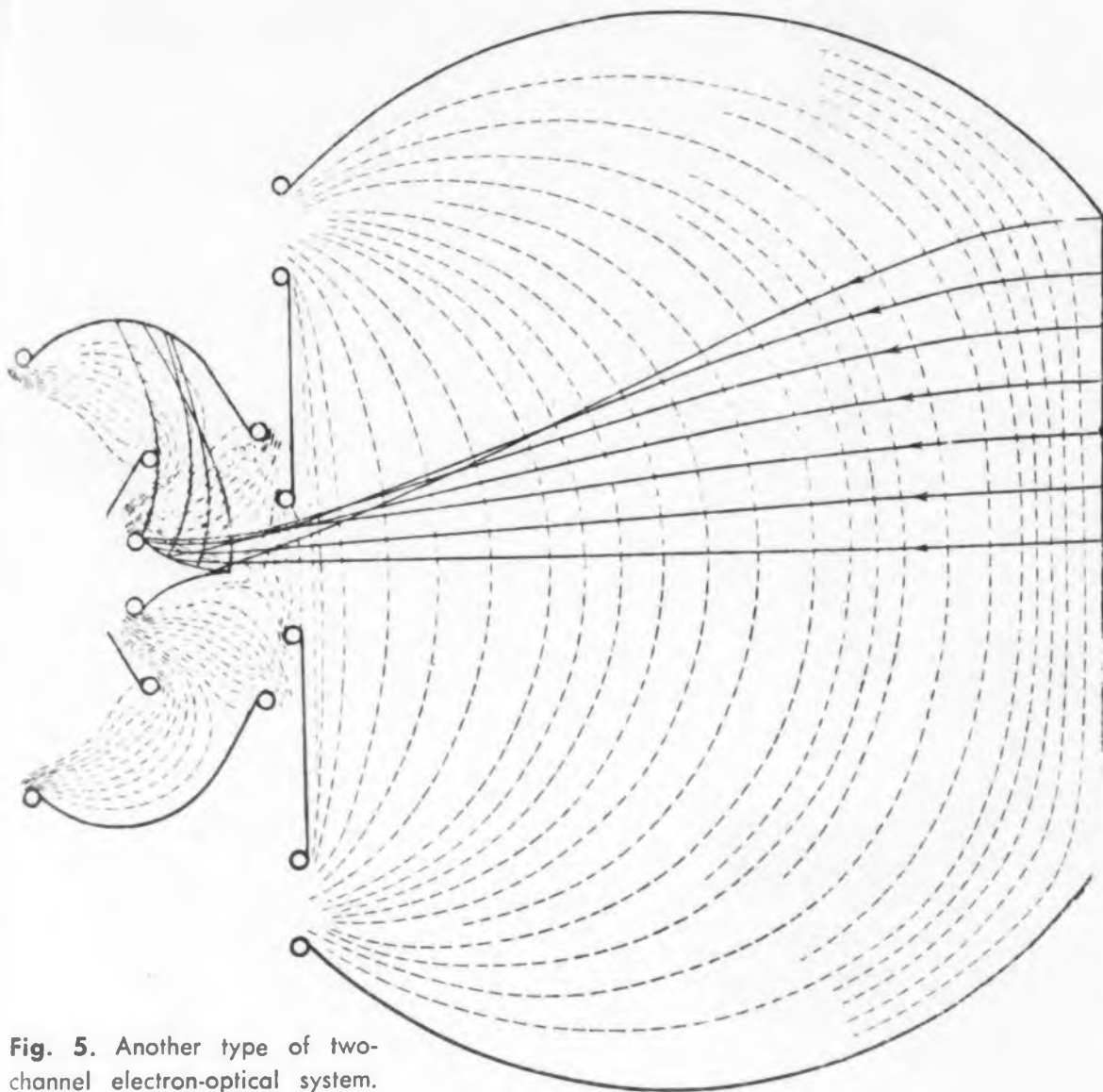


Fig. 5. Another type of two-channel electron-optical system.

on the electron-optical properties of the output emitters of the change in collector voltage during the instant of the current pulse.

Fig. 3 shows a two-channel electron multiplier in which the collector forms a capacitor that operates directly into the coaxial line. In this case too, the collector is so constructed as to shield the collector field from the output-emitter fields. This aspect is shown more clearly in Fig. 4.

In all systems, the output terminal of the coaxial collector is a coaxial metal-glass seal, permitting broadband transition to an ordinary 75 ohm coaxial cable through a special coaxial plug. The entire collector cable system has a flat frequency characteristic up to 10^9 cps.

The fact that several parallel channels feed a common collector makes it possible to use large emitter surfaces and still keep the entire device relatively small.

To permit registration of X-rays, a copper-beryllium cathode is used. This cathode, only 20 mm thick, has a quan-

tum yield from 2.5×10^{-3} to 1.5×10^{-3} electrons/quantum for X-rays of energies from 0.5 to 1.3 Mev. One of the variants of the cathode electron-optical system, with two channels, is shown in Fig. 5.

The insulating material used for the electron-optical systems of multichannel electron multipliers is synthetic mica. It has good vacuum properties and is easily machined. Before assembly, the synthetic mica should be degassed in vacuum at 450 C. ■ ■

This article was translated from the Russian journal Radio Engineering and Electronics of July 1959.

References

1. R. F. Post and N. S. Schiren, *Physical Review*, 1950, Vol. 78, pp 80, 81.
2. A. Lunly, *Physical Review*, 1950, Vol. 80, p 477.
3. W. C. Hall, B. M. Norton, J. W. Keller, and S. H. Liebson, *Nucleonics*, 1953, Vol. 11, No. 1, p 49.
4. J. D. Shipmen, M. R. McCraven, *IRE Transactions Nuclear Science*, 1956, Vol. S-3, No. 1, p 10.



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GERMAN ABSTRACTS

E. Brenner

Frequency

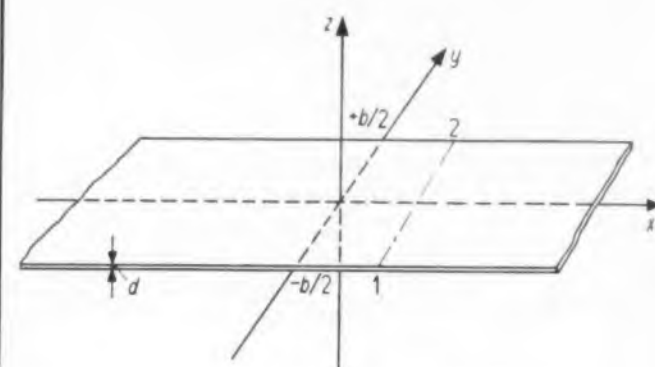
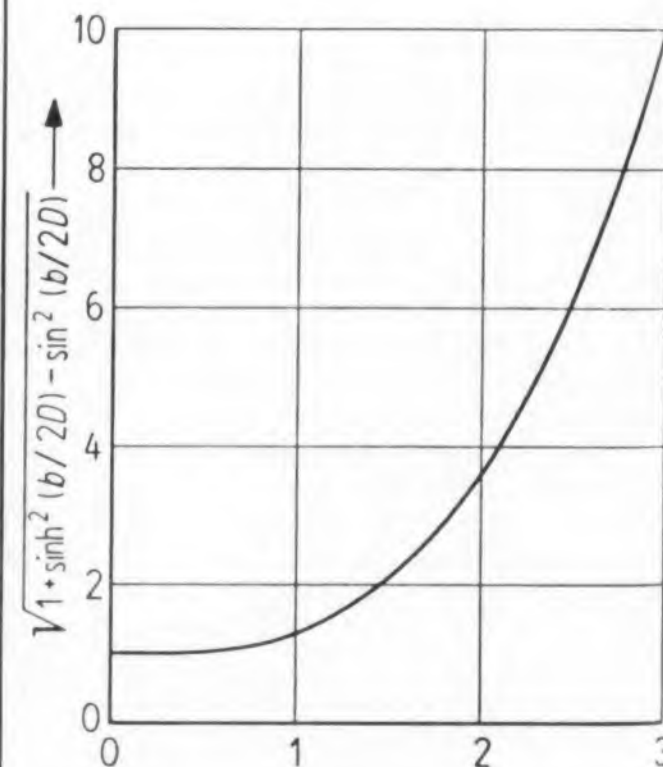


Fig. 1. Semiconductor plate in a coordinate system.



Frequency Dependence

IF IT IS assumed, for an infinite semiconductor plate with geometry as shown in Fig. 1, that the magnetic field has only a z -component which does not vary with z then the Hall voltage amplitude, V_h , increases with frequency over its dc value V_o according to the equation

$$\frac{V_h}{V_o} = (1 + \sinh^2 a - \sin^2 a)^{\frac{1}{2}} \quad (1)$$

where $a = b/2D$, $D = 1/(\pi\mu_0 \delta f)^{\frac{1}{2}}$ (1)

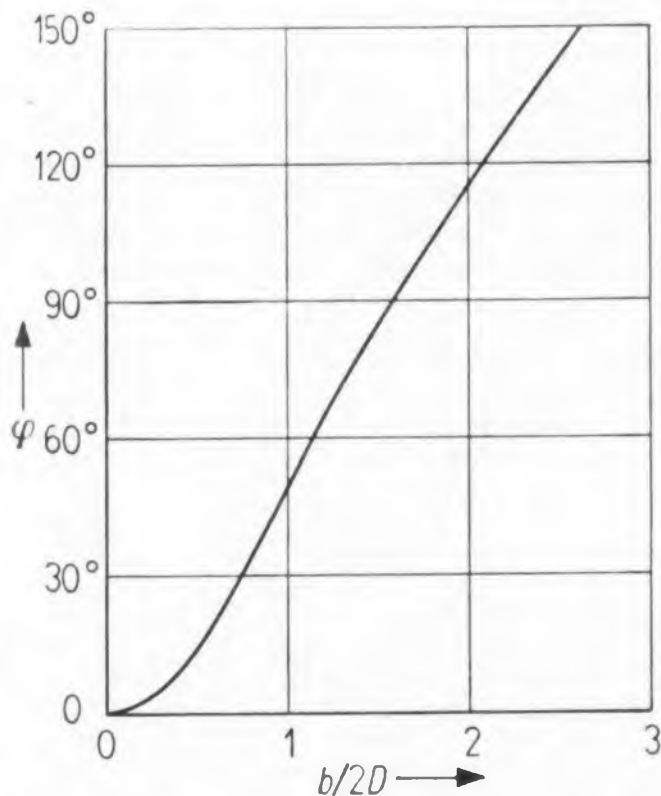


Fig. 2. Dependence of Hall voltage on the ratio $b/2D$ (i.e. with square root of frequency) (a) Amplitude (left). (b) Phase.

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GERMAN ABSTRACTS

In addition, the Hall voltage leads the impressed magnetic field by the phase angle given by

$$\psi = \tanh a \tan a \quad (2)$$

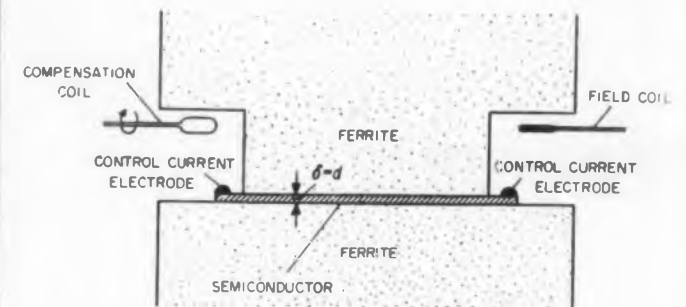
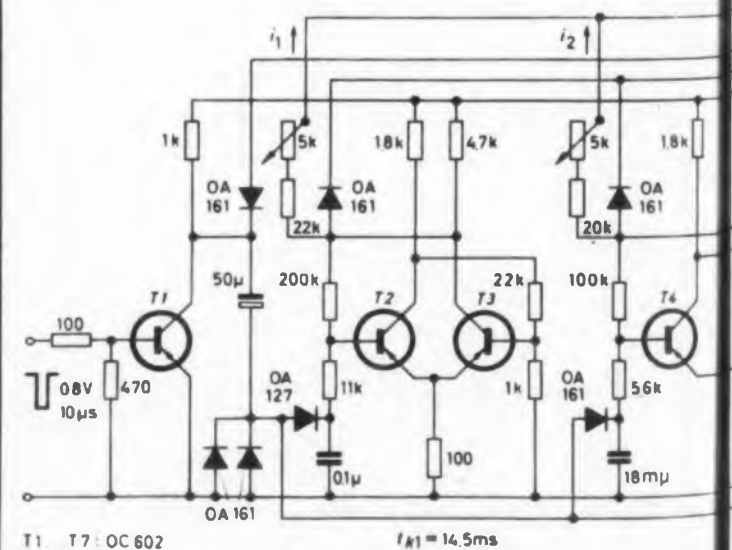


Fig. 3. Hall generator embedded in ferrite.

Quasilogarithmic

A CIRCUIT which employs seven transistors, Fig. 1, has been developed for unambiguous quasilogarithmic pulse indication of pulse repetition rates up to 7 kc. The circuit consists of a cascade of three multivibrators whose mean output voltage approximates the logarithm of the pulse count but which has ambiguity when the time between pulses exceeds the relaxation time of the



Circuit of the quasilogarithmic pulse indicator.

sed

(2)

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Eqs. 1 and 2 are illustrated in Fig. 2.

In order to realize the assumptions regarding the space distribution of the magnetic field, it is necessary to embed the semiconductor plate in a material with high permeability, e.g. a ferrite, as shown in Fig. 3. The remaining airgap must be small compared to d . If this condition is not fulfilled, the calculated frequency dependence of the Hall voltage does not occur and a substantially frequency-independent amplitude is observed.

A detailed description of the experimental procedure and results, as well as a discussion of eddy current losses and their relation to control power, is included in the original paper.

Abstracted from an article by F. Kuhrt, H.-J. Lippmann and K. Wiehl, *Archiv der Elektrischen Uebertragung*, Vol. 13, No. 8, Aug. 1959, pp 341-347.

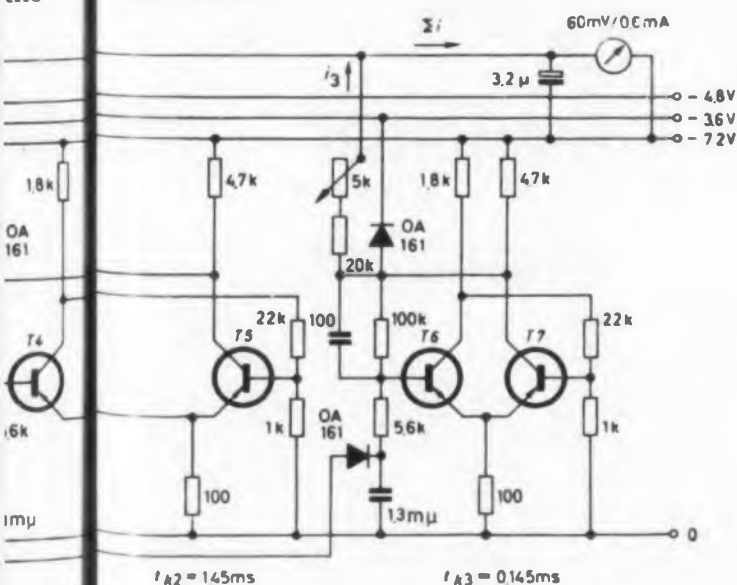
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An analysis of errors in the new circuit shows that the indication differences between statistical and equal pulse distribution gives less than one per cent error at pulse repetition rates of 700 cps.

Abstracted from an article by T. Friese, *Elektronische Rundschau*, Vol. 13, No. 8, August 1959, pp 283-285.



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2 Model 600A, 54 ranges

This portable instrument is a battery-operated counterpart of the 610A. Its ranges cover 10 mv to 10 volts, 3 amperes to 10^{-13} ampere, and 10^4 to 10^{13} ohms full scale. Like the 610A, it has selectable input resistance, a dc to 100 cps bandwidth, and output sufficient to drive recorders directly. Battery life is 500 hours; condition may be checked on the panel meter.

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GERMAN ABSTRACTS

Cross-Modulation Frequency

BOTH ANALYTICAL and experimental investigation of the behavior of high-frequency transistor circuits show that such circuits are generally more sensitive to cross-modulation than comparable electron tube circuits. For this reason,

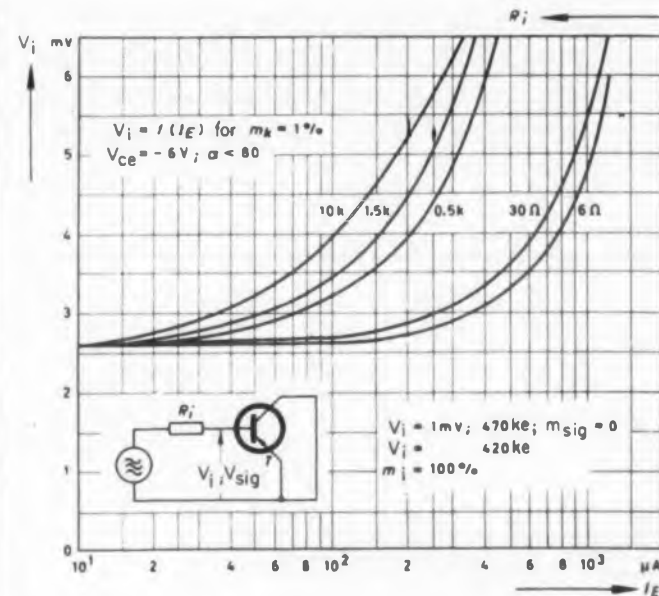


Fig. 1. Influence of source output impedance R_i on the effective value of interfering voltage to produce one percent cross-modulation.

An Organic Nonlinear Dielectric

LANESTEROL is an organic substance whose dielectric constant exhibits a marked dependence on field strength. Using a metallized, Lanesterol impregnated paper capacitor in a bridge at 800 C, it is found that the momentary super-position of a dc potential results in a momentary decrease of capacitance. The original

High Frequency Transistors

special transistor circuits in which cross-modulation is minimized must be developed.

The cross-modulation factor K is defined as

$$K = 3 \frac{cm_i}{am_a} V_i^2$$

where m_i is the amplitude modulation index of the interfering signal, V_i is its amplitude, m_a is the modulation index of the signal proper and the parameters a and c are defined from the assumed input voltage-output current equation

$$i = I_0 + av + bv^2 + cv^3 + \dots$$

For unmodulated signals, the cross modulation index m_k is defined as

$$m_k = 3 \frac{c}{a} m_i V_i^2$$

For very small emitter current, the effective interfering voltage which produced one per cent cross modulation corresponds to about 0.1 v ($V_T = kT/e$) when the interfering signal is 100 per cent modulated. With increasing emitter current, the effective value of V_i needed for $m_k =$ one per cent increases, as shown in Fig. 1, at a rate depending on source resistance.

Abstracted from an article by H. Lotsch, Elektronische Rundschau, Vol. 13, No. 8, August 1958, pp 290-294.

capacitance value is restored after removal of the dc component.

The dependence of dielectric constant on field strength has the form

$$\frac{\Delta \epsilon}{\epsilon} = -aE^b$$

where, for the impregnated paper, a typical value of b is 1.90.

Unfortunately (from the point of view of capacitor applications) the superposition of long time constant voltages results in time- and temperature-dependent decreases in capacitance which persist after discharge.

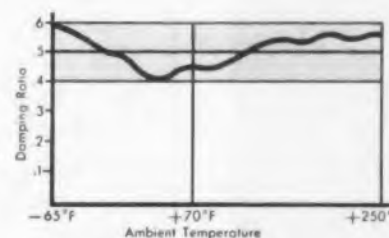
Detailed experimental results are cited in the original paper.

Abstracted from an article by G. Helwig Zeitschrift fuer Angewandte Physik, Vol. 11, No. 7, July 1959, pp 255-259.



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$+250^{\circ}\text{F}$. The gyro spin motor, requiring only 15 seconds run-up time, will operate on one (split), two, or three phase power, and is isolated from ground.


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Type M-100 is specifically designed for autopilot damping, radar antenna stabilization, and fire control applications. Its small size, high performance, and ruggedness suit it particularly for advanced military aircraft and guided missile applications. Write for Bulletin M-100 to Minneapolis-Honeywell, Boston Division, 40 Life Street, Boston 35, Mass.

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- Threshold-Resolution: Less than 0.01 degrees/sec.
- Damping: 0.4 to 0.6 from -65°F to $+250^{\circ}\text{F}$
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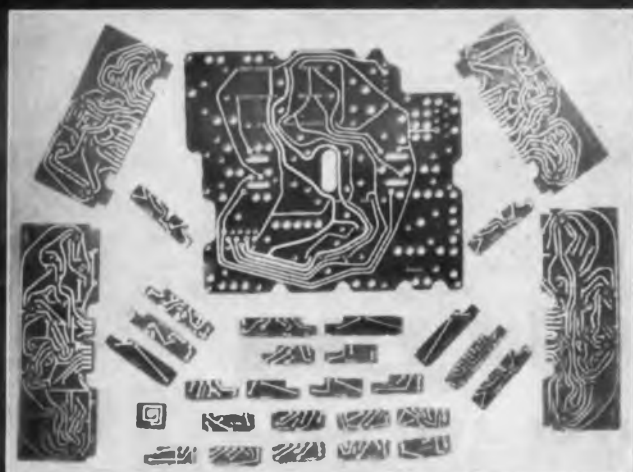
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ELECTRONIC DESIGN DIGEST

Tunnel Diode Oscillator Works At 3010 Mc, Uses Lumped Parameter Design

THE USE of the negative-resistance diode, also called the Esaki or tunnel diode, in very high frequency oscillator circuits using wave guides and cavities as tuned elements has met with difficulties as a result of so-called parasitic oscillations that arise from having to drive the circuit from a very low impedance dc source. A different design approach, based on lumped-parameter principles, which is free from this type of biasing problem, is described here. It has produced oscillators that operate well into the microwave region (3000 mc) where it has not previously been thought profitable to use only lumped-parameter elements. (A more recent model has a fundamental frequency of oscillation of 4020 mc.)

The structure used in these oscillators (shown schematically in Fig. 1) consists of a highly doped *n*-type germanium wafer, about 2 mils thick, which is soldered to a 3-mil nickel mounting tab that serves as one electrode of the circuit. Two tin impurity dots, one doped with gallium, the other with arsenic, are alloyed to the *n*-type wafer in close proximity to each other. The SnGa dot forms a recrystallized *p* region which makes an abrupt junction with the heavily doped *n* material. This produces a negative resistance of the Esaki type when a forward bias in the region of 50 to 350 mv is applied. The SnAs dot forms an ohmic contact to the *n*-type wafer. If the resist-

ance between the SnAs dot and the mounting tab is smaller than the absolute value of the negative resistance of the Esaki diode, then the system oscillates at a very high frequency when a shorting bar, which acts as the second electrode of the circuit, is connected as shown. A biasing current

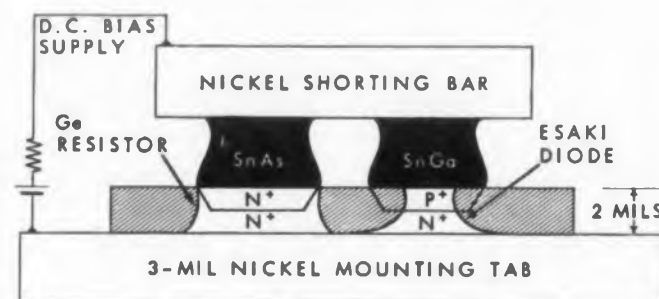


Fig. 1. Schematic cross section of the semiconductor microwave oscillator. Shaded area is heavily doped *n*-type germanium wafer.



Fig. 2. Simplified equivalent circuit of the microwave tunnel diode oscillator.



Fig. 3. Two views of the microwave oscillator mounted on conventional header.



then flows through the resistive part of the circuit of sufficient magnitude to produce a dc voltage across the tunnel diode, making it behave as a negative resistance.

The oscillator frequency is increased as the dimensions of the dots and their spacing decrease. The frequency of such an oscillator structure can be increased by etching away the shaded areas of the Ge wafer. This etching procedure has the effect of reducing the area of the tunnel diode junction, hence also its capacitance. Etching also isolates the bias resistance part of the circuit from the diode part and suggests the simplified equivalent lumped-parameter circuit of Fig. 2. Here the diode part of the circuit is represented by a negative resistance $-R_E$ shunted by a capacitance C_E . The bulk resistance of the diode is not explicitly represented in this simplification. The bias resistor, which is concentrated under the SnAs dot, is represented by R and the loop inductance of the circuit is represented by L . A necessary condition for oscillation is that:

$$R < |-R_E|$$

Experimentally, the frequency of a given oscillator increases as the diameter of the tunnel diode junction area is decreased. Table 1 shows the results of measurements for one oscillator.

The resistor portion of the germanium was covered with stop-off wave, and for each successive measurement shown in Table 1, the diode portion

Table 1. Frequency vs Tunnel Diode Junction Area

Frequency in Mc	Diameter of Esaki diode junction in mils
1490	3.5
1850	2.9
2240	2.4

was electrolytically etched in dilute KOH. This etching action concentrates the removal of germanium in the vicinity of the junction so that the junction capacitance is mainly affected while the loop inductance is essentially unchanged. This condition will not hold if the etching is continued to the point where the germanium becomes a very thin pedestal and contributes to the total loop inductance. Assuming that the junction is uniform over its area, and that area is proportional to the square of the measured diameter, then these results strongly suggest that for this oscillator, in the frequency range indicated, the frequency is very nearly inversely proportional to the square root of the junction capacitance.

Experiments show that the frequency generally decreases slightly as the forward dc bias is increased. For a typical oscillator operating at 2200 mc, the frequency decreased approximately 30 mc

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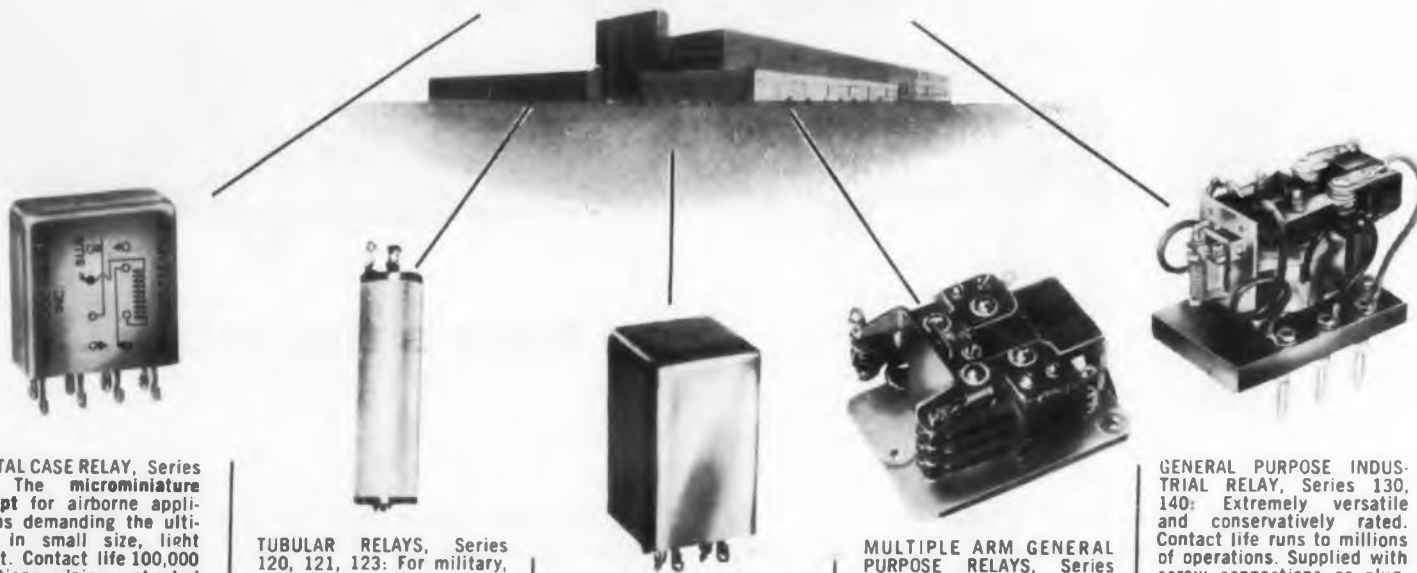
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DIGEST

as the voltage was increased by 30 mv. This decrease in frequency is consistent with increase in capacitance to be expected with increasing forward bias. But the change in negative resistance with bias, which is not accurately known for these units, can also have an effect. The range of forward bias voltage (normally about 0.1 v) over which the oscillations are sustained is so small, and the experimental error of measurement so large, that the exact functional relationship between frequency and bias cannot be easily deduced from measurements made thus far.

For convenience of making electrical connections to the oscillator structure, the units were mounted on conventional 3-pin circular transistor headers (Fig. 3). The dc bias was applied between the center pin which is soldered to the base of the header and one of the two outer pins which support the shorting bar. The frequency was essentially unaffected by the lengths and positions of the leads to the external dc bias supply—if the resistance in the supply loop is high compared to the resistance of the germanium resistor in the oscillator structure. Since these resistors have typical values of about 50 milliohms, the power supply impedance will be sufficiently high if it is one ohm, a condition easily achieved in practice.

The frequency is measured by placing a small length of wire, which serves as a pick-up antenna, near the oscillator and mixing the pick-up signal with that of a known oscillator, then detecting the difference frequency on a General Radio if amplifier and detector. The use of this type of loose coupling prevents the generation of spurious signals produced by interactions of the strong local oscillator signal with the nonlinearities of the Esaki diode structure, which otherwise makes the determination of the true fundamental frequency difficult.

Other methods of detecting the oscillations have included strongly coupling the output into a coaxial line that is directly connected to a receiving system. The lack of influence of the power supply



Fig. 4. Photomicrograph of the oscillator. The tunnel diode is the thin pedestal on the right. The narrowest dimension is about 1 mil.

wires on frequency may be attributed to the fact that the header leads are of much greater inductance than the loop inductance of the oscillator structure itself, and hence they act as rf chokes. The dimensions of the critical portions of the oscillator are small compared to the wavelength of the oscillations even at S-band frequencies.

Fig. 4 is a photomicrograph of an oscillator which oscillated at a fundamental frequency of 3010 mc. The significant features shown correspond to those in the schematic cross-section of Fig. 1, the tunnel diode portion being the right pedestal and the germanium resistor the thicker pedestal on the left. The $p-n$ junction is almost coincident with the bottom edge of the tin dot, and its diameter in this unit is about 1 mil. The capacitance per unit area for $p-n$ junctions formed by the same alloying techniques on the same n -type crystal wafer used in constructing the oscillator units has been found to be $3 \mu\text{f}$ per cm^2 , so that the capacitance for this diode is about $20 \mu\text{f}$. To produce resonance at 3000 mc would require an inductance of $0.15 \mu\text{h}$, a value reasonable to expect for the loop inductance of the oscillator structure. An estimate of the peak current of the tunnel diode $p-n$ junction, based on measurements of the peak current per unit area of units similarly fabricated, is about 10 ma. Considering that the negative resistance region is thus limited to a few milliamperes of current and 100 mv of voltage, the rf power output of this oscillator is, at most, a few tens of microwatts. It is believed, however, that improved fabrication techniques will allow higher powers in future models. The arsenic concentration in the n -type crystal was measured to be 1.4×10^{19} atoms per cc.

Abstracted from an article by R. F. Rutz in the "IBM Journal," October, 1959.

Switching Circuits: Measuring Recovery Time

A SEMICONDUCTOR diode, when switched from forward current conduction to a reverse bias condition, will briefly allow an appreciable amount of current to pass in the reverse direction (shown in Fig. 1). The phenomena of "charge storage"—more specifically, "minority carrier storage"—causes this effect.

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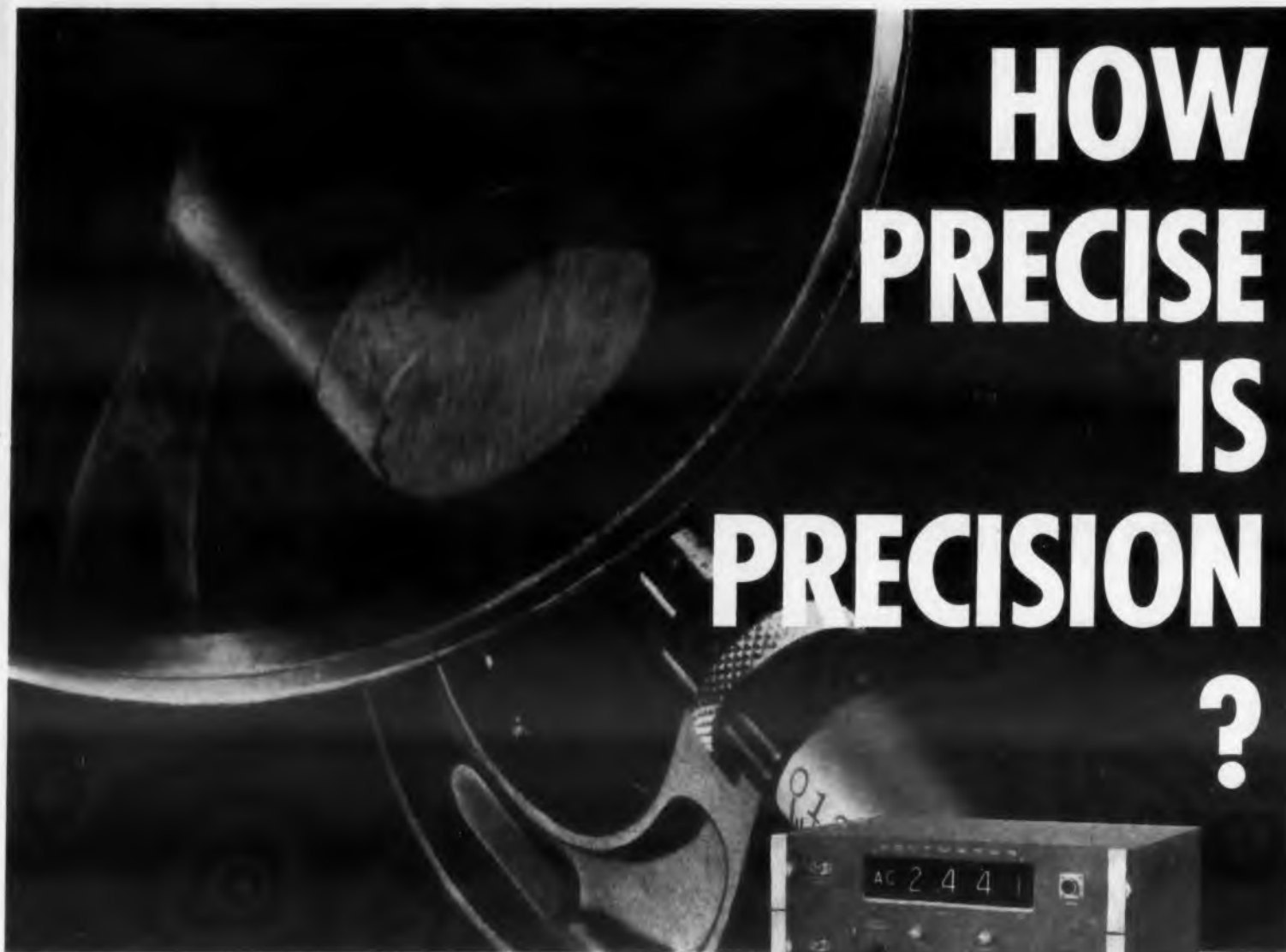
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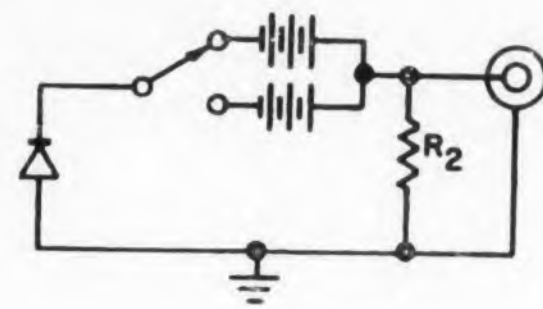
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DIGEST



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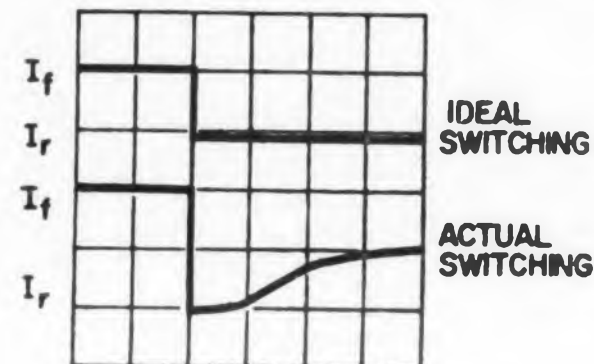


Fig. 1. Basic switching circuit.

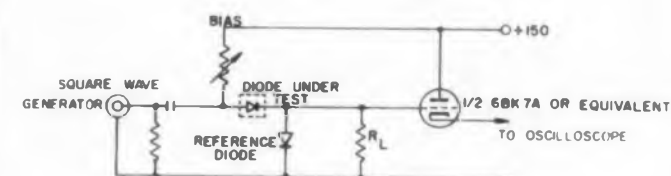
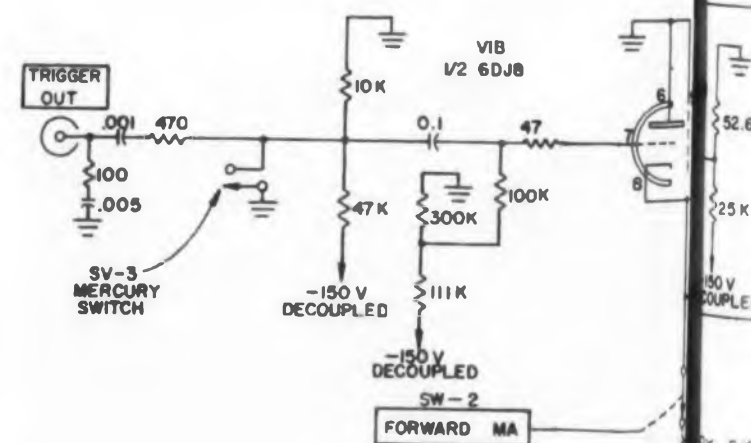


Fig. 2. The JAN-256 Test Circuit.

ticular diode in a given switching circuit. Some of them are described and illustrated here.

A simplified schematic of an early standard test circuit, the JAN-256, is shown in Fig. 2. In this circuit, forward bias is supplied by the +150 v plate supply. The diode is switched off by the external square wave generator. And the time required for the initial diode reverse current to decay



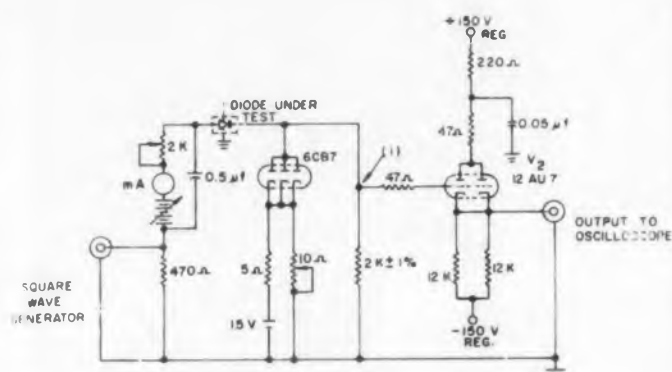


Fig. 3. The standard circuit proposed by the Electronic Industries Association.

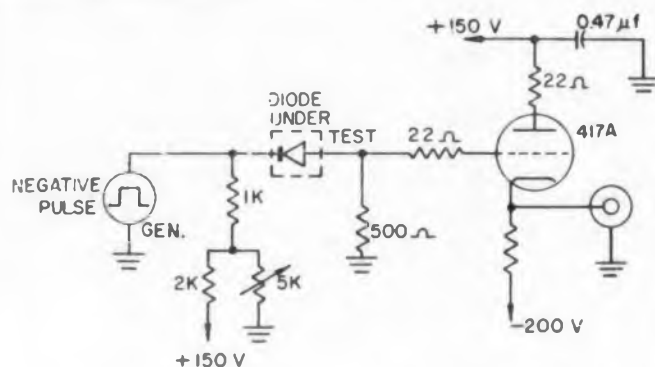


Fig. 4. The modified Bureau of Standards circuit.

to the specified value is measured by observing the voltage drop across R_L . Since it is usually necessary to measure the time required for the diode to reach a high reverse impedance (small reverse current), it is necessary that R_L be relatively large. To allow reasonable supply voltages, and prevent over driving the oscilloscope input stages during the

(Continued on p. 202)



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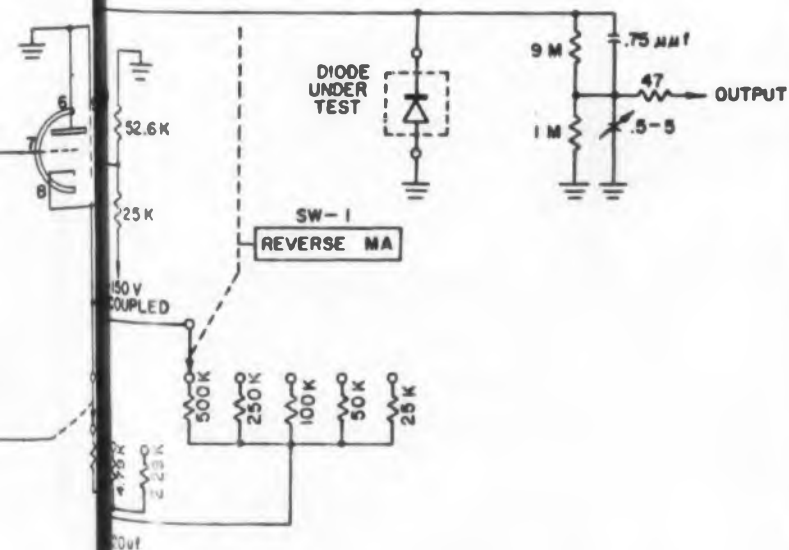
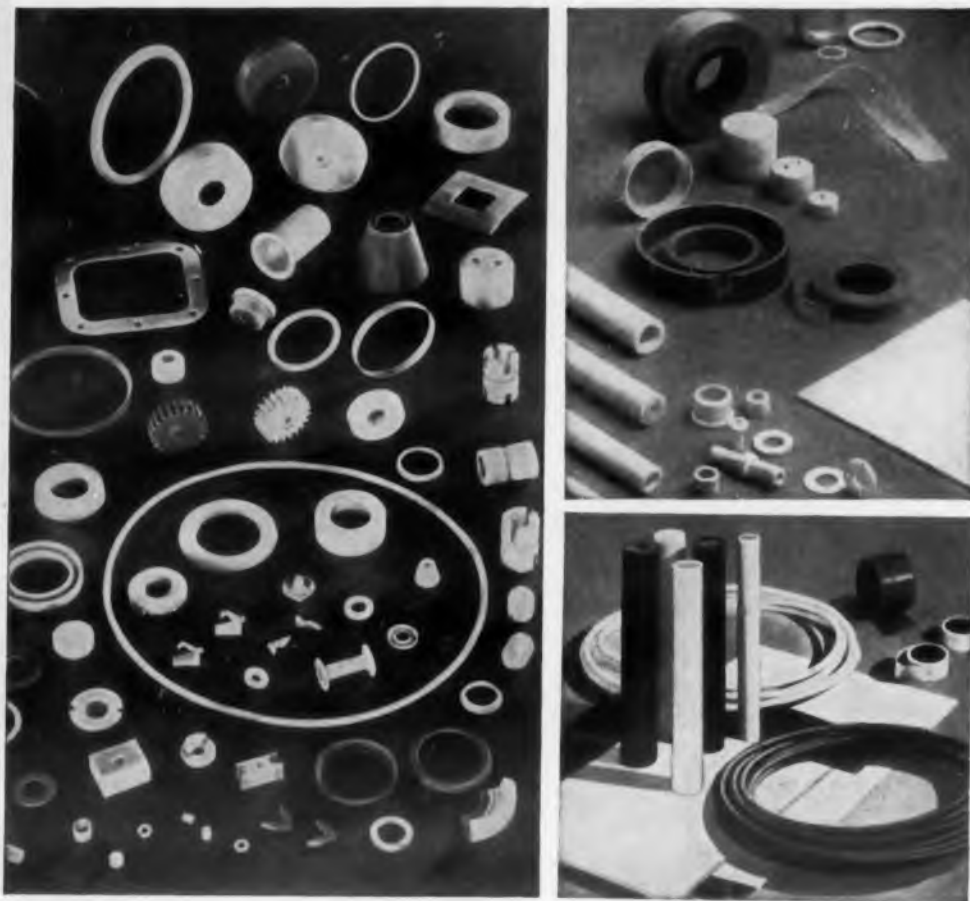


Fig. 5. Tektronix plug-in test circuit.



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DIGEST

forward current pulse, a "reference diode" is placed across R_L to clamp the drop across R_L to a low value.

Since the JAN-256 circuit uses a semiconductor clamp, there is some question about the circuit's accuracy. An alternative circuit is that described in EIA SP590 as Method I (Fig. 3). Up to the point marked (1), this is the old IBM "Y" circuit. The cathode follower has been added because of difficulties found in trying to correlate readings made by different users and manufacturers. For example, minor differences in the length of the cable connecting the tester to the oscilloscope caused significant differences in recovery time measurements.

The Most "Accurate" Tester

Probably the most "accurate" recovery time tester is the Bureau of Standards circuit, which has been modified (Pacific Semiconductors, Inc.) as shown in a simplified schematic (Fig. 4). This circuit avoids the problems associated with the use of clamping diodes by reversing the diode so that the forward pulse drives the triode into cut-off. There are, unfortunately, other problems with this circuit.

The most serious criticism of the circuit arrangements already described is that the diodes are tested under *very specific* conditions of forward bias, reverse bias and load resistance. Figs. 4 and 5 show two attempts to devise circuits that will measure a property of the diode, independent of the external circuit parameters. Fig. 5 shows the Tektronix circuit. It allows measurement of the charge stored in the diode as a function of the forward current. This quantity, coulombs per ma, appears,

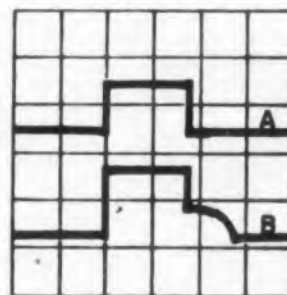
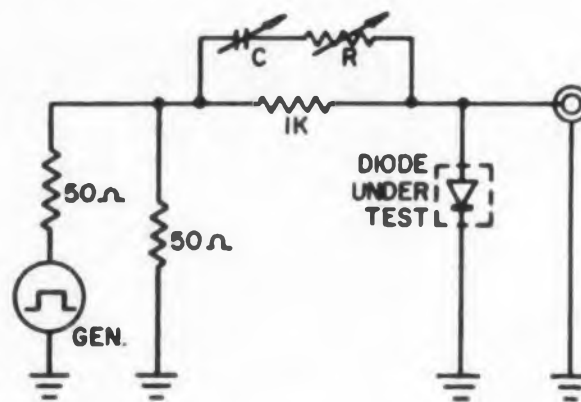


Fig. 6. Stromberg-Carlson test circuit.



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under certain circumstances, to be a "constant" for a particular diode, allowing fairly good prediction of diode performance in almost any circuit. The circuit in Fig. 6 (Stromberg-Carlson) shows a bridge type measurement of this quantity. Here R and C are adjusted until the output (B) appears like the input (A). The values of R and C then give a measure of the equivalent capacity and series resistance of the diode.

The circuit in Fig. 7 is an example of the complications that arise when attempting to measure

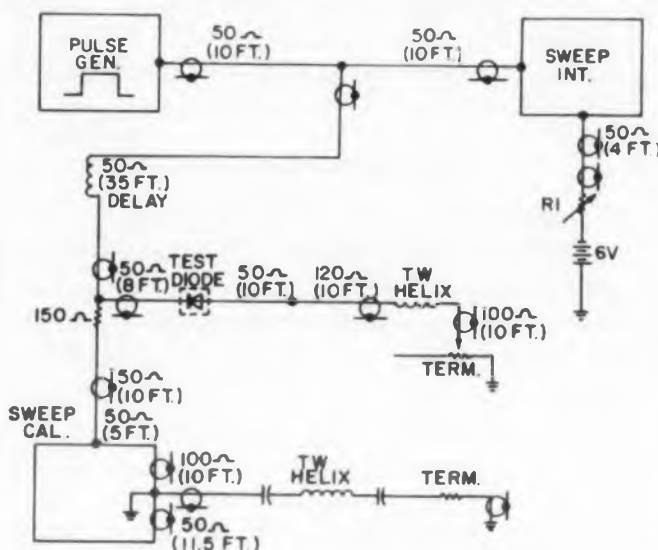


Fig. 7. Edgerton, Germeshausen and Grier test circuit.

the characteristics of some of the newer "milli-microsecond diodes." Since the forward currents used in testing these diodes are usually small, clamping is not necessary. Stray capacitances and bandwidth consideration are important.

Abstracted from an article by W. Macdonald in *Semiconductor Product Application News*, September-October, 1959, published by Hoffman Electronics Corp., Semiconductor Div.

How To Specify Relays Realistically

A REALISTIC re-evaluation of his relay application may allow the designer to use existing relays with subsequent cost-saving and often immediate delivery. Points to keep in mind during re-evaluation are:

Vibration

The vibration resistance of a relay is most important in its effect on size, weight and cost. The average magnetic relay has a fundamental resonant frequency in the range of 200 to 500 cps. Vibration specifications below 200 cycles tend to minimize cost and facilitate delivery. Vibration



Heli-Coil® Screw-Lock Inserts* lock screws against impact and vibration and permanently protect critical tapped holes in this transducer assembly.

Critical Electronic Controls Get Internal-Locking, Protective Threads

with

HELI-COIL

Screw-Lock Inserts



Principle of Heli-Coil Screw-LOCK Insert. Locking center coil grips internally, holds screw firmly

Electronic control devices for aircraft and missiles, like this angle of attack vane transducer made by U. S. SCIENCE CORPORATION, LOS ANGELES, CALIF., have to withstand severe vibration, impact, corrosion and temperature change. They must be made of light materials and still have strong threads — able to hold fasteners tightly and stand frequent assembly and disassembly.

U. S. SCIENCE insures rock-solid screw assemblies by protecting vital tapped holes with one-piece internal-locking Heli-Coil Screw-LOCK Inserts. These precision formed, stainless steel wire inserts eliminate thread wear, lock screws securely — without resort to clumsy, external lock nuts and lock wiring.

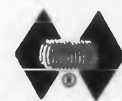
Simple Installation Procedure

U. S. SCIENCE finds it easy to install Heli-Coil Screw-LOCK Inserts. Drilled holes are tapped with a Heli-Coil tap and the Inserts wound in with a prewinder inserting tool. Conventional screws are used in assembling the unit.

Heli-Coil Screw-LOCK Inserts

- positively lock fasteners against loosening under impact and vibration
- prevent thread wear, stripping, corrosion, galling and seizing
- eliminate lock nuts, lock wiring, other supplementary locking devices
- permit repeated disassembly and reassembly
- can be used in standard proportion bosses without need for redesign
- save assembly time, space, weight and cost
- meet government specs for locking torque and vibration

*Patented



HELI-COIL CORPORATION
DANBURY, CONNECTICUT

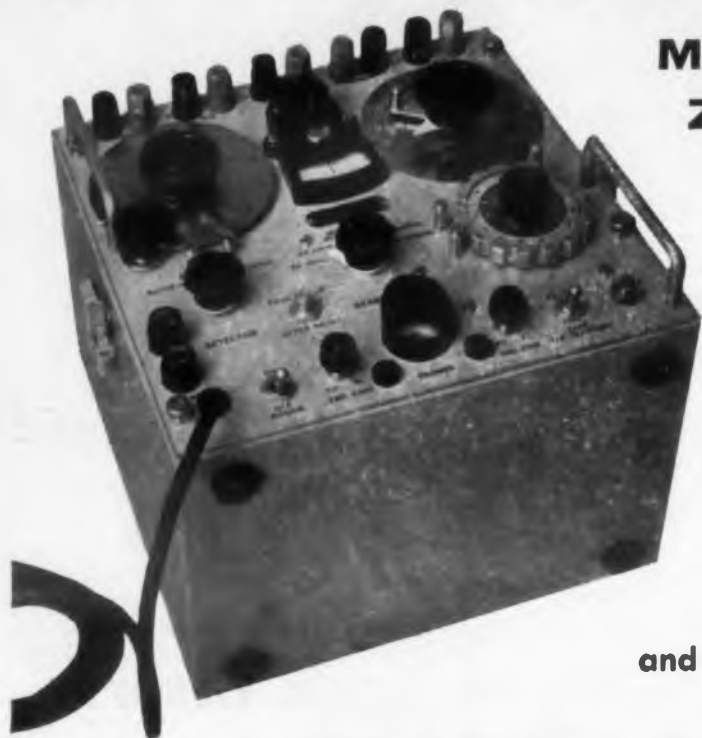
HELI-COIL CORPORATION, 407 Shelter Rock Lane, Danbury, Connecticut
Send complete design data on Heli-Coil Screw-LOCK Inserts

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MODEL
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Resistance

★ Inductance
and Storage
Factor

★ Capacitance
and Dissipation Factor

The Model ZB-1 provides for measurement of AC and DC resistance, inductance and storage factor, capacitance and dissipation factor. It is a laboratory instrument in accuracy, range and versatility in addition to being compact, portable and ruggedly constructed. It meets all the requirements of the Military Impedance Bridge Model AN/URM-90.

SPECIFICATIONS

RANGE:

RESISTANCE	0.001 ohm to 11 megohms A-C or D-C (8 ranges)
CAPACITANCE	1 uuf to 1100 uuf (7 ranges)
INDUCTANCE	1 uh to 1100 h (7 ranges)
D	0.001 to 1.0 at 1 KC } Provision for external extension
Q	0.02 to 1000 at 1 KC }

ACCURACY

RESISTANCE	0.1 ohm range	±0.35%	INDUCTANCE	100 uh and below	±2 uh
	100 K ohm range	±0.2%		10 h and above	±10%
	All other	±0.15%		All other	±1%
CAPACITANCE	100 uuf and below	±2 uuf	D FACTOR		±(5%+0.0025)
	100 uuf range (above	±2%	Q FACTOR	to 10 hy	±(5%+0.0025)
	100 uuf)	±0.5%		at 100 hy	±(5%+0.015)
	All other	±0.5%		at 1000 hy	±(5%+0.055)

INTERNAL OSCILLATOR FREQUENCY.....	1 KC ±1%
INTERNAL D-C SUPPLY.....	{ 10 V at 250 ma. (D-C Low) 200 V at 10 ma. (D-C High)
INTERNAL DETECTOR	Response flat or selective at 1 KC; sensitivity control provided.
POWER LINE	115 volts, 50-1000 cycles, 18 watts.
DIMENSIONS	10 1/4" x 11 1/4" x 11 1/4" overall with cover.
WEIGHT	21 lbs.
ACCESSORIES SUPPLIED	Set of red and black test leads (19" long) with 2 alligator clips.

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Industrial Instruments:

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DIGEST

resistance at the resonant frequency and above presents a design problem. Relays meeting these vibration categories can and are being produced today but at slower rates and higher costs.

Basically, the vibration resistance of a relay may be increased by either decreasing the mass or strengthening the component parts. Decreasing the mass results in smaller and lighter units which are more difficult to produce. Strengthening the parts introduces a weight penalty. The approach to this dilemma is to recognize the existence of these resonances and investigate the need for vibration resistance at these frequencies.

Shock And Acceleration

Specifications sometimes call for shock and acceleration requirements in which the g level is far greater than 20 or 30 g. A relay which will withstand 20 g of vibration will withstand the same order of magnitude for acceleration and usually three or four times this g value for shock. Serious consideration should be given to determine the necessity of meeting extreme g values. If these high values are satisfied, there is a possibility that other environmental features will suffer. Realistic requirements will result in minimum weight and size.

Size

Small size and producibility do not go hand in hand. The smaller the relay, the more difficult it becomes to manufacture on a mass production basis. Inquiries for size reduction of the "crystal can" size relay have been received and turned down for one reason: the required practical optical instruments necessary to produce these smaller units on a production basis are not available.

Life

The following hypothetical case illustrates an extreme condition frequently occurring among relay users: Circuit designer A requires a relay capable of performing 50,000 switching operations maximum for a particular application. He requests components engineer B to write a specification for this relay allowing a safety factor of 100% for a total of 100,000 operations. Purchasing agent C receives the subsequent specification and is advised to procure the relay with a "little safety factor," say 100%. Relay manufacturer D receives an inquiry about the availability of this relay and discovers that his standard in-stock item, type X, with a selling price of Y dollars, would meet all requirements except for life which is rated for 50,000 operations (probably with the usual 100% safety factor). Therefore, the relay would "have to be redesigned." Purchasing agent C then is advised that the relay he wants can be made but at

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Kearfott's unique approach to electrohydraulic feedback amplification design has resulted in a high-performance miniature servo valve with just two moving parts. Ideally suited to missile, aircraft and industrial applications, these anti-clogging, 2-stage, 4-way selector valves provide high frequency response and proved reliability even with highly contaminated fluids and under conditions of extreme temperature.

TYPICAL CHARACTERISTICS

Quiescent Flow 0.15 gpm
Hysteresis ... 3% of rated current
Frequency Response
3 db @ 100 cps
Supply pressure.....500 to 3000 psi
Temperature-Fluid & Ambient
- 65° F to +275° F
Flow Rate Range 3 to 10 gpm
Weight 10.5 ounces

Write for complete data.

Kearfott

A
**GENERAL
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COMPANY**

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.
A subsidiary of General Precision Equipment Corporation
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West Coast Office: 253 N. Vinado Avenue, Pasadena, Calif.

CIRCLE 606 ON READER-SERVICE CARD
ELECTRONIC DESIGN • November 11, 1959

a cost of 2Y dollars with an allowance of six to eight weeks for tooling.

Contact Rating

The contact rating of a relay is also a measure of its relative cost and size. Realistic contact requirements will prevent the relay designer from using special contact materials which will perform substantially above the actual requirement—but will result in a costlier item. The larger the contact load, the larger will be the contact size. It is advantageous to limit contact rating to a reasonably safe limit since large contact masses cause a consequent penalty in shock and vibration resistance.

Contact Bounce

Increasingly more relay specifications dictate a contact bounce limit in terms of maximum allowable total bounce. The thought behind this is: keeping the bounce time as low as possible will increase the longevity of the relay contacts. In the majority of relay applications, the bounce time of a relay will not adversely affect its control function.

Contact Arrangement

Many users will procure all 4-pole relays to be used in either 1, 2, 3 or 4-pole applications. This encourages mass production. The program, however, is sometimes defeated when the manufacturer is asked to decrease the weight of the entire 4-pole line, when a 1 or 2-pole type would have solved the user's weight problem. Specify only the required number of contacts.

Temperature Limits

Many manufacturers are producing Class A relays using materials which are completely satisfactory for Class B temperatures. In many cases, the only Class B requirement which these Class A relays do not meet is: minimum attract voltage at maximum temperature. To minimize costs, determine if the requirements for low voltage operation and maximum temperature exist simultaneously.

Relay Coil Power

The size and cost of magnetic relays are dependent on allowable coil power. The operating ampere-turns are proportional to the power input and the size of the magnetic structure. For a given set of operating conditions, decreasing the size of the magnetic structure will increase the required coil power. Conversely, increasing the size of the magnetic structure will decrease the required coil power. Many relay users specify a value of allowable coil power which is less than that required for optimum performance. This leads to a "sensitive" relay adjustment. It means

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* The ASW use depicted here is typical.

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C.E.C. specializes in the design and production of Custom and Standard Delay Lines and Filters in varied configurations to meet MIL or Commercial Specs.

Electromagnetic Delay Lines: Lumped & Distributed Constant • Fixed • Multi-tapped • Mechanically Variable • Electrically Variable • System Delays

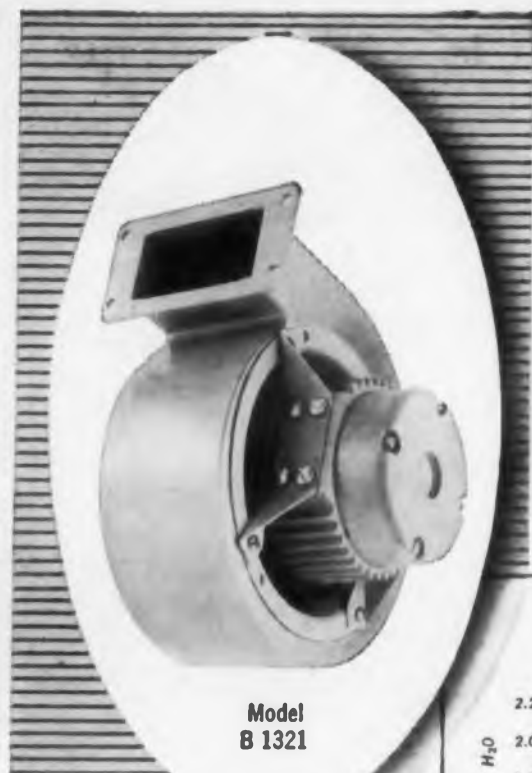
Magnetostrictive Delay Lines: Fixed • Multi-tapped • Variable
Standard Filters: High, Low and Band Pass, Inter-Stage
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NOTE:
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CONTROL ELECTRONICS CO., INC.
Ten Stepar Place, Huntington Station, New York

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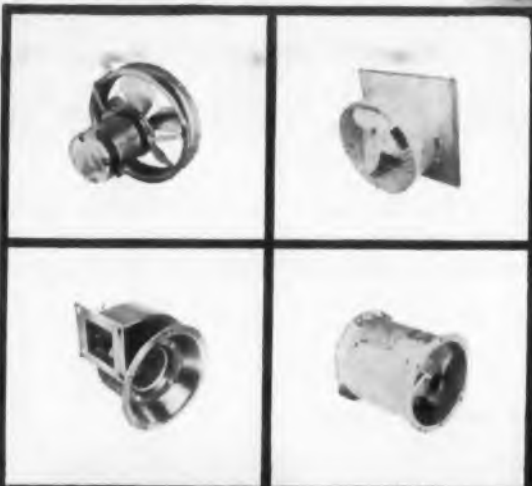
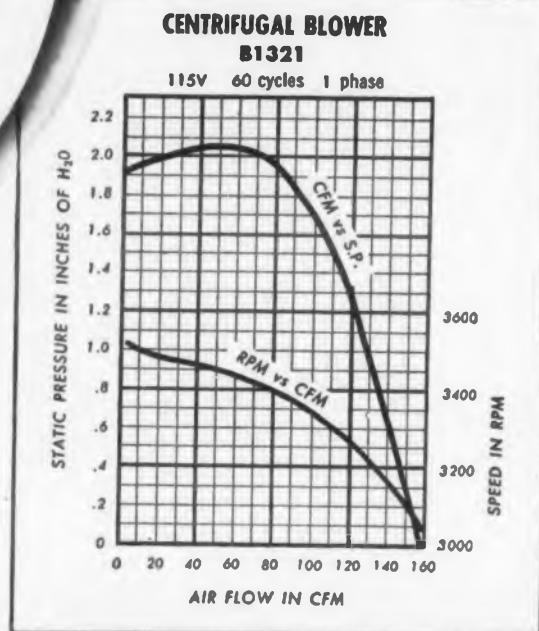


Model
B 1321

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158 CFM at 0" SP at 3000 RPM;
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DIGEST

decreasing contact pressure and contact gap to the point where the allowable power will just operate the relay. This is not recommended for long life and optimum performance. Stringent shock, vibration and acceleration specifications are not compatible with sensitive relay adjustments.

Ac vs Dc Coils

Pure ac coils are inefficient. More contacts can be actuated by a 5 w dc coil than by a 5 w pure ac coil. The use of pure ac introduces weight and size penalties. An ac unit has far less inherent shock vibration and acceleration resistance than its dc counterpart. Many close differential units and relays requiring specific attract and release values are impractical to produce for pure ac use. The efficiency of dc structures can be utilized for ac operation by the use of rectification networks. This results in all of the advantages of the dc relay with only a cost penalty for the rectification network.

Attract And Release Values

Where simple on-off operation is the basic requirement of a relay, the minimum operating value should be determined by the lowest voltage anticipated in the application. In a like manner, release values specified where differential operation is not required, increase the cost of manufacturing and may penalize the user from the standpoint of vibration, shock and acceleration resistance.

Dielectric

The dielectric specification of a relay is often much higher than actually required with a consequent penalty in size, weight, and cost. Specify a higher voltage rating than the open circuit condition to safeguard against high voltage surges, but be reasonable.

Leak Testing

The method of leak testing hermetically sealed relays should be seriously considered. Most relay specifications permit the use of either mass spectrometer testing or water testing for production inspection, and usually require both for qualification approval. The water test is the fastest and least costly of the two. A water test performed under a vacuum equivalent to 80,000 ft altitude is about equivalent in sensitivity to an allowable mass spectrometer leak rate of 1000×10^{-8} cc per sec. Thus a relay of the size of MS-25024-2, which could have an allowable leak rate of about $10,000 \times 10^{-8}$ cc per sec when tested per MIL-R-6106-C, could positively be detected by a water test.

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BASIC BUILDING BLOCKS FROM KEARFOTT



Data Logging

Kearfott's broad line of test equipment includes the Scanalog 200-Scan Alarm Logging System which monitors, logs and performs an alarm function of up to 200 separate temperature, pressure, liquid level or flow transmitters. This precise data handling system is equipped with manual controls for scanning rates, automatic or manual logging, data input relating to operator, time, day, run number and type of run. 200 numbered lights correspond to specific points being maintained and provide a visual "off normal" display for operator's warning. System can be expanded to 1024 points capacity and 2000 points per second scanning rate.

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CIRCLE 625 ON READER-SERVICE CARD

Finish

The finish specification of a sealed relay is often overlooked in cost-saving analysis. Extensive testing under extreme environmental conditions indicates that plating properly applied has the endurance of paint at substantially lesser cost.

Abstracted from a paper by John Schmidt, Jr. and W. Warren Wright of Guardian Electric Mfg. Co., delivered at the Seventh Symposium of Electro-Magnetic Relays and reprinted by Potter & Brumfield, Div. of American Machine & Foundry Co.

Three Tentative Definitions Given For Relay Contact Loading

How Dry Is Dry Circuit Area?

IN GENERAL terms, the Absolute Dry Circuit Area is that area of contact loading in which only mechanical forces (impact, pressure, wipe, abrasion, strain-hardening) can change the condition of the contact interfaces; there can be no thermal effects (softening, melting) or electrical effects (arc transfer, bridge transfer, loss of material). Thus the Absolute Dry Circuit Area shall be defined as that in which the open-circuit contact voltage does not, for an appreciable time, exceed the softening voltage for the contact material used.

For example, with the contact temperature at 0 C, the softening voltage for gold is 0.08 v, the lowest value among the practical contact materials, and for platinum it is 0.25 v, the highest value among the practical contact materials. Therefore, the Absolute Dry Circuit Area may be designated as that area in which the open-circuit contact voltage does not exceed 80 to 250 mv, for more than 1 μ sec when operated so as to maintain the bulk temperature of the contact at 0 C, the exact millivolt maximum limit depending on the contact material used. The softening voltage decreases as the contact bulk temperature increases, the softening voltage for gold being 0 mv at 100 C, and the softening voltage for platinum

Microwave Component News

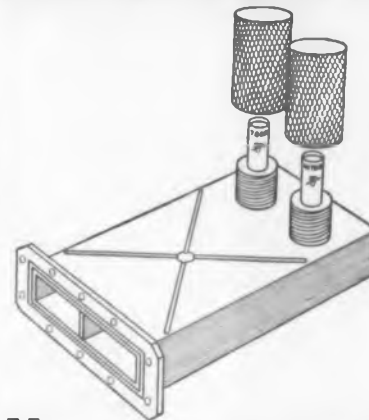


from SYLVANIA



Lowest receiver noise figure yet

via
new Ku Band Diodes



Now SYLVANIA has new Ku band silicon microwave diodes, types 1N78D and 1N78DR, with a 7.5 db maximum over-all noise figure* for mixer applications.

Extremely low noise figure for Ku band receivers is now possible with a new silicon microwave mixer diode developed by Sylvania, and available in both forward and reverse polarities. When the 1N78D and 1N78DR microwave diodes are used as a matched pair, they virtually eliminate excess noise due to the local oscillator, thus providing a receiver system with a realistic 7.5 db over-all noise figure at Ku band. The use of the matched pair also serves to effectively isolate the antenna and local oscillator terminals.

The new microwave diodes also feature a maximum operating temperature of 150°C as well as a complete hermetic seal for maximum protection under severe environmental conditions.

Contact your Sylvania representative now for complete information on these new low noise Ku band diodes or write the factory directly at the address below.

Write for your free copy of this completely new Sylvania Microwave Diode Characteristics and Replacement Guide.



*with IF amplifier NF equal to 1.5 db

BASIC SPECIFICATIONS OF NEW 1N78D AND 1N78DR DIODES*

Operating Temperature.....	150°C max.
NOISE FIGURE (CALC)	
N-LC (NIF+NR-1).....NF.....	7.5 db max.
where NIF-1.5 db	
CONVERSION LOSS.....LC.....	5.7 db max.
P-1.0mw, F-16,000 mc	
JAN-201 holder	
OUTPUT NOISE RATIO.....NR.....	1.3 times max.
P/1-0.5	
MADC (min), F-9375 mc	
JAN-105,202 holder	
IF Impedance.....Z _{IF}	400-565 ohms.
RF Impedance.....VSWR.....	1.5 max.
Moisture Resistance.....	All units are hermetically sealed and pass MIL-STD-202 Method 106 Moisture Test.

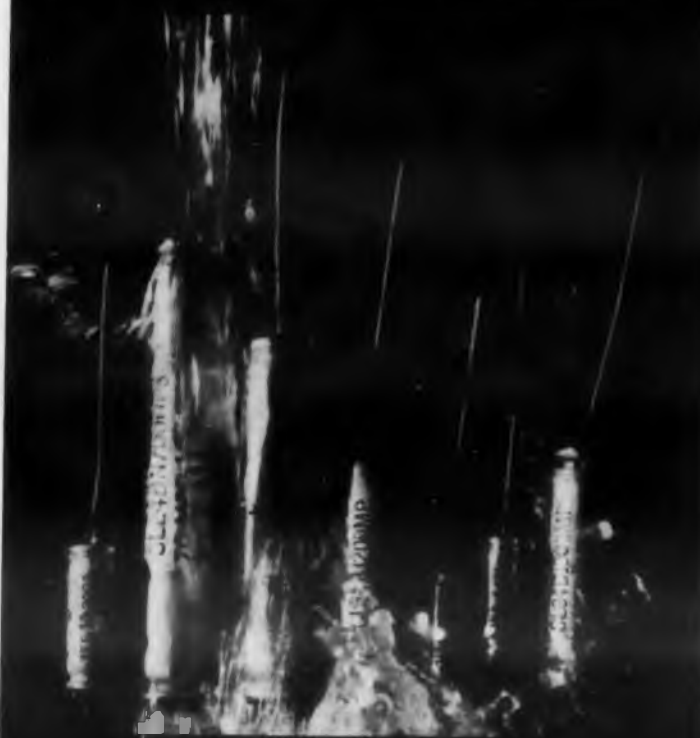
*available also in matched pairs (designated 1N78DM and 1N78DMR. Matching criteria are conversion loss within .3 db and IF impedance within 25 ohms of each other.

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Where Reliability Comes First
Tantalum Capacitors

DIGEST

being 200 mv at 140 C, 122 mv at 340 C, and 0 mv at 540 C.

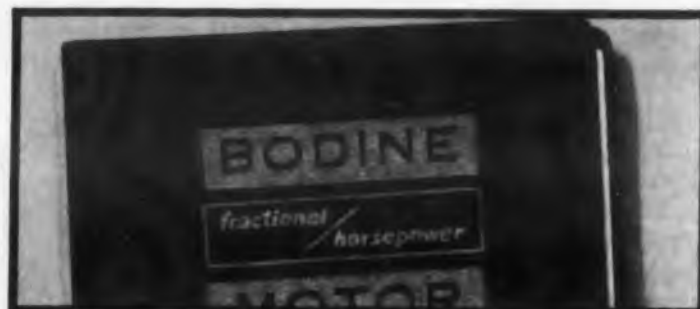
Intermediate Energy Level Area

In general terms, the Intermediate Energy Level Area (formerly called a fringe or gray area) is that area of contact loading in which mechanical, thermal, and electrical effects, except arcing, can change the condition of the contact interfaces. Thus, the Intermediate Energy Level Area, in which somewhat variable contact performance may result due to softening, melting and/or bridge transfer, shall be defined as that area of contact loading exceeding the softening voltage and less than the minimum arcing level for the contact material used.

For example, the intermediate energy level area for pure gold contacts would be the softening voltage (80 mv at 0 C) and the minimum arcing level (approximately 15 v peak maximum and/or 0.38 amp peak max when operated in normal atmosphere at room temperature with 90% humidity); similarly, the intermediate energy level area for pure platinum contacts would be between the softening voltage (250 mv at 0 C) and the minimum arcing level (approximately 17.5 v peak max and/or 0.9 amp peak max when operated in normal atmosphere at room temperature with 35 to 60 per cent humidity). For the common contact materials, the minimum arcing voltages range from 11 ± 5 v for silver-gold and silver-palladium contacts operated under normal atmospheric conditions to 21 ± 5 v for pure silver contacts operated in a dry hydrogen atmosphere and the minimum arcing currents range from 0.25 amp for silver-gold contacts to 0.9 amp for pure platinum contacts, both operated under normal atmospheric conditions.

High Energy Level Area

In general terms, the High Energy Level Area (formerly called a power area) is that area of contact loading in which mechanical, thermal and electrical effects can change the condition of the contact interfaces, and in which arcing and arc transfer will take place. Thus, the High Energy Level Area shall be defined as that area of contact loading which exceeds the minimum arcing level for the contact material used. In this area, arcing will rupture any films present and contact life and performance will be determined by such factors as loss of material, arc transfer, mechanical sticking, welding, and particle contamination. The high energy level area will include all contact loadings exceeding those previously specified



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IS EASY TO INSTALL

- 1 Insert Jack Nut into hole. Needs only $\frac{3}{16}$ " expansion space.
- 2 Run in screw to collapse spider anchor backing by exerting pull on threads.
- 3 Jack Nut now is installed and ready to receive attachment screw.

CIRCLE 629 ON READER-SERVICE CARD

as the minimum arcing level values.

Abstracted from *Relay Testing Procedures*,
Technical Committee II Progress Report, Na-
tional Association of Relay Manufacturers.

Reliable Relay Contact Systems: What To Consider Before Specifying Them

MUCH can be done to minimize the erratic nature of relay contact performance—thus improving the reliability of electronic equipment—by considering some basic facts about contact materials and cleanliness before specifying the relay contacts.

The initial contact of two spherical metal surfaces results in point contact. Deformation occurs as the compressive force between them increases, and the point becomes a small area. Other contact points occur and become small areas, perhaps merging with the first. Under normal conditions, surface molecules are not pure metal. They may be adherent gaseous or hydrocarbon molecules, tarnishes, or oxides, plus minute dirt particles. The thickness of these films of foreign materials may be considerable.

In the accompanying enlarged sketch of the contact area, note the shaded portion in which insulating films are substantially undamaged, and two small conducting ("A" spots) in which insulating films have been badly cracked or displaced. One widely held theory states that a potential difference between the two mating metal surfaces results in a small trickle of current, but rather sizeable I^2R losses at the tiny A spot. This energy loss becomes heat, and metal is melted. A bridge of molten metal continues to enlarge, increasing current and reducing contact resistance, and indirectly resulting in a reduction of potential drop between the mating contacts.

The energy dissipated is now greatly reduced, and the metal bridge solidifies. This mated pair of contacts now carries current in an entirely acceptable manner. The metallic bridge breaks as

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to-Digital
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Kearfott's rugged shaft position-to-digital converters are resistant to high shock and vibration and high and low temperature environments. Ideally suited for missile applications, these converters are available for many uses, including latitude, longitude, azimuth or conventional angular shaft displacement conversion and decimal count conversion. Exclusive drum design provides large conversion capacity in smallest size. Combination counter converter assemblies for both visual and electrical readout also available.

TYPICAL CHARACTERISTICS

Kearfott Unit No. P1241-11A
Code Cyclic Binary
Range 0-32,768 (2¹⁵)
Bits per Revolution 16
Revolutions for Total Range
..... 2,048
Volts D.C. 10.5
Current (ma.) 20
Inertia (gm. cm.²) 20
Unit Diameter (in.) 1 1/4
Unit Length (in.) 3
Life 10⁶ Revolutions or 10³ hours
Static Torque (in.-oz.) .. 2 (break)
..... 1 (running)
Weight (oz.) 5
Maximum Speed (RPM) 600
*Write for new ADAC
brochure.*

*Miniature
Floated
Gyro*



*Electrohydraulic
Servo Valve*



*Scanalog
200-Scan
Alarm Logging
System*



Engineers: Kearfott offers challenging opportunities in advanced component and system development.

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BASIC BUILDING BLOCKS FROM KEARFOTT



*20 Second
Synchro*

This synchro, just one of a broad line offered by Kearfott, provides the extreme accuracy required in today's data transmission systems. Kearfott synchro resolvers enable system designers to achieve unusual accuracy without the need for 2-speed servos and elaborate electronics. By proper impedance matches, up to 64 resolver control transformers can also operate from one resolver transmitter.

TYPICAL CHARACTERISTICS	SIZE 25	
	Transmitter	Control
Type Resolver	25161-001	25151-003
Part Number		
Excit. Volts (Max.)	115	90
Frequency (cps)	400	400
Primary Imped.	400/80*	8500/80*
Secondary Imped.	260/80*	14000/80*
Transform. Ratio	.7826	1.278
Max. Error fr. E.Z.	20 seconds	20 seconds
Primary	Rotor	Stator

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Excitation Voltage (400 cps) 115
Volts at 0 rpm (RMS)020
Volts at 1000 rpm (RMS) 2.75
Phase shift at 3600 rpm 0°
Linearity at 0-3600 rpm07
Operating Temperature
Range -54° + 125°

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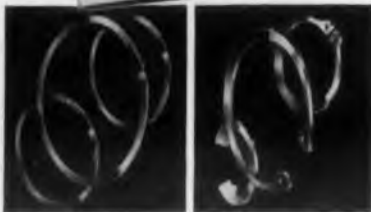
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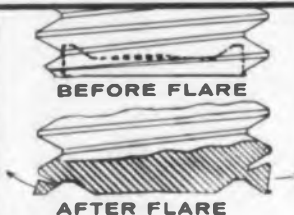
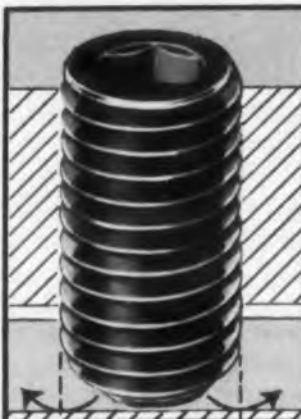
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DIGEST

contacts are opened, and surface films generally reform quite rapidly.

When surface films are relatively thick and tough, and the potential difference between contacts is relatively small, the trickle of electrons through cracks in this film, if any, is too small to result in any effective energy dissipation. No metal is liquefied, and no metallic bridges formed. Contact resistance remains high—possibly 100 ohms, or 1000 ohms, or many megohms. If we open and close the contacts, the surface films will crack or deform in a different manner and a substantially different contact resistance may result.

Factors Affecting Contact Performance

It is evident, then, that contact performance is readily affected by these key factors:

Circuit Characteristics. Low level circuits, in which the total energy available for dissipation at the contact surfaces, may be insufficient to build a metallic bridge. High resistance, or apparent open circuits, occur very often unless all other conditions are ideal. If the current and voltage level are excessive for the contact in question, the resulting metal bridge may be sufficiently large to damage the contact surface upon rupture, or perhaps even result in sticking or welded contacts. Excessive contact heating will promote the growth of films.

Contact Movement. Contact closure might in some remote way be considered analogous to a hammer hitting an anvil. It is apparent that there will be a tendency to rupture the surface film. And there will be a tendency for the contacts to bounce. Also, there may be a lateral, or wiping movement associated with contact closure. Well designed contact systems feature the practicable hammer action on closure even though this hammer action is of insufficient magnitude to deform or penetrate tougher surface films. Contact bounce, however, may be either inconsequential or detrimental, depending on the intended application. Circuit intermittence for a millisecond or more after contact closure, associated with contact bounce, may be objectionable in some cases. Generally, for contacts intended only for low level applications, a small amount of contact bounce is not harmful, and may aid slightly in deforming or breaking surface films. Bounce is usually considered harmful where contacts are intended for currents and voltages of a higher level, as each bounce represents an opportunity for arcing to occur. Contact wiping action is helpful in the removal of particles of foreign material which occasionally interfere with normal contact performance. Contact opening, and the reopening associated with contact bounce, will result in arcing unless the circuit is low level. The cumulative

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KP-125,
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The KP-150 is a subminiature glow-discharge indicator tube for transistor monitor service, which eliminates over a dozen other circuit components for coincidence applications; acts as an "and" gate; indicates. Its output may be used as a control, e.g., to close a relay. The KP-150 operates (glows) only when two coincident, low voltage signals are applied to its dual grids. This tube is specifically designed for transistor monitor service, and requires very low signal voltage and currents, thus preventing loading of the test circuit. The KP-150, operated, with AC on the anode, is grid-controlled, that is, will conduct (glow) when a grid signal is present, and is off when the signal is removed. For "memory" applications, the KP-150 may be used with DC anode supply. In this case, the operation is that of a conventional thyatron. The tube remains on (glows) until the anode current is interrupted, thus providing an electrical memory. A bright, "ball-of-fire" discharge provides exceptional visual indication which fills the tip of the tube, indicating in areas of high ambient light without special masking. No special mounting orientation is needed, as the tubes may be viewed from any angle. The KP-150 is in production and in stock. A single control type, the KP-145A is also available. For further details, data sheets, etc., contact

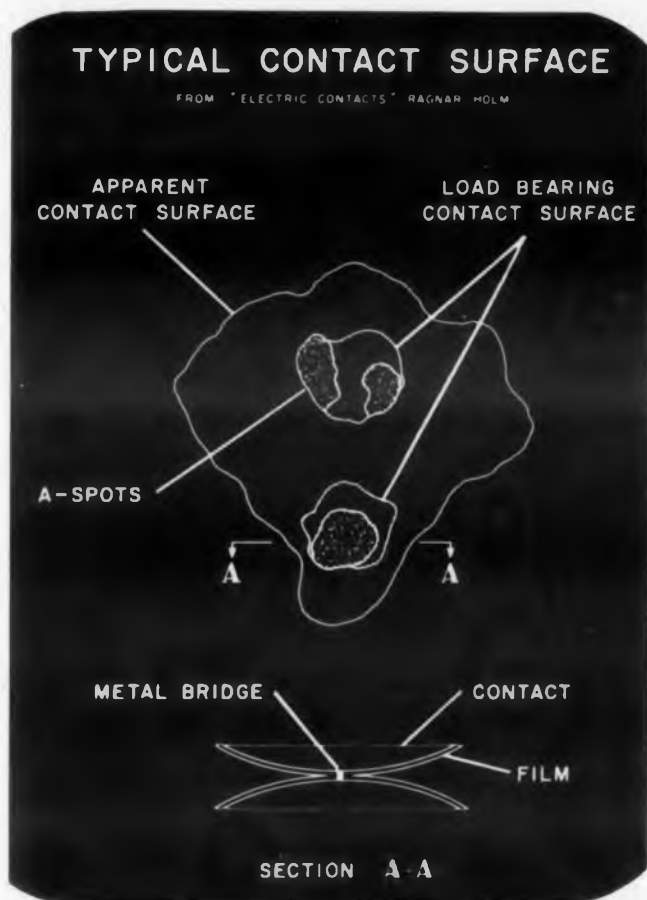
KIP ELECTRONICS CORPORATION
Dept. 920, Box 562, Stamford, Connecticut

CIRCLE 634 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

effect of this arcing is the major factor in limiting the normal life of high level contacts.

Contact Pressure And Shape. High contact pressures are helpful in squeezing or rupturing some surface films. Therefore, for contacts not intended to handle higher currents, small size is necessary to obtain higher contact pressure from a given force system. When high currents must be considered, contact size is governed by the need to provide adequate area of contact, so that over-



heating and subsequent damage will not occur.

Contact Materials. The ideal contact material should have conductivity comparable to silver or copper, the heat resistance of tungsten, the freedom from oxidation of platinum and palladium, the freedom from affinity for surface films of gold, and should be dirt cheap. All of the above are used as contact materials, but perhaps none so much as dirt. The most desirable contact material changes depending on conditions. Experience shows that gold and some gold alloys, such as the 60% gold, 25% silver, and 6% platinum are about the best materials for low level circuits. Palladium is a poor choice in hermetically sealed enclosures due to affinity for hydrocarbons. Flash platings of gold over some less expensive metal are frequently unsatisfactory due either to the tendency of the base metal to migrate through the gold or

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CIRCLE 638 ON READER-SERVICE CARD

DIGEST

the gold to wear off after a limited number of operations.

Foreign Particles And Dust. Minute foreign particles which become lodged between mating contacts may be responsible for unrepeatable open or high-resistance circuits that are vexing during tests. There is no sure way to eliminate all foreign particles from the contact area. A minimum of protection is provided by hermetic sealing.

Surface Films. The ease of establishing an electrical circuit is inversely proportional to the thickness of the surface film on the contacts. The contact enclosure should, if at all possible, be completely devoid of organic materials. Glass and ceramics are the preferred insulation materials in this enclosure. The vacuum bake is primarily to insure riddance of organic materials.

Specifying Contacts

A specification for components and component parts incorporating contacts should contain performance requirements for these contacts, and should contain or reference test procedures for insuring conformance. The maker should be told of the closed circuit current, maximum permissible resistance, and the available open circuit voltage. It should be noted whether this voltage will be available at closure, and whether the current will be flowing as the contacts are opened.

The nature of any surge currents should be described, including amplitude and duration. The required contact life should be noted in number of operations, taking into account all component, sub-system, and system testing plus a reasonable safety factor.

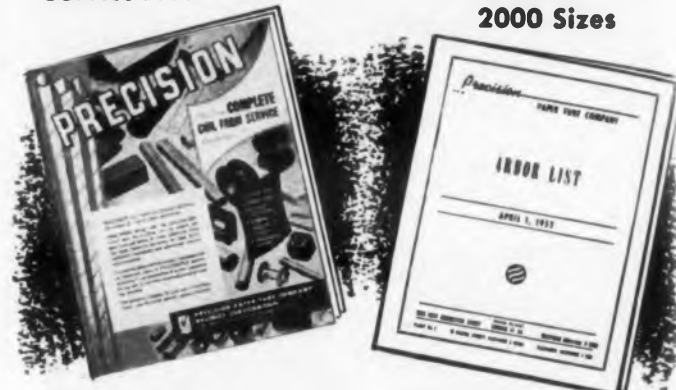
Note all external environments, such as shock, acceleration, vibration and temperature. In the event failure of contacts to make, or high resistance, for any one operation might cause a critical circuit failure, a run-in, or "miss" test should be specified for each unit. When this critical operation takes place either well above or well below the room ambient area, testing at the extreme temperature should be specified. The specification should avoid requirements for specific design details, such as contact material, size, force, type of enclosure, etc. However, where certain necessary performance requirements are impractical, there is no alternative to specifying such readily controlled details as hermetical sealing or gold alloy contacts.

Abstracted from a paper by Howard P. Lynch of the General Electric Co., delivered at the Seventh Symposium on Electro-Magnetic Relays, and reprinted by Potter & Brumfield, Div. of American Machine & Foundry Co.

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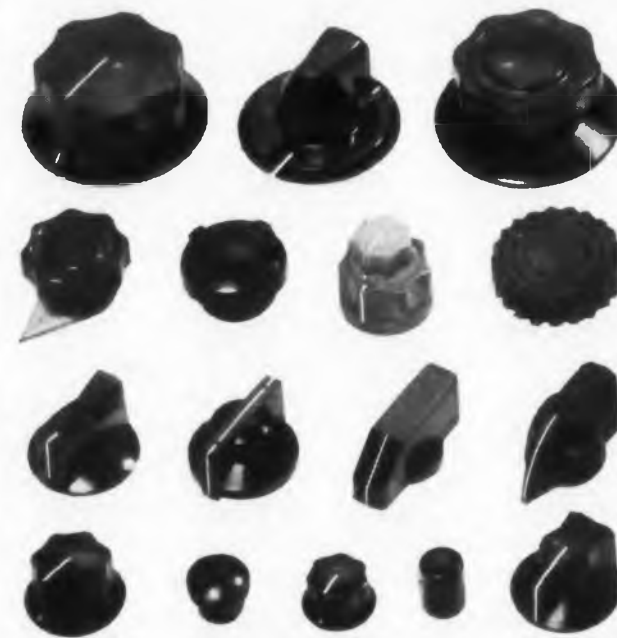
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CIRCLE 640 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 11, 1959

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LT TO "N" TYPE TRANSITION, 350-5000 MCS.

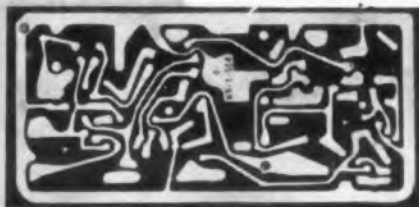
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Switching Devices: Relays vs. Semiconductors

IN COMPUTER and business machine circuitry there is a degree of overlap in the switching characteristics of semiconductors and relays. A proper analysis of the application, and the functional, cost, physical and standardization requirements will determine which device should be used.

The functional characteristics of the semiconductors and relays are:

Functional Characteristics

Semiconductors

1. Microsecond range with faster speeds already proven feasible.
2. Reliability appears to be much superior.*
3. Single point.
4. Low power requirements.
5. Off state resistance: many megohms for transistor but in the 100 K region for photo conductors.
6. Forward resistance: a few ohms for transistor and in the 10 K region for photo conductors.
7. Current carrying capacity affects operate time.

Relays

1. 250 μ sec and up.
2. Average reliability from our laboratory tests —1 failure in 5,000,000 contact operations.
3. Multiple points with single control.
4. Reasonable power but adds appreciable inductance and capacitance.
5. Infinite.
6. Short circuit (1 ohm or less).
7. Capable of handling heavy loads.

*(The reliability of a component is often nebulous and this is particularly true when trying to compare an electromechanical device with an electronic one. Our experience with relays indicates that we can expect one contact failure in 5,000,000 contact operations. Using transistors, our experience indicates one failure in 10,000,000 transistor hours.)

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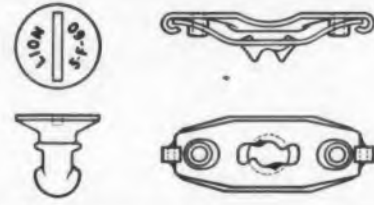

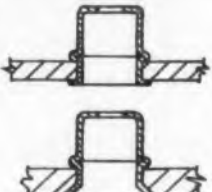
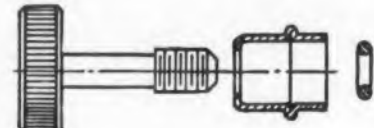

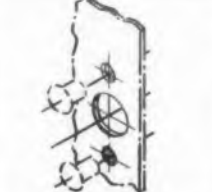
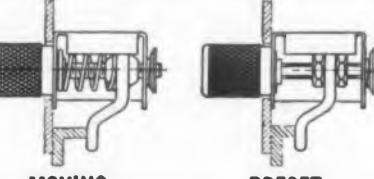

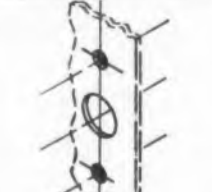
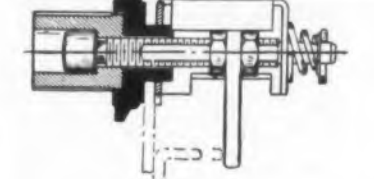


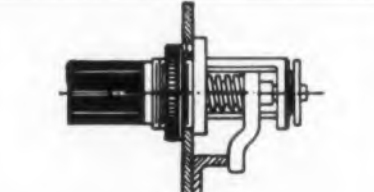


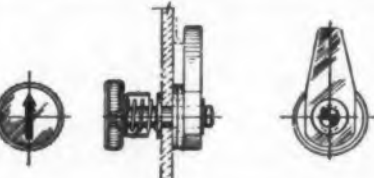
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DIGEST

Functional Characteristics

Semiconductors

- Contact bounce or chatter: none.
- Life: in excess of 10,000 hr.

Relays

- Measurable.
- Life: average 10,000 to 300,000 operations.

Factors In Relay Replacement

A rough estimate of components needed to replace a 4-position transfer relay would be 20 resistors rated at 1/2 w, and 8 bilateral transistors. This is not considering the actuating device in either case. The semiconductor actuating device has more components than the actuating device of the electrochemical.

Point by point replacement is not economically feasible at this time and it appears that it will not become economically feasible for quite some time. The unit cost of a semiconductor would have to be considerably less than the present cost of industrial transistors. However, economics is not the only factor to be considered in replacing relays and in some critical applications functional characteristics make it necessary to use a semiconductor.

Replacement of relays by transistors or semiconductors primarily for functional gains (speed advantages, etc.) permits flexibility in circuit design which enables the circuit designer to use different concepts in performing machine logic thus, in many cases, reducing the quantity of circuit switches required. Information which was formally fed in parallel can now be fed serially and circuit duplication reduced substantially.

These advantages and disadvantages in each mode of switching are:

Electrochemical Switches

Advantages

- Positive action; the desired effects are very pronounced.
- Flexible in contact material and construction to provide numerous contact combinations.

Disadvantages

- Inherent contact bounce and chatter on most types.
- Operating speed limited by mass.

Electrochemical Switches

Advantages

3. A proven device; backed up with many years of engineering effort.

4. Can be made independent of temperature, humidity or radiation, within reason.

5. Relatively low cost switching when figured on a per contacts basis. (Relays at from 15 to 30 cents per point can be made on a multipoint basis).

6. Readily available.

7. Can be made to carry and break large loads.

8. Visual analysis of operation or state is usually possible.

Disadvantages

3. Actuating coil introduces transients in circuitry.

4. Contact materials and pressures restrict use in so-called dry circuits.

5. It is possible to get intermittent failure.

6. Life is limited due to wear of moving parts.

Semiconductor Switches

Advantages

1. High speed except for photo conductors.

2. Reliable.

3. Low power.

4. Small.

5. Long life.

6. No contacts; thus no chatter or bounce.

7. Versatility in types of control.

8. Flexibility in logic.

Disadvantages

1. Cost high on a per point basis.

2. Complicates the power source.

3. Reverse voltage limitations.

4. Relatively new; still undergoing development.

5. Has a definite shelf life.

6. Affected by temperature.

Abstracted from a paper by G. L. LaPorte and R. A. Marcotte of IBM Corp., delivered at the Seventh Symposium on Electro-Magnetic Relays, and reprinted by Potter & Brumfield, Div. of



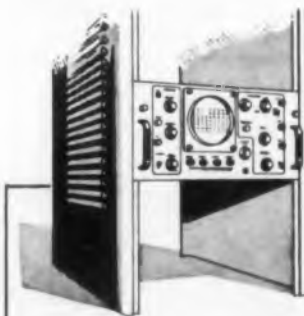
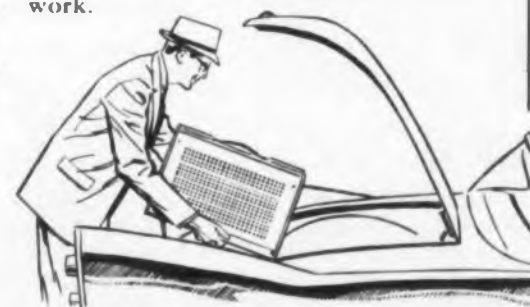
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The Tektronix Type 515A is a low-cost oscilloscope with a wide range of capabilities. Its dc-to-15 mc vertical response, wide sweep range and accurate calibration extend its application coverage from the very slow to the very fast, and simplified controls make it very easy to operate.

Although a higher-performance instrument, the Type 515A is smaller and weighs less than most other five-inch laboratory oscilloscopes. Therefore it is more easily moved from place to place in the laboratory, and to remote locations for applications requiring precise measurements. Take a look at the specifications and see if you don't think the Type 515A has interesting possibilities in your work.



TYPE RM15

Same instrument electrically as the Type 515A, but in rack-mounting form. Dimensions—8 $\frac{3}{4}$ " high, 19" wide, 23" rack depth.

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TYPE 515A

SPECIFICATIONS

VERTICAL RESPONSE

Passband—dc to 15 mc.
Risettime—0.023 μ sec.
Signal Delay—0.25 μ sec.

VERTICAL SENSITIVITY

0.05 v/cm to 50 v/cm, continuously variable.
9 calibrated steps from 0.05 v/cm to 20 v/cm.

SWEEP RANGE

0.04 μ sec/cm to 6 sec/cm, continuously variable.
Single control selects any of 22 calibrated steps from 0.2 μ sec/cm to 2 sec/cm.
5 x magnifier, accurate on all ranges.

FOUR-WAY TRIGGERING

1. **Amplitude-Level Selection**—adjustable amplitude-level and stability controls for triggering at a selected level on either the positive or negative slope of external, internal, and line signals, ac or dc-coupled.
2. **Preset Stability**—same as above, except stability control is preset at the optimum triggering point and requires no readjustment.
3. **Automatic Triggering**—automatic level-seeking trigger circuit provides dependable triggering for most applications. One simple setting assures positive sweep-triggering by signals of widely differing amplitudes, shapes, and repetition rates. No trigger controls need be touched until a different type of operation is desired. Provides a reference trace on the screen when no trigger signal is present.
4. **High-Frequency Sync**—assures a steady display of sine-wave signals up to approximately 20 mc.

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Weight—40 pounds.

TYPE 515A \$800

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NEW ALLOY DAMPS VIBRATIONS IN U.S. ARMY NIKE HERCULES

Dow plants cast a new lightweight magnesium alloy with superior damping capacity for electronic bases, housings.

K1A CASTINGS used on the Nike Hercules. Electronic guidance components are mounted on the die casting and housed within the sand casting. Dow is the production source for both castings.

Damping capacity—the ability of a material to reduce vibration by absorbing energy—is a highly important factor in electronic equipment used in missiles and aircraft. The performance of sensitive instruments can be severely affected by high energy vibrations generated in missiles in take-off and flight.

A big step forward in solving this increasingly critical problem is the development of K1A, a new magnesium alloy. Used in electronic bases and housings, this lightweight alloy eliminates complex mounting and suspension systems that often take up precious weight and space in missiles.

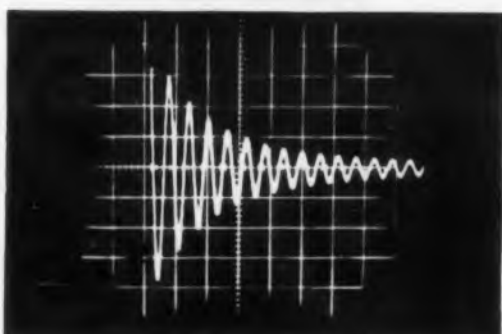
This new magnesium alloy has vibration damping characteristics much better than cast iron, aluminum or other magnesium alloys. Its heat conductivity and diffusivity are approximately twice that of standard magnesium alloys, thus making possible substantially reduced environmental temperatures for electronic instruments. Welding and machining have no adverse effect on the damping properties of K1A.

Bell Telephone Laboratories has done extensive work in determining properties and characteristics for the alloy, and in establishing its suitability for Western Electric's work on the guidance control system of the Nike Hercules. K1A is now available in the form of sand and die castings.

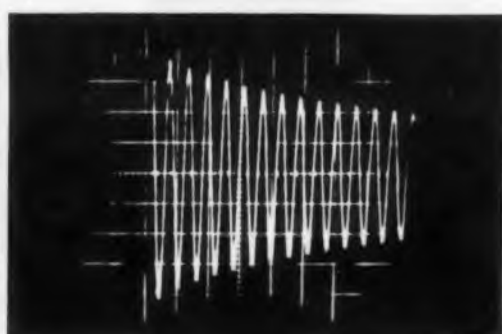


NEW BROCHURE on damping characteristics of magnesium discusses K1A, other Mg alloys. Contact the Dow sales office or THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Sales Dept. 1313BC11-11.

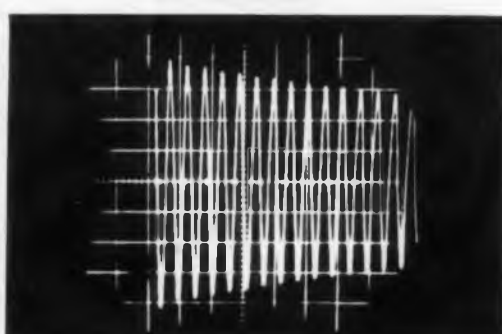
K1A MAGNESIUM



AZ81A MAGNESIUM



355 ALUMINUM



OSCILLOSCOPE PATTERNS, taken under identical test conditions, demonstrate high damping capacity of K1A compared to other magnesium and

aluminum alloys. The superiority of K1A is evidenced by rapid absorption of energy as shown by the sudden reduction in amplitude of the vibration.

THE DOW METAL PRODUCTS COMPANY, Midland, Michigan

DIVISION OF THE DOW CHEMICAL COMPANY

CIRCLE 647 ON READER-SERVICE CARD

REPORT BRIEFS

System Reliability Studies

The research under this contract has been concerned with some theoretical studies in the field of Reliability and Probabilistic Networks. The following specific results have been obtained: (1) A proof for the Shannon-Moore Expansion Theorem. (2) A generalization of the above expansion theorem. (3) Certain necessary conditions for realizability of $h(p)$ functions. (4) Development of some basic inequalities for $h(p)$ functions. (5) Evaluation of certain upper-bounds for coefficients of reliability functions. (6) Calculations of coefficients of reliability functions for series, parallel and composition of networks. (7) Development of a difference equation for reliability functions. *System Reliability Studies*, F. M. Reza and S. Jutila, Syracuse University Research Institute, N. Y., Dec. 1958, 42 pp, Microfilm \$3.30, Photocopy \$7.80. Order PB 139579 from Library of Congress, Washington 25, D. C.

PNPN Triodes in Magnetic Core Memories

Magnetic core switching arrays require a large current drive for fast operation. Series driving circuits using tubes or transistors dissipate excessive power. A shunt current pulser using trinistors (pnpn triodes) appears promising as an efficient driver. Trinistors have two states, ON (low impedance) and OFF (high impedance). Base current may be used to trigger the trinistor to either state. The turn-off time depends on base current and collector current. Increasing collector current increases turn-off time, and increasing base current decreases turn-off time. Trinistors, in their present state of development, were found to be unsuitable for use as drivers for magnetic cores. *Application of PNP Triodes To Magnetic Core Memories*, Aultman Doty, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, Mar. 1959, 46 pp, Microfilm \$3.30, Photocopy \$7.80. Order PB 140728 from Library of Congress, Washington 25, D. C.

Photoconductive Detectors

A description of the basic characteristics of photoconductive detectors is given to aid in the interpretation of data obtained in photoconductive research and experimentation. Properties described include variation in signal and noise with bias voltage; frequency response; time con-

stant; spectral response; black body sensitivity; temperature dependence; and sensitive contours. *Characteristics of Photoconductive Detectors*, A. J. Cussen, Naval Ordnance Laboratory, Corona, Calif., Feb. 1958, 24 pp, \$0.75. Order PB 151728 from OTS, Washington 25, D. C.

Ferrites: Properties and Microwave Uses

Interim Report No. 2, Faraday rotation at microwave frequencies in waveguide structures containing ferrites. Interim Report No. 3, analysis of the non-reciprocal reflections expected when a microwave field propagates through a ferrite of finite length in the direction of propagation. Interim Report No. 4, experimental arrangement for measuring the scattering matrices of microwave devices. Interim Report No. 5, development of a microwave circulator as a cascaded arrangement of identical non-reciprocal coupling holes between two rectangular waveguides. *Electronic Properties of Ferrites and Their Application to Microwave Devices*, D. W. Healy, Jr. and R. A. Johnson, Syracuse University, Research Institute, N. Y., Oct. 1956, 6 pp, Microfilm \$1.80, Photocopy \$1.80. Order PB 137279 from Library of Congress, Washington 25, D. C.

C-Band Klystron

A series of experimental C-band klystron oscillator tubes, resonator test apparatus, and an electron gun were designed and tested. Fourteen tube models were built according to the floating-drift-tube-klystron theory and nine tubes were developed to the point of producing useful rf output power. Reported in detail are the characteristics and electrical performance of all tubes manufactured, along with cross-sectional drawings of the various models. A new and original principle of klystron operation, the reflex floating-drift-tube klystron theory, was used in one experimental model and the results are described. The resonator test apparatus was used to investigate the resonant frequency of the floating-drift-tube resonator and a number of other important characteristics, including the figure of merit. Accurate information regarding the beams produced by convergent-flow electron guns was provided by the gun tester. *Development of C-Band Klystron*, W. H. Thon, Sylvania Electric Products Inc. for Wright Air Development Center, U. S. Air Force, Washington 25, D.C., Sept. 1958, 94 pp, \$2.25. Order PB 151332 from OTS, Washington 25, D.C.



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REPORT BRIEFS

Electron Physics

A drift-tube klystron with a harmonic resonator was constructed and operated as a self-excited frequency multiplier at millimeter wavelengths. It is believed that this multiplier has potential capabilities at well over one watt at 2 millimeter wavelength. The mixed-field reflex oscillator provided a power output of 270 mw with a beam voltage of 500 volts at a wavelength of 3.05 cm. New methods of generating millimeter waves were studied preliminary to construction, with some parts for the first designs being built. Results from test to predict electron trajectories and to determine electrode geometry showed the proposed designs feasible. These tests were completed with an analog computer and an electrolytic tank automatic plotter. A powerful tool in cathode evaluation was developed in the thermionic electron emission microscope. *Electron Physics at Millimeter Wavelengths*, E. M. Boone and others, Ohio State University Research Foundation for Wright Air Development Center, U. S. Air Force, Washington 25, D.C., Oct., 1958, 72 pp, \$2.00. Order PB 151553 from OTS, Washington 25, D.C.

Transistors

A 1959 revision of its *Catalog of Technical Reports* on transistors lists 146 technical reports available to industry through the facilities of OTS, in some cases in printed form and in others in photocopy or microfilm. The reports are the results of research by the Army, Navy, and Air Force between 1949 and June 1959. *CTR-310 Transistors* OTS, U. S. Department of Commerce, Washington 25, D.C., 10 cents a copy.

Ferrites

This paper summarizes the ferrite development program at the Diamond Ordnance Fuze Laboratories (DOFL). A brief discussion of the fundamentals of magnetic materials and the results of the theory as related to ferrites are included to give the electronic design engineer a better understanding of the function of ferrites in microwave systems. A number of significant ferrite components developed at DOFL are described and the experimental results obtained are given to illustrate applications of the theory

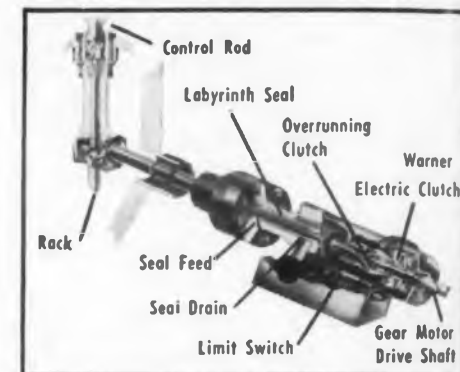
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Electric clutch performs dual function in control rod drive for nuclear reactor

Ingenuity is illustrated in the way Warner SF-400's are applied in this control rod drive in the Alco-built packaged power reactor at Fort Belvoir, Va. They provide both free-wheeling emergency release and automatic positioning of rods that operate as a "throttle" to control rate of reactivity.

During normal operation, clutches are constantly engaged—lowering and raising rods of neutron-absorbing material to carefully calibrated positions within the reactor. Motor



torque is transmitted by the rotor which is bushed and running free on a thru shaft, to the armature, mounted to the outer member of an overrunning cam-type clutch. Rods are positioned by the electric clutch acting through the overrunning clutch.

In "scramming," the electric clutch flux circuit is de-energized, instantly breaking the connection between drive motor and control rod shaft. This lets the rods drop into the reactor. At the same time, the drive motor starts rotation in a downward direction. And, any obstruction of the rod causes engagement of the overrunning clutch, which then transmits full motor torque to the control rod drive shaft.

Reliability tests put the Warner clutch through 60,000 scram cycles. In another test, rods were left in one position for periods of up to two months and then "scrammed" to see if temperature, humidity, or pressure affected reliability. (It didn't.)

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ELECTRONIC DESIGN • November 11, 1959

and to provide basic design data for microwave-systems engineers. *Properties of Ferrites and Their Applications to Microwave Systems*, F. Reggia and R. D. Hatcher, Diamond Ordnance Fuze Laboratories, Washington, D. C., Feb. 1959, 59 pp, \$1.50. Order PB 151749 from OTS, Washington 25, D. C.

Sensitivity of Active Networks

An important consideration in the design of an amplifier is the extent to which the amplifier's performance can be desensitized to changes in its active elements. In this report the three possible methods of achieving gain constancy despite changes in the parameters of a linear network are described. *Sensitivity of Active Networks to Variations in Internal Parameters*, E. M. Davis, Jr., Stanford Electronics Laboratory, Stanford University, Calif., Aug 1958, 174 pp, Microfilm \$8.10, Photocopy \$27.30, PB 140881 from Library of Congress, Washington 25, D. C.

Power Resistor Mounting Hardware

Mountings for the twelve resistor styles under investigation were divided into three groups, each with similar resistor-tube diameters. Three hundred ceramic washers for all three groups were procured, with associated L-brackets, through-bolts, nuts, locking washers, and resistors. Only two manufacturers (AG and D) of the seven included could provide the type with the ceramic insulating washers. The investigations consisted of the following mounting torque, temperature cycling, thermal shock, moisture-resistance cycling, and high-temperature exposure. The D ceramic insulating washers, being smaller in size than those from Manufacturer AG, showed up the weaker, breaking at lower values of mounting torque and failing during temperature cycling, thermal shock and high-temperature exposure. The brackets and bolts from both manufacturers corroded extensively when exposed to moisture-resistance tests. A standard set of mounting hardware was suggested, separated as before into three groups of similar resistor styles. A sequence of tests was also suggested for future qualification of the hardware. *Component Evaluation and Specification Engineering. Final Report on Task XXVIII. Power Resistor Mounting Hardware*, L. H. Stember, Jr. and P. G. Perry, Battelle Memorial Institute, Columbus, Ohio, June 1956, 47 pp, Microfilm \$3.30, Photocopy \$7.80. Order PB 137081 from Library of Congress, Washington 25, D. C.

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TIME DELAY RELAYS

Instant reset — Voltage compensated

Curtiss-Wright "IR" thermal time delay relays reset the instant they are de-energized. The second cycle will always provide the same delay as the first cycle. Variations from 22 to 32 volts will not affect the time delay of the "IR" Series.

SPECIFICATIONS

Time delay Preset 20 to 180 seconds
Contact arrangement . . . SPST, DPDT OR SPDT
Temperature comp. -65°C to +125°C
Weight 4½ ounces
Terminals Hooked solder type
Mounting Bracket or stud
Variations of the above relay characteristics available upon request.



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Tolerance ± 0.1 microsecond
Signal to noise ratio Greater than 10:1
Input and output impedance . . . 50 to 2000 ohms
Carrier frequency 100 kc — 1 mc
Delay to pulse rise time Up to 800:1



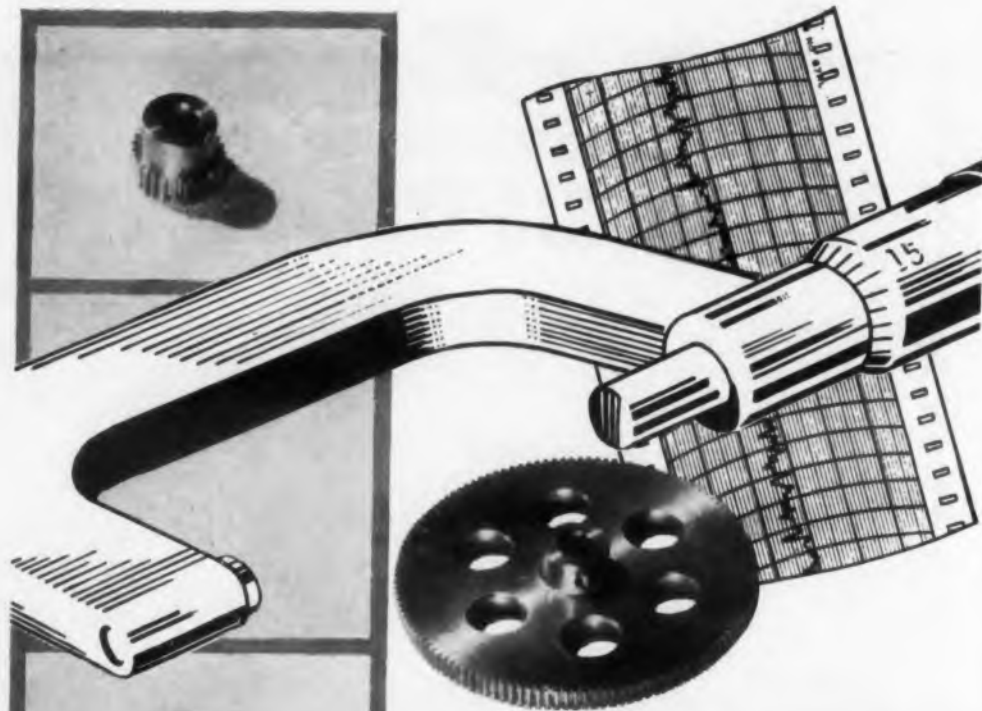
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REPORT BRIEFS

Reliability and Maintainability

A new philosophy of reliability and maintainability is suggested as a means of assuring that newly developed military electronic equipment will be reliable and maintainable. This philosophy would shift the burden of detailed reliability specifications concerning component parts from Government to industry, leaving only the specification of functional operation and environment in Government hands. This shift of responsibility necessitates a change in contracting attitude. Contractors must be assumed competent unless proved otherwise. The new philosophy also requires contractors to be responsible for maintenance of equipment for a predetermined period of time so that all defects can be removed and maintenance techniques simplified. *Reliability and Maintainability Assurance*, Walton B. Bishop, Air Force Cambridge Research Center, Bedford, Mass., Nov. 1958, 17 pp, Microfilm \$2.40, Photocopy \$3.30. Order PB 139588 from Library of Congress, Washington 25, D. C.

Thermoelectric Generators

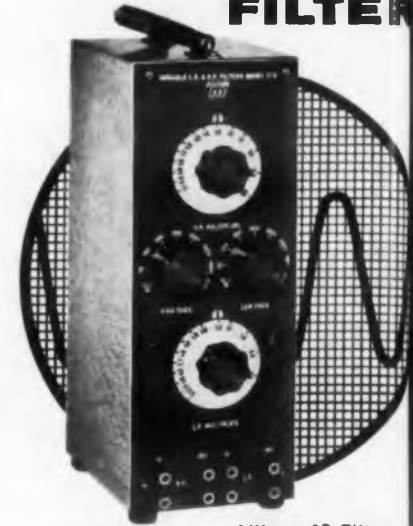
The thermoelectric effects are described and the efficiency of a thermoelectric generator is developed based upon the assumptions that the thermal conductivity, the electrical resistivity and the Thomson coefficient are constant along the length of the material. This development differs from the usual ones presented in the literature in that the thermoelectric power is not assumed to be constant but instead is assumed to vary with temperature in a manner so that $\tau = T (da/dT)$ is a constant. *The Efficiency of Thermoelectric Generators*, Jose M. Borrego, Henry A. Lyden and John Blair, Aeronautical Accessories Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, Sept. 1958, 81 pp, \$2.25. Order PB 151748 from OTS, Washington 25, D.C.

Cooling Considerations for Airborne Equipment

The purpose of this paper is to acquaint the electronic designer with some of the problems concerned with cooling electronic equipment in high-speed aircraft. *Cooling Considerations for the Design of Airborne Electronic Equipment*, Henry Cohen, Riverside Research Laboratory, Motorola, Inc., Calif., July 1956, 42 pp, Microfilm \$3.30, Photocopy \$7.80. Order PB 140751 from Library of Congress, Washington 25, D. C.

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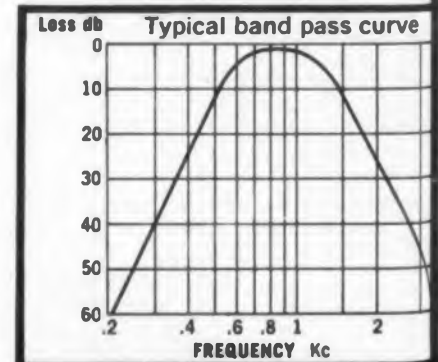
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Type A: general-purpose relay with up to 20 Form "A" spring combinations. This relay is excellent for switching operations.

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Type C: two relays on the same frame. A "must" where space is at a premium.

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Electromechanical Filters

This report summarizes the techniques which have been found applicable, within the scope of the contract, to the design of piezoelectric bandpass filters with their center frequencies greater than one megacycle per second. While the most important aspects of the problem are discussed in detail, many others are dealt with more briefly, but in such cases copious references to the more extended discussions of the quarterly progress reports are included. *An Investigation of the Characteristics of Electromechanical Filters*, C. R. Mingins, A. D. Frost and others, Research Laboratory of Physical Electronics, Tufts University, Medford, Mass., Feb. 1954, 70 pp, Microfilm \$3.90, Photocopy \$10.80. Order PB 139610 from Library of Congress, Washington 25, D. C.

Radiation Damage in Semiconductors

Experiments to determine the effects of radiation upon silicon carbide diodes. When a voltage was applied to the diode in either forward or back direction, this appears to remove all accumulation of radiation effects of permanent nature. After 1.18×10^{16} nvt integrated dose, the diodes tested had a forward to back current ratio of approximately 7400, indicating these devices to be as good as they were at the beginning of the experiment. *Annealing of Radiation Damage in Semiconducting Devices*, Vern E. Bryson, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, Mar. 1959, 50 pp, Microfilm \$3.30, Photocopy \$7.80. Order PB 140729 from Library of Congress, Washington 25, D. C.

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STANDARDS AND SPECS

Sherman H. Hubelbank

Data Given On Standardizing Interconnections

Covering standardized interconnections and index pin codes, this publication is noteworthy for the listing contained and the guidance notes for designers of plug interconnections. Standardized index pin code arrangements have been adopted to guard against airborne equipment from being inadvertently placed in the wrong rack location.

By standardizing specific combinations of index pins (on the rack) and corresponding index holes (on the equipment) for each specific unit of equipment, a unit cannot be installed in a rack location where it is not intended to be. Each unit of equipment having a particular size and a set of pin connections will be assigned a specific index code arrangement. It is this compilation of index pin code arrangements that is listed in this ARINC (Aeronautical Radio, Inc.) publication.

In assigning pin numbers (if technical considerations permit) these factors should be considered:

1. Assign pin numbers for functions which can be related to the pin number. For example, in a device which might use ten selectable channels, it is useful in simplifying maintenance to assign Channel 1 to Pin 1, Channel 2 to Pin 2, etc.

2. Another useful technique is to assign pin numbers by groups. One group of perhaps ten pins for channel selection, the second group for gain, volume, and sensitivity controls, the fourth group for power, etc. It is particularly useful here to provide a small number of spares immediately after a group. This permits the spares to be used in a logical manner when modifications are made at a later date.

Precautionary considerations are also involved. Do not assign input and output leads so that they are adjacent in the plug. Isolate high-impedance leads such as AVC bus (for testing).

Sensitive circuits, or circuits where leakage may be a problem, should be arranged so that any leakage is to ground via adjacent pins rather than to other sensitive circuits or to circuits above ground.

Pins for circuits requiring twisted, shielded leads should be adjacent to each other and to a ground connection, or to a pin which can carry a ground connection through to some common ground. In most cases, ground pins must be pro-

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vided in the plug if a ground is to be used for a particular purpose such as shielding.

And designers should select pin types and sizes suitable for the functions for which they are used. Not only normal operating currents, but also possible overload conditions should be considered in selecting pin ratings.

Copies of this document are available from Aeronautical Radio, Inc., 1700 K St., N.W., Washington D.C. ARINC No. 406, Airborne Electronic Equipment Standardization Interconnections and Index Pin Codes.

Standards Cover Magnetic Tape And Wire

Covering recording tape primarily for home use, this newly issued standard is published by the Electronic Industries Association. The standard establishes dimensions and preferred operating speeds for standard 1/4-in. magnetic recording tape. This tape may be used for single, dual, or four track recording. Copies of this standard are available from EIA, 11 W. 42nd St., New York 36, N.Y., for 30 cents each. EIA RS-224, Magnetic Recording Tapes, August 1959.

Also issued by EIA is a standard on magnetic wire. This standard specifies the nominal wire speed, direction of rotation, the wire size, and the recording wire spool dimensions. Available from EIA for 25 cents, specify EIA RS-223, Magnetic Recording Instruments, August 1959.

Definitions And Descriptions Of Transmission Lines Provided

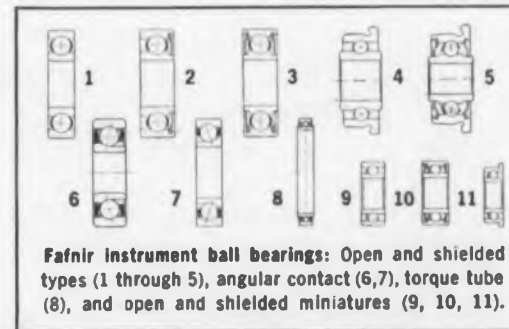
This new standard issued by EIA limits itself to gas-filled rigid coax transmission lines and their connectors. Semiflexible transmission lines and their connectors are not covered. It is the intent of this standard to provide complete mechanical interchangeability for all rigid coax connectors and lines. Standard definitions are established for terms such as average wall thickness, characteristic impedance, attenuation, standing wave ratio, and power and voltage ratings. In addition, the upper frequency limit is established. Tables and illustrations are provided to show the dimensions, tolerances, characteristic impedance and cutoff frequencies for rigid air dielectric coaxial transmission lines having 50-ohm impedances. Copies of this standard are available from the Electronic Industries Association, 11 W. 42nd St., New York 36, N.Y., for 80 cents each. EIA RS-225, Rigid Coaxial Transmission Lines 50 Ohms, August 1959.

MIL-P-20693 Plastic Compounds

Upgrading of this spec has been accomplished by including the standard responsibility for inspection clause. Amendment 2, 12 June 1959.

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UME-14	output	600	3.2
UME-15	output	1200	3.2
UME-16	output	10,000	3.2
UME-18	choke	3 hy @ 2 Madc	—
UME-19	output or driver	10,000 CT/12,500 CT	500 CT/600 CT
UME-20	driver	10,000/12,500	1200 CT/1500 CT
UME-21	driver	10,000/12,500	2000 CT/2500 CT
UME-22	single or PP output	150 CT/200 CT	12/16
UME-23	single or PP output	300 CT/400 CT	12/16
UME-24	single or PP output	600 CT/800 CT	12/16
UME-25	single or PP output	800 CT/1070 CT	12/16
UME-26	single or PP output	1000 CT/1330 CT	12/16
UME-27	single or PP output	1500 CT/2000 CT	12/16
UME-28	single or PP output	7500 CT/10,000 CT	12/16
UME-29	output	300 CT	600
UME-30	output	500 CT	600
UME-31	output	900 CT	600
UME-32	output	1500 CT	600
UME-33	interstage	20,000 CT/30,000 CT	800 CT/1200 CT
UME-34	input	200,000 CT	1000 CT
UME-35	interstage	10,000 CT/12,000 CT	1500 CT/1800 CT
UME-36	choke	6 hy @ 2 Madc	—
UME-37	choke	1 hy @ 2 Madc	—
UME-38	choke	12 hy @ 0 dc	—
UME-39	choke	20 hy @ 0 dc	—



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STANDARDS AND SPECS

Reference Data Included In Industrial Control Standard

Valuable reference data for any design engineer is contained in this NEMA standard. Among other things, this standard covers the rating and application of control devices, such as contactors, relays, resistors, etc. It also covers ac general purpose controllers and dc controllers. Available from National Electrical Manufacturers Association, 155 E. 44th St., New York 17, N.Y., for \$6.00 per copy. NEMA IC 1-1959, Industrial Control.

Radiation Measurements Standardized

Standardized methods of test for determining rf radiation from broadcast radio and television receivers are established by this new IEC publication. These methods were established to make possible comparison of the results of radiation measurements obtained by different observers. The first section covers radiation at frequencies below 30 mc from am receivers and from television receiver time-base circuits. Frequencies between 30 and 300 mc are covered in a second section. Copies of this International Electrotechnical Commission standard are available from the American Standards Association, 70 E. 45th St., New York 17, N.Y., for \$3.60 per copy. IEC Publication 106.

Test Methods Covered For Ceramic Capacitors

Ceramic dielectric capacitors specifically suited for resonant circuit applications or where low losses and high stability are essential are covered in this IEC standard. Excluded are capacitors for rf currents exceeding one ampere or for a large reactive power. Test methods are described as are color codes for marking. Copies are available from the American Standards Association, 70 E. 45th St., New York 17, N.Y., for \$3.20 per copy. IEC Publication 108.

Standard For Fixed Resistors Under 3 W Issued

Fixed resistors having a rated dissipation less than 3 w are covered by this IEC standard. The total resistance value is between 10 ohms and 22 meg. These resistors are intended for use where high stability of the resistance is not of major importance. Copies of this standard are available from the American Standards Association, 70 E. 45th St., New York 17, N.Y., for \$3.20 per copy. IEC Publication 109.

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Small 22

Contact combinations to 12 arms per stack; 24 per relay. Contact ratings to 15 amps. Operate sensitivity (SPDT) 100 mw. min. TIME DELAY: operate to 65 ms; release to 150 ms.



Medium 66

Contact combinations to 12 arms per stack; 24 per relay. Contact ratings to 15 amps. Operate sensitivity (SPDT contacts) 60 mw min; TIME DELAY: operate to .15 sec; release to .25 sec.



Above relays available with contacts ranging from bifurcated gold alloy for low level switching to heavy duty power; plug-in mounted; with snap action contacts; open, dust tight or hermetically sealed; to meet applicable military specs. Tell us what you need or send for catalog 3350D

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ELECTRONIC DESIGN • November 11, 1959

New Candlepower Standards Available

New candlepower standards consisting of inside-frosted lamps with monoplane filaments and medium-bipost bases are now available from the National Bureau of Standards. These lamps are available in sizes of 100, 300, and 500 w. These standards show little or no variation in intensity with change in orientation. They follow closely the inverse square law and are easily calibrated on the photometer bar. The lamps may be procured from the Photometry and Colorimetry Section, National Bureau of Standards, Washington 25, D.C. They are priced at \$37.00 for the 100-w size; \$34.00 for the 300-w size; and \$35.00 for the 500-w size.

New Semiconductor Spec (2)

General tests specified include: breakdown voltage; capacitance; case insulation; drift; dew point; high and low temperature operation; noise figure; and thermal time constant, resistance, and response time. Adequate inspection procedures and precautions are included for proper inspection and test. The devices shall also be subjected to environmental tests such as: bending moment; burnout by pulsing; constant acceleration; moisture resistance; and operation life, storage life, and intermittent life tests. Special test procedures are also established for the diodes covered by this spec. MIL-S-19500B, General Specifications for Semiconductor Devices, 30 June 1950. At the same time a detail spec was issued for a 25-milliwatt, high-frequency, germanium, pnp transistor for use in high-frequency amplifiers and oscillators and video circuits. The Transistor is type JAN-2N128, MIL-T-19500/9A.

New Semiconductor Spec Approved By DOD

Approved by the Department of Defense, this spec is mandatory for use by the Army, Navy, and Air Force. This spec, MIL-S-19500B, covers the general requirements for semiconductor devices used in Military equipment. Specified requirements for a particular type of semiconductor are listed in the applicable detail spec.

Included in this spec are transistors and semiconductor diodes. Identification numbers of semiconductors meeting this spec will be assigned by the Joint Electron Device Engineering Council. The numbers agree with the type of numbers currently in use.

The type designation may be either marked in accordance with MIL-STD-130 or color coded. A suitable polarity marking shall be included on diodes. Country of origin shall also be marked.

An appendix to this spec contains definitions of terms used with semiconductor devices. Another appendix covers abbreviations and symbols.

2N416
2N417
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CIRCLE 900 ON CAREER INQUIRY FORM

Blocks to CREATIVITY

Perception Deception

DESIGNING YOUR FUTURE

A. L. Simberg, AC Spark Plug Div.
General Motors Corp., Flint, Mich.

IT IS NOT surprising today to find at the head of some of our largest industrial corporations men with degrees in engineering. What are the routes by which these men achieved their present position? Traditionally, the young engineer going into a company has one of two routes open to him. The first of these is through his technical know-how, his engineering specialty. In short, he becomes an expert. The other traditional alternate way to the top has been through the path of supervision, accepting higher and higher supervisory responsibilities, until he reached the top of the organization.

In the past few years, especially since the Korean War, a third way to the top has opened. It is by means of creativity.

With the ever increasing competition, especially in the area of electronic development, those companies are successful which find the unusual, the unique new products, processes, manufacturing methods and cost reductions. All positive change comes about as a result of someone's ideas, a newer and better way of doing or making something.

Ideas mean creativity. Creativity means being able to develop end results which will satisfy the needs of the organization in a way which they have never been sat-

isfied previously. All engineers have within them the basic capacity to be creative. What prevents many of them from doing so are obstacles which must first be overcome.

The obstacles to creative thinking lie primarily in three areas: perceptual, cultural and emotional. This article will deal with the first of these obstacles, the perceptual blocks to creativity.

The family of perceptual blocks is probably the single most frustrating and damaging one. These are the types of blocks that make us "want to kick ourselves" for not having seen the solution previously. They are caused primarily by not seeing what the problems are or what actually may be wrong in the situation. These are the types of blocks that cause us to begin our work in problem solving without the proper goal in mind. These have to do primarily with our statement of the problem, our biases toward and preconceived notions about the problem. While we are not talking about attitudes as such, it should be realized that there is very little in our outward behavior that is not colored in some manner or other by our attitudes toward them.

To a great degree, our perceptual blocks may be classified as merely having a mental set or predisposition toward see-

2. Difficulty caused by narrowing the problem too much.

This block is caused by paying little or no attention to the environment surrounding the problem. It is not unusual to find in scientific endeavors that experiments are sometimes conducted to determine a particular point while the effect of other variables of the total situation is ignored.

The above block comes about primarily because of our inability to see the problem stated in any other terms than it is. For example, try the little exercise below:
HOW CAN YOU MAKE FOUR NINES EQUAL ONE HUNDRED

3. Difficulty in not investigating the obvious.

Once we have become accustomed to looking at certain situations and problems in a particular way, it becomes increasingly difficult not to do this. Everyday we look at the same things, but really cease to "see" them. Pass the same bulletin board every day, and even though the notices change from time to time, unless there is something really different about the new notice (a different color paper, etc.) the chances are that we will not see it. So it is with our design problems. The first reaction to the assignment of designing a new component is to look for components which are similar and provide the same function. Is it not just as easy to sit down and ask yourself what better or simpler or cheaper method could be used to achieve the same end result?

The person who first thought of using a flexible ice cube tray got the idea from noticing that some water in his boots, which had been left outside, had frozen during the night and had flipped out quite readily when the boot was turned inside out. How obvious.

Try this problem:

Two Indians, a big one and a little one, were walking through the woods. They resemble each other and in truth are related. The little Indian is the son of the big Indian, but the big Indian is not the father of the little Indian. What is their relationship?

4. The failure to distinguish between cause and effect.

The young engineer, especially one who has his sights set on a career in research, often feels quite confident that he

This is the first of three articles on blocks to creativity. Subsequent articles will discuss cultural and emotional obstacles.

ing the situation in a certain way, no matter how closely or how thoroughly we look at it. Let us look at a few examples of this type of block:

1. Difficulty in isolating the problem.

This is the case where the individual is unable to separate the real problem from related problems, or as we say, he cannot see the forest for the trees.

While this sounds basic and elementary, it is nevertheless extremely important to pinpoint the problem specifically. Too often we are not tackling the real problem at all. This is similar to the physician who treats symptoms rather than curing the disease or to the mechanic who when unable to figure out whether the car has ignition, fuel system or other trouble, will eventually decide on a complete overhaul.

To show just how deadly these little blocks can be, try some of the problems associated with them. You will find the answers to these problems at the end of the article.

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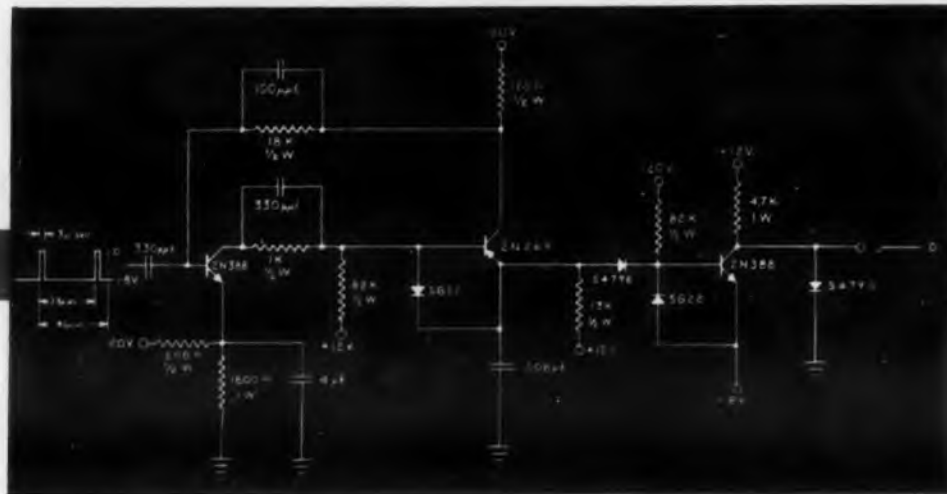
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CIRCLE 902 ON CAREER INQUIRY FORM



knows the difference between cause and effect. However, these, as he will learn, are not always this clear-cut. Nor do statistics always provide the correct answer.

For example, in a large university, it was recently found that engineering senior students who made poor grades were much heavier smokers than those earning good grades. Did the smoking cause poor grades or did the poor grades cause more tension which led to heavier smoking? Or is it possible that both the poor grades and the heavy smoking were a result of a common cause? Or is it possible that none of these facts was related to one another, except by coincidence?

The person who would be creative must learn not to jump to conclusions regarding causality.

5. Failure to use all of the senses in observing.

While we have talked about the five senses for years, and although we know what these are and also know that we can observe through all of them, when we use the word observation the meaning is still for most of us in terms of vision only. A great amount of information can be gained from experiences other than visual. Concept formation, the reaching of conclusions, classification of situations—all of these can be formed through other than visual methods.

We are all familiar with people who have a deficiency in one of the five senses. People who are either blind or deaf are able to compensate by the strengthening of the faculties which they have remaining to them. Try sometime shutting your eyes for awhile and try doing things with your eyes shut. You will find, after the first few frustrations and bumped knees, that you can do quite well really by using the senses of touch, hearing and smell. ■ ■

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Answers to Problems of Preceding Story.

1. Time flies (insects)? You cannot! They fly too fast.
2. 9 + 9/9
3. His mother

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Circle Career Inquiry numbers of companies that interest you

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For Further Information
Please Contact

MR. J. W. DWYER
Employment Manager

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Division of Sperry Rand Corp.

Great Neck, Long Island, New York
Fieldstone 7-3665

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CIRCLE 903 ON CAREER INQUIRY FORM

**CAREER
OPPORTUNITIES
BROCHURES**

Sprague Electric Company



Sprague Electric is made up of many departments and divisions: Research and Engineering, Sales, Sales Engineering, Manufacturing, Production Engineering, Plant Engineering, Employee and Community Relations.

Products are supplied by Sprague to manufacturers of electronic equipment in the fields of military industrial, communications and entertainment. On-the-job photos and a brief company history are included. Services and benefits for employees are covered.

Employee and Community Relations, Sprague Electric Co., Dept. ED, North Adams, Mass.

CIRCLE 870 ON READER-SERVICE CARD

Autonetics



Autonetics invites the prospective employe to study this 26-page illustrated brochure and to consider the opportunities presented in the scientific and engineering frontiers. Department areas are: Inertial Navigation, Digital Computers, Flight Control and Special Products. A synopsis of helpful background requirements is given for

each area, in addition to the available working facilities.

Who and what Autonetics needs and is aiming for is clearly delineated. Company benefits and community facilities are presented.

Autonetics, Div. of North American Aviation, Inc., Dept. ED, Downey, California.

CIRCLE 871 ON READER-SERVICE CARD

Radio Corporation of America



"Working in Research at RCA," a 36-page brochure, outlines activities and aims of the Radio Corporation of America. Technical operations fall into three categories: manufacturing, services and Research.

Manufacturing includes engineering, development and production of a wide range of electronic equipment. Services include the operations of the National Broadcasting Company, with its radio and television systems; RCA Communications, Inc., with radiotelegraph facilities, and RCA Institutes, which train thousands of electronic technicians.

The work of the research laboratories is directed toward improvement in methods, devices, production, and operation in every branch of radio, television, electronics and allied fields and toward the creation of new products and services.

Descriptions of the various laboratories and their functions are covered and depicted in the brochure. The laboratories covered are Physical and Chemical, Electronic, Acoustical and Electro-mechanical, Systems and Radio.

Educational opportunities, including employee fellowships, a tuition loan and refund plan, part-time study and study abroad are discussed. An Administrative Chart is given, and a map delineating community facilities concludes this brochure.

Radio Corporation of America, RCA Laboratories, Dept. ED, Princeton, N.J.

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A big promise. But let the facts speak:

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Long Range Projects—Hughes was first to develop three dimensional radar. Today this work is expanding to encompass highly advanced data processing systems and electronic display systems.

Privacy—At Hughes-Fullerton, engineers enjoy private or semi-private offices in new air conditioned quarters.

Growth of Opportunity—Hughes-Fullerton (30 minutes from downtown Los Angeles) has grown from 800 employees in 1957 to 5,000 today. This programmed growth means unusual advancement opportunity. Engineers' average age: 31. One out of five has an advanced degree.

It will pay you to investigate Hughes-Fullerton as the place to further develop your career as an engineer—no matter what your experience level. Please call or write to Mr. A. P. Ramstack, Director of Professional Placement, at the address below.



HUGHES

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FULLERTON-RESEARCH & DEVELOPMENT, FULLERTON, CALIFORNIA

electronic engineers:

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off
from
creativity?



CIRCLE 908 ON CAREER INQUIRY FORM

E Engineers

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Specializing in undersea weapons, also working with special weapons and missiles, we supply the Fleet with the best... from a wooded 13,500-acre site on the unspoiled Virginia Peninsula where you'll have a choice of city, suburban, or rural waterfront living in the world's most extravagantly restored history-land.

You'll like working with your government too—the feel of a job that boosts your country's security. Right now we have openings for the right men, starting at \$6285 to \$8810. Get applications (Standard Form 57) from your postmaster. Mail an application or copy of your resume to the Employment Officer today.

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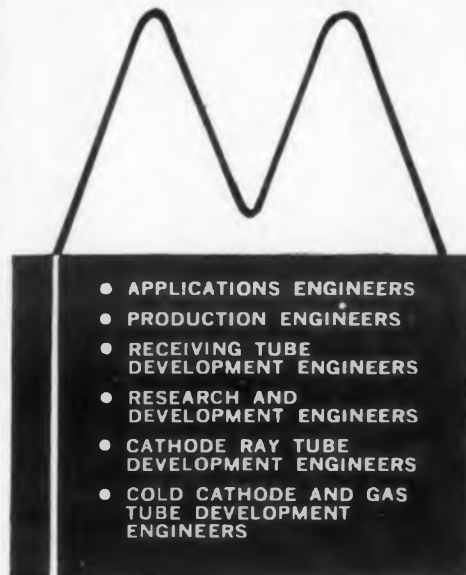


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CIRCLE 909 ON CAREER INQUIRY FORM

232

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CIRCLE 910 ON CAREER INQUIRY FORM

YOUR CAREER

NEWS AND NOTES

Back to school for engineers describes the purpose of UCLA's two-week courses in fast-moving technologies. Headway in some engineering fields is so rapid that often engineers only five years out of school find themselves thrust, by interest or company expansion, into areas in which they have no solid foundation—and indeed in some cases where there is no recent unclassified literature. Some of these fields are infrared, information storage and retrieval (come a long, long way in five years) astrodynamics and rocket navigation and nuclear rocket propulsion systems.

Recognizing the paucity of academic information specifically designed for engineers who are already working in, or interested in entering, such fields, the University of California at Los Angeles Extension Division has set up a program of short engineering and math courses. These courses last two weeks. The engineer attends school from 8:00 a.m. to 5:00 p.m. —with midterms on the first Friday and a final exam on the second.

UCLA is not the first university to have such a program, of course, but it has one of the most extensive. This past summer marked its first full scale venture into the program. Its summer courses included Nonlinear Problems in Random Theory (Norbert Wiener of MIT heading the course); Astrodynamics and Rocket Navigation (Robert M. L. Baker, Jr. of Aeronutronic Systems Div., Ford); Thermochemistry of Rocket Propulsion (Donald J. Simkin, Marquardt Aircraft); Theory and Applications of Infrared Radiation and Detection (K. N. Satyendra, now with Nortronics Div. of Northrop, and Max Garbuny of Westinghouse Research); Strain Gauge Techniques (William Murray, MIT); Metal Processing,
(Continued on p. 234)



Two-week infrared course at UCLA was sparked by Dr. K. N. Satyendra (l), Dr. Max Garbuny (c) and Tom Vogl (r), all with Westinghouse Electric at the time. Dr. Satyendra is now with Nortronics.

ENGINEERS RESEARCH OPPORTUNITIES

Aeronutronic, a new division of Ford Motor Company, has immediate need for computer engineers to staff its new \$22 million Research Center in Newport Beach, Southern California. Here, you have all the advantages of a stimulating environment, working with advanced equipment, located where you can enjoy California living at its finest.

Look into these ground floor opportunities in research and development work that is challenging and exceptionally rewarding to qualified men.

Positions now open:

- Systems Engineer
- Magnetic Memory Engineers
- Communications Engineers
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- Transistorized Circuit Engineers
- Logical Designers
- Circuit Engineers
- Mechanical Engineers
- Optical Engineers

Qualified applicants are invited to send resumes or inquiries to Mr. R. E. Durant, Aeronutronic, Box NJ-486, Newport Beach, California.

COMPUTER OPERATIONS

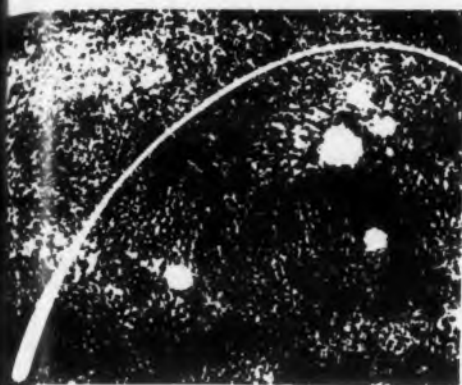
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CIRCLE 911 ON CAREER INQUIRY FORM

ELECTRONIC DESIGN • November 11, 1959



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CIRCLE 912 ON CAREER INQUIRY FORM

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To these men, Raytheon's new SYSTEMS MANAGEMENT offers unparalleled professional satisfaction. They are invited to inquire of: Mr. Donald Sweet, Engineering & Executive Placement, Raytheon Company, 624S Worcester Road, Framingham, Mass. (suburban Boston).

SYSTEMS MANAGEMENT GOVERNMENT EQUIPMENT DIVISION



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Radar Development opportunities for engineers with either experience or interest as follows:

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Includes low noise figure front ends using crystal mixers, travelling wave tubes, parametric amplifiers and multistage IF amplifiers with special characteristics like wide bandwidth, logarithmic action, ultrastability and bipolar clipping.

Radar Modulator Development

Includes switchgear, high voltage DC power supplies, pulse shaping, and driver stages, crowbar and protective circuitry, control and monitoring function, and pulse transformer switch tube combination.

Radar Transmitter Development

Includes high voltage design techniques, X-radiation monitoring and shielding, high power wave guide and RF components, transmitter multiplexing, high stability frequency sources, and travelling wave tube amplifiers.

Other Career Opportunities:

Airborne Electronic Counter-Measures
Digital Computer Development
Microwave Systems and Components
Antenna Design
Infrared Systems Development
Solid-State Devices and Systems
Automatic Check-Out and Fault Isolation
Ferret Reconnaissance
Electronics Instructors
Communications Circuitry
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Westinghouse
BALTIMORE

FOR DETAILS . . . and a copy of the informative brochure "New Dimensions" . . . write to: Mr. A. M. Johnston, Dept. 981, Westinghouse Electric Corporation, P. O. Box 746, Baltimore 3, Maryland. Please include a resume of your education and experience.

CIRCLE 914 ON CAREER INQUIRY FORM

CAREER NEWS

(Continued from p. 232)

Cutting (Milton C. Shaw, MIT); Statistical Methods in Industry (Edward P. Coleman); Information Storage and Retrieval (R. M. Hayes, Magnavox R & D Laboratories); and other courses not of consuming interest to electronic design engineers, such as Design of Prestressed Concrete Structures.

Cryogenic Engineering, Corrosion Engineering, Communications in Science and Industry, and Packaging, Plant Layout and Material Handling were given during November. Currently finishing up are a series of lectures on "Foundations of Future Electronics."

Good Investment for Engineers, Industry says Dr. Sam Houston, dynamic assistant head of the UCLA Engineering Extension. The intent of the courses, according to Houston, is to cover the fundamentals and applications in each field as thoroughly as possible in 70 hours.

Cost of courses is about \$150 per person—a pretty good deal considering the two units credit given for passing the course.

"We try to get the top people in the field to set up and coordinate the courses," says Dr. Houston. "These are on-the-job men and can tell what their engineering confreres want and need to know. They can point out gaps in present-day knowledge and describe new trends and developments.

"Courses themselves are chosen in different ways—by request from industry or the military, or by talking to engineers and deciding a blank exists in a given category. One of the problems in frontier courses like these is classification. We are never too sure how broad a field we should cover."

UCLA plans to conduct two courses per month throughout the year on roughly a graduate level. The program, to be successful, calls for an average of 50 students in each course. This has so far been achieved easily—the spread is from about 40 to 100 students, depending on the course. As a rule more students apply than were planned for—the infrared course expected 50, got 113; Norbert Wiener asked for no more than 20, got 33.

How good are the courses? To find out ELECTRONIC DESIGN went to the *Theory and Applications of Infrared Radiation and Detection* course.

In two weeks the class covered the origin and nature of infrared radiation, physical phenomena for infrared detection, industrial uses and target detection, terrestrial infrared and modern aspects of infrared and missiles.

During the first week of the course the fundamentals, background and physics of infrared were given relatively exhaustive treatment. Students were expected to have a solid grounding in mod-

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AVAILABLE**

specific career opportunities now open at Texas Instruments

SEMICONDUCTOR-COMPONENTS DIVISION

DEVICE DEVELOPMENT—Develop new semiconductor devices; conduct experimental and theoretical studies on the effects of nuclear radiation on semiconductor materials and devices; evaluate experiments in the analysis of gases and electro-chemistry; conduct physical measurements on semiconductor surfaces; determine the effects of chemical reaction on semiconductor surfaces; studies in device stability, reliability and characterization; materials research and development including crystal growth and crystallography.

CIRCUIT DEVELOPMENT—Transistor circuit design and application; design automatic and semi-automatic test equipment.

MECHANIZATION—Design and develop high speed automatic machinery.

Please write to C. A. BESIO, Dept. 1104, P. O. Box 312, Dallas, Texas

CIRCLE 904 ON CAREER INQUIRY FORM

APPARATUS DIVISION

MANUFACTURING ENGINEER—To perform the planning and coordination of the manufacture of electro-mechanical/electronic systems and components on an assigned project basis; to determine action to be taken; follow-up and report successful operation of the course of action selected. BS in EE, ME or IE, with minimum 3 years experience in manufacturing processes, tooling, scheduling, and costs.

QUALITY CONTROL ENGINEER—To establish and maintain standards of quality and inspection methods for all raw materials, work in process and finished products. BS in EE, ME or IE with minimum 3 years experience in working to customer requirements, procedures, quality reports plus prevention and detection of defects in electro-mechanical apparatus.

SENIOR MICROWAVE ENGINEER—To perform applied research and development in the field of microwave and high-powered transmitter equipment including ASR transmitter and automatic performance monitoring. MS in Physics or EE with minimum 5 years experience in the field of microwave and high-powered transmitting equipment.

SENIOR ELECTRONIC ENGINEER—To conduct engineering analysis of techniques that will be incorporated into various product lines. Electronic design experience associated with the missile field involving circuit (transistor), computers, telemetry, and guidance systems design essential. MS in EE, ME or Physics with minimum 7 years experience in field of missile electronic design and systems planning and analysis.

CIRCUIT DESIGN ENGINEER—With strong instrumentation background with emphasis on circuit design. Experience in application of transistor circuits to instrumentation highly desirable although not essential. BS or MS in EE or Physics with minimum 5 years experience.

RESEARCH ANALYST—To perform industrial marketing research in the field of military and industrial electronics; requires analytical ability with imagination to foresee variables and recognize limitations and data; ability to present ideas clearly in verbal and written form. Must also be able to interpret and point out use and conclusion of statistical studies to division management. BS in ME, EE or MBA or MA in Economics.

SENIOR GUIDANCE ENGINEER—To design microwave antennas and circuit components; supervise engineering personnel in design and development of complete missile antenna and microwave systems; contribute original advancements in missile microwave and antenna concepts for proposals and system development. BS in EE or Physics with minimum of 5 years experience in stripline microwave design. Also thoroughly familiar with radiation and propagation theory.

MATHEMATICAL STATISTICIAN—To specialize in the study of noise applications; to perform systems analysis of sonar and radar product lines; to provide consulting service to other technical personnel. MS or PhD in Mathematics with minimum of 6 years experience in applied analysis of advanced mathematics.

MATHEMATICIAN—To specialize in transform calculus as applied to servo mechanisms and network analysis and continued fraction work; provide consulting services to other technical personnel. MS or PhD in Mathematics with minimum of 6 years experience in applied analysis of advanced mathematics.

Please write to JOHN PINKSTON, Professional Placement, Dept. 1104, 6000 Lemmon Avenue, Dallas 9, Texas

CIRCLE 905

GEOSCIENCES AND INSTRUMENTATION DIVISION

MECHANICAL DESIGN ENGINEERS—BS or MS in ME to design small electro-mechanical mechanisms.

ELECTRICAL DESIGN ENGINEERS—BS in EE or Physics to design and construct supervisory control systems of electro-mechanical and electronic design; transistor test equipment, requiring heavy experience on electronic circuit design, preferably with transistors; digital computers with experience in detailed logical design.

MANUFACTURING ENGINEER—BS in ME or IE with experience in production, planning, production control, methods and tooling in the electronics industry.

SALES ENGINEER—BS in EE, Physics or ME with sales experience in electro-mechanical instruments.

Please write to DAVE TURNER, Dept. 1104, 3609 Buffalo Speedway, Houston, Texas

CIRCLE 906 ON CAREER INQUIRY FORM

CENTRAL RESEARCH LABORATORY

HEAD-PHYSICS SECTION—4 to 5 years experience in semiconductor physics and proven ability to direct a variety of technical projects. Responsible for directing work on the measurement and understanding of electrical, thermal, magnetic, optical, and transport properties of semiconductors. Educational requirement is PhD in Physics.

HEAD-DEVICE SECTION—4 to 5 years experience in semiconductors plus experience in group leadership and proven ability to supervise a variety of technical projects. Will be responsible for directing work on design, fabrication and evaluation of new solid state devices. Educational requirement is MS or PhD in either Physics or EE.

SOLID STATE THEORIST—Responsible for the understanding and interpretation of the physical properties of semiconductors and other solid state materials. Educational requirements: PhD in Physics with concentration in quantum mechanics. Solid state experience desirable but not necessary.

DEVICE THEORIST—Responsible for the design of new solid state devices and interpretation of their characteristics in terms of physical and fabrication parameters. Educational requirement is PhD in Physics or EE, or MS with 2 to 3 years experience in solid state device theory.

SEMICONDUCTOR TECHNOLOGY—Responsible for the design and interpretation of experiments on the technology of semiconductors, including impurity diffusion and alloying. Educational requirement is PhD in Physical Chemistry or Metallurgy. Experience requirement: 3 to 4 years experience in semiconductor technology.

THEORETICAL PHYSICIST—2 to 3 years experience in electron or nuclear magnetic resonance with interest and background to perform theoretical analysis of EMR and NMR to develop possible new types of magnetometers or to make significant improvement in present types. Sufficient experimental background and interest to assist in translating theoretical results into experimental projects.

PHYSICISTS—Either MS or PhD with 1 year minimum experience in the fields of superconductivity and low temperature physics. Should be acquainted with conventional techniques of transferring and handling liquid helium and designing circuits and instrumentation for studies in this area.

Please write to A. E. PRESCOTT, Dept. 1104, P. O. Box 1079, Dallas, Texas

CIRCLE 907 ON CAREER INQUIRY FORM

CIRCLE 904 THROUGH 907 ON CAREER INQUIRY FORM



It's a new automatic flight control system.

This one isn't operational yet, but maybe you could lend us a hand in exchange for things like salary and

LRCP*

General Electric's **ARMAMENT AND CONTROL SECTION** in Johnson City (Binghamton) New York, has 14 openings for men with degrees and/or experience in mechanical engineering, electrical (electronics) engineering—also in mathematics and physics.

Some of the product areas include airborne defense systems, automatic flight control systems (not in any way similar to the cartoon), inertial navigation systems, analog and digital computers, gyros, fluid controls, servo controls and many more.

General Electric has the right combination for developing your career potential. *Long Range Career Potential.

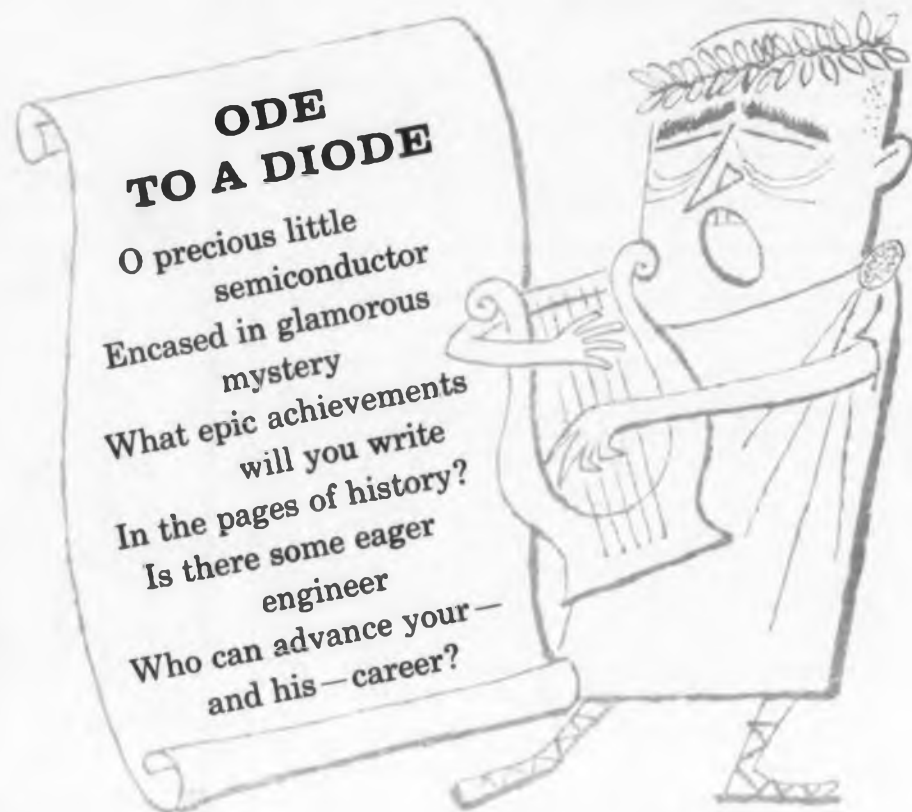
Let's trade facts. Tell us about your education, experience and interests. We'll send you details about where you'll fit into the Armament and Control Section.

Write in confidence to:

Mr. R.C. McConnell, Div. H221-2
Armament and Control Section
General Electric Company
600 Main Street
Johnson City, New York

ARMAMENT AND CONTROL SECTION
GENERAL ELECTRIC
JOHNSON CITY, NEW YORK

CIRCLE 915 ON CAREER INQUIRY FORM



If You Know Semiconductors You Ought to Know Raytheon

Raytheon has all types of engineering opportunities in just about every fascinating phase of semiconductors. No matter what your interest — or experience — you're almost sure to find the position you want at Raytheon. The descriptions in this ad are typical of the positions open. Your resume doesn't need to be in iambic pentameter — but get it in *today* to

Joseph McGovern,
Semiconductor Division, Raytheon Company,
164 California Street, Newton 58, Mass.

Here are typical examples of key positions now open:

PROCESS ENGINEER

Develop and specify production processes. Analyze and rectify manufacturing problems. Improve processes with respect to quality, yield and cost reduction. Act as consultant on production and quality control. BS with basic coverage in chemistry, physics and mathematics.

INDUSTRIAL ENGINEER

Standards and methods, planning and facilities, and cost control in semiconductor manufacturing. Minimum of two to three years experience in electronic industry. BS in IE or equivalent required. Work factor or MTM training desirable.

PRODUCT ENGINEER

Design, development, pilot production and evaluation of advanced semiconductor devices and circuit-paks for market samples. BS in physics, metallurgy, chemistry or electrical engineering.

APPLICATIONS ENGINEER

To design and study amplifying and switching circuits and the properties of new devices in these circuits. Minimum of two years semiconductor circuit design experience. Electronics degree.

RAYTHEON

**SEMICONDUCTOR
DIVISION**

*If you know SEMICONDUCTORS
You ought to know RAYTHEON*

CAREER NEWS

(Continued from p. 234)

ern physics: the first week was in the nature of orientation and a more intensive examination of the characteristics of 0.75 to 1000 micron frequencies.

In more detail, the class covered emission and absorption of heat radiation, emission and absorption of selective excitation, transmission phenomena, ir radiation sources for measurement and detection, ir optical systems, thermal detection, quantum detection, limits of detection, thin films, thermal detectors, photoconductivity and emissive cells, infrared imaging, the evolution of detectors and infrared electronics. Applications of infrared detection systems were enumerated and described: industrial safety and quality control, imaging and scanning systems in darkness and fog viewing, air-to-air and air-to-ground uses, radiation of missiles during escape and reentry, uses of ir for satellites and space vehicles, infrared spectra of extraterrestrial objects and so forth.

Sound like a lot of ground to cover in a short time? It was. Each day students attended a lecture from 8:00 to 9:45. A coffee break followed, and a discussion period after the break until 12:15. After an hour and a half lunch at the faculty club—during which most students continued to hash out problems among themselves—another lecture, from 1:45 to 3:15, was given. Coffee break, then another discussion period until 5:00.

On Saturday a field trip to Aerojet-General Corp. in Azusa exposed newcomers to infrared processes, techniques and equipment.

In many ways the discussion periods were the most helpful. Homework problems were reviewed, students got a chance to work out mutual difficulties in the design of infrared equipment and made some very fine contacts with other people in the field.

Generally the course level was graduate. K. N. Satyendra, then of Westinghouse in Philadelphia, presently then Nortronics Div. of Northrop in Hawthorne, Calif., and Max Garbuny of Westinghouse Research in Pittsburgh guided the course. "The amount of material covered," Dr. Garbuny said, "would otherwise have been given during a sixteen-week term. Some of the material of course dated back as far as the 1890's—Wien, Rayleigh, Planck—but some, as far as possible without exposing classified information—was brand new."

Dr. Satyendra commented on the feasibility of giving so much material in so little time. "You must realize that first of all we require the student have at least a Bachelor's in Engineering or Science or its equivalent. Then, in each group are a number of PhD's in Physics. Many people are now working in infrared by necessity and do not

(Continued on p. 240)

Thinking of changing your job someday?

Here are 14 Reasons
to Consider

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Top Salaries, fully competitive with compensation throughout the industry, with increases based on actual performance, not seniority.



Desirable Assignments to match your electronics specialty in any one of 30 expanding groups; activities range across the spectrum from audio to Infrared. Specific programs include a revolutionary Bomb Nav. Radar System, Polaris Fire Control and Guidance Computer, Sidewinder Guidance, Satellite Communications, Advanced Airborne Detection/Data Processing/Command System, and Missile Fuzing, to name a few.



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CIRCLE 920 ON CAREER INQUIRY FORM

CAREER NEWS

(Continued from p. 238)

have the appropriate foundation. They are often specialists in one small part of the field—through experience—and realize their shortcomings in other areas."

Some 113 persons attended the infrared course. They came from all over the United States and Canada. Military, academic, research and engineering personnel were numbered in the group. "Most people, of course," Garbuny said, were newcomers to infrared. This is the most often-occurring situation—the boss sends a new man to a short course to pick up information quickly." Viewed from this perspective it is hard to see a better investment of time and money, particularly if the company does not have a working training program of its own.

Independent talks were avoided in the series set up by Satyendra and Garbuny. The course was presented as an integrated unit. Other experts invited to lecture—J. R. Hansen of Westinghouse Research, Pittsburgh; W. Horn of Westinghouse Air Arm, Baltimore; and T. Vogel of Westinghouse Research, Pittsburgh—based their presentations on practical experience.

To insure good coordination, not too many big-name lecturers were chosen—five seemed plenty. Moreover Satyendra and Garbuny insisted that most of the teaching be based on practical experience. "We preach what we practice," said Dr. Garbuny.

This was not a matter of each expert presenting a unit lecture, however. When this happens there are often too many redundancies and too little material covered—it amounts to a speech on infrared electronics or ir detectors or the like, with no relation to the material that has gone before or will come after. The course as presented was written as a whole; each expert contributed one or more chapters as a natural growth of the information presentation.

The notes distributed at the lecture will be published: they make a good-sized book, complete with as much new information as possible. The book should be a valuable contribution to the study of infrared.

To engineers in the field it may seem strange that an infrared course was given in Los Angeles. "Like bringing oranges to California," commented Garbuny. With such centers of infrared activity as the Santa Barbara research centers, Hughes Aircraft, Raytheon, Stanford Research Labs, Lockheed, Berkeley, Thompson-Ramo-Wooldrige, Nortronics and Aerojet-General, there is certainly no dearth of enterprise in infrared on the West Coast.

"Actually it is practical and appropriate to



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electronic engineers

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CIRCLE 922 ON CAREER INQUIRY FORM
ELECTRONIC DESIGN • November 11, 1959

have the course in Los Angeles," said Garbuny. "First, the UCLA program is very well set up. Then Eastern people can get away from office worries and concentrate on just one thing. We have the advantage of a certain cross-pollination of information."

UCLA hopes to repeat the course next year. Satyendra and Garbuny are already planning their future activity. "It seemed quite a successful course," says Dr. Satyendra. "Perhaps next year we will arrange for a little extra time and more get-togethers. The problem and discussion sessions were very useful."

The UCLA short courses are a pleasure to attend. There is first of all the knowledge that the course provides the student with as much information as he can absorb in two weeks. He spends his whole day concentrating on one subject to the exclusion of all else. Months of this treatment would be dreary, but two or three weeks of it is satisfying and rewarding.

Courses are set up with plenty of notes, so the student can review the work after he has left.

Instructors and lecturers are experts currently working in the field. The student is always certain the information he is getting is of singular practical importance.

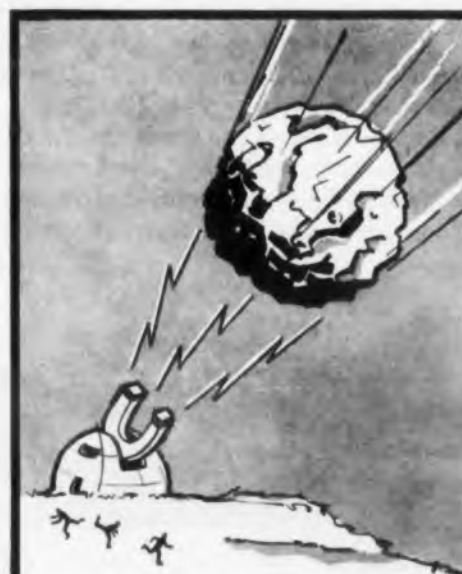
As mentioned before, most students taking the short courses are engineers entering the field, who want to pick up as much advanced information as possible as quickly as possible. But there are usually a healthy number of PhDs in attendance; as well as engineers currently working in the field. These latter two types get most of their new information from the discussion periods, where they bring up problems that have been bothering them.

In this sense, the course is like a two-week symposium, with all attendees living in fairly close proximity; able to talk shop at leisure.

How can you go? Most students are informed of the courses via their company training officer. The training officer receives a brochure from UCLA and asks the chief engineer if he can name somebody he'd like to have attend the course.

UCLA's facilities for locating companies that might have an interest in any given field are limited, of course. Moreover, Harold Caysen, assistant to Dr. Sam Houston, notes that the school is presently involved in deciding just which classes to give. Some that are planned for next year include Missile Silo Construction and Ventilation; Plasma Physics and Controlled Fusion; Behavior of Dislocations (involving failure of materials); Human Factors; Operations Research and Systems Analysis; Hot Cell Technology (nuclear

(Continued on p. 242)



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Farmingdale, Long Island, New York

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CAREER NEWS

(Continued from p 241)

power plants); Computers, Advanced Programming; and, tacked on to the original infrared course, an extra week in Advanced Infrared. Microminiaturization, Cryogenics, Advanced Cryogenics and Applications of Generalized Harmonic Analysis will also be included—all in addition to the courses mentioned in the first part of this article.

Do any of these strike a note? To receive the UCLA program for any given course, write to the Engineering Extension, University of California at Los Angeles, 405 Hilgard, Los Angeles 24, Calif.

New course ideas are being sought by UCLA Extension Division. They are very open to suggestion, and always willing to consider any fields they may so far have overlooked.

ENGINEER-IMPROVEMENT COURSES AND SEMINARS

Below are courses and seminars intended to provide the engineer with a better knowledge of various specialties. Our grouping includes several different types of meetings: National Courses—those held on consecutive days and intended to draw attendees from all geographic areas; One-Day Seminars—one-day intensive seminars which move from city to city; and Regional Lectures—regional symposia or lecture series which generally run one night a week for several weeks.

National Courses

UCLA Engineering and Management Course, January 25-February 4

A course for the professional development of managers and engineers, will be held at the University of California, Los Angeles. The 10-day program will offer a choice of 22 subjects to fit the needs of both executives of large industries or of middle-level personnel from small companies.

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Emphasis will be on the principles and techniques which form a systematic approach to management, and on the quantitative methods which supply the facts for such an approach. Information on registration and living accommodations may be obtained from Reno R. Cole, College of Engineering, University of California, Los Angeles 24, Calif.

Training Course In Value Engineering and Analysis, IEI, November 30

This five-day course, which will be held in Boston, starting Nov. 30, has been developed by the Industrial Education Institute, in cooperation with the Materials Handling Institute. The program, covering all phases of the subject, has been designed especially for men responsible for product design, procurement and manufacturing in industry and government.


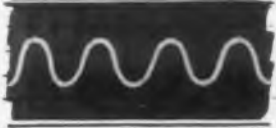

Value Engineering and Analysis is a technique developed for reducing product cost. It is a concentrated effort to improve the value of any product by eliminating unnecessary costs in product design, manufacture and procurement.

The five-day training will combine formal instruction, guest lectures, informal discussion, demonstration, case study and problem solving. Through specially developed work projects, the participants will learn "by doing" by value analyzing a wide variety of products. Through the free exchange of information with men with similar responsibilities and problems, the registrants will pick up new functional design and procurement techniques they can apply to their own products.

The members of the faculty have been drawn from industry, government and education. They include L. S. Miles, Manager of Value Services, General Electric Co.; Rear Admiral A. G. Mumma (USN Ret.), Vice President, Engineering, Worthington Corp.; Rear Admiral R. S. Mandelkorn, (USN Ret.), Chairman of Value Engineering Committee, Electronic Industries Association; Vincent de P. Goubeau, Vice President, Materials, Radio Corp. of America; Frederick S. Sherwin, Manager, Value Analysis Service, Raytheon Co.; Don Otis, Controller, Electric Typewriter Div., IBM Corp.; Bernard W. Eades, Manager, Value Engineering, Stromberg-Carlson Co., and President of the Society of American Value Engineers; Raymond J. Soenard, Value Analysis Education, U. S. Army Ordinance; Morgan D. Roderick, Office of Value Engineering, Bureau of Ships, U. S. Navy; Louis J. De Rose, Executive Director, Materials Man-

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319	1, 10, 100, 1000	YES	NO	NO	NO
318RA	1, 10, 100	YES	NO	YES	YES
318R	1, 10, 100	YES	YES	NO	NO
318	1, 10, 100	YES	NO	NO	NO



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CAREER COURSES

agement Institute, and others. Further details and registration information may be obtained from the Registrar, Industrial Education Institute, 25 Huntington Ave., Boston 16, Mass.

Fastener and Report Writing Courses Offered By Engineering Institute

The Engineering Institute of the University of Wisconsin is offering two 3-day courses of interest to electronic engineers: Industrial Fastener Application, Nov. 19-20 and Technical Report Writing, Jan. 20-22. For further information write to: Engineering Institute, University Extension Div., 3030 Stadium, The University of Wisconsin, Madison 6, Wis.

One-Day Seminars

Communications One-Day Seminar, Boston, New York and Philadelphia

The Industrial Education Institute is offering a one-day seminar entitled, "More Effective Communications." Conducted by Don Fuller, the seminar will be held at the hotels: Sheraton-Plaza, Boston, Mass., Nov 2; Park-Sheraton, New York, N.Y., Nov. 4; Sheraton, Philadelphia, Pa., Nov. 5.

The program outline is as follows: The Role of Communication in the Organization; The Report as an Aid to Decision Making; Tailoring Presentations to Get Desired Action; Insuring the Proper Perspective and Emphasis; The Creative Procedures in Putting Thoughts on Paper; Recognizing and Avoiding Communication Traps; Meeting Objections to Presentations; and Developing the Most Effective Format. For further information write to: Industrial Education Institute, 25 Huntington Ave., Boston 16, Mass.

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The Communication Division of the New York section of AIEE is offering a fall, winter and spring study-group course in Telecommunication Technology. The fall session on transmission media is under way now; the final three meetings are scheduled for Nov 10, 17, and 24.

The winter session on transmission techniques starts Jan. 12 and meets weekly through Feb. 23. All meetings run from 7 to 9 P.M. and are held

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PAPER DEADLINES

Convention Program Chairmen have issued the following deadlines to authors wishing to have their papers considered for presentation.

December 15: Deadline for abstracts of 150-200 words for the 1960 Electronic Components Conference scheduled for May 10-12 in Washington, D. C. Please send in triplicate to: *Gilbert B. Devey, Technical Program Chairman, Sprague Electric Co., North Adams, Mass.*

November 2: Deadline date for Transaction papers for the American Institute of Electrical Engineers scheduled for next January 31 through February 5, 1960, in New York City. (December 2: Deadline for full text of conference papers—preprints only). Abstracts of prospective papers are needed as soon as possible. Address all correspondence to: *G. L. Hollander, Chairman, c/o Philco Corp., 4700 Wissahickon Ave., Philadelphia 44, Pa.*

November 9: Deadline date for papers for the 1960 Western Joint Computer Conference scheduled for next May 3-5 in San Francisco, Calif. Papers to be submitted to the Technical Program Committee should be prepared on the basis of a thirty-minute delivery. No advance abstract of the paper will be required. Forward three copies of the original draft to: *H. M. Zeidler, Chairman, Technical Program Committee, 1960 Western Joint Computer Conference, Stanford Research Institute, Menlo Park, Calif.*

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From 2-ring to 500-ring assemblies ... currents as high as 350 amps continuous at 220 volts and 700 amps overload at 220 volts. Special high voltage designs available; radio frequency assemblies ... high speed rotation for thermocouple and strain gage applications. Also segmented ring assemblies for accurate sequencing and timing.

Consult us or write for detailed literature.



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FOR A CHECKUP

A year ago, he was only reading about cancer, just as you are now. But cancer was something that happened to the other fellow. No need for *him* to go to a doctor.

Now that he knows better, it is unfortunately too late. He is one of the 75,000 cancer patients who will die needlessly this year because they did not see their doctors in time.

... AND A CHECK

Nor could he see any reason, last year, for backing the fight against cancer with his dollars.

But cancer always strikes close to home—in two of every three families, to be exact. This toll can be reduced by supporting the medical counterattack with a contribution.

The other fellow? He's always one of us. Some find it out the hard way. What will it take to convince you?

*Guard your family—
fight cancer with a
checkup and a check.*

Send your check to "Cancer,"
c/o your local post office.

AMERICAN CANCER SOCIETY

New PRECISION
FREQUENCY

STATIC INVERTER SUPPLY

INPUT 28V D.C. \pm 10%

OUTPUT Nom. 115V \pm 2%

400 CPS \pm 0.01%

1 \emptyset (2- or 3-phase output available)

RATINGS: 30VA 50VA 100VA

Higher ratings available.

APPLICATION:

For gyro wheel supplies and where precise 400 cycle voltages are required in aircraft, radar and missile computers.



FEATURES:

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- VIBRATION ISOLATED
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- LIGHTWEIGHT
- MILITARY SPECIFICATIONS

(Send for Bulletin S-864)



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SHAGGY FISH STORY

At the height of the Boston Tea Party, while the "Indians" were busy throwing everything in sight over the side, the British radar operator suddenly found himself pitched overboard.

Since he couldn't swim, he clung precariously to a wooden tea case bobbing in the water, and floated aimlessly around, thrashing wildly and yelling for help.

Just as he was about to lose his grip on his precious raft, a codfish surfaced nearby.

"What's going on here?" the codfish asked.

"Some wild Indians surprised our radar, overran the ship, and threw all the tea overboard," the radar man gasped.

"Well," the codfish said, "Bet you a fin you didn't have any Bomac tubes* in that radar of yours."

"Good cod, here I am drowning in front of your eyes and you have to give me a commercial," the man said. "I can't hang on much longer!"

The fish ignored him. "... Anybody knows Bomac makes the finest microwave tubes and components either side of Boston Harbor," he said.

"Look," the man said. "I've just about haddock. But tell me this: How do you know so much about microwaves?"

"I'm no expert," the codfish said. "I just dabble in it for the halibut."

"O," the man said. And he sank silently into the sea.

No. 16 of a series . . . BOMAC LOOKS AT RADAR THROUGH THE AGES



* Bomac makes the finest microwave tubes and components either side of Boston Harbor



BOMAC

Leaders in the design, development and manufacture of TR, ATR, Pre-TR tubes; shutters; reference cavities; crystal protectors; silicon diodes; magnetrons; klystrons; duplexers; pressurizing windows; noise source tubes; high frequency triode oscillators; surge protectors.

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