

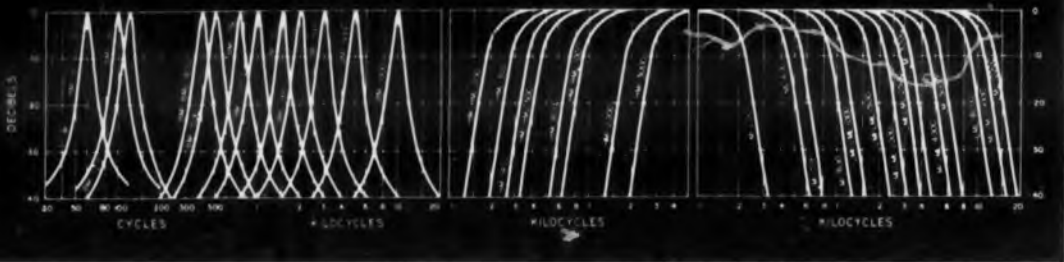


FILTERS

HERMETICALLY SEALED TO MIL-T-27A & MIL-F-18327

FOR ALL
APPLICATIONS
FROM STOCK

UTC INTERSTAGE AND LINE FILTERS



This standardized group of filters covers most popular filter applications and frequencies. Units are in compact, drawn, magnetic shielding cases... 1 1/4 x 1 1/4 base, 1 1/2 high for BMI, LMI, BML; others 2 1/2 high. There are six basic types:

BMI band pass units are 10K input, output to grid 2:1 gain. Attenuation is approximately 2 db at 3% from center frequency, then 40 db per octave.

HMI high pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at .67 cut-off frequency.

LMI low pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at 1.5 cut-off frequency.

HML high pass filters are same as HMI but 500/600 ohms in and out.

LML low pass filters are same as LMI but 500/600 ohms in and out.

BML band pass units are same as BMI but 500/600 ohms input, output to grid, 9:1 gain.

STOCK TYPES
(number in figure is cycles)

BMI-60	BMI-10000	LMI-800	HML-300
BMI-100	HMI-200	LMI-1000	HML-500
BMI-120	HMI-400	LMI-1500	HML-1000
BMI-400	HMI-500	LMI-2000	LML-1000
BMI-500	HMI-800	LMI-2500	LML-1500
BMI-750	HMI-1000	LMI-3000	LML-2000
BMI-1000	HMI-2000	LMI-4000	LML-2500
BMI-1500	HMI-3000	LMI-5000	LML-4000
BMI-2000	LMI-200	LMI-10000	LML-6000
BMI-3000	LMI-400	BML-400	LML-10000
BMI-4000	LMI-500	BML-1000	LML-12000
BMI-5000		HML-200	



UTC TELEMETERING BAND PASS FILTERS

STOCK TYPES
(number in figure is KC)

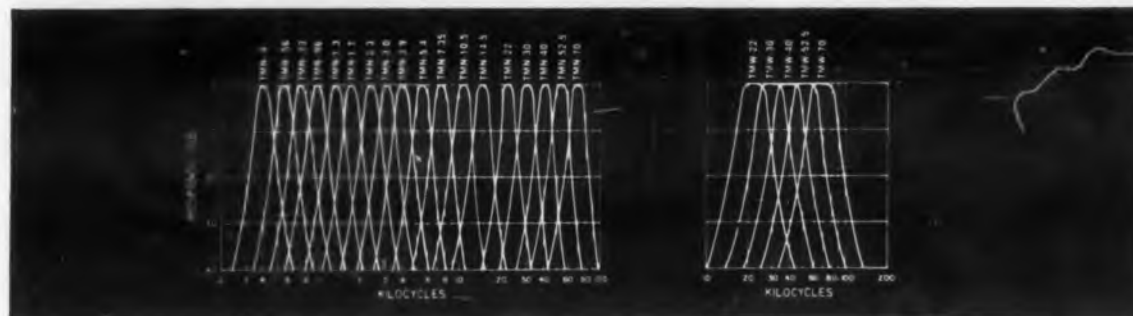
TMN-4	TMN-2.3	TMN-14.5	TMW-22
TMN-56	TMN-3.0	TMN-22	TMW-30
TMN-73	TMN-3.9	TMN-30	TMW-40
TMN-96	TMN-5.4	TMN-40	TMW-52.5
TMN-1.3	TMN-7.35	TMN-52.5	TMW-70
TMN-1.7	TMN-10.5	TMN-70	



TMN-4 thru TMN-1.7
1 1/4 x 1 1/4 x 2 inches
Weight 3.5 oz.



TMN-2.3 thru TMW-70
3/32 x 5/32 x 1 3/8 inches
Weight 1.2 oz.



UTC standard telemetering filters provide extreme miniaturization with maximum stability, a complete set of 18 filters taking 19 cubic inches. They are 100K in and out and have an insertion loss of less than 6 db, 4 pin header for small Winchester socket.

TMN units are within 3 db at $\pm 7.5\%$ of center frequency... down more than 18 db at $\pm 25\%$... more than 40 db beyond 1.75 and .58 center frequency.

TMW are within 3 db at $\pm 15\%$ of center frequency... down more than 20 db at $\pm 50\%$... more than 40 db beyond 2.5 and .4 center frequency.

STOCK TYPES
(number in figure is cycles)

RECEIVING

TGR-425	TGR-1785
TGR-595	TGR-1955
TGR-765	TGR-2125
TGR-935	TGR-2295
TGR-1105	TGR-2465
TGR-1275	TGR-2635
TGR-1445	TGR-2805
TGR-1615	TGR-2975

TRANSMITTING

TGT-425	TGT-1785
TGT-595	TGT-1955
TGT-765	TGT-2125
TGT-935	TGT-2295
TGT-1105	TGT-2465
TGT-1275	TGT-2635
TGT-1445	TGT-2805
TGT-1615	TGT-2975



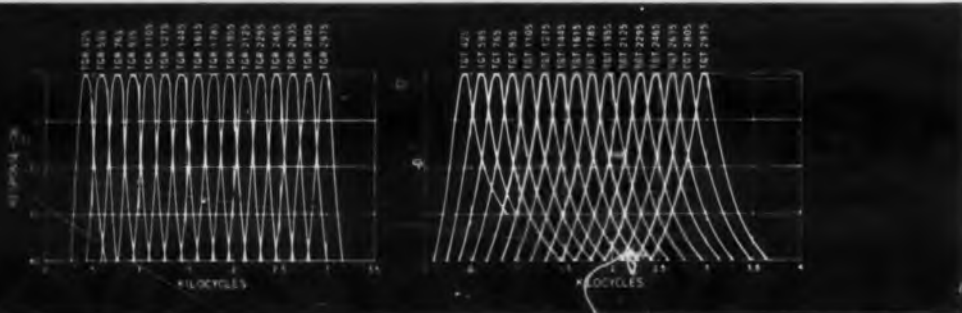
TGT CASE

1 1/2 x 1 1/2 x 2 1/2 in. 8 oz.

TGR CASE

1 1/2 x 1 1/2 x 4/4 in. 15 oz.

UTC TELEGRAPH TONE CHANNEL FILTERS



These band pass filters for multiplex transmitting and receiving provide maximum stability in miniature sizes. Both receiving and transmitting types are 600 ohms in and out, and employ 7 terminal header for sub-miniature 7 pin socket.

TGR receiving filters are within 3 db at ± 42.5 cycles from center frequency... down more than 30 db at ± 170 cycles... down more than 15 db at adjacent channel cross-over.

TGT transmitting filters are within 3 db at ± 42.5 cycles from center frequency... down more than 16 db at ± 170 cycles... down more than 7.5 db at adjacent channel cross-over.

HIGHLIGHTS OF ISSUE



Design '59—Challenges Facing Design Engineers (Cover) 20

In Year Two of the Space Age, demands on the designer's talents are heavy, not only in "glamour" fields like missiles, spacecraft, radar and computers, but in the prosaic but nonetheless vital areas of communications, consumer products, components, industrial and medical electronics. New and old problems are many, ranging from rfi to less-than-perfect reliability.

Mesa Switching Transistor . . 42

The T12N559 offers high switching speeds, high alpha cutoff, and higher power in one tiny package. It is in full scale production.

FM Tuning Unit 44

Practical approach in consumer product design achieves economy without sacrifice in performance or quality.

NEXT ISSUE A Microminiaturization Series Starts

Starting in the next issue, the first articles of an exclusive series on microminiaturization based on papers delivered at the Symposium on Microminiaturization of Electronic Assemblies sponsored by the Diamond Ordnance Fuze Laboratories.

Russian Book on Nonlinear Radio Engineering to be offered by ELECTRONIC DESIGN. See 120.

And Special Units to
Your Specifications

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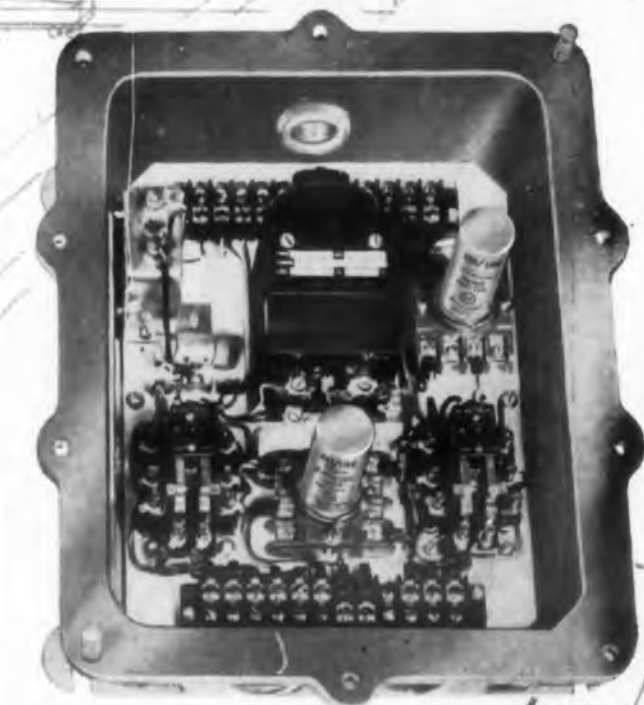
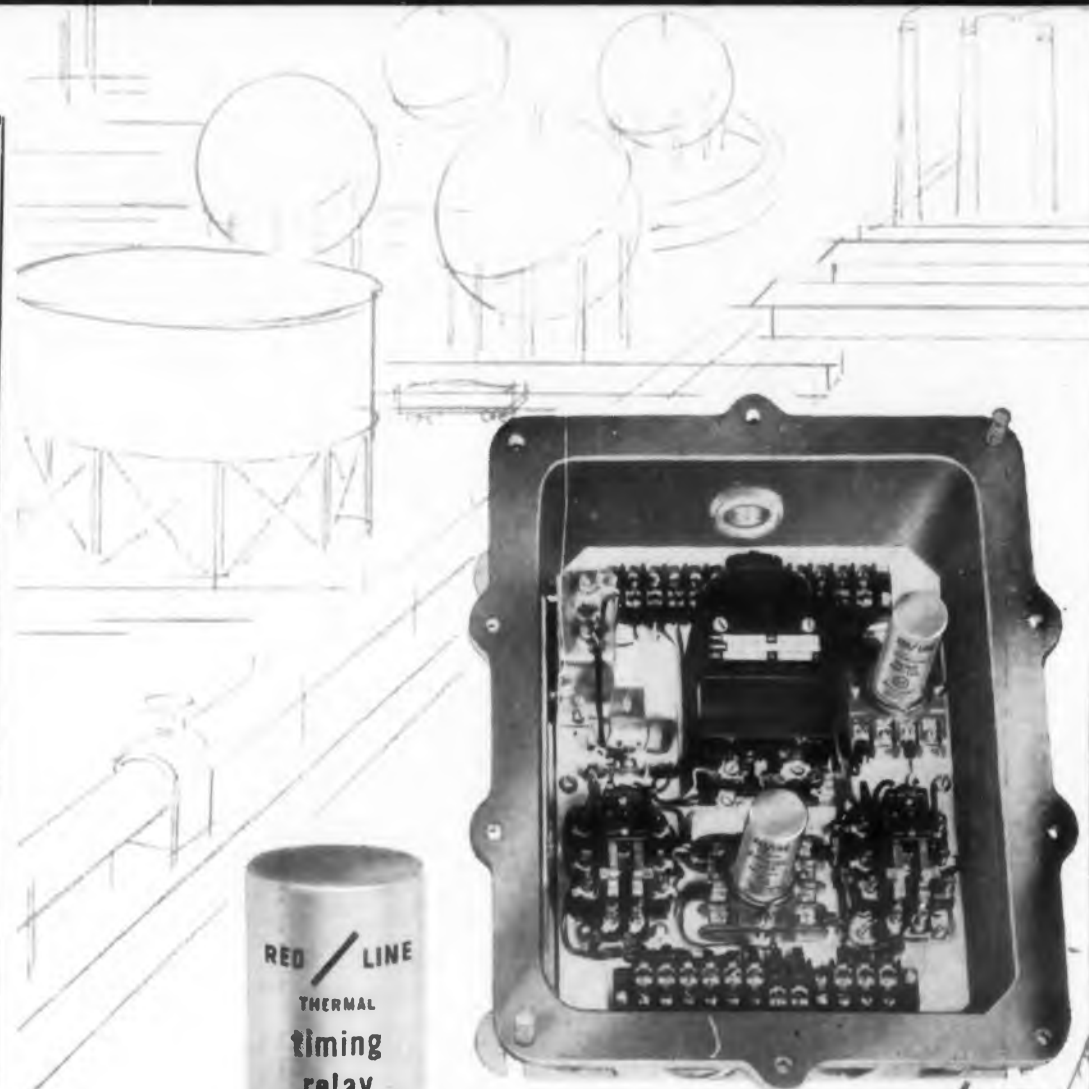
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THE LIBRARY OF CONGRESS SERIAL RECORD

JAN 8 - 1959



Robertshaw-Fulton

G-V stands guard with Robertshaw to detect harmful vibration...

Abnormal and persistent vibration in rotating equipment usually means costly trouble. Robertshaw-Fulton's Vibraswitch Detectors and Model 651 control units detect vibration and shut down valuable equipment before damaging trouble develops.

Two G-V Red Line Thermal Time Delay Relays are used in each control unit. One blocks out the vibration detector while the protected equipment is starting up. The second times the duration of vibration and permits shut-down only if trouble persists.

Absolute reliability of every component is vital in a protective system of this sort. G-V Red Line Delay Relays meet this requirement for reliability ... at surprisingly low cost. Apply them in your equipment and be safe.

Write for Publication 131.

G-V CONTROLS INC. LIVINGSTON, NEW JERSEY WRITE IN 2 ON READER-SERVICE CARD



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CK5842

CK5847

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High gain

LOW noise
WIDE band



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Reliable FRAME GRID*
MINIATURE TUBES

for military and industrial microwave relay I. F. service



CK5842 (417A) Triode*		CK5847 (404A) Pentode
25000	G_m (μ mhos)	13000
25.0	I_p (mA)	13.5
9.0	C_{in} (μ mf)	7.2
1.8	C_{out} (μ mf)	3.15
—	C_{G-P} (μ mf)	0.05 max.
0.55 max.	C_{P-K} (μ mf)	—



*Grounded Grid Service

Tubes shown actual size

*Raytheon Frame Grid construction assures: strength and rigidity
high transconductance • low capacitance • low microphonics



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BEHIND THE NEWS

Challenges Pinpointed at Communications, Computer and Connector Conferences

IN SUNNY St. Petersburg and windy Chicago, in Philadelphia and in Dallas, delegates gathered last month to discuss a theme universal to all electronic design engineers, regardless of their specialties. Their common topic was the challenges facing them in the immediate as well as the far future, and the developments they anticipated ranged from a 10,000 mc "information pipe" to electrical connections rugged enough for outer space.

The delegates, thousands of them, pinpointed design problems in technical sessions at the Second National Symposium on Global Communications at the Ninth National Conference of the IRE Professional Group on Vehicular Communications, at the Eighth Eastern Joint Computer Conference, and at the Third EIA Conference on Reliable Electrical Connections.

Looking to the far future, IRE president Don G. Fink told the Globe-Com II delegates in Florida that one day a 10,000-mc "information pipe" would be wired into every city and suburban home, just as water and gas connections are today. Over this super-bandwidth cable would come almost every conceivable service—TV, video telephone, audio-visual magazines.

Rapid advances in wire communications in the next few decades will make this possible, said Fink. Already, he told the 900 delegates, Bell Labs engineers have a submarine-type cable on their drawing boards capable of 3 mc bandwidth. Such a cable would make trans-Atlantic television possible.

It may be another 10 years, however, before transoceanic TV goes into operation, Fink said. Installation date of the first such cable will be governed by demand for service, and by economics of operation.

Wireless Overloaded

Wireless, dominant for 40 years or so, is choking itself out of existence because of its own rapid growth. Now, said Fink, wire and cable will become all the more important.

High reliability and efficiency are the major advantages of wire communication links, he pointed out. Except in unusual circumstances, there is no fading or interruption from man-made interference.

Today's methods of point-to-point communication are inefficient, said Fink. Broadcast techniques are used to communicate between two stations. Microwave links are directional, but equipment efficiency is low—and tropo-scatter links are even more inefficient. Again, cable networks would seem to be the answer, he said.

Faster and more reliable global communications was the theme of Globe-Com II technical papers. James E. Hacke, Jr., of GE predicted demand for message facilities will double in the next 12 years. But he anticipated no major technical advance in that period.

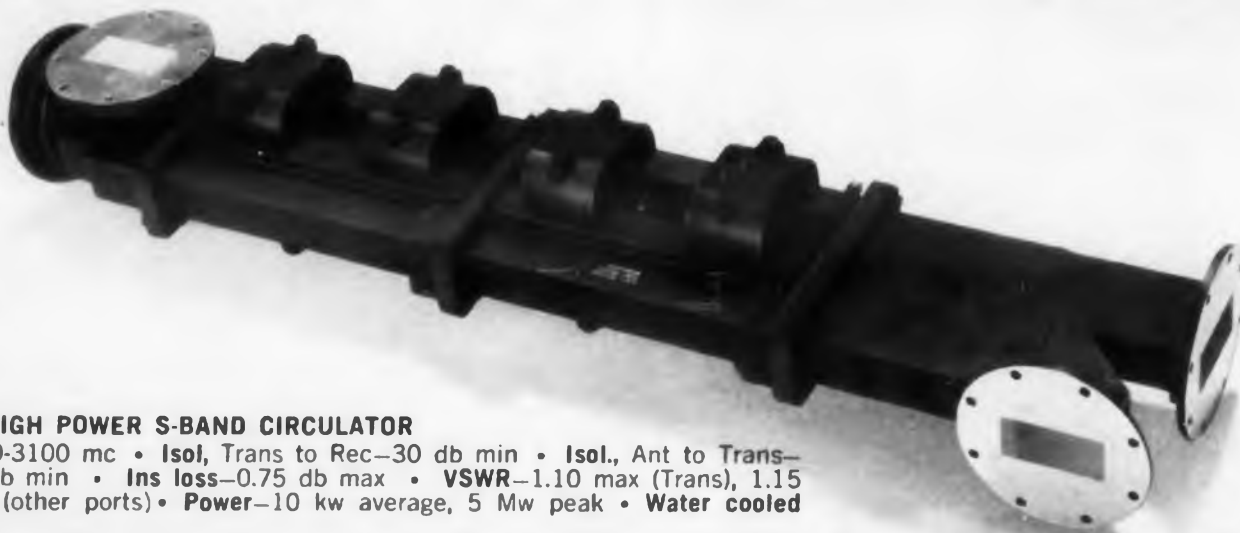
By 1970, Hacke said, air travel also will double. And this will add to demands on communication facilities, probably forcing the industry into the age of machine-to-machine communication. In



IRE president Don G. Fink predicts: An "information pipe" for everyone.

For the challenges facing the entire industry, read the special report starting on page 20.

Recent Raytheon developments in microwave ferrite devices



1. HIGH POWER S-BAND CIRCULATOR

2600-3100 mc • Isol, Trans to Rec—30 db min • Isol., Ant to Trans—20 db min • Ins loss—0.75 db max • VSWR—1.10 max (Trans), 1.15 max (other ports) • Power—10 kw average, 5 Mw peak • Water cooled



2. HIGH POWER L-BAND ISOLATOR

1250-1350 mc • Isol.—11 db min • Ins loss—0.55 db max • VSWR—1.15 max • Peak power—3 Mw • Av power—2.5 kw (cooled); 1.0 kw (uncooled)



3. HIGH POWER S-BAND ISOLATOR

2750-3050 mc • Isol—10 db min • Ins loss—0.6 db max • VSWR—1.10 max • Peak power—3 Mw (pressurized) • Av power—3 kw (water-cooled)

For those lower microwave frequencies...

THREE ADVANCED RAYTHEON FERRITE DEVICES FOR MAXIMUM SYSTEM EFFICIENCIES



MICROWAVE SYSTEM DESIGNERS: Raytheon's constantly expanding line of ferrite devices now covers over 100 units for use in all bands from UHF to K_V band. These new devices for the lower frequencies offer advantages you'll want to know about. *Drop us a line for details.*

... **WRITE FOR COMPREHENSIVE BROCHURE:** Ten pages of facts about microwave ferrite devices and their applications written by Raytheon's Dr. Colin Bowness. For your copy, write today to the address below.

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BEHIND THE NEWS

global telephone traffic, he said, human operators will become extinct.

Two rival systems of world-wide communications were explored. Dr. Joseph Vogelmann, Rome Air Development Center, presented a paper by RADC's Charles Strom and Allan Kunze evaluating development trends in Air Force global communications, dwelling particularly on AF Project 456L. The paper outlined goals in radio relay and scatter equipment, and disclosed the switching complex and tentative system standards.

The Army's rival Universal Integrated Communications System (Unicom) was the subject of a discussion by a panel of Signal Corps experts, moderated by Col. George P. Sampson, Chief, Army Communications Service Division.

Mark Time on Both

Unicom has the same basic objectives as the AF 456L system. Reports indicate both may be temporarily curtailed by the Defense Department until it is decided which project will be developed into a working system.

Looming importantly in any discussion of global communications was the use of earth satellites. Several technical paper authors discussed parameters necessary for reliable long-distance networks using active and passive satellite relays. One stated that if 72 satellites were equally spaced, revolving around the earth, there would be a maximum wait of less than three seconds before a message could be successfully relayed.

In Chicago, meanwhile, vehicular communication engineers were unanimous in stressing the urgent need for getting additional frequencies allocated to them.

EIA studies to support the demand for additional 40 mc frequency allocations for land-mobile radio services cited figures showing that mobile communication transmitters have increased from 37,000 in 1947 to 700,000 in 1950. Within 10 years, the studies indicated, 2,800,000 such transmitters will be in operation (excluding telephone service) for such fields as mining, agriculture, taxi, utility and manufacturing.

GE's Harrison Van Akens said the future of land-mobile radio may hinge on FCC hearings this year and stressed the urgency of FCC reallocation of service priorities. A reasonable sequence of priorities, he said, might start with national defense, then continue with public safety, travel safety, communications, education, entertainment, research, public correspondence and, finally, hobby purposes.

Efforts to increase available spectrum space have resulted in splitting the 25-50 mc spectrum into 20 kc rather than 40 kc channels, and the

152-162 mc spectrum into 30 kc instead of 60 kc channels. But delegates among the 350 engineers at the sessions said these changes have imposed severe restrictions on both transmitter and receiver design and operation.

Indicating how tight the space situation will grow, Bell Telephone System said that in the next 10 years, 7,000,000 to 15,000,000 autos will be equipped with mobile radio equipment.

Whether the answer is frequency reallocation, or whether newer transmission techniques also will be required, remained unanswered.

Computer for Every City

Future needs also dominated the Philadelphia gathering of 2400 computer engineers. Typical of the ideas presented at the "blue sky" panel discussions was this vision:

"Every major city will have a computer center. Computer services will be available to anyone for a fee—just like telephone or power distribution services. The computers may help people fill out their income tax returns . . ."

Papers ranged over a wide area, from "Data Processing in Banking and Other Service Industries" to "New Logical and Systems Concepts."

Perhaps the most significant news to emerge from the meeting was the fact that there are no new vacuum tube computers. All computers now on drawing boards use solid-state electronics.

In Dallas, engineers concerned with reliable connections entered into controversy on almost all aspects of the field, but reached agreement on one dictum: good workmanship and cleanliness are essential at all stages during the production of electrical connections. Poor workmanship was blamed for defeating many of the best efforts of engineers to design improved systems.

But areas of contention included hand vs. automatic soldering of printed circuit boards, crimp vs. solder connections, and the basic definition of what constitutes a connection failure.

Some engineers said resistance meant failure; others said it was a definitely open circuit. In printed circuit boards, some insisted hand soldering was the only reliable method, others said the whole purpose was to attain automated soldering techniques. Agreed was that there are practically no prosaic problems in electronics.

For the future, engineers were warned of the need for electrical connections that will withstand the high stresses of outer space. Already, it was testified, there is a necessity for soldered connections to function at 400 to 500 F or down to -200 F.

(A special report on electrical connections will appear in the Feb. 18, 1959, issue of ELECTRONIC DESIGN.)



MAXIMUM TELEMETERED RESPONSE THROUGH FLAT AMPLITUDE AND CONSTANT DELAY

In keeping with its reputation as a pioneer in the field of toroids, filters and related networks, Burnell & Co. now offers a complete line of low pass and band pass constant delay filters for standard RDB telemetering channels. These Burnell constant delay filters combine accurate amplitude and phase to effectively limit intelligence distortion and false transients to a minimum. Telemetered signals from off course missiles or those in distant or terminal flight are no longer blocked by attenuation and noise.

Amplitude and Phase Necessary

For maximum performance of telemetering systems, it is recognized that filtering of sampled data requires *both* linear phase and flat amplitude in the pass band. However, until recently a combination of the two in one unit had not been available.

Combination Achieved

Existing sub carrier discriminators afford no better than a choice of flat amplitude pass band with *non-linear* phase in one filter or a constant time delay filter with *distorted amplitude*. In contrast, Burnell constant delay filters combine both—are flat within 3 db over the pass band—1½ db for the low pass filters—and possess a time delay constant within 5%.

Write for Bulletin CD 051 Dept. D13.

TECHNICAL DATA

FOR ± 7½% PASS BAND

- 1 Flat within 3 db over pass band
- 2 21 db at ± 15% of center freq.
- 3 40 db at ± 22% of center freq.
- 4 Time delay over the pass band, constant to ± 5%

FOR ± 15% PASS BAND

- 1 Flat to 3 db over pass band
- 2 23 db at ± 30% of center freq.
- 3 40 db at ± 44% of center freq.
- 4 Time delay over pass band constant to ± 7%

Input impedance — 500 ohms

*Output impedance — 500 ohms and high impedance for operation to a grid

*optional impedance available on special order.

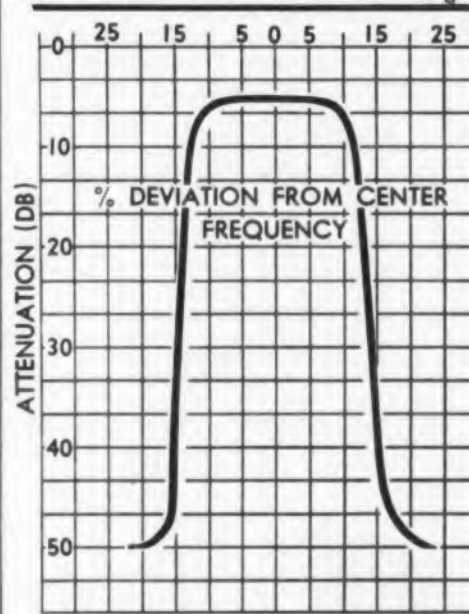
CONSTANT DELAY BAND PASS

Channel	Frequency	Part #	Delay in ms.	B/W
1	4 KC	S-60051	34.00	15%
2	.56 KC	S-60052	24.30	15%
3	.73 KC	S-60053	18.60	15%
4	.96 KC	S-60054	14.20	15%
5	1.3 KC	S-60055	10.50	15%
6	1.7 KC	S-60056	8.00	15%
7	2.3 KC	S-60057	5.93	15%
8	3.0 KC	S-60058	4.40	15%
9	3.9 KC	S-60059	3.38	15%
10	5.4 KC	S-60060	2.44	15%
11	7.35 KC	S-60061	1.80	15%
12	10.5 KC	S-60062	1.26	15%
13	14.5 KC	S-60063	0.91	15%
14	22. KC	S-60064	0.60	15%
15	30. KC	S-60065	0.44	15%
16	40. KC	S-60066	0.33	15%
17	52.5 KC	S-60067	0.252	15%
18	70. KC	S-60068	0.189	15%
A	22. KC	S-60069	.305	30%
B	30. KC	S-60070	.224	30%
C	40. KC	S-60071	.168	30%
D	52.5 KC	S-60072	.128	30%
E	70. KC	S-60073	.096	30%

CASE SIZE—2" x 3½" x 4½"

* INPUT IMPEDANCE = 500 ohms

* OUTPUT IMPEDANCE = 500 ohms and to grid



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PIONEERS IN TOROIDS, FILTERS AND RELATED NETWORKS

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New Speed...Versatility...Reliability...



**TRANSISTORIZED DIGITAL
MAGNETIC TAPE HANDLER
MODEL 906**

• Check these new standards
of reliability and performance

- Completely transistorized for maximum reliability
- Trouble free brushless motors
- Over 50,000 passes of tape without signal degradation
- Linear servo system
- Life expectancy of pinchroll mechanism: over 100,000,000 operations
- Skew ± 3 μ sec $\frac{1}{2}$ " tape, center clock at 100 i.p.s.
- Vacuum loop buffer
- Continuous flutter free cycling 0 to 200 cps
- Normal speed up to 100 i.p.s.
- Rewind or search speed constant at 300 i.p.s.
- Six speed forward or reverse up to 150 i.p.s.
- Better than 3 milliseconds start, 1.5 millisec. stop
- Front panel accessibility
- In line threading
- End of tape and tape break sensing
- All functions remotely controllable
- Tape widths to $\frac{1}{4}$ "

The 906 is usually supplied with the Potter 921 transistorized Record-Playback Amplifier; a unit that features:

- | | |
|------------------------|---|
| Pulse or level outputs | Manual, relay, or electronic function switching |
| Output gating | Dual read-write operation |
| 1 i.p.s. to 150 i.p.s. | |

Potter also manufactures a complete line of Perforated Tape Readers, High Speed Printers and Record-Playback Heads

Contact your Potter representative or call or write direct for further information.



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Potter has career opportunities for qualified engineers who like a challenge, and the freedom to meet it.

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BEHIND THE NEWS

**Large Reciprocating Gas Compressors
Controlled From 40 Miles Away**



Reciprocating gas compressor station at Linden, shown with entire operating staff.



Sole attendant at Linden compressor station replaces chart paper about once a month.



This console at Lambertville, N. J. controls three compressors at Linden, 40 miles away. It starts and stops the engines; it controls and monitors all vital parameters; it even detects fire, explosive mixtures, and unauthorized entry of personnel.



OR
ciproc
ion is t
rol. Th
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over tel
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The I
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clean. F
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FOR THE first time, a large reciprocating gas compressor station is under complete remote control. Three 2050 hp natural gas compressors at Linden, N.J., are controlled from another station at Lambertville, N.J., about 40 miles away. Controlling signals are sent over telephone lines or over a microwave link in the form of discrete tones.

The Linden station of the Texas Eastern Transmission Corp. has one man in attendance on a forty-hour a week basis. He keeps the building clean. He wipes and oils the engines. He replaces oil filters and chart paper and sees that things are shipshape. But he has nothing to do with the plant's operation.

All controls are either pneumatic or electronic. The principal objection to the electronic controls is the requirement for costly, explosion proof housings for switches, relays, and other equipment. So, where line length permits, pneumatic controls are used.

Electronic equipment records all vital information for correct operation of the station, and controls most of the important engine parameters. Engine controls such as starting air, jet air, cylinder end-pocket clearance, cylinder valves, and fuel gas are all operated by electronically sequenced controls.

Sylvania Packaging Its Maser for Aircraft

Sylvania Research Laboratories announced that the maser in the near future will be reduced from unwieldy laboratory size and packaged for military aircraft.

This revolutionary device is expected to increase the range of radar up to seven times, and boost substantially the "seeing" power of other electronic equipment.

Dr. Robert M. Bowie, vice president of the laboratories, said Sylvania is engaged in a program to ruggedize, miniaturize and package the maser so it may be used initially in military applications, and ultimately in industry and peacetime scientific research.

WRITE IN 7 ON READER-SERVICE CARD

First from **PHILCO**

MADT* TRANSISTORS CONTROLLED IN DESIGN AND MANUFACTURE ...

to meet your exact
circuit requirements
... **NOT SELECTED!**



Actual photo of Philco's out-front automatic precision etching production equipment.

*Trademark Philco Corporation for Micro Alloy Diffused-base Transistor.

New VHF-UHF Transistors available in unlimited quantities - at realistic prices!

NOW, TRANSISTOR CENTER, U. S. A., offers a new family of MADT (field flow) transistors in unlimited quantities. Here are precision transistors which greatly expand the design potentials of high-gain, high frequency amplifiers; high speed computers; high-gain, wideband video amplifiers; and other critical high frequency circuitry.

Due to Philco's exclusive electrochemical manufacturing process, MADT's are *controlled not selected*. The electrodes are precisely placed in the graded field to produce the exact characteristics you require. MADT's are available immediately in unlimited quantities. Quantities 1 to 99 available "off-the-shelf" from your local franchised Philco Industrial Transistor Distributor.

Make Philco your prime source of information for high frequency transistor applications.
Write to Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa., Dept. ED 159

MADT FAMILY APPLICATIONS DATA

TYPE*	f _{max}	Power Gain	Oscillator Efficiency	Class of Use
2N499	320 mc	10 db at 100 mc		amplifier to 125 mc
2N500			45% at 200 mc	Oscillator to 350 mc
2N501	Ultra high-speed switch typical t _r = 9 μsec; (18 max.); t _f = 9 μsec; (12 max.); t _l = 7 μsec; (10 max.) in circuit with current gain of 10 and voltage turnoff.			
2N502†	800 mc	11 db at 200 mc		amplifier to 250 mc
2N503†	420 mc	12.5 db at 100 mc		amplifier to 175 mc
2N504	50 mc (min.)	46 db at 455		high gain IF amplifier
2N588	250 mc	14 db at 50 mc		Oscillator and amplifier to 80 mc

*Available in voltage ratings up to 35 V and dissipation ratings to 50 mw at 45°C.
†In JETEC TO-9 Case (Widely known as JETEC 30 Case).

PHILCO CORPORATION
LANSDALE TUBE COMPANY DIVISION
LANSDALE, PENNSYLVANIA

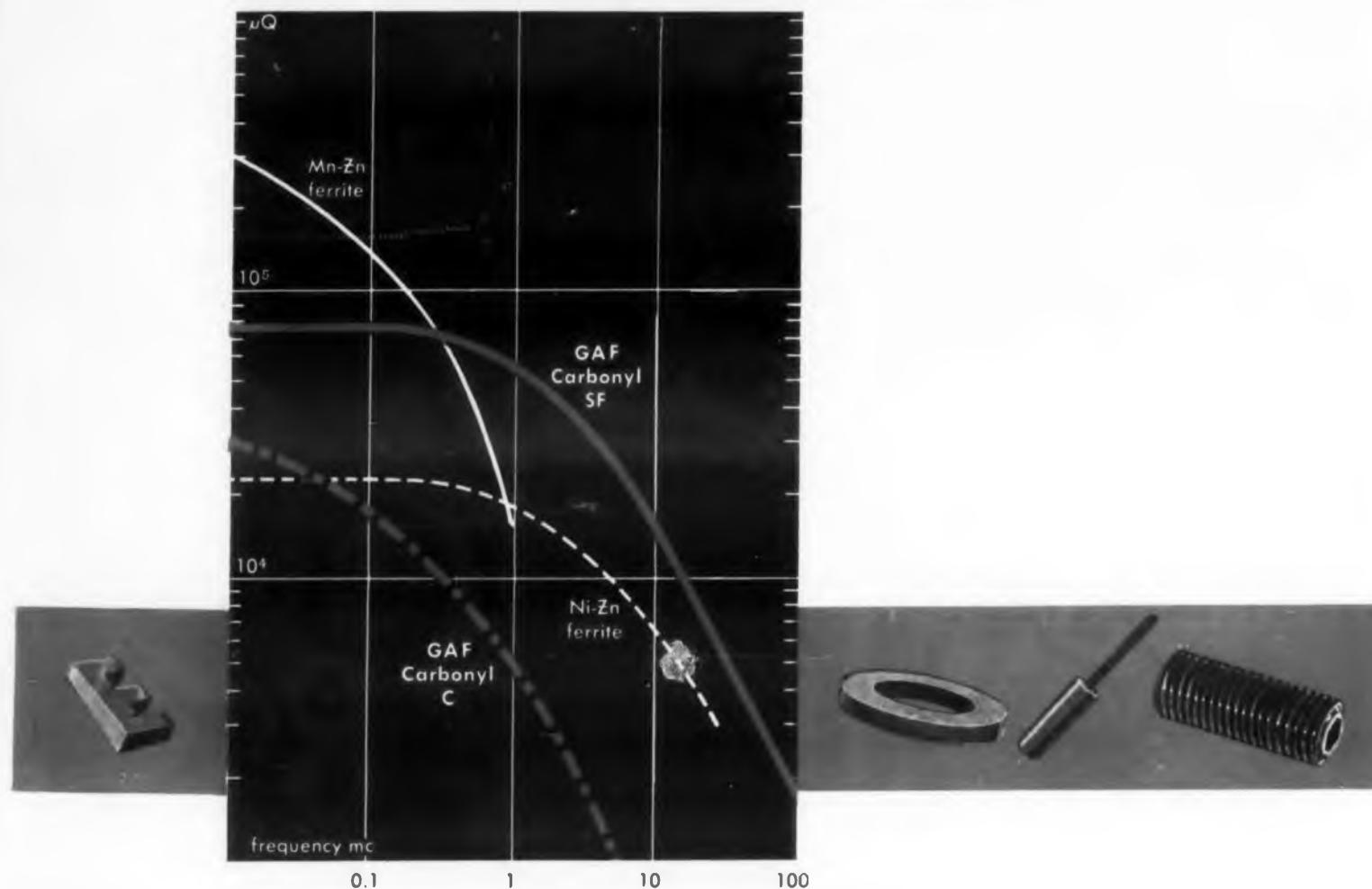


GAF CARBONYL IRON POWDERS

For the production of superior cores
for high frequency induction coils.

lower cost · higher quality · proven stability · ease in handling

HERE ARE FACTS THAT PROVE THE VALUE OF GAF
CARBONYL IRON POWDERS AS CORE MATERIALS —



The selection of the proper magnetic core material for the frequency range an inductance coil will be used is of utmost importance.

GAF Carbonyl Iron Powders are the proper materials in the frequency range 100 kc to 150 mc and higher. The above chart proves the value of the selection using the highly desirable relationship of the μQ product versus frequency.

Heat, cold, humidity, atmospheric influences, stray fields and similar con-

ditions — any of these can have an adverse effect on the core materials and on the final performance of the equipment.

An iron core made with GAF Carbonyl Iron Powders has a high degree of stability — and is thereby protected against these many influences.

We urge you to ask your core maker, your coil winder, your industrial designer, how GAF Carbonyl Iron Powders can increase the efficiency and performance of the equipment or prod-

uct you make, while reducing both the cost and the weight.

This 32-page book offers you the most comprehensive treatment yet given to the characteristics and applications of GAF Carbonyl Iron Powders. 80% of the story is told with photomicrographs, diagrams, performance charts and tables. Write today for your free copy.



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WRITE IN 8 ON READER-SERVICE CARD

BEHIND THE NEWS

Fiction Plots Made Real For American Rocketeers

Science-fiction's classic plots were translated into near-future possibilities at the American Rocket Society's 13th annual meeting, first since dawn of the Space Age. Sober discussions ranged from invisible force fields to international V-mail via satellites, from mice and man in space to heat and acceleration effects on cosmic travelers.

Delegates to the sessions had the mood set for them by Princeton's Russell M. Kulsrud, who declared that the new science of hydromagnetics (or magnetohydrodynamics) may turn into reality the fiction writer's dream of an invisible force field to deflect enemy missiles.

Intangible Field vs. Tangible Object

The Project Matterhorn researcher said intangible magnetic fields not only could deflect but could handle missiles and other concrete objects so long as they are highly conducting.

For more immediate application, Kulsrud said, hydromagnetics offers obvious advantages in the field of rocket propulsion, where burning fuel reaches such temperatures it can damage combustion chamber walls.

Magnetic fields, said the physicist, constitute the only known way to keep a thermonuclear plasma away from walls of a containing chamber long enough to allow nuclear reactions to take place, and to permit the removal of useful power from the fusion reaction.

The Re-Entry Problem

In addition, hydromagnetics can be useful in re-entry, where hot ionized gases can severely damage a vehicle hitting the atmosphere at very high speeds.

This re-entry problem also was analyzed by North American Aviation's Earl T. Carter and M. W. Jack Bell from the standpoint of crew survival. Minimal performance could be expected of men working just below 250 F, they said. But as that top limit would be reached in the vehicle's cabin 250 to 300 seconds after re-entry begins, unprotected occupants could not perform effectively after that time, and probably would be fatally burned before completion of the descent. The answer: pressure suits designed to reduce interior temperatures.

Keeping the Crew Alive

Crew survival also was the problem discussed by Wright Air Development Center's Col. John P. Stapp of rocket sled fame, but his concern

as protecting men against acceleration. The Air Force officer, president-elect of the Society, told members that man definitely is capable of enduring the accelerations necessary for attaining orbital or escape velocity with present three-stage rocket systems. He also can sustain the prolonged exposure to low acceleration required for re-entry.

Man will not enjoy these ordeals, nor will he be spared them until space vehicles are designed in compliance with parameters of human effectiveness rather than man's survival limits, said the Aeromedical Lab chief.

The research goal, a promising one, is development of propulsion systems with continuous low acceleration. Man, Stapp said, can effectively handle extremely long accelerations that do not exceed 4 g's. And one hour at only 3 g's would get a vehicle to a speed 10 times greater than escape velocity.

Man Can Take 10 g's

But if no method of propulsion can be developed within man's range of physiological adjustment, if the present means of three-stage rockets must be relied on to propel him into space, man can take it. Stapp warned, however, that 10 g's is the limit, and crewmen must be optimally positioned for forces above 4 g's.

For transverse accelerative forces, such as Stapp personally tested in his rocket sled rides, survival limit for lightly anesthetized chimpanzees restrained by nylon webbing, he said, was reached at 236-g peak with 11,250-g per sec rate of onset and 0.35 sec total exposure duration.

Not only chimpanzees, but mice too can stand high-g stresses. F. L. van der Wal and W. D. Young of Space Technology Labs, in the first full public report on the Air Force Mouse-in-Able (MIA) program, revealed at least two mice survived re-entry from 1400 miles up.

First U.S. Space Travelers

On April 23, July 9 and July 23, Able vehicles carried mice in special MIA packages mounted in nose cones, but only the last two mice—named Laska and Benji—were instrumented.

Telemetry data on the July flights indicated take-off conditions were not severe enough to produce violent or continuing response from Laska and Benji. There was no evidence of distress due to weightlessness, though they were flightless for longer periods than any animal apt Sputnik II's Laika. (The American mice were some 350 miles higher than the apogee of Laika's orbit, and 100 miles higher than the 100 miles reached by the Russian dog.)

Instrumentation showed the mice were alive when they hit the surface of the Atlantic Ocean, but the nose cones could not be retrieved.

(Continued on following page)

High capacitance for low voltage circuits . . .

NEW TANTAPAK* CAPACITORS

SPRAGUE'S TANTAPAKS are the newest members of the Tantalex* family of tantalum electrolytic capacitors. TANTAPAKS have as much as 2400 μ f at 10 volts d-c or as little as 140 μ f at 75 volts d-c. Five case sizes—ranging from less than a cubic inch to a mere $3\frac{1}{2}$ cubic inches—are identical to Type CP-90 paper capacitors. Standard footed and spade-lug brackets simplify mounting. All units are dual-voltage rated for operation at both 85°C and 125°C under 2000 hour life tests.

The construction of TANTAPAK Type 200D capacitors assures excellent shock and vibration resistance. Glass-to-metal solder-seal terminals provide positive hermetic sealing. There are no electrolyte leakage problems.

Porous tantalum anodes give better leakage and temperature coefficient characteristics than foil-type capacitor sections of comparable ratings. In addition, the impedance and equivalent series resistance of Type 200D are superior to foil units at high temperatures and frequencies.

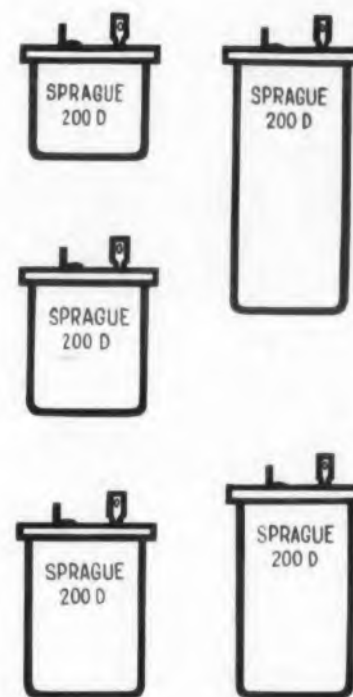
Get complete information by writing for Engineering Bulletin No. 3705. Address request to Technical Literature Section, Sprague Electric Co., 347 Marshall Street, North Adams, Massachusetts.

*Trademark

SPRAGUE COMPONENTS:

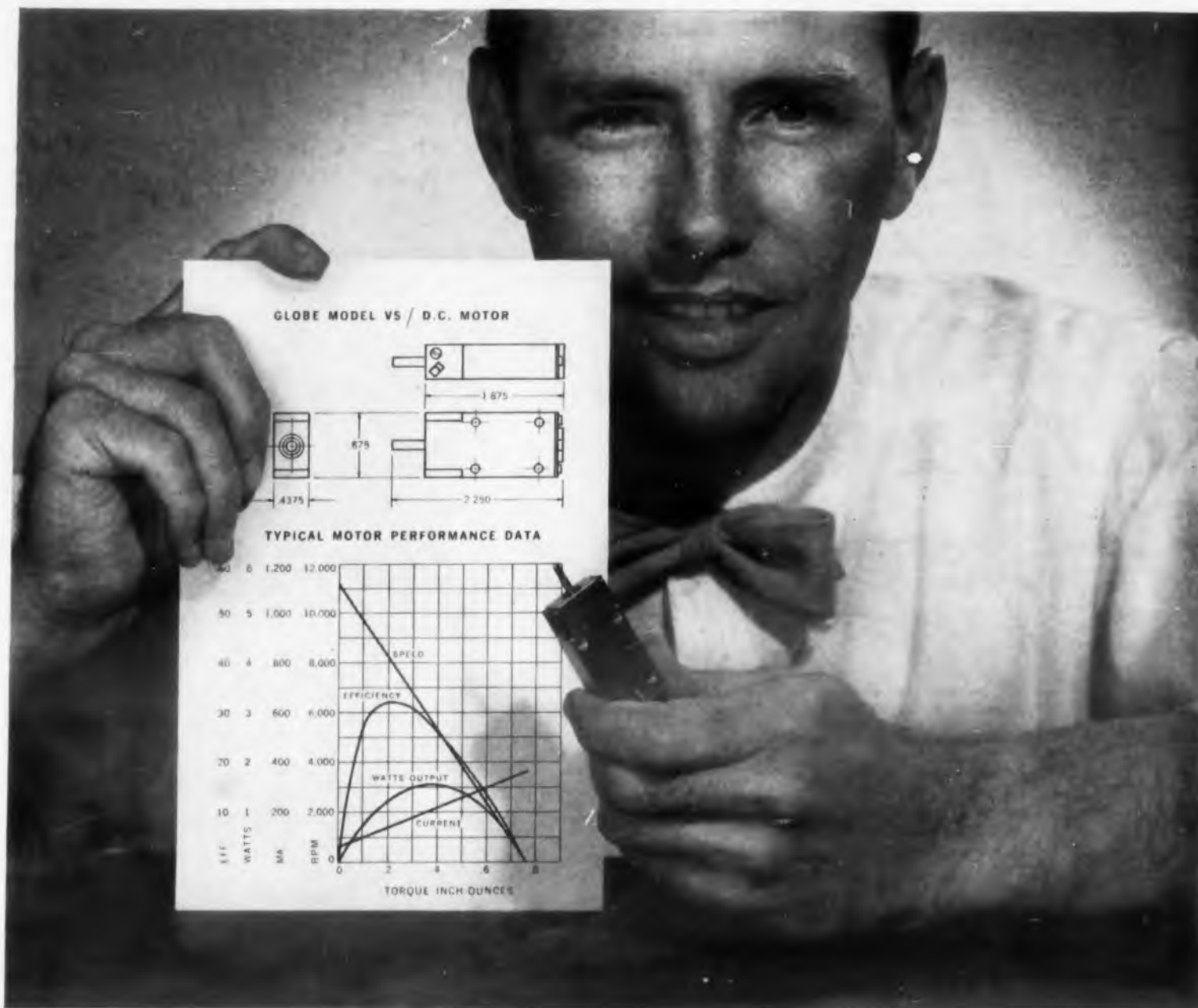
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One-half actual size.

SPRAGUE®
the mark of reliability



NEW FLAT MOTOR / SMALLEST YET

Globe Industries announces a new precision miniature d.c. motor, the smallest we have made. Like all Globe motors, it can be modified easily and quickly to meet your electrical and mechanical requirements. It is called the VS, and takes its place with the SS, MM and LL in Globe's family of superb quality motors.

The VS weighs $1\frac{3}{4}$ ozs., is $\frac{7}{16}$ in. thick. A breakthrough in miniaturization, it can deliver .2 oz. in. of torque at 10,000 rpm and is the first precision motor of its size available. Multiple units can be gang-mounted in modules.

The fastest way to get full technical data on the VS motor is to phone or write direct: Globe Industries, Inc., 1784 Stanley Avenue, Dayton 4, Ohio, Telephone BALdwin 2-3741.

WRITE IN 10 ON READER-SERVICE CARD



BEHIND THE NEWS

Tomorrow's Mainliner

Weightlessness—or nearly that condition—was a factor reckoned with in Convair's plastic model of a spaceship displayed for Society delegates. It simulated 1/10th-g conditions in the forward sections, the working and living sections of the multicompartmented ship.

The axis of ship rotation that provides partial gravity for the forward sections leaves the center section at zero g. Spacemen arriving at the orbiting ship via "taxi" would disembark at the stern and move past engines in a corridor containing subway-strap-like handgrips to enable them to "swim" forward.

Besides orbiting spaceships, earth's immediate cosmic neighborhood in the foreseeable future might also contain a satellite "post office" repeating station traveling at earth-rotation speed, fixed at a longitude midway between Europe and America. Its proposed purpose: to handle all first class and air mail letter traffic between the continents at lower cost and substantially greater speed than present postal services.

U.S.A. to Europe via Space

The system, mapped after preliminary studies at RCA's Astro-Electronic Products Division, was outlined by communications engineering manager Sidney Metzger. He proposed using standard letter forms similar to WWII's V-Mail gummed forms.

At major post offices, letters' contents would be converted to microwave radio signals, transmitted through a 5-mc "party line" circuit to a ground station, and relayed across the ocean via the orbiting satellite. Said Metzger:

"A satellite at an altitude of thousands, or even of hundreds of miles above the earth, can provide line-of-sight paths between cities separated by thousands of miles. These paths permit use of microwave frequencies—from 1000 to 100,000 mc—and their attendant wide bandwidths capable of handling . . . a high-speed facsimile signal which can be converted into print at a rate of 600 pages per minute."

A Boost from ICBM

The satellite, weighing several hundred pounds and equipped with low-power receivers, amplifiers and a transmitter, could be boosted 22,000 miles up by an Atlas or Titan, plus upper stages, he said. For conversion of written letters into transmission signals, Metzger proposed the RCA "Ultrafax," and for reconversion, the "Electrofax" electronic printing process. This could be combined with a thin-window display tube now under development by RCA for high-speed

printing directly onto "Electrofax" paper.

Unlike most Rocket Society proposals, this one, Metzger said, would save money. He estimated costs at 12 to 15 cents per letter.

Propulsion by A-power

Most of the Society's sessions discussed the conquering of space in terms of traditional rocketry, but Raemer A. Schreiber, Los Alamos Scientific Lab engineer, told of work under the Rover nuclear rocket propulsion program.

The Kiwi-A reactor, first to go into operation under the program, is only the first in a series of experimental devices in which more and more advanced ideas will become incorporated as they become available, said Schreiber.

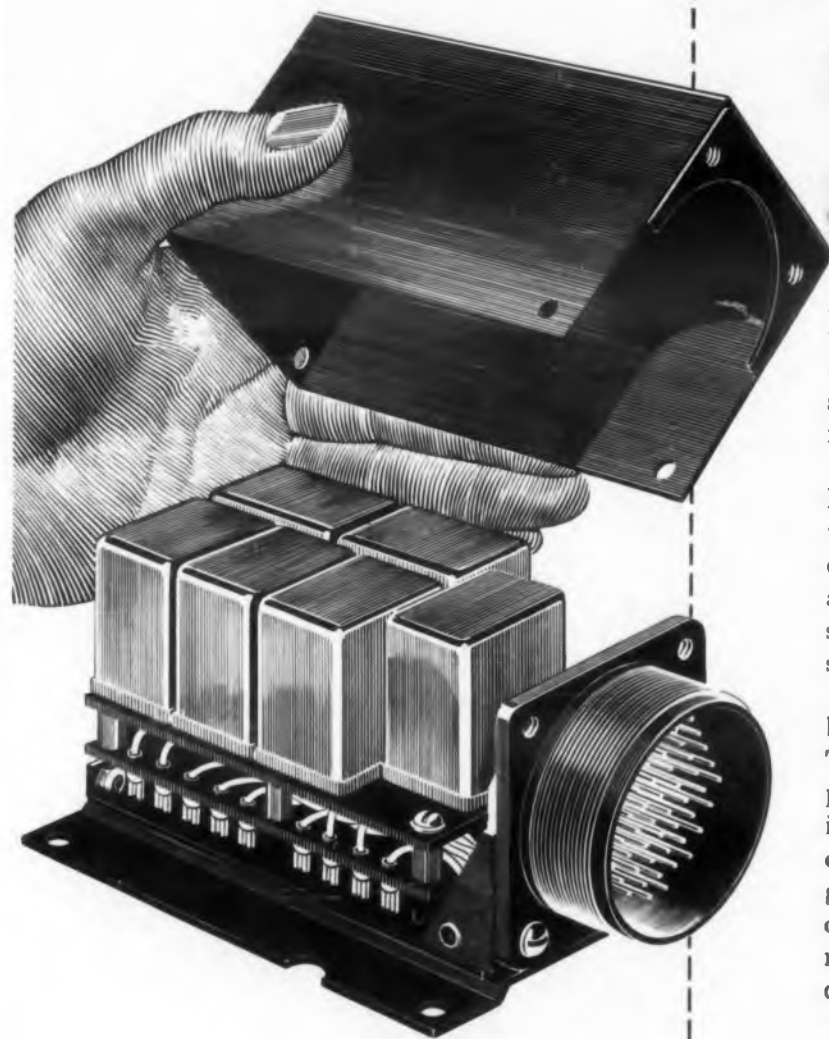
In other parts of the program, he indicated, research is going forward in the development of new materials and new concepts for the conversion of nuclear energy, from which a practical propulsion system may be developed. "Very attractive performances," he said, can result from use of liquid and gaseous reactor systems—if they can be made to work. But these new concepts in turn require new materials and a more thorough understanding of extremely high-temperature phenomena.

Among models displayed for meeting delegates was GE's pulsed plasma generator, which is designed to change space vehicle direction in flight (ED, Oct 29, p. 5).



Sealing Sapphire to Glass

Technique perfected by Philco seals sapphire window of infrared detector to glass tube in rf furnace. Seal can be immersed in liquid nitrogen for 60 seconds, then be transferred without harm to boiling water.



When a jet screams down the runway fully loaded with fuel and ammo... reliability is the key to safety and "mission accomplished".

Here's where warning of system failures is vital... where Leach reliability proves itself again and again.

Look to Leach for packaged reliability!

A major airframe manufacturer relies on three types of Leach Relay assemblies in a single dimmer package to solve the problems of pilot safety, visual distraction and eye discomfort for pilots of two of its advanced jet trainers.

The assemblies switch on master caution lights, fire warning lights and other emergency warning lights... each requiring significant differences in intensity to catch the pilot's attention. Each of these assemblies has its own series of resistors and diodes; altogether they serve 27 different circuits.

Clear lamps of fixed light intensity are used behind green, amber and red colored elements. The resistors in the Leach Relay package permit varying degrees of light intensity for instrumentation illumination. They assure control of instrument panel lighting during ground taxiing, under extreme opaque conditions at high altitudes, during night missions and in the strong brightness of daytime flights.

Most important of all, they do not fail. For dependable relays... for packaged reliability, look to Leach!

SEE FOR YOURSELF how Leach relays surpass all others in electrical and environmental specifications. Write today for catalog and complete information.



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WRITE IN 11 ON READER-SERVICE CARD

BEHIND THE NEWS

Nose Cone Work Brings Hypervelocity Instruments

Hypervelocity instruments today are sophisticated enough to permit study of transient phenomena which have associated velocities equivalent to those which would be encountered in space travel.

Avco Research and Advanced Development Division, as part of its work on the Titan ICBM nose cone, has developed instruments to measure shock waves, flow patterns and other events occurring at high Mach numbers in shock tubes and on ballistic ranges.

A high-speed shadowgraph system includes a collimating and an objective lens. A projectile fired between the two lenses in the collimated light beam is detected in the center of the optical field by a Catadioptric Light Screen, whose photomultiplier sends a signal through a video amplifier to a trigger unit.

With a high-voltage pulse, it triggers a Synchronized Pulse Generator-Light Source. The action of the light source and a Kerr Cell photographic shutter are mutually synchronized with the projectile's position. The action takes place with a jitter of less than 0.1 microsecond, enabling study of the projectile's drag, attitude and associated flow patterns. Exposure times in the range of 10^{-8} and 10^{-7} seconds prevent image blur.

The Synchronized Pulse Generator-Light Source, key to the system, consists of a coaxial transmission line and a spark gap. The two-inch-aperture Kerr Cell shutter is connected directly across the load resistor on the line, therefore does not require an impedance matching network.

Rotating mirror and rotating drum cameras are streak cameras driven by an air turbine. Heart of the rotating mirror camera is a hexagonal, first-surface mirror rotating at 3000 rps, which provides writing speed of 4 mm./microsecond for a total writing time of 50 microseconds.

Mission of U.S. Air Force XQ-4 supersonic drone: ACT AS MISSILE TARGET. Air-launched and recovered by parachute, the XQ-4 was developed by Radioplane, a division of Northrop Aircraft, Inc., to test U.S. air defense systems.



NEW SUPERSONIC TARGET DRONE BY RADIOPLANE... LIQUID-COOLED WITH COOLANOL* 45

*Coolanol: Monsanto Trademark

AiResearch uses Coolanol 45 for increased reliability

Liquid cooling with Coolanol 45 keeps temperatures within critical operating limits to assure reliable function of electronic equipment. Coolanol 45 is a coolant-dielectric liquid... operable from -65°F. to 400°F. Pumped around tubes

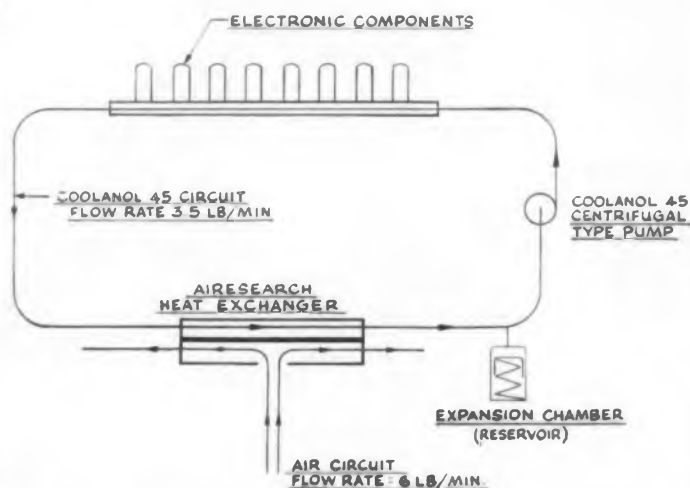
and other jacketed components, it absorbs heat... carries it from sensitive areas to be dissipated in the heat exchanger. Coolanol 45 is versatile... operates as hydraulic fluid as well as a coolant. One fluid "package" you can satisfy both

RGE
Radio
stem



UNIT No. 173030
Performance Data
Heat rejection: 1233 watts
Fluid flow (Coolanol 45): 5 GPM
Coolanol 45 temp. in: 122 degrees C.
Coolanol 45 temp. out: 101 degrees C.
Unit dimensions: 7 x 6.4 x 20 in.
Wet weight: 11.63 lbs.

Coolanol 45 dissipates heat from electronic components of the XQ-4 through this liquid-cooling system (above) designed by The Garrett Corporation, AiResearch Manufacturing Division. System utilizes liquid cooling with Coolanol 45, forced air and cold plate as shown in the diagram.



AiResearch uses Coolanol 45 in all these missile cooling components to assure precise temperature control of electronic equipment . . . a key factor in missile reliability.

MINIATURE CENTRIFUGAL PUMP
Performance Data

Operating temperatures: 65 degrees to 275 degrees F.
Fluid flow (Coolanol 45): 0.5 GPM at 10 psig. and 160 degrees F.
Motor: 10,000 rpm, 3-phase, 400-cycle ac (1 1/2 inches)
Net weight: Less than 1 lb.



UNIT No. 172010
Performance Data

Heat rejection: 2 kw at 15,000 ft. under the following conditions:
Ambient air: 50 degrees C.
Fluid flow (Coolanol 45): 2 GPM
Fluid temp. in: 117 degrees C. (Max. system temp.)
Envelope dimensions: 8.2 x 6.8 x 4.12 in.
Wet weight: 3.81 lbs.



UNIT No. 172030
Performance Data

Heat rejection: 10 kw at 5000 ft. under following conditions:
Ambient air: 53 degrees C.
Fluid flow (Coolanol 45): 5 GPM
Fluid temp. in: 135 degrees C. (Max. system temp.)
Envelope dimensions: 11 x 9.06 x 6.34 in.
Wet weight: 9.48 lbs.



UNIT No. 172040
Performance Data

Heat rejection: 2 kw at 60,000 ft. under following conditions:
Ambient air: 22 degrees C.
Fluid flow (Coolanol 45): 1 GPM
Fluid temp. in: 147 degrees C. (Max. system temp.)
Envelope dimensions: 7.5 x 8.5 x 6.6 in.
Wet weight: 9.06 lbs.



UNIT No. 171600
Performance Data

Heat rejection: 175 watts
Fluid flow (Coolanol 45): 1.5 GPM
Fluid temp. in: 50 degrees C. (Max. system temp.)
Compartment temp.: 63 degrees C.
Unit dimensions: 13x24x6 in.



Infrared Detector Now Responds 10 Times Faster

An ultra-sensitive detector that can respond to less than one-twentieth of a billionth of a watt of infrared radiation has been developed at Westinghouse Research Laboratories, Pittsburgh, Pa.

The photoconductor is gold-doped germanium. The detector has good sensitivity throughout the range of infrared frequencies. It is highly sensitive to infrared up to a wavelength of 10 microns, corresponding roughly to the peak radiation at room temperature. At the same time, it is about 10 times faster than any previously measured photoconductor detector, Westinghouse reports.

Because of the fast response of the new detector a mechanical light chopper had to be developed in order to test its speed. The chopper breaks infrared into pulses only a few billionths of a second long. The pulses, reflected to the surface of a detector, show its time constant to be two-tenths of a millionth of a second.

Since the sensitivity and frequency response of a photoconductive infrared detector is increased by operating it at low temperatures, the new detector is cooled to a temperature of -320F by surrounding it with liquid nitrogen in a special container.



Encyclopedia in One Fast Gulp

Engineers work on some of 40 racks of equipment for Emidec 2400, which, when completed at Hayes, Middlesex, Eng., will rank with the world's most advanced computers. Made by E.M.I. Electronics, Ltd., it should be able to absorb all *Encyclopedia Britannica's* data in less than four minutes.

← WRITE IN 12 ON READER-SERVICE CARD

Reliability in missile cooling systems

... cooling and power transmission. can eliminate the variables of multi-fluids and fluid systems by standardizing on Coolanol 45. For complete technical data, write today for Technical Bulletin AV-3 on Coolanol 45.



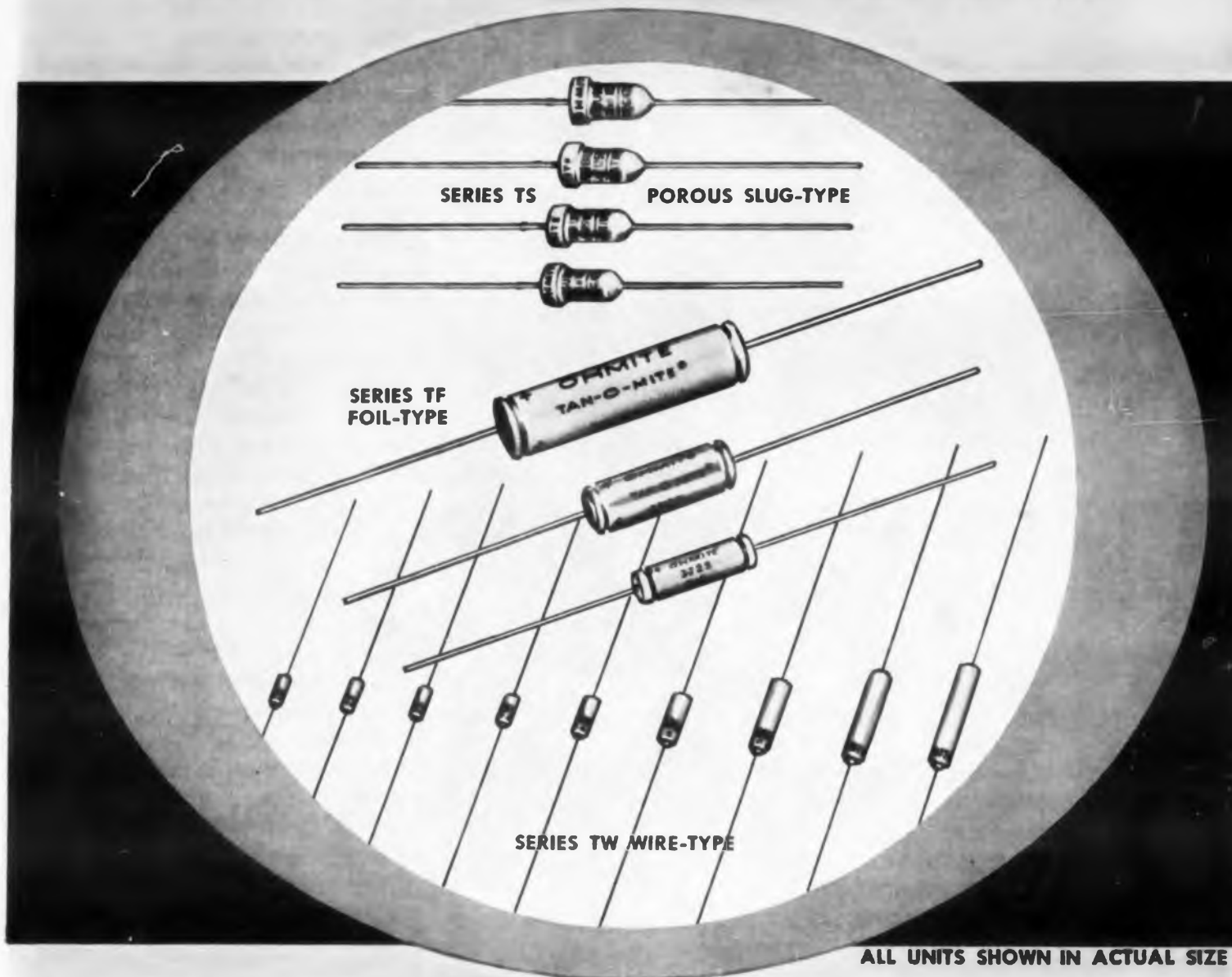
MONSANTO CHEMICAL COMPANY
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CHOOSE THE TYPE THAT BEST FITS YOUR APPLICATION FROM THE COMPLETE LINE OF QUALITY

OHMITE®

"TAN-O-MITE" TANTALUM CAPACITORS



- Stability of Electrical Characteristics • Long Shelf and Operating Life
- Excellent Performance Under Temperature Extremes (-55°C to +85°C)

Ohmite offers you a complete line of quality tantalum capacitors including three types . . . all available from stock in reasonable quantities. **SERIES TS POROUS SLUG-TYPE TANTALUM CAPACITORS** employ a porous anode of sintered tantalum sealed into a fine silver case, externally uninsulated. Size "U" unit offers a range of 1.75 microfarads to 30 microfarads. Working voltages to 125 are available, depending upon capacity. These capacitors are polar units intended for d-c applications. **BULLETIN 159.**

SERIES TF FOIL-TYPE These capacitors are tantalum foil, electrolytic units for low-voltage, a-c and d-c applications. Three sizes now available; .25 to 140 mfd over-all capaci-

tance range. Standard tolerance is $\pm 20\%$. Working voltages up to 150. Polar and nonpolar units available. **BULLETIN 152.**

SERIES TW WIRE-TYPE TANTALUM CAPACITORS These Mylar® insulated, subminiature, wire-type units feature greater capacitance per unit volume, lower leakage current and power factor, and small capacitance drop at extremely low temperature as compared to other kinds of electrolytics. Ultrasmall for low-voltage, d-c, transistorized electronic equipment. Available in nine subminiature sizes; .01 to 80 mfd over-all capacitance range. Smallest size is .080 x .203 inch; largest is .134 x .812 inch. **BULLETIN 148.**

QUALITY Components **OHMITE® Manufacturing Company** 3643 Howard Street, Skokie, Illinois

RESISTORS RELAYS TAP SWITCHES RHEOSTATS TANTALUM CAPACITORS R. F. CHOKES VARIABLE TRANSFORMERS DIODES

WRITE IN 14 ON READER-SERVICE CARD

BEHIND THE NEWS



TV Sees Supersonic Dogfights

Using TV camera (Dage transistorized, foreground) for the first time to monitor supersonic jets in intercept action, Florida's Tyndall AF Base transmitted to H such "live" pictures as Falcon (inset) fired from F-10. Three Model 320 Dages recorded ground activities while airborne cameras in F-102 and TF-102 jets sent air views from 150 miles away.



Makes Ions, Will Travel

Experimental rocket engine creating ions and harnessing them for propulsion is due soon from North America's Rocketdyne Div. Program Engineer R. H. Boder holds full-scale model of engine designed to develop 1/4-lb thrust—enough to send 5-ton vehicle through space at 250,000 mph. Ions are formed by knocking loose an electron from each molecule of vaporized propellant (mercury, thorium, uranium tetrachloride etc., are "ideal.")

NEWS BRIEFS . . .

. . . ULTRA HIGH-SPEED INFORMATION handling system combining advantages of microfilm, punched cards and digital computing techniques now is being used by the Air Force in the Pentagon. Not yet generally available, the Kodak Minicard System records documents, pictures or other material photographically on film the size of a postage stamp. Information is retrieved by searching film records automatically at speeds up to 1000 per min. Magnavox built some components of the system for Eastman.

. . . SPERRY GYROSCOPE'S SUBMARINE celestial altitude recorder (SCAR) more and more is winning submariners' respect, now is being hailed as a scientific breakthrough ranking with development of the snorkel and the high-speed Albacore hull design. Still highly classified, it is installed in both Nautilus and Skate, operates independently of inertial systems, permits navigators to automatically "shoot the stars" through periscopes while submerged.

. . . CHICAGO'S STATE ST. regained its title of "world's best-lighted street" with installation of GE's new radio tone control system, which activates 280 street lights in a seven-block Loop area. First in the U.S., it uses radio techniques similar to those employed for programming traffic signals. A 60-watt radio station transmits to receivers in 28 of the 70 poles, setting up tone codes which go out in pulses. The sender unit consists of motor-driven code wheels to operate microswitches keying an audio oscillator, which modulates the transmitter. Time switches with astronomic dials operate relays at pre-set times, compensating for seasonal changes in daylight periods. The 70-pole system generates 15,624,000 lumens, providing a maintained illumination level of 14 footcandles via 280 GE fluorescent luminaires.

. . . ELECTRONIC SYSTEM being furnished Curtis Publishing Co. by Stromberg-Carlson will register address information, perforate paper to size and print address labels 10 times faster than electro-mechanical printers. Each eight-hour day 1,000,000 labels will be printed for *Saturday Evening Post*, *Holiday*, *Ladies Home Journal*. An S-C 5500 high speed label printer utilizes a Charactron shaped beam tube and XeroX Copyflo printer impressing simultaneously on four inexpensive, untreated paper rolls. Combined with it is an M-60 auxiliary editing buffer handling four magnetic tape inputs.

New all-epoxy E-PAK[®] system drastically cuts encapsulation costs!

*Assembly Time and
Reject Rate Greatly Reduced*

The E-Pak System consists of an all-epoxy header with embedded lead wires, a cured epoxy shell and a premeasured epoxy pellet. The three may be custom-made for your component and are available from one source.



①



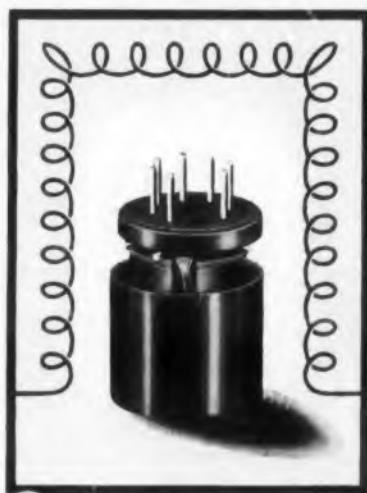
Soldering of leads is quick, simple, safe—never a cracked glass or broken seal because it's all epoxy. And with rugged epoxy covers, your lead wires can be made of any metal. No coefficient-of-expansion problem.

②



After the component is soldered to the epoxy header, a premeasured pellet is dropped into the cured epoxy shell. The cover and component are then inserted into the shell.

③



The entire package is then heated; the pellet automatically melts and cures, embedding the component and sealing the cover. In cases where encapsulation is desired without embedment, a self-sealing epoxy cover is available.

④



You now have a solid, chemically-inert seal from within; there is no solder, no flux, no acid to endanger component reliability. Your component is hermetically sealed and embedded in cured epoxy forever.

⑤

Write today for complete information and samples.

EPOXY PRODUCTS, INC.

A Division of Joseph Waldman & Sons

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ESsex 5-6000

WRITE IN 15 ON READER-SERVICE CARD

BEHIND THE NEWS

... A BRITISH ELECTRONIC detector now measures a car's speed and prolongs duration of a green traffic light exactly long enough to permit the car to get across the intersection before the light changes. Developed to Ministry of Transport specifications by Automatic Telephone and Electric Co., it detects car speed by measuring time taken for wheels to pass over two channels five inches apart. Operating from the channels via relays, the timer translates speed into a time factor corresponding to intersection distance.

... SEVENTH-DECIMAL MEASUREMENT accuracy—tenth of a millionth of an inch—probably will be attained in the U.S. within 10 years, Louis F. Polk told the Ninth National Conference on Standards in New York. Polk, president of Sheffield Corp., a Bendix Aviation subsidiary, said sixth-decimal accuracy already is achieved by some plants manufacturing grinding, honing and other machine tools and measuring equipment for volume production of precision parts. In aircraft and missile work, however, seventh-decimal accuracy is needed "right now," he said, adding: "Projected piloted plane speeds of more than 4500 mph and missile altitudes of up to 240,000 miles, with speeds of more than 24,000 mph, present incredible precision requirements in making such parts as gyros, control systems, power linkages and various sensing devices."

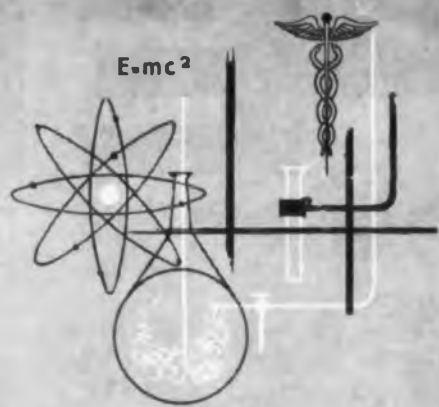
... NEW FAMILY of solid-state devices that serve as tiny contactless thermal switches has been developed by Westinghouse and put to work providing over-temperature protection of hermetic motors in large air conditioning and refrigerating systems. The switches are new-type thermistors which function as closed switches when temperatures drop below a certain critical value, and as open switches above that value.

... RE-ENLARGEMENT OF MICRO-REDUCTIONS with no loss of original drawings' detail is a feature of Paragon-Revolute's new Retrivable Miniaturization system. Designed to expedite data communication, minimize file space and cut print-making cost, the equipment includes a continuous-flow-type camera with optical system to produce various ratios of reduction, an enlarger for blowbacks, and automatic processors. Copyable material may be 42 in. wide, any length, and can be processed at 30 ft per min. Card stock miniatures reduced to 1/6 full size proved excellent for reference without a "reader."

The complete standard line of DE MORNAY-BONARDI microwave test equipment — now adding...

Size Designation Frequency Band in KMC Waveguide Nomenclature	DBA 60-90 RG-99/U	DBB 50-75 RG-98/U	DBC 33-50 RG-97/U	DBD 26.5-40 RG-96/U	DBE 18-26.5 RG-95/U	DBF 12.4-18 RG-91/U	DBG 8.2-12.4 RG-52/U	DBH 7.05-10.0 RG-51/U	DBJ 5.85-8.2 RG-50/U	DBK 3.95-5.85 RG-49/U	DBL 2.6-3.95 RG-48/U					
	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price	Cat. No.	Price				
Tube Mounts Klystron Tube Mount Noise Tube Mount with Tube																
			DBC-140-T	\$1.75	DBD-140T	\$2.75	DDE-140-T	\$2.00	DBF-140-T	\$2.50	DBG-111-1	\$2.15				
												DBH-111-1	\$2.25			
													DBJ-140-T	\$2.65		
													DBK-111-1	\$2.70		
													DBL-111-1	\$2.85		
													DBL-140-T	\$3.00		
Transmission Line Components Adaptors, Choke to Cover Tapered Transitions N to Waveguide Transformers Straight Sections 90° E-Plane Elbows 90° H-Plane Elbows Rotating Joints 90-90 Rotating Joints 90-Col Rotating Joints Col-90 Rotating Joints Col-Col 90° Twisted Sections Bulkhead Flanges Bulkhead Flanges with Seals Pressurizing Units	DBAL-018	\$2.25	DBBL-018	\$2.25	DBCL-018	\$1.25	DBDL-010	\$3.00	DBEL-010	\$2.50	DBFL-010	\$2.50	DBG-010	\$2.50	DBH-010	\$2.50
													DBJ-010	\$2.50	DBK-010	\$2.50
													DBL-010	\$2.50	DBL-018	\$2.25
													DBL-057	\$2.50	DBL-057	\$2.50
													DBL-210	\$2.50	DBL-210	\$2.50
													DBL-224	\$2.50	DBL-224	\$2.50
													DBL-234	\$2.50	DBL-234	\$2.50
													DBL-266-1	\$2.50	DBL-266-1	\$2.50
													DBL-266-2	\$2.50	DBL-266-2	\$2.50
													DBL-266-3	\$2.50	DBL-266-3	\$2.50
													DBL-266-4	\$2.50	DBL-266-4	\$2.50
													DBL-274	\$2.50	DBL-274	\$2.50
													DBL-275	\$2.50	DBL-275	\$2.50
													DBL-275-1	\$2.50	DBL-275-1	\$2.50
													DBL-276	\$2.50	DBL-276	\$2.50
Crystal Mounts & Multiplexers Crystal Mounts Movable Short Tunable Crystal Mounts Crystal Multipliers	DBA-310	\$2.50	DBB-310	\$2.50	DBC-310	\$2.50	DBD-310	\$2.50	DBE-310	\$2.50	DBF-310	\$2.50	DBG-310	\$2.50	DBH-310	\$2.50
													DBJ-310	\$2.50	DBK-310	\$2.50
													DBL-310	\$2.50	DBL-310	\$2.50
													DBL-319	\$2.50	DBL-319	\$2.50
													DBL-350	\$2.50	DBL-350	\$2.50
Power Absorbing Units Precision Attenuators Variable Attenuators, Calibrated Variable Attenuators Fixed Attenuators Low Power Terminations Movable Low Power Terminations Movable Term. with Extension Movable Term. with Ext. & Vernier Tunable Low Power Terminations High Power Terminations	DBA-410	\$3.50	DBB-410	\$3.50	DBC-410	\$3.50	DBD-410	\$3.50	DBE-410	\$3.50	DBF-410	\$3.50	DBG-410	\$3.50	DBH-410	\$3.50
													DBJ-410	\$3.50	DBK-410	\$3.50
													DBL-410	\$3.50	DBL-410	\$3.50
													DBL-430	\$3.50	DBL-430	\$3.50
													DBL-450	\$3.50	DBL-450	\$3.50
													DBL-440A	\$3.50	DBL-440A	\$3.50
													DBL-450A	\$3.50	DBL-450A	\$3.50
													DBL-456A	\$3.50	DBL-456A	\$3.50
													DBL-456-1	\$3.50	DBL-456-1	\$3.50
													DBL-459	\$3.50	DBL-459	\$3.50
													DBL-460	\$3.50	DBL-460	\$3.50
Horns Pickup Horns Standard Gain Horns, 15 DB Standard Gain Horns, 20 DB	DBA-510	\$2.50	DBB-510	\$2.50	DBC-510	\$2.50	DBD-510	\$2.50	DBE-510	\$2.50	DBF-510	\$2.50	DBG-510	\$2.50	DBH-510	\$2.50
													DBJ-510	\$2.50	DBK-510	\$2.50
													DBL-510	\$2.50	DBL-510	\$2.50
Tees, Junctions and Mixers E-Plane Tees Waveguide Switches, 2 Way Waveguide Switches, 4 Way H-Plane Tees Basic Directional Couplers Directional Couplers, Fig. to Term. Directional Couplers, Coax. to Term. Directional Couplers, Xtal. to Fig. Directional Couplers, Xtal. to Term. Magic Tees Balanced Crystal Mixers	DBA-610	\$2.50	DBB-610	\$2.50	DBC-610	\$2.50	DBD-610	\$2.50	DBE-610	\$2.50	DBF-610	\$2.50	DBG-610	\$2.50	DBH-610	\$2.50
													DBJ-610	\$2.50	DBK-610	\$2.50
													DBL-610	\$2.50	DBL-610	\$2.50
													DBL-616	\$2.50	DBL-616	\$2.50
													DBL-617	\$2.50	DBL-617	\$2.50
													DBL-620	\$2.50	DBL-620	\$2.50
													DBL-630	\$2.50	DBL-630	\$2.50
													DBL-631	\$2.50	DBL-631	\$2.50
													DBL-632	\$2.50	DBL-632	\$2.50
													DBL-633	\$2.50	DBL-633	\$2.50
													DBL-634	\$2.50	DBL-634	\$2.50
													DBL-650	\$2.50	DBL-650	\$2.50
													DBL-665	\$2.50	DBL-665	\$2.50
Frequency Meters Precision Cavity Wavemeters Reaction Type Absorption Type Transmission Type Reference Cavity Reaction Type Reference Cavity Absorption Reference Cavity Transmission	DBA-715-1	\$2.50	DBB-715-1	\$2.50	DBC-715-1	\$2.50	DBD-715-1	\$2.50	DBE-715-1	\$2.50	DBF-715-1	\$2.50	DBG-715-1	\$2.50	DBH-715-1	\$2.50
													DBJ-715-1	\$2.50	DBK-715-1	\$2.50
													DBL-715-1	\$2.50	DBL-715-1	\$2.50
													DBL-715-2	\$2.50	DBL-715-2	\$2.50
													DBL-715-3	\$2.50	DBL-715-3	\$2.50
													DBL-715-1A	\$2.50	DBL-715-1A	\$2.50
													DBL-715-2A	\$2.50	DBL-715-2A	\$2.50
													DBL-715-3A	\$2.50	DBL-715-3A	\$2.50
Impedance Meters Precision Standing Wave Detectors, Complete Carriage Units Only Waveguide Sections Broadband Probes	DBA-825	\$2.50	DBB-825	\$2.50	DBC-825	\$2.50	DBD-825	\$2.50	DBE-825	\$2.50	DBF-825	\$2.50	DBG-825	\$2.50	DBH-825	\$2.50
													DBJ-825	\$2.50	DBK-825	\$2.50
													DBL-825	\$2.50	DBL-825	\$2.50
													DBL-821	\$2.50	DBL-821	\$2.50
													DBL-822	\$2.50	DBL-822	\$2.50
Phase Shifters, Tuners & Shorts Phase Shifters Calibrated Phase Shifters Variable Stub Tuners Fixed Shorts Movable Shorts Movable Shorts with Extension Movable Shorts with Ext. & Vernier E-H Plane Tuners E-H Plane Tuners with Vernier	DBA-915	\$2.50	DBB-915	\$2.50	DBC-915	\$2.50	DBD-915	\$2.50	DBE-915	\$2.50	DBF-915	\$2.50	DBG-915	\$2.50	DBH-915	\$2.50
													DBJ-915	\$2.50	DBK-915	\$2.50
													DBL-915-1	\$2.50	DBL-915-1	\$2.50
													DBL-919	\$2.50	DBL-919	\$2.50
													DBL-960	\$2.50	DBL-960	\$2.50
													DBL-969A	\$2.50	DBL-969A	\$2.50
													DBL-969	\$2.50	DBL-969	\$2.50
													DBL-969-1	\$2.50	DBL-969-1	\$2.50
													DBL-979	\$2.50	DBL-979	\$2.50
													DBL-979-1	\$2.50	DBL-979-1	\$2.50
Accessories Standard Plain Flange Standard Choke Flange Aluminum Plain Flange Aluminum Choke Flange Special Round Flange Screw Plain Flange Screw Choke Flange Adjustable Waveguide Supports, Ultramicrowave Adjustable Waveguide Supports, Microwave Waveguide Chassis Mounting Stands Waveguide Fastening Screws, Pt. Waveguide Window Seals	DBA-1000	\$2.50	DBB-1000	\$2.50	DBC-1000	\$2.50	DBD-1000	\$2.50	DBE-1000	\$2.50	DBF-1000	\$2.50	DBG-1000	\$2.50	DBH-1000	\$2.50
													DBJ-1000	\$2.50	DBK-1000	\$2.50
													DBL-1000	\$2.50	DBL-1000	\$2.50
													DBL-1002	\$2.50	DBL-1002	\$2.50
													DBL-1003	\$2.50	DBL-1003	\$2.50
													DBL-1010	\$2.50	DBL-1010	\$2.50
													DBL-1010-1	\$2.50	DBL-1010-1	\$2.50
													DBL-1010-2	\$2.50	DBL-1010-2	\$2.50

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These millimeter wave units can greatly enlarge your scope of microwave activity. Research previously considered impractical at 140 KMC can now be carried on successfully.

De Mornay-Bonardi manufactures cavity wave-meters, crystal multipliers, crystal mounts, E-H tuners, and standing wave detectors specifically for use at 140 KMC. They work—we've been using these units effectively in our own laboratories for developing other items. These instruments are accurate—functionally as accurate as De Mornay-Bonardi equipment used at 90 KMC. You can order these units now—we're currently filling orders on 140 KMC instruments.

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CRYSTAL MULTIPLIERS



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CRYSTAL MOUNTS



E-H TUNERS



CAVITY WAVEMETERS

*TRADE MARK DE MORNAY-BONARDI

... AIR TRAFFIC CONTROL simulator system is scheduled for completion in May, 1960, under \$2,951,920 CAA contract awarded to eight-year-old Aircraft Armaments, Inc. Designed to improve study of local control problems, evaluation of traffic control systems and training of controllers, the system utilizes the "building block" design approach to permit future flexibility. Each of 60 consoles is designed to simulate flight of a plane within a 400 x 400-mile area, and four radar simulators furnish all data normally supplied by radar. Equipment also provides simulated wind conditions, data collection and reduction devices, electronic "noise," and associated power supply.

... IBM MACHINES are being integrated to form prototype systems for the "automatic library" of the future. Eventually, say IBM engineers, vast quantities of data on all fields will be automatically read, summarized, coded, distributed, and filed by machines within a network of linked libraries. By electronic means a researcher will gain access to information in his field wherever it exists. Newest technique developed toward that goal is "auto-abstracting," a process by which an IBM 704 analyzes articles word by word, selects the most significant data, and reproduces them on a printer. The auto-abstract is a source of key words which pinpoint significance of a document and form the basis of various automatic coding and indexing systems. The new IBM Special Index Analyzer meanwhile provides fast, accurate and automatic reference to catalogued data.

... FLIGHT SYSTEMS SIMULATORS that test flight characteristics of missiles before they are launched have been sold for \$500,000 each by Bendix Aviation to the Army Ordnance Missile Command, Huntsville, Ala., and Convair Aircraft, Ft. Worth, Tex. A 7,000-lb, electronically controlled flight simulation table simulates pitch, roll and yaw. An analog computer, 7 ft high and 21 ft long, contains some 5,000 vacuum tubes and more than 12 miles of signal wiring.

... SOLAR TELESCOPE several times larger than any now in existence will be built with \$4 million allocated to the Association of Universities for Research in Astronomy, Inc., by the National Science Foundation. Allocation raises to \$7,545,000 the amount committed for erection and operation of a national astronomical observatory on Kitt Peak, in Arizona's Quinlan Mountains. The 80 x 60 in. telescope's mirror will have a focal length of some 300 ft, twice that of the 150-ft tower telescope on Mt. Wilson.

WRITE IN 16 ON READER-SERVICE CARD

HYFENTM

CONNECTORS

with crimped, snap-locked contacts



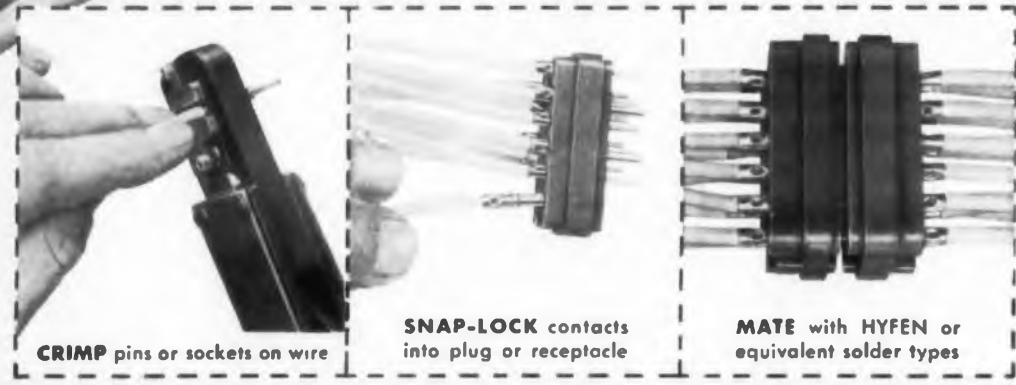
Cutaway view of
**MINIATURE
MS-type HYFEN**
with closed-entry sockets
(enlarged)



15 contact, multi-purpose
connector. Mates with, or re-
places existing solder con-
nectors.



Feed-thru, modular design,
multiple insert connector. 35
contact inserts, can be re-
moved from frame for easy
contact insertion or removal.
5 or 8 insert frames available.



CRIMP pins or sockets on wire

SNAP-LOCK contacts
into plug or receptacle

MATE with HYFEN or
equivalent solder types



AN-type HYFEN connector,
showing HYFEN method
adapted to round design.

HYFEN types illustrated are typical of those already supplied to the Industry by Burndy. HYFEN connectors are engineered to meet specific requirements. For other types and sizes, contact Burndy.

SAVE WEIGHT, SPACE, TIME—Burndy's HYFEN method brings added Reliability and Versatility to the connector field, allowing the design of lighter and more compact equipment...saving space, weight and time. Pins and Sockets can be bench-installed on the wire and can be snap-locked in place even after the Plug and Receptacle have been mounted on the equipment.

Designed to replace or mate with virtually all existing connectors, including AN, MS, and other Miniature types, the HYFEN meets or exceeds MIL specs.

The HYFEN method ends the high rejection rate inherent with the use of solder...especially important in today's continuing trend toward miniaturization.

OMATON DIVISION

BURNDY

For detailed information Write or Wire BURNDY, Norwalk, Connect., or Toronto, Canada...in Europe: Antwerp, Belgium

58-14

WRITE IN 600 ON READER-SERVICE CARD

NEW PRODUCT

Crimp-Type Modular Connector



Designed especially for complex electronic systems, a new concept in connector design, utilizing the convenience and flexibility of modular construction, has been developed by the Omaton Division of the Burndy Corporation.

The device, newest of the company's HYFEN[®] line, incorporates all the standard innovations of earlier HYFEN connectors, featuring crimp-type snap-locked contacts, and meets all application requirements of MIL-C-8384. All contacts are tool-installed with tested Burndy compression tooling (hand, pneumatic, semi-automatic, and automatic), eliminating time-consuming solder operations—and the high rejection rate inherent with solder.

Actual crimping of contacts to wire ends can be done before or after the harness is in place. These contacts fulfill MIL-T-7928 requirements.

The components of the new modular HYFEN include a die-cast anodized aluminum frame; high-impact strength glass melamine plug or receptacle inserts; and gold-plated contacts with nickel-plated beryllium copper locking springs. The frames are designed to accept inserts from either the front or rear of the mounting panel, and are available in either a 5-insert or 8-insert model. Each insert accommodates 35 pins or sockets.

Burndy Corporation, Norwalk, Connect.

WRITE IN 599 ON READER-SERVICE CARD

EDITORIAL

Design '59—A Challenge

Despite undisputed wonders already accomplished by the electronic design engineer, the need to do more is, in this year 1959, greater than ever before.

Electronics has not yet met the challenges put to it by the transportation and manufacturing industries. And hard to recognize is the fact that communication and control technology is not keeping up with the technology of propulsion.

Until last month, U. S. rockets appeared to lag the Soviet's. But we have always been smug about our electronics being ahead because it was miniaturized to weigh little.

The hard truth is: electronics more often than not is the limiting factor in aircraft and spacecraft design.

Propulsion advances, such as they are, already have outstripped man's ability to control the power at his disposal. Electronics must match the man to the machine—and so far it has not succeeded. Not in spacecraft, in aircraft, or even in groundcraft—as demonstrated by America's highway jams.

Nor has electronics met the challenges posed by automatic manufacturing. Industry often uses pneumatic and hydraulic controls, despite the relative inflexibility of these techniques. But in planning and inventory control, fortunately, computers are fulfilling their destined role, and are doing well for commerce as a whole.

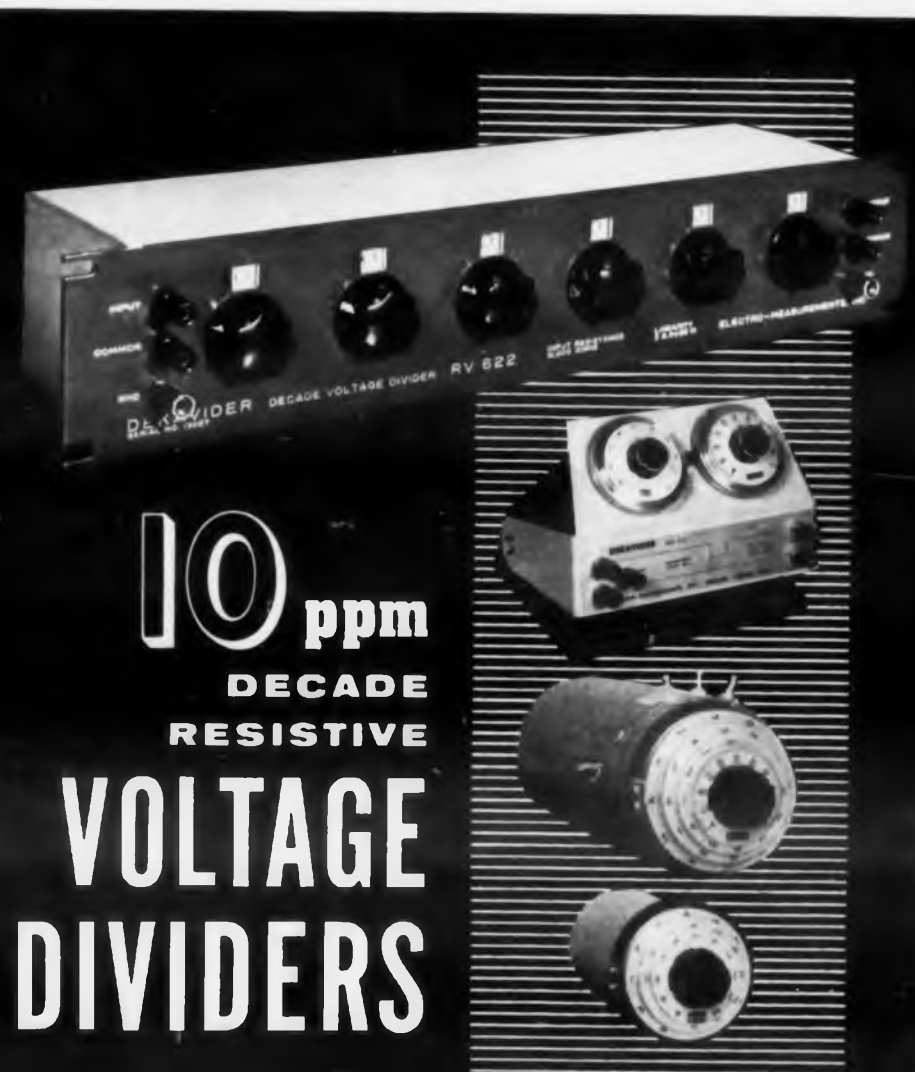
Demanding serious attention, though, is the fact that electronics has not fulfilled its own prime function—that of providing adequate world-wide communications. The challenge this year is real.

The year 1959 will see a few engineers cast in glamorous leading roles, with the great majority in unpublicized supporting roles. The engineer working in astro-electronics and computers will continue to make headlines and amaze laymen. But while there will be no headlines for the thousands of others, the plodding, anonymous engineers, history will be determined by their output.

In either role, leading or supporting, the professional must supply the same crucial need, and that is for sound engineering. The theories of space flight have been worked out; what is needed now is engineering to prove or modify the theories.

For the few, 1959's challenges will be aimed at conquering space or developing fusion power. But for the many, the challenge will be the same this year as it was last year: engineering for more exacting, wide-range performance, full-environmental reliability, producibility, maintainability, and operability.

James G. Kuffner



10 ppm DECADE RESISTIVE VOLTAGE DIVIDERS

Your choice of superior resistive decade voltage dividers in highly accurate rack mount DEKAVIDER® units featuring linearity to 10ppm... Bench mount DEKAVIDER® units or convenient panel mount DEKAPOT® units featuring linearity to 50ppm. They provide known voltage and current ratios for meter calibration, linearity checking, ratio measuring, synchro testing, computer standardization and many other applications.

The high resolution and accuracy of the Kelvin-Varley circuit are made even more useful by human engineering features which simplify dial setting and permit easy in-line reading.

Precision mica card resistors using recently developed stable resistance alloys assure the reliability of these units. The resistors have an extremely low temperature coefficient and a negligible thermal emf to copper.

The audio frequency performance of these dividers is comparable to their high dc accuracy. This is accomplished by the low reactance design of the resistors and the minimum capacitance arrangement of the circuit.

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WRITE IN 18 ON READER-SERVICE CARD

A CHALLENGE Engineering digital communications equipment, low-noise masers, accurate check-out equipment, faster computers, more reliable components and equipment, are but a few of the challenges to be met in 1959. Many more are pinpointed in the pages that follow. Needed is a frontal attack on the entire spectrum, from dc through the gamma rays.

DESIGN



Starting from Scratch—on ALL Communications

COMMUNICATIONS problems in 1959 will encompass every presently known mode. Much work will be done in wire communications, tropospheric scatter and ionospheric scatter systems. Old problems—telephone line phase distortion, switching speeds—will get increased attention.

Reason for all this activity is the strong possibility that industry will be called upon to design a completely new world-wide communications system. Air Force project 456L proposes a system that will enable designers to start from scratch. Rather than patch up existing equipment, the Air Force wants a completely new system tying together all its military bases. Objective is to be able to send a message from any point to any other point in the world automatically—and swiftly.

All modes of communications are to be incorporated into the system: wire links, microwave, tropospheric scatter, ionospheric scatter and low,

medium and high frequency radio bands.

Digital Esperanto

A common language for translating all intelligence must be developed. Possible signal sources will include voice, video, teletype, telegraph and facsimile. Each of these forms will be converted into some sort of digital code—the same code no matter what is being transmitted. Decoders at the receiver will unscramble the code and recreate the original signal.

It is not as simple to design as to functionally describe, however. Some of the problems:

- How to choose whether the message will be sent by wire, radio, microwave, or other means?
- How to work priority of the message into the system?
- How to handle low priority messages being sent or about to be sent when a message of high priority comes through?
- How to store them?

- How to accomplish high-speed switching without distorting the coded message?
- How to insure security?

The answers to these broad questions are but a part of the challenge for the coming year. They involve complex problems of computations, switching and priority, as well as the problem of getting engineers to decide upon a workable digital code. (Some of them remain "analog" men, and promise to fight a conversion to a digital system. One reason: analog signals can be measured in real time.)

Modernizing Wire

One important link in any communications systems is wire. This oldest form of electronic communication is going to require some major modernization. Old problems will have to be revived and increased efforts made to solve them.

A major advance will be made in adopting the 4-wire telephone system. Signaling and voice cir-

uits then can be separated, thus simplifying much system design.

There has been a trend toward changing from dial to pushbuttons. Many telephone systems engineers feel there is no good reason for a change, except, they say, to provide an opportunity to design a new signaling system. One system now being tested uses 10 transistorized tone oscillators instead of dial pulses.

Phase distortion in wire communications has been a problem for a long time. There are many ways to compensate for phase distortion, but newer, better methods will have to be devised.

Stability, Hot or Cold

Single sideband communications will be exploited further. Many engineers feel that it has not yet been used to its full advantage. More stability over wide temperature variations must be achieved. In airborne SSB equipment, work will have to be aimed at overcoming the doppler effect.

There has been a recent resurgence of interest in very low frequency. These bands offer very reliable, long range communications, but bandwidth is limited. At 100 kc, bandwidth is only about 5 kc. Systems in the vlf range may prove desirable as a means of communication in bad weather.

To the military services, communications remains a prime problem. Each service wants to carry heavy traffic over existing circuits. They seek 3 kc bandwidths on channels that carry cw, teletype, even voice messages.

UHF Can't Do It

There are other problems. Uhf techniques, for instance, are not adequate if the pilot of the Air Force's newest super-Mach F-108 wants to communicate with his base 1000 miles away. The Air Force believes the problem may be solved by the Hughes "Long Arm" technique in the hf region of the frequency band. But officials are not sold on the technique, and remain on the lookout for others.

Development of more efficient microwave links will depend largely upon development of better components. Masers and parametric amplifiers seem to promise improvements throughout the entire microwave range. By improving receiver signal-to-noise ratio, transmitted power can be reduced and more reliability can be achieved. How to incorporate these new developments into present equipment in the shortest possible time will be one of the design engineer's problems in 1959.

And Now Tropo-scatter

Tropospheric scatter, a relatively new means of communication, will be much improved, and

find many new uses. Over short ranges, tropo-scatter achieves good reliability and bandwidth. The Florida-Cuba link installed by IT & T, operating over a distance of 180 miles, has a bandwidth of two television channels. A new parametric amplifier announced by IT & T recently will increase the system's range one-third. But still unsolved is the problem of pushing tropo-scatter to 600 miles without frequency restriction. Engineers will be thinking in terms of 400 to 10,000 mc operating frequencies.

Work remains to be done in standardizing scatter communications equipment. Some method must be devised for changing from a microwave relay to a tropo system without frequency conversion.

Diversity systems will be under more intensive study this coming year. At present space diversity is used; two independent paths require a pair of



antennas at each end. Angle diversity is an interesting and promising new system; here one antenna radiates four or eight beams. (Two experimental links are under test now. One operates at 8000 mc, the other at both 900 and 2000 mc.)

Meteors A Target

Ionospheric scatter has become the "glamor" communications system in the past year. Emphasis on space travel has drawn more attention to the technique of bouncing radio waves off ionized meteor trails and the ionosphere itself.

Many challenges exist here. Some novel tricks are being used to achieve measurable results. But tests show some surprising effects. There is no relationship, for example, between phase at one frequency and another 1000 cps away. The maximum signal does not always come from the

Great Circle route—it varies. Receiving the signal is more difficult, since the receiving antenna must be varied electrically to follow these variations.

One of 1959's challenges will be to figure out the rhyme or reason for these variations. Where does the maximum signal come from? Answers would help antenna systems designers.

More problems are added when the system is extended to ground-to-air communications. Here antenna size becomes a problem requiring a great deal of study. Work is needed on electronic steering of antennas, and on new means of power multiplication. Better control of side lobe-beams is necessary.

How To Hit Meteors?

Air Force engineers working with scatter over 1000-mile links envision scatter from meteor trails as eventually having a capacity of 2000 words per minute. Bouncing waves off meteor trails holds great promise for long range communications. But a big problem is: How to tell when a good meteor is coming around, and how to send the message before it gets away? Design engineers will have to come up with something to detect a useable trail, start a transmitter, aim it correctly, and automatically cut it off when the trail becomes untrustworthy.

(Fulfilling the role of a meteor trail, Pioneer I became a passive reflector during its flight last October.)

Reliability will always be a problem. But as component quality continues to improve, other ways to improve reliability will have to be devised. Engineers this year will be finding new ways to trade bandwidth, time and power for more reliable operation.

Faster Printing Needed

Display and encoding devices must be made to operate at increased speeds. While it now is possible to transmit at a rate of 2000 words per minute, there are few practical ways yet of printing words that fast. [Burroughs last month demonstrated a 3000 wpm electrostatic printer.]

By the end of 1959 it may be possible to convert typewritten messages directly into teletype signals. But a problem is to devise something to read the 46 different fonts of typewriter type now being used in the U.S.

Information Theory May Help

Recent activity by information theorists may pave the way for the advanced system designs of tomorrow. Here are some of the concepts under active study.

System with noise disturbed feedback channels. One of the ways to insure faithful signal reception is to transmit part of the information re-



ceived back to the sending station. The problem lies in how to make best use of the return channel to improve forward transmission.

Data links with different message values.

If some of the information to be transmitted is less important than other information, it might be feasible to use a faster message rate for the less important information.

Channel capacity of a channel with varying signal to noise ratio. Perhaps signal channels can be used more efficiently if message rates can be varied with the signal to noise ratio.

Sequential encoding and decoding. Some important theoretical work indicates that it may be easier to minimize incorrect sequences by sequential coding than by block coding.

Multipath signals. There is a growing interest in systems to combat the effects of multipath transmission. If the receiver can recombine the energy reaching it by different paths and get the separate signals in proper phase sequence, the demands on receiver sensitivity and transmitted power can be substantially reduced.

Nonbinary codes. Binary systems provide least ambiguity. Analog systems provide the best information rate. Perhaps some compromise (more than two levels of coding) can provide an optimum rate with minimum ambiguity. ■ ■

Telemetry's Job: Study Space

PERHAPS THE most exciting challenge this year is the one facing the telemetering engineer—learning about space. The challenge is immediate, for space will not be conquered until the telemetering engineer fulfills his role and functions.

He must gather information about radiation of all kinds, about temperature, space density, gravities, magnetic fields, and the effect of these on equipment. He must know how spacecraft respond to control signals.

New Concepts for Space

In space, the straightforward approach—sensing phenomena, transmitting it to the ground, recording it, later playing it back and analyzing it— isn't good enough.

Not all the data from the thousands of points now telemetered during missile and aircraft flight can be transmitted from spacecraft or from satellites. They do not have enough power or bandwidth to permit the sending of mass data. Nor is there enough manpower or enough time to study such a collection of data.

This means that the decisions as to what is to be observed on the ground should be made in space. The ground observer, however, should be able to take command of the situation and ask for more data to be transmitted if there is some phenomenon he wants to study closely.

Computers and switching techniques must be developed which present less of a weight and

power burden than do existing methods. Optimum information coding techniques must be worked out.

Systems Thinking Now

Aircraft and missile telemetering evolved in a helter-skelter fashion, with no coordination and no direction from the top. But the Space Age is being ushered in under the aegis of the National Aeronautical and Space Administration, and this means systems thinking is possible.

The aircraft and missile telemetering engineer this year will face as big a challenge as the spacecraft instrumentation engineer. And he will continue to despair, for he will continue to be frustrated in putting his ideas into practice.

If he finds a new and better way of doing something, there will be no one with the authority to say that it is an improvement and to okay spending money on it.

DOD Direction Needed

A missile manufacturer cannot install new equipment if the range testing facilities do not include the proper receiving equipment. Department of Defense direction is needed—and the designer must ask for it.

The telemetering engineer will still have the challenge of working with an inadequate frequency spectrum. He may have to move into the 1100 mc range, as it is likely he will lose his present bands.

Calibration of oscillators before and in flight is a problem still to be licked. The ultimate in eliminating drift and nonlinearity of subcarriers has not been reached. There is a real challenge in finding means of sending more information in smaller bandwidths.

For Space, Simplify

Efficient pulse coding schemes are needed. Pulse code modulation systems show great promise for testing aircraft, but they must be simplified for missile and spacecraft use. Different and better encoders for code modulation are needed.

Although large tracking antennas have reduced the necessary amount of transmitter power, all equipment can be improved; to name a few—pickups, commutators, multiplexers, subcarrier oscillators, modulators, transmitters, amplifiers, antennas, channel-splitters, and discriminators.

Phase-lock fm discriminators have proved a boon. But more improvement is possible if narrow band fm can be used, or if discriminators are employed on subcarriers. Noise in subcarriers must be reduced.

The recording and using of information pose equally large problems. Recording of all kinds of modulation on one recorder is desirable. Automatic data reduction must become practical, and advances in high speed printers, plotters and calibrators are needed. ■ ■



High Power, Big Antennas NOT Radar Answers

THE SINGLE instrument on which the preparedness of this nation most depends is the radar set. Without it Americans would not have the minimum required 15-minute warning of the approach of enemy missiles and planes, should another D-Day dawn. Yet present radar technology—married to tremendous power amplifiers and huge turnstile antennas—is quickly approaching the limit of its capacity.

To get away from megawatts of power and 100-foot-plus diameter antennas is a major goal of the military services. The masers, parametric amplifiers, and frequency scanning techniques only scratch the surface of the problem. What is needed is a whole new concept for the signal processing field.

Some researchers are looking into the fine structure of signals for a means of carrying intelligence. Once this breakthrough is made, a whole multitude of applications would open up.

Too Many, Too Fast

The problem revolves around the fact that today's targets travel too fast and in too large numbers for the average detecting instrument to record them efficiently. In addition to a slow response time, the signal-to-noise ratio is inadequate.

Today the Army and the Navy are looking for higher data rate equipment, electronic scanning with fixed antennas, phased rays, beyond-the-

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SPECIFICATIONS

Band	Frequency (mc)	NARDA Model	Coupling (db)	VSWR	Isolation (db)	Size (excl. conn)	Price
—	460-950	3031	3.0 \pm 0.25	1.2	20	10½x2½x7/8	\$225
L	950-2000	3032	3.0 \pm 0.25	1.2	20	6½x2½x7/8	225
S	2000-4000	3033	3.0 \pm 0.25	1.2	20	5x2½x7/8	225

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SPECIFICATIONS

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500-1500	1 mc	700	1.15	0.2 mw	805	375
1500-2400	2 mc	500	1.25	0.5 mw	806	375



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horizon search capability. They see new data processing techniques as helpful in countering countermeasures. They want small, tactical radars for field forces, radars with capabilities far above those now on the drawing boards.

And Too Big, Too

With the advent of space technology, the volume-mass problem has become further aggravated. Power requirements must be reduced, equipment must become digitalized.

The parametric amplifier should increase radar and communication ranges considerably, require less transmission power, and allow reception of weak signals.

The device also should find important applications in radio astronomy and space communications.

Amplifier vs Maser

Engineers predict that the parametric amplifier will find many more microwave applications than the maser. It is more simply designed, for the parametric amplifier does not require helium or a magnet to operate. R & D activity in gaseous and solid-state masers, however, will be intensified in order to exploit the maser's almost noise-free operation.

Development of variable reactance diodes should advance the art considerably in the microwave field during 1959. Parametric amplifiers, using these mesa diodes, will operate at better than 22 db gain, with less than 1 db noise figure. The diodes will become commercially available in a few months.

TWT's Better

Traveling-wave tubes will continue to find many transmitter applications, particularly now that they are available with wide bandwidth (more than one octave). Their frequency range can be expected to be extended considerably at both ends of the spectrum—to 200 mc as well as to 10,000 mc.

More high power, low duty cycle tubes will become commercially available, and more rugged tube types—possibly of metal-ceramic construc-

tion—will be produced. Designers should not overlook the improved ruggedness of TWT (antenna lengths have been cut to 30 in.)

The Temperature Problem

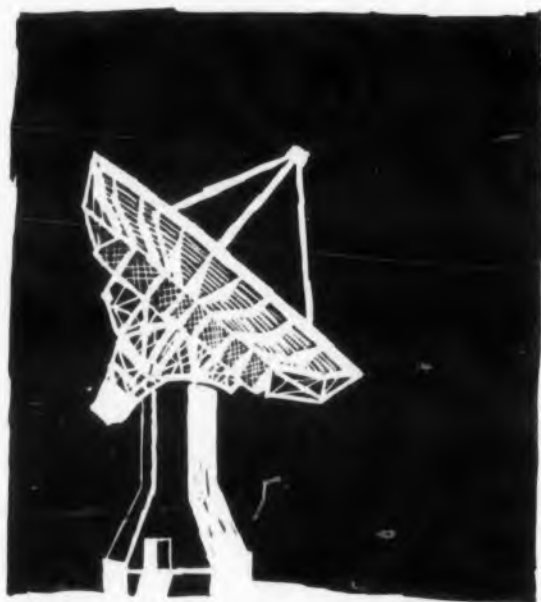
Much work will be done in 1959 on overcoming still further the temperature limitations of periodically focused traveling-wave tubes. In 1959, development of appropriate shunt elements within the magnetic assembly of the periodically focused traveling-wave tube should extend its operating range from -50 to 80 C.

Electrostatically focused traveling-wave tubes requiring no magnet for operation, will be emphasized because of their simplified construction and their power range should be extended up to 1 kw.

Radar engineers will be able to redesign power supplies. Smaller, lower voltage units will emerge as lower operating voltage klystrons become more readily available.

Ferrites will continue to be applied in modulating and phase shifting devices. Because of their long life, ferrite devices will replace many more gaseous tubes. They will find important applications in ferromagnetic parametric amplifiers, which use a ferrite as a nonlinear variable inductor.

All-Mechanical Antenna Scan On Its Way



DESIGN of very large antennas will keep engineers busy in 1959. Much work is in progress in radio astronomy, and large antennas are necessary to pick up the very weak signals emanating from celestial objects.

To obtain the necessary resolution, reflector tolerances must be kept to within 1/16 wavelength. At wavelength of 30 cm, this is about 1 in.

The problem is largely mechanical: How do you make a 100-ft-diam antenna to withstand snow, wind, heat and cold, yet still maintain mechanical tolerances to within 1 inch? One solution may be digging a parabolic hole in the earth and covering it with a conductive material.

Low Side Lobes, Or None

More emphasis will be put this year on decreasing radar antenna side lobes, or at least finding better ways to define side lobes. Antenna gain, susceptibility to jamming and coupling to ground all are affected by side lobes. Low side lobes, or no side lobes at all, are goals for both airborne and ground radar antenna designers.

Scanning is being attacked from many angles. Industry experts feel that mechanical scanning is on its way out. Systems already have been

perfected that offer the reliability of nonmechanical methods with speeds up to 1000 looks per second.

Scanning, Old and New

Three scanning methods, all purely electrical will occupy antenna engineers' time this coming year:

- Frequency scanning.
- Ferrite scanning.
- Ferroelectric scanning.

Frequency scanning is an old system in which frequency determines the phase shift between driven elements. New devices will be under investigation here.

Ferrites in feed lines to the radiators change phase of the driven elements. This phase change is controlled by application of a magnetic field to the ferrites. But the trouble is that ferrites are nonreciprocal. They may be used in a purely receiving antenna, but not for both transmitting and receiving. Someone will be working up

Ferrite vs Yttrium

Significant advances will be made in design of ferrite devices as isolators, Faraday rotation devices, duplexers and filters. New materials such as yttrium and yttrium-gadolinium garnets, however, will compete with ferrite materials. Range of operation of microwave solid-state tubes will be extended to frequencies below 100 mc; a better than 50 db to 1 db reverse to forward wave attenuation ratio at 1000 mc also will be attained.

In the field of Faraday rotation devices such as variable power dividers, switches, modulators and isolators, good performance will be realized over bandwidths as broad as 45 per cent in waveguide.

Important advances will be made in the field of microwave filters. Microwave solid-state filters will be designed with low vswr both inside and outside the passband.

From Lab To Field

But the basic problem confronting the microwave engineer in 1959 is how to exploit the potentials of such promising devices as parametric amplifiers, solid-state masers and variable reactance diodes. Interest will necessarily shift from the laboratory to the field, from research to systems application. ■ ■

It Way Out

mechanism to achieve reciprocity.

Ferroelectric elements are reciprocal. This scanning method is expected to get fair scrutiny by workers in the field. Something must be done about losses, however.

New Shapes Emerge

New shapes of antennas will become more evident. One of the more interesting arrays is the Luneberg antenna. It looks like a huge ball with the feed point rotated around the outer periphery. Made of artificial dielectric, the antenna remains focused at infinity at all times.

Another new configuration to undergo more changes this year is the stacked end-fire array developed by General Bronze Corp. More evaluation of its side lobes now is necessary, say some industry engineers.

More attention is to be given to feed systems. What is wanted is improved efficiency and a more sophisticated system. ■ ■

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For Instrumentation—Lab Accuracy in Field

ONE OF THE crucial needs in electronic instrumentation is accuracy, particularly in time measurements. This year more than ever it will be necessary to bring laboratory accuracy out into the field.

Especially in missile and spacecraft instrumentation, standards of stability and accuracy of time measurements are as demanding as those met in many of the toughest laboratory projects.

In the lab itself, meanwhile, equipment will have to be ruggedized if end products developed from prototypes are to meet requirements of an ever widening range of applications.

A New Technology

Since dawn of the Space Age, quite unobtrusively a whole new form of electronic technology has grown out of the initial assignment to manufacture missiles, and that is the technology of ground support and check-out equipment.

Such equipment eventually will provide a major proportion of the industry's income, according to informed observers. But techniques now are fraught with complications.

In this era of the weapons system concept, a whole new array of test and ground equipment must be developed each time a new system is developed. The Defense Department soon will clamp down on this costly, self-perpetuating process, and begin to impose more stringent demands on design engineers.

DOD's first step will be to lay down an across-the-board policy on testing and check-out instrumentation for all missiles. Certain parameters will be established for quantitative read-out, qualitative measurements, and go-no go checking.

But instrumentation problems are not confined exclusively to the missile field. Among the more intriguing challenges are those facing designers of equipment used in aircraft and spacecraft. The emphasis here is on reducing weight and volume, and it has resulted in development of many miniaturized components and systems.

Helping The Pilot

Aircraft must fly in all kinds of weather, day or night, at high level or close to the ground.

Instruments for novel approaches on unim-

proved fields, for blind landings and for tree-top navigation must be within the capabilities of each type of aircraft.

With more and more planes crowding the sky, a greater degree of automatic operation is required to bring a pilot in for a landing and at the same time allow other pilots to take off. A panel display giving full, detailed pictures, rather than instrument readings, may prove to be the answer.

Says Dr. George L. Haller, General Electric v-p:

"The major problem still facing us is how to uncomplicate the cockpit. The pilot still has to watch dozens of instruments. He still has to tune two or three receivers. He still has to make split-second decisions. The man at a missile control center is faced with the same problems. We need electronics to take over as many of these functions as possible."

Faster Computers Still the Goal

From the marketing standpoint, computers will be a booming business in 1959. But to the design engineer, it largely will be more of the same. Last year's challenges are this year's, with the major emphasis remaining on means of increasing switching speeds—in the millimicrosecond range, possibly with plumbing.

Digital systems are coming into their own, and will be used extensively in process control. This will be a big step forward, for very few if any



two-way-control digital computers now are being used. The major problem here is not so much hardware design as function design. Says Packard-Bell's V. Van Praag:

"Hardware's not so much of a problem. You can now pretty well build what you want. But how do you blend the computer into the system? How do you use it in your organization? That's going to be the biggest problem to solve."

Parallel vs. Serial Operation

For most purposes, Van Praag believes, serially operated computers will give way to parallel operated computers—except for such functions (as accounting) that are inherently serial in nature.

The year 1959 will see continued emphasis on low temperature devices. Most companies are at about the same level of technology, and have the same problems—materials, fabrication techniques, and how to get information in and out. (The latter problem can be troublesome. For instance, if a copper wire runs down the side of a helium tank, it conducts away heat.)

There remains hope in some quarters that a material will emerge which will prove to be a super-conductor at room temperature. No one knows what such a conductor would be like, and there are no immediate prospects that it will be found.

No Smaller, Yet

Eventually there will be a reduction in computer size—but not in 1959. Computers in the foreseeable future will remain the same size, but they will get more complex as technology improves and as materials get cheaper.

One problem engineers will tackle this year is getting the computer closer to the original data. To eliminate the necessity for a secretary's transcribing the data to feed into the computer, transducers will have to be developed to feed the information directly into the machine.

Industrial Requirements Stiff

If electronics is to increase its penetration of industry, and all signs point that way, new levels of reliability will be required. Many industrial control applications call for reliability



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as high as those required by the military—higher than what the military often gets.

The near future should see the beginnings of a new class of electronic equipment, developed specifically for industrial use. As industrial requirements are so varied, the shift to such equipment probably will be a slow one.

Industrial environments can be just as severe as military ones—but the environmental spread fortunately is not so great. Military gear, for example, may be subjected to an extremely wide range of temperatures. But industrial gear, if it is to withstand high temperatures, probably will have to take extremely low temperatures as well.

Eliminate The Man

In automatic control, the challenging requirement is to eliminate the man who now has to make the control decisions. Most processes still depend on monitoring parts of the process and using set-point controllers to keep certain variables within limits. When the final product does not meet specifications, a man has to adjust one or more of the set points—often on the basis of educated guesswork.

The future should see more overall control, with instruments and computers making the decisions instead of men. More often than not, the roadblock will prove to be the process itself. The technology already is here for controlling most processes, once the processes are fully understood.

Wanted: Transducers

The near future will see considerable activity in the transducer field. The history of automatic control has been pendulum-like. Efforts first could be concentrated on improving the actuators, at the tail end of a system, until actuators became much better than the transducers at the front end. Then there would be a swing toward improving the transducers.

The industry is in just that kind of a swing now, according to Dr. J. E. Ward of MIT's Servomechanisms Lab. It is faced with many measurement problems yet to be solved—problems of measuring more accurately, more rapidly, more dependably, and problems of measuring in-stream parameters that could not be measured before.

Nonlinear Systems—Not Yet

So far there is no real trend toward nonlinear systems. There have been some analyses of self-adaptive and self-optimizing systems, and nonlinear concepts have been used as theoretical tools to find out why certain systems did not work. But there has been very little work in deliberate nonlinear designs. ■ ■



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Urgent: Reliability, Less RFI

LAST YEAR'S problems of reliability remain as this year's challenges to design engineers. As never before, there is a great need for components which operate reliably under the severe stresses of vibration and high temperature. And there are new challenges.

The year 1959 will see more encapsulation to help reduce the vibration problem, and miniaturization will continue to occupy designers' thoughts. But two areas will win increasing attention: equipment operation at high voltages, and packaging.

Higher, Higher Voltages

The Space Age has seen voltages rise to the hundreds of thousands in ground support equipment. Development of reliable components is a priority order of business if equipment is to handle the voltages required for transmission over great distances, as in satellite communications.

Packaging of electronic equipment essentially is a mechanical problem—but it must be mastered if the equipment is to function reliably. Too many electronics engineers have been satisfied if the equipment operates in the laboratory.

"Hot spots" in packages must be avoided by intelligent placement of components. Heat must be evenly distributed throughout the entire package.

More Than Statistics

On the general subject of reliability and quality control, to many people this has come to mean statistical control, or, in effect, statistical analysis. So much work has been done on determining probabilities of failure that there has been a tendency to neglect designing to minimize failures.

Many engineers have become so entranced by reliability curves that they forget these mathematical tools do not in themselves impart reliability to a system.

This year should see acceleration of the trend towards spending more time in designing reliability into a system. More and more engineers are

recognizing that mathematics is an important tool, but not a panacea.

Companies are paying more attention to reliability factors not considered before. Some have set up lists of preferred parts for engineers to design into equipment, and samples have been displayed so the engineers can see the part.

Companies also are setting up internal standards to improve quality. They are paying more attention to suggestions made by workmen on production lines, and are teaching such personnel the importance of top-quality workmanship and careful handling of equipment. They are promoting feedback of information to catch mistakes.

The greater efforts devoted to designing reliability into systems have not negated the statistical efforts, nor will they in the future. Many manufacturers now are insisting that their vendors supply reliability statements with their equipment.

Components are not being purchased under the most stringent specifications, however. MIL-C-125, for example, is more popular with industry and with the military than the tougher spec, MIL-C-14175. The reasons: lower cost and faster delivery.



Testing Costs High

Extensive tests are fine for reliability—but the price is high in dollars and time. A failure rate of 0.1 per cent for the lifetime of the component generally is being accepted as satisfactory.

More reliability of equipment provided under military contracting is expected to result from implementation of recommendations made by Task Group 4, the Advisory Group on Reliability of Electronic Equipment (AGREE). The Department of Defense now is selecting equipment to evaluate by criteria cited in the recommendations, and segments of the industry will be invited to cooperate.

Government analyses of reliability have demonstrated that the major problems arise in the use of vacuum tubes and relays. Quality control of transistors and diodes also proved troublesome. But as might be expected in a growing technology, use of components often was found to be faulty because of ignorance of the components' true performance.

Some Department of Defense officials feel it is too early to even use the term "reliability" in guided missile work. Some believe that the ratio of mission "success" to "opportunity to fail" is an erroneous basis for assessing missile reliability; they feel that missile sub-systems must be analyzed in much the same way mean-time-between-failures of individual electronic parts is determined.

There is a tendency, unfortunately reported to be growing, to design into a missile the capability to perform only through a 10-hour test plus the period of its mission. In practice this means an overall operating reliability of 90 per cent—and in time of emergency, this kind of reliability could spell disaster.

Using 10^8 unit hours as a goal for equipment reliability—a goal considered adequate—we see that a missile as complicated as the Nike Zeus, with about 2,000,000 parts (units), would have a 50-hour lifetime.

The challenge to the designer is to develop uncomplicated units which work, yet build in redundancy to compensate for part failures.

RFI Makes Missiles Miss

An ever-rising flood of demands to eliminate radio-frequency interference—demands from the Pentagon, from military installations, from systems manufacturers—is bringing into prominence one of the most glaring weaknesses in the design of electronic equipment. It is ranking in importance with reliability.

To RFI is attributed such events as missile failures, blackouts of communication and radar contact, and submission of false information by computers. Far more important than the vast

amount of money thus wasted is the dangerous disruption of defense facilities resulting from RFI signals.

Recognizing the specific source or sources of RFI is the major problem confronting the design engineer if he is to bring the problem under control. Like a small brush fire, the cause must be stamped out before the situation gets out of hand.

While conventional methods such as shielding and use of low-loss feedthrough components often reduce RFI, no universal set of rules can be presented. Individualized investigation of cases is required since factors such as operating frequency, power output, size and mode of operation tend to individualize equipment.

Check At Each Stage

Perhaps the most universally applicable prescription for controlling RFI is maintaining a close watch along the various stages of the engineering project and applying appropriate remedies as interference develops. If RFI is neglected until the equipment is in field use, brute force filtering may then require considerable increases in size and cost.

Future designs must be devised with maximum freedom from spurious radiation. This will result in more reliable communication and data transmission, and a subsequent decrease in the number of headlines announcing missile and satellite failures. ■ ■

Remember Man? He's In It, Too

PERHAPS MORE overlooked than any other factor in system design is the man. According to Henry P. Birmingham of the U. S. Naval Research Lab, there is too much tendency to view a system as one to be "operated" by the human.

For proper design, man must be considered an integral part of a system.

Many of the design parameters of the human component in a system already are known. It is known that man has a limited bandwidth (about 12 to 1 cps); he is basically a single-channel, single-process device; he is not very precise or stable; and he is noisy. It is known that man is very poor in processing analog information; he cannot measure velocity or distance very well.

But there is a good deal about man still to learn. We must know more accurately what his figure of merit is, how his gain is likely to vary, and how much noise he contributes. These are important factors in overall system design—factors the design engineer would do well to ponder more deeply in 1959. ■ ■



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LC306	200-450 MC	1.104	5/16"
LC309	125-200 MC	1.691	5/16"



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WRITE IN 22 ON READER-SERVICE CARD

Components Demand Outstrip Advances; Goal's Reliability

THE ELECTRONICS industry's customers today are far from getting the ultimate in reliable components.

This is evident from the problems and sore spots outlined in the preceding section. Progress toward component reliability is imperative, but in 1959 the design engineer may not succeed in making a great deal of headway. Demands may outstrip developments, for the range of requirements over which reliable component operation is needed will inevitably continue to increase.

Among today's pressing demands is development of components which can stand up to vibration, both acoustical and mechanical.

How Much Stress?

In missile and avionic applications, this is particularly important; but here no one quite knows how much vibration the components are subjected to inside the high-flying equipment.

Looming just over the horizon is the need to develop components capable of withstanding nuclear radiation. And again there is no one to say just how much radiation a component should be able to take without damaging effects. The problem faces not only the design engineer working with missiles and spacecraft destined to cross radiation fields in space, but those concerned with radiation in nuclear-powered aircraft or in nuclear plants.

The need for components to operate in extreme environments can be overemphasized, however. In military applications roughly 95 per cent of all components are used in ground support equipment. They do not have to withstand the extreme temperatures, humidity, vibration, radiation and other stresses to which the remaining five per cent of missile and avionic components are subjected.

Improve Today's Components

Undoubtedly much work is needed in developing components immune to extreme stresses, in order to supply this five per cent segment of the military market as well as limited industrial users.

But most of the developmental work—at least in 1959—must continue to be concentrated on improving reliability of existing components, those needed for less glamorous and less stressful uses.

If a rough estimate were to be made of how far existing components have been refined, it might be said that they are about 90 per cent perfect. Improving existing components, aiming at the 100 per cent mark, is 1959's challenge—and in military applications cost is a secondary consideration. But the challenge for the years beyond 1959 is the development of utterly new and different components. The Leyden jar principle and a coil of wire will still serve well but newer combinations are needed.

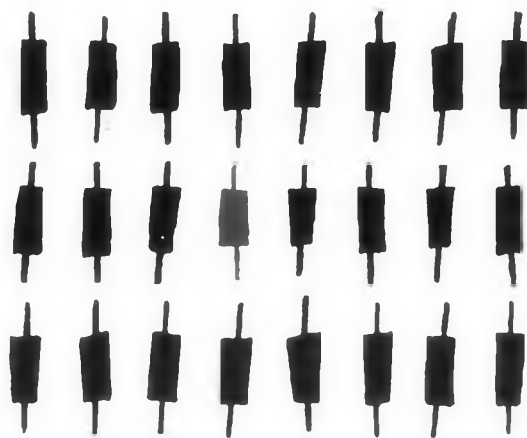
Focus On The Lab

The real need in the coming years is for a fresh approach in the laboratory. Materials will have to be investigated, and new theories evolved. Such fundamentally new components as the transistor must be thoroughly developed. For without new components based on new concepts, the electronics industry may turn into a dead end.

Among challenges for the future are these needed components:

- Batteries of the primary cell variety which have an almost indefinite life and cost little.
- Variable bandwidth filters.

More efficient utilization of the radio frequency spectrum would result from more rapid and more efficient control of the bandwidth of signals sent



through space.

■ Resonant circuits that can operate at 125 C for a sustained period, return to normal temperatures, and perform satisfactorily in both environments—R-L-C's must be stable.

The Do-It-Yourself Man

One of the biggest challenges in components design constitutes a burden falling on the shoulders of a relative newcomer to the field—the designer for a weapons system contractor. This engineer has been telling management that he can build a better component than the long-time component manufacturer can. But can he?

The contractor's designer must face up to the responsibility of deciding if those portions of the nation's defense dollars which come within his purview are being properly spent. A good deal can be at stake in making these decisions, for the military is turning more and more responsibility and funds over to the weapons system contractor. The component designer must ask himself:

- Am I producing a standard part or a special one?
- Can the part be mass produced in case of emergency?
- Am I using money wisely by investing contract funds in lab equipment and study phases, or could an experienced component producer make the money go further?

Compete For Market

To the components manufacturer, the challenge is to move into competition with the weapons system producer.

He must be able to produce the components that will be needed in the Space Age. And with only five per cent of his sales resulting from all of his research effort, the challenge is a demanding one.

What is needed, say military officials, is a breakthrough in production techniques. Systems are required which can produce components in small quantities, but components that are precise and reliable.

Use of standard parts is one of the greatest boons to overall reliability. Component manufacturers must agree among themselves on standards for the industry.

Speedier Semiconductors Seen

If he is to satisfy demands for faster transistorized computers, the semiconductor engineer must develop devices with greater switching speeds—and all signs indicate the challenge will be met successfully.

In 1959 it is expected that the 4-layer switch will reach speeds on the order of 10 millimicrosec. And commercially available within the next few months will be very high speed diodes with a

reverse recovery time of 1 millimicrosec.

The mesa transistors, already finding applications in missile work, will become more readily available on commercial markets, at lower cost. Alpha cutoffs of about 10,000 mc are visualized for these devices, but a range of 1000 to 3000 mc will be more typical. [See recent development, p. 42.]

Unipolar transistors will be in greater demand because of their resistance to radiation, and the demand will increase as missiles reach the stronger radiation fields of outer space.

The silicon controlled rectifier, which got off to an auspicious start in 1958, will find many more applications. The demand for these devices in order to handle higher currents will stir up considerable R & D activity.

For Reliability, Stability

The problem of temperature compensation of transistors, many semiconductor engineers feel, is far from solved. Clearly a big challenge for 1959 is development of new circuit techniques to stabilize transistor performance.

Nine-Year Transistors

One of the brightest pictures of progress today is in the transistor field. In GE's labs are transistors on life test which so far have exceeded 26,000 hours with no change of characteristics. This is the equivalent of nine years at eight hours a day—longer than most electronic equipment will last. One group of transistors was fired from a mortar, withstanding about 15,000 g's shock, then continued to operate, GE reported.

The 1959 trend in transistor production will be towards automation. The year will see additional segments of the assembly line becoming automatic, such as the measuring of wafer thickness, and the testing and separating of transistors according to characteristics. The semiconductor engineer also will continue experiments with new packaging techniques, such as the use of Kovar glass seals.

A Transistor Plateau?

But the industry may well have reached a plateau in transistor developments. No radically new technology will greatly affect the kinds of transistors to be used in the next five years. "We have come to a mesa in changing technology," observed J. J. Ebers of Bell Telephone Labs.

With transistor manufacturers shifting emphasis to automatic production, reliability and tolerances will improve. But this goal cannot be achieved for 900 different types. The result will be fewer, but preferred, types. A new challenge before the design engineer is to use fewer transistor types in developing his circuits. ■ ■



DELCO HIGH POWER TRANSISTORS



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TYPICAL CHARACTERISTICS AT 25°C.

	2N1100	2N1099	2N174A	2N174	2N173	2N278	2N277	2N443	2N442	2N441
Maximum Collector Current	15	15	15	15	15	15	15	15	15	15 amps
Maximum Collector Voltage (Emitter Open)	100	80	80	80	60	50	40	60	50	40 volts
Saturation Resistance	.02	.02	.02	.02	.03	.03	.03	.03	.03	.03 ohms
Thermal Gradient (Max.) (Junction to Mounting Base)	.8	.8	.8	.8	.8	1.0	1.0	1.0	1.0	1.0 °C/watt
Base Current I_b ($V_{ec} = 2$ volts, $I_c = 5$ amps)	135	100	135	135	100	100	100	150	150	150 ma
Collector to Emitter Voltage (Min.) Shorted Base ($I_c = .3$ amps)	80	70	70	70	50	45	40	50	45	40 volts
Collector to Emitter Voltage Open Base ($I_c = .3$ amps)	70	60	60	60	50	45	40	55	45	40 volts

*Designed to meet MIL-T-19500/13A (Jan) 8 January 1958 †Formerly DT100 ‡Formerly DT80

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DESIGN 59

For Consumers: Price, Quality

COMPETITION from abroad has placed a heavy burden on the U.S. consumer-product designer, one which will grow heavier in 1959.

Particularly difficult to meet is steadily growing competition from Japanese firms in the transistor radio field, and from West German and Italian companies in the packaged high-fidelity market.

Increased labor and other costs have boosted the price range of American components to a relatively high level. Cost reduction must be achieved by means of improved circuit design, multipurpose components, and improved production techniques. But since most engineers for many years have been applying the policy of "economy design," the necessity for further stretching poses a distinct challenge.



For A Competitive Market

In an effort to combat the foreign-import deluge, compact multiband receivers (covering the 200-400 kc range and up) are being made available to U.S. consumers.

Television designers will continue their quest for better noise immunity, improved sync stability in fringe areas, and simplification of remote-control devices. Development groups are busy on transistorizing portable TV sets, but they will need a major assist from the battery manufacturers to achieve their goal.

Reflecting insistent public demand is the growing trend toward designing receivers so that subsequent servicing and repair work is simplified.

Improved audio quality and inclusion of tone controls are new features calculated to meet the demands of the swelling hi-fi public this year.

Color television perhaps poses the greatest challenge for 1959, as drastic reductions in consumer-product cost must be realized if the market is ever to develop.

Full-scale advertising campaigns have given color receivers a \$350 price tag. This figure, unfortunately, is not even close to the actual cost of the item, and most manufacturers do not wish to sell at a loss in order to promote the product.

Towards Low-Cost Color

Simplification of circuitry and components may not furnish a satisfactory solution to this cost-price problem. What is needed is a breakthrough providing simplified color kinescope.

With its associated major decrease in cost, this would eliminate convergence assemblies and controls, as well as set-up time. New concepts in the technique of color broadcasting could simplify the overall system, and ultimately bring the receiver's cost down to an attractive price.

Medicine Rx: Bring Engineer, MD Together

IN MEDICAL electronics the challenges to the design engineer are as varied and complex as the human body itself. But perhaps the most important problem is improving communications between the engineer and the doctor.

Hearing Is Believing

Problems faced by designers of high fidelity equipment this year will be more psychological than technical. Engineers will be reading up on experimental psychology more than ever.

This is predictable because at long last, audio engineers are beginning to realize that the old adage—"the final test is in the listening"—contains more fact than fancy. Audio equipment designed to reproduce sound between both extremes of audibility within ± 0.1 db can be no better than the conditions under which it is heard. Sound reproduction has been developed to the point where further improvement probably could not be heard.

The Listening Ear

The problem now is to take advantage of this fine reproduction by presenting it properly to the listener. More attention therefore is going to be paid to problems of sound as received by the listener.

With the advent of stereo, the necessity for doing it justice has come to the forefront. Design requirements will have to be tightened. The requirements will have to be tightened. Stricter quality requirements must be met.

Turntable signal to noise ratio, for example, must be improved because of the response of the stereo cartridge to the vertical component. This mechanical problem in turntable isolation will face some engineers this year.

Turntable speed control and speed regulation also will haunt a few engineers this year. While hysteresis synchronous motors maintain constant speed within close limits, the 60 cps line frequency seldom is 60 cps. Many engineers have awakened to the fact that power companies often vary frequency as much as 3 cps above and below 60 cps, depending upon system load conditions. While it all comes out even in 24 hours

The engineer is not equipped to study medical literature, and he simply does not know what the doctor needs in the way of new equipment. He cannot build an item, then ask the doctor, "Can you use this?"

The physician, on the other hand, has little idea of what the engineer can do. Coupled with this unfamiliarity with engineering's potentialities is the doctor's suspicious attitude toward the engineer and his products, based on past history of charlatanry by advocates of therapeutic and diagnostic "magnetic belts" and similar devices.

Cut X-ray Exposure

Potential applications of electronics to medical research are almost infinite. A boon would be, for example, a machine to produce X-ray pictures without using X-rays—which can be

(looping electric clocks on time), frequency at any one time may be as much as five per cent off. Induction motor designers have a slight advantage here; speed of these machines may be regulated over a limited range. But to check them, the strobe light will have to be operated from a separate 60 cps precision oscillator.

Kill That Hum

Another problem facing audio designers is hum pickup by the stereo cartridge. Stereo pickups are more sensitive to hum than monaural types; they will require shielding without added weight, and some study of hum paths.

In the design of speakers, the important technical area of transient and intermodulation distortion needs more concentrated study. New forms of mechanical construction must evolve before some of the knotty loudspeaker problems can be solved.

Delusion Compounded

The entire high-fidelity component field must face up to the important problem of measurement. Consumers, confused by sales-type specifications, are beginning to demand more honesty in measurements. Even designers complain that they have been fooling themselves. No one seems to be able to compare, for example, the noise level of one manufacturer's turntable with that of any other manufacturer. Some standardization of test procedures must be achieved—preferably before the end of 1959.

Multiplexing of stereo signals from fm broadcast stations may be standardized within the next year. Now five different methods exist. Development of the proper system, engineers say, involves study of many psychoacoustic factors, as well as study of the economics of broadcasting and receiving the signal. ■ ■

damaging both to the patient and the doctor.

Short of that achievement, there is need for a good image intensifier for X-ray photography so the patient will not have to be exposed to so much radiation. Several companies now have such items in development, but none perfected.

Also needed by the medical researchers is apparatus that could measure the long-range effect of low energy radiation on humans. So far the evidence available is not conclusive.

Dr. Umer Liddel of the National Institutes of Health asks for means of measuring blood flow in the heart or in an artery without the necessity for intruding instruments into the blood stream. Since hemoglobin contains iron—which can be magnetic—and serum is conductive, medical electronics design engineers have two starting points for development of such instrumentation

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Nominal No Load RPM†	Gear Ratio	Intermittent Rated Load (oz.-in.)	Max. Starting Torque (oz.-in.)	Power (watts) Loaded††	Current (amps) Loaded	Temp. Rise Deg. F.
330	44:1	4	10	7.6	.11	70
148	10:1	5	20	7.0	.11	70
44	30:1	15	50	7.6	.11	70
22	60:1	30	120	7.6	.11	70

SYNCHRONOUS

RPM†	Gear Ratio	Pull-In Torque, Min. (oz.-in.)	Continuous Torque (oz.-in.)	Power (watts) Loaded	Current (amps) Loaded	Temp. Rise Deg. F.
180	10:1	12	12	19	.21	100
180	10:1	3.5	4	13	.11	65
90	20:1	14	12	11	.095	55
60	30:1	13.5	12	13	.11	65
30	60:1	27.5	12	13	.11	65

†1/6 less at 50 cycles. Some speeds available at 25 cycles.

††6.0 watts in field winding, balance in amplifier winding.



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Continuously variable screwdriver adjustment. Recessed slot protects setting

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Operation unaffected by mounting position

OPTIONAL FEATURES

(a) thermocouple burn-out 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, (h) 220-110 volt transformers.

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(moving conductors and moving magnets). But nobody really has tackled this problem.

Do Brains Emit Waves?

Many doctors would like to see proof that the human brain emits "waves." The electroencephalograph, which measures voltage changes from electrodes on the head, does not prove the existence of such waves. But measurements with a detector placed a distance from the head, without physical contact, might constitute proof of wave emission.

An outstanding problem is electromechanical duplication of functions of the vital organs. That has been accomplished for the heart, permitting "dry field" operations during which the blood supply bypasses the heart. Similar apparatus is needed to perform functions of the liver and pancreas, organs which need rest to heal.

Another challenge is the need for development of transducers for measuring body conditions, thus simplifying diagnosis. One urgently required is a transducer to indicate eyeball pressure without having to touch the eye. This would permit speedier and more accurate diagnosis of glaucoma, a hardening of the eyeball which blinds 150,000 Americans annually.

Automatic Hospitals

Automation of hospitals also is on the "needed" list. Applications might be devised for routines followed at all stages from diagnosis to cure. Automation would prove particularly beneficial in the operating theater. For instance, a quick analysis of cells suspected of being malignant would permit the surgeon promptly to isolate and excise cancer while an operation is in progress. This would eliminate the necessity for follow-up operations in cases where the biopsy proves positive.

In another field, for investigating effects of high altitudes or the pressures encountered in deep-sea diving, a useful device would be one measuring the nitrogen in exhaled air. The mass spectrometer would seem to suggest itself here. But its use is ruled out by the fact that nitrogen has a molecular weight of 28—and so does carbon monoxide. Basal metabolism measurements still are crude; they depend on measuring the time it takes to inhale a known amount of oxygen and going on the assumption that all the exhaled air is carbon dioxide. How much oxygen is exhaled, if any, remains unknown. ■ ■

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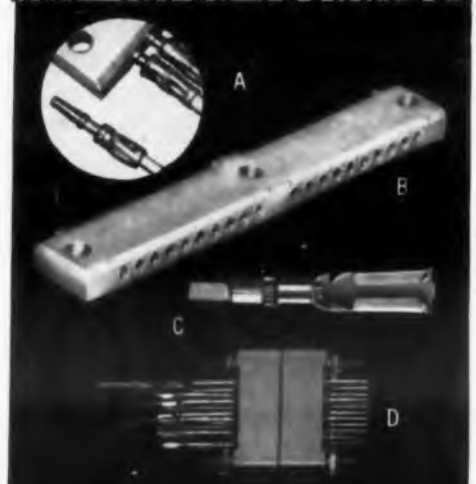
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Bulletin Number 58

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(B) **A-MP "53" SERIES TAPER BLOCKS** . . . are available in either solid blocks or two piece blocks . . . 10 or 20 cavity series . . . single or dual insert.

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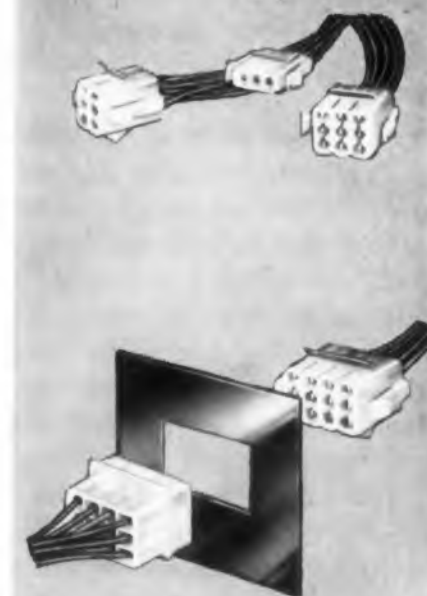
(D) **A-MP MINIATURE TAPER PIN RECEPTACLES** . . . eliminate tedious and costly operations of soldering leads to miniature connectors . . . use A-MP "37" Series Pins.

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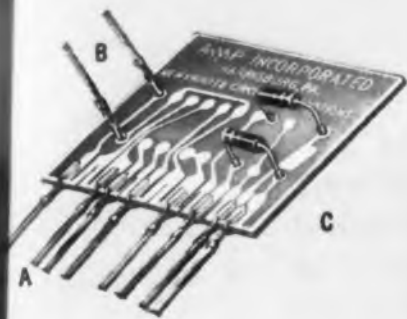
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AMP INCORPORATED
GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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(B) **AMPin TERMINALS** . . . eliminate loose leads during solder-dip operation . . . promote good capillary action during solder dipping . . . accommodate solid or stranded conductors . . . are self retaining and self-aligning.

(C) **AMP COMPONENT TIPS** . . . prevent movement of components during solder dipping cycle . . . permit bridging or offsetting of components . . . protect semi-conductor leads from solder dipping heat . . . eliminate need for eyelets and thru-plating on two-sided boards, by excellent solder wicking characteristics and uniform solder deposit.

Bulletin Number 81

WRITE IN 382 ON READER-SERVICE CARD

SHIELDED WIRE PRODUCTS



(A) **TERMASHIELD SHIELDED WIRE FERRULES** . . . assure positive grounding of wire shield . . . eliminate solder, danger of burning insulation and uncertain attachment . . . feature one-piece construction . . . accommodate one or more grounding wires.

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Bulletin Number 24

WRITE IN 383 ON READER-SERVICE CARD

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(A) **STRATO-THERM TERMINALS AND SPLICES** . . . for high temperature and heat resistant requirements . . . accommodate a wide range of wire sizes either solid or stranded or both . . . with or without fully circumferential wire insulation support as desired.

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Bulletin Number 37

WRITE IN 384 ON READER-SERVICE CARD

Basic Research, Inventions Needed

There are many areas where engineers are virtually stymied. One is underwater communications and underwater detection.

Sonar has apparently gone as far as it can using today's known techniques. Use of high frequency systems show some promise but submarines are small and hf requires large equipment and large power supplies.

The latest "Inventions Wanted by the Armed Forces" bulletin poses the following challenges: a man-made "electric eel" to power underwater cable repeater amplifiers, a small acoustic transducer to detect signals as low as 5 cps.

At the other end of the spectrum, receivers sensitive in the 9-14 micron region with a response time of a few microsec and more sensitive, narrow-band infra red devices are needed. The general need for better infra cells is well known; just what is needed is not known. As some engineers put it, the biggest challenge in infra red is to overcome the security bottleneck so that information can be more readily disseminated. ■ ■

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 W. H. Huggins, Johns Hopkins University
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 David Klem, Sperry Gyroscope Company
 H. K. Ishler, Lansdale Tube Co., Philco Corp.
 Dr. Colin Bowness, Raytheon Manufacturing Co.
 Theodore Saad, Sage Laboratories
 Dr. Arthur Uhlir, Microwave Associates
 Richard Smedes, Sperry Gyroscope Company
 William Sichak, ITT Laboratories
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(moving conductors and moving magnets). But nobody really has tackled this problem.

Do Brains Emit Waves?

Many doctors would like to see proof that the human brain emits "waves." The electroencephalograph, which measures voltage changes from electrodes on the head, does not prove the existence of such waves. But measurements with a detector placed a distance from the head, without physical contact, might constitute proof of wave emission.

An outstanding problem is electromechanical duplication of functions of the vital organs. That has been accomplished for the heart, permitting "dry field" operations during which the blood supply bypasses the heart. Similar apparatus is needed to perform functions of the liver and pancreas, organs which need rest to heal.

Another challenge is the need for development of transducers for measuring body conditions, thus simplifying diagnosis. One urgently required is a transducer to indicate eyeball pressure without having to touch the eye. This would permit speedier and more accurate diagnosis of glaucoma, a hardening of the eyeball which blinds 150,000 Americans annually.

Automatic Hospitals

Automation of hospitals also is on the "needed" list. Applications might be devised for routines followed at all stages from diagnosis to cure. Automation would prove particularly beneficial in the operating theater. For instance, a quick analysis of cells suspected of being malignant would permit the surgeon promptly to isolate and excise cancer while an operation is in progress. This would eliminate the necessity for follow-up operations in cases where the biopsy proves positive.

In another field, for investigating effects of high altitudes or the pressures encountered in deep-sea diving, a useful device would be one measuring the nitrogen in exhaled air. The mass spectrometer would seem to suggest itself here. But its use is ruled out by the fact that nitrogen has a molecular weight of 28—and so does carbon monoxide. Basal metabolism measurements still are crude; they depend on measuring the time it takes to inhale a known amount of oxygen and going on the assumption that all the exhaled air is carbon dioxide. How much oxygen is exhaled, if any, remains unknown. ■ ■

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A-MP PATCHCORD PROGRAMMING SYSTEMS AND PANELS offer tremendous versatility and flexibility. Exclusive feature of A-MP Systems is wiping action of pins against springs for clean contacts. A-MP Universal Patchcord Programming Systems and Panels are excellent for digital computers, data processing equipment and automatic test equipment. A-MP Shielded Patchcord Programming Systems and Panels are excellent for analog computers, telemetering equipment, test equipment and other low level applications where reliable shielding is required. Patchcords are made in a complete series for all programming requirements.

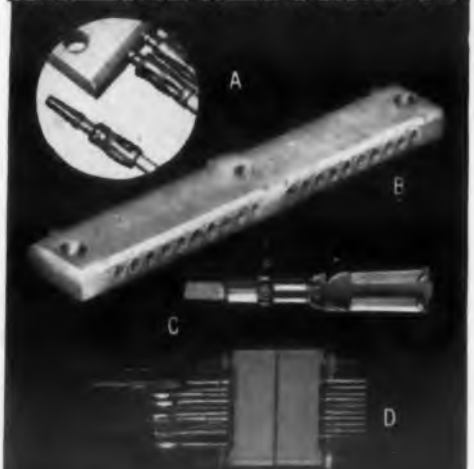
A-MP "240" SYSTEMS . . . offer complete reprogramming in seconds in airborne applications. The compact "240" System weighs 3¼ pounds and features 240 patchcord receptacles for maximum program combinations. It, too, features the exclusive wiping action to assure optimum electrical contact at all times.

Bulletin Number 58

WRITE IN 380 ON READER-SERVICE CARD

Information concerning any termination problem will be forwarded on request. For literature on the above products, write, giving bulletin numbers desired, to:

AMP TAPER TECHNIQUE



(A) **A-MP "53" SERIES TAPER PINS** . . . insulated solid, screw machined or uninsulated formed pins to mate with tapered receptacles. Both types provide noise-free, low resistance electrical characteristics.

(B) **A-MP "53" SERIES TAPER BLOCKS** . . . are available in either solid blocks or two piece blocks . . . 10 or 20 cavity series . . . single or dual insert.

(C) **A-MP TAPER TAB RECEPTACLES** . . . accommodate flat tabs employing the taper key principle . . . feature standardized tapered section to fit relays, stepping switches, multiple connectors and other electronic components.

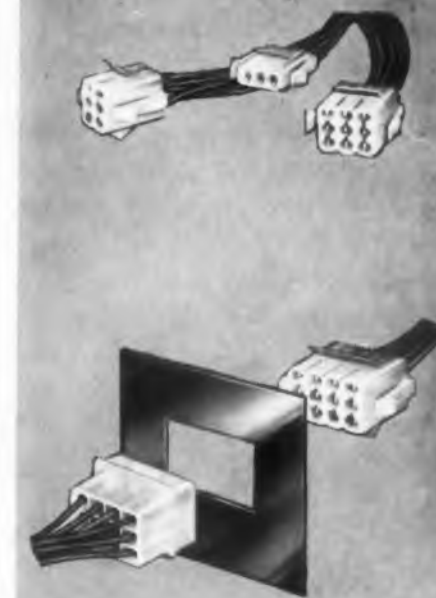
(D) **A-MP MINIATURE TAPER PIN RECEPTACLES** . . . eliminate tedious and costly operations of soldering leads to miniature connectors . . . use A-MP "37" Series Pins.

Bulletin Number 77

WRITE IN 379 ON READER-SERVICE CARD

AMP

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AMP-LOK CONNECTORS . . . are made in 3, 6, 9, or 12 circuit units . . . the most versatile multiple connectors available to the electronics industry. Self anchoring units require no extra mounting parts for through-panel applications. All contacts are identical and self cleaning . . . recessed for safety. Finger grip engagement and disengagement of housing which is polarized to eliminate circuit error. AMP-lok will accommodate a wide range of panel thicknesses . . . may be color coded. AMP-lok may also be used with complete safety as a free hanging multiple connector.

Bulletin Number 45

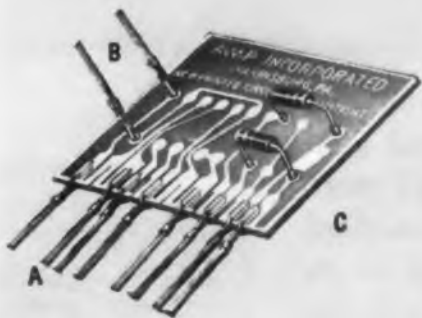
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AMP INCORPORATED

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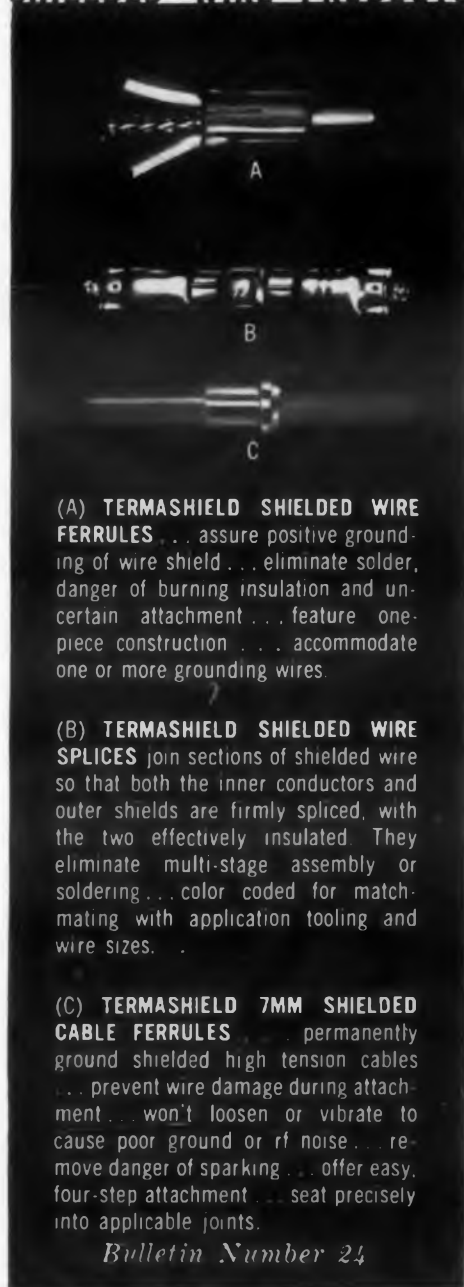
(B) **AMPin TERMINALS** . . . eliminate loose leads during solder-dip operation . . . promote good capillary action during solder dipping . . . accommodate solid or stranded conductors . . . are self retaining and self-aligning.

(C) **AMP COMPONENT TIPS** . . . prevent movement of components during solder dipping cycle . . . permit bridging or offsetting of components . . . protect semi-conductor leads from solder dipping heat . . . eliminate need for eyelets and thru-plating on two-sided boards, by excellent solder wicking characteristics and uniform solder deposit.

Bulletin Number 81

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(A) **TERMASHIELD SHIELDED WIRE FERRULES** . . . assure positive grounding of wire shield . . . eliminate solder, danger of burning insulation and uncertain attachment . . . feature one-piece construction . . . accommodate one or more grounding wires.

(B) **TERMASHIELD SHIELDED WIRE SPLICES** join sections of shielded wire so that both the inner conductors and outer shields are firmly spliced, with the two effectively insulated. They eliminate multi-stage assembly or soldering . . . color coded for matching with application tooling and wire sizes.

(C) **TERMASHIELD 7MM SHIELDED CABLE FERRULES** . . . permanently ground shielded high tension cables . . . prevent wire damage during attachment . . . won't loosen or vibrate to cause poor ground or rf noise . . . remove danger of sparking . . . offer easy, four-step attachment . . . seat precisely into applicable joints.

Bulletin Number 24

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(A) **STRATO-THERM TERMINALS AND SPLICES** . . . for high temperature and heat resistant requirements . . . accommodate a wide range of wire sizes either solid or stranded or both . . . with or without fully circumferential wire insulation support as desired.

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(C) **OTHER A-M-P TERMINALS AND SPLICES** . . . designed for the most diverse circuitry requirements . . . stringently tested for corrosion resistance, vibration resistance, conductivity and long life . . . ideal for all types of electronic equipment.

Bulletin Number 37

WRITE IN 384 ON READER-SERVICE CARD

Basic Research, Inventions Needed

There are many areas where engineers are virtually stymied. One is underwater communications and underwater detection.

Sonar has apparently gone as far as it can using today's known techniques. Use of high frequency systems show some promise but submarines are small and hf requires large equipment and large power supplies.

The latest "Inventions Wanted by the Armed Forces" bulletin poses the following challenges: a man-made "electric eel" to power underwater cable repeater amplifiers, a small acoustic transducer to detect signals as low as 5 cps.

At the other end of the spectrum, receivers sensitive in the 9-14 micron region with a response time of a few microsec and more sensitive, narrow-band infra red devices are needed. The general need for better infra cells is well known; just what is needed is not known. As some engineers put it, the biggest challenge in infra red is to overcome the security bottleneck so that information can be more readily disseminated. ■ ■

Our Thanks

We sincerely thank the following persons, and the several who preferred to remain anonymous, for their help in preparing this report.

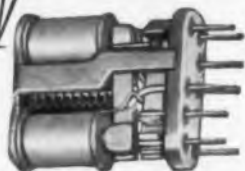
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5 Amp 6 Pole, Double Throw. Meets or exceeds MIL-R-6106B and MIL-R-5757C. Built to withstand 100 G shock. Vibration resistance is 10 G minimum from 75 to 2000 c.p.s. in all mounting planes. All contacts rated at 5 Amps 24 to 30 v. D.C., resistive load. Operates with voltage variations as low as 16 v. at 25° C., ambient.



Series 3205 Miniature Control

L. $2\frac{1}{2}$ " W. $1\frac{1}{2}$ " D. $1\frac{1}{4}$ "
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10 Amp 4 Pole, Double Throw aircraft and missile relay uses same size envelope as AN 3304 (4 P.D.T. 3 Amp relay) and is approximately the same weight. Designed to meet and exceed test requirements of MIL-R-6106B, Class B. Meets minimum current requirements of military specifications.

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Microwave Test Instruments

Test Sets—Part III

Different types of microwave instruments were described in the first part. Signal generators were taken up in Part II. They were classified into different types and described both as a source of signal power and as an accessory to supply a calibrated signal for companion purposes.

Microwave test sets are now taken up. Such accessory units as microwave attenuators, impedance matching devices, termination and directional couplers are also described.

David Fidelman
Roslyn Heights, N.Y.

THE MOST common type of test set consists of a signal generator, a power meter and a frequency meter. The power and frequency meter section can be used both to monitor the output of the signal generator itself, for greater accuracy, and to measure external signals.

A block diagram of a microwave test set is shown in Fig. 1. The signal generator uses a klystron oscillator, of the type described in Part II, coupled to the load through a calibrated attenuator. The generator usually has some form of internal modulation available.

Power is measured by a thermistor bridge in conjunction with a calibrated attenuator. An absorption type wavemeter is used to indicate frequency. A suitable switching arrangement selects the specific functions of the units. The block diagram shows a typical microwave test set, although there may be differences in the design and the features included in different units. Some include a spectrum analyzer, which in certain units can also be used as a synchroscope.

Since the test set includes a power meter and a frequency meter, it can be used without accessory equipment for a number of different types of measurements. Such measurements include:

measurements of receiver sensitivity; selectivity measurements; transmitter tuning and power level measurements; measurement of external microwave power or frequency; signal-to-noise ratio; antenna gain; and transmission line characteristics. Test sets are especially useful in testing of complete radar, fire control, or beacon systems, and in field-testing of microwave relay sta-

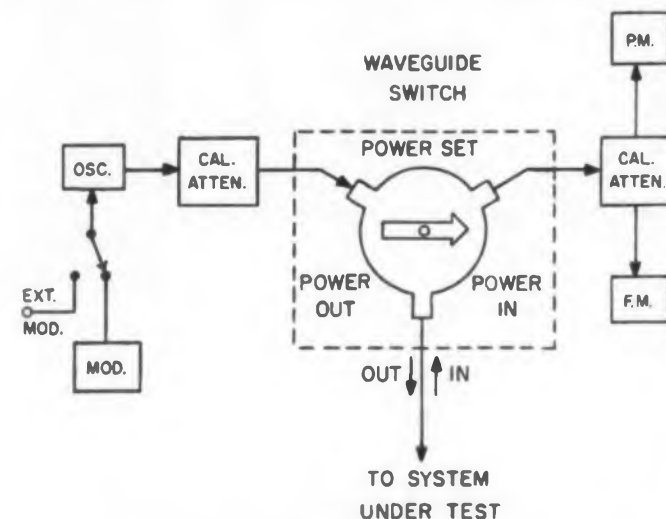


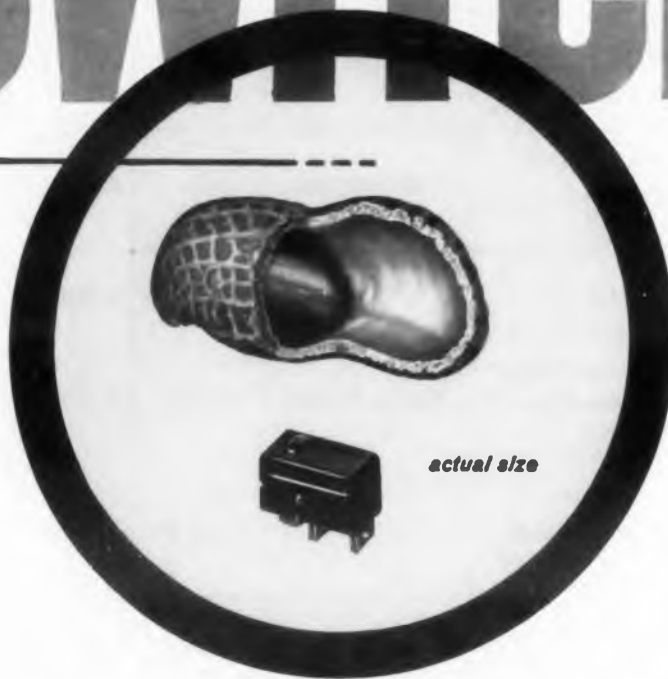
Fig. 1. Basic block diagram of a typical microwave test set.

Table 8. Common Microwave Test Sets

Manufacturer	Model No.	Signal Generator			Power Meter		Frequency Meter		Price	Other Features; General Comments
		Frequency Range	Power Output	Modulation	Range	Accuracy	Range	Accuracy		
Amerac, Inc.	1000	900-4600 mc (using 20 separate oscillators)	Up to 2 kw pulse (0.001 duty cycle)	Int: Pulse	Output power of unit	—	Covers individual ranges	±0.5%	—	Supplies high power output; power meter measures average power and chart used to convert peak power
Telerad Mfg. Co.	TSG-147D	8500-9600 mc	-7 to -85 dbm	Int: cw, fm Ext: Pulse	+7 to +30 dbm	±1.5 db	8470-9630 mc	—	—	Output power continuously variable; accurate to ±1.5 db
Espey Mfg. Corp.	385	8500-9600 mc	-42 to -83 dbm	Int: fm Ext: Pulsed	+7 to +30 dbm	—	8500 to 9600 mc	±2 mc	—	Output power continuously variable by attenuator accurate to ±1 db
General Communication Co.	CBX	8500-9600 mc	-7 to -85 dbm	Int: cw, fm Ext: Pulsed	+7 to +30 dbm	±2 db	8500 to 9600 mc	±2.5 mc	—	Output power continuously variable by attenuator accurate to ±2 db
	BHS	8500-9600 mc	-7 to -85 dbm	Int: cw, fm, Pulsed Ext: Pulsed	+7 to +30 dbm	±2 db	8500 to 9600 mc	±2.5 mc	—	Contains internal pulse and delay generator; output continuously variable, accurate to ±2 db
	BDX	8500-9600 mc	0 to -105 dbm	Int: cw, fm, Pulsed Ext: cw, fm, Pulsed	+1 to +30 dbm	±1.5 db	8500 to 9600 mc	±1 mc	—	More versatile and accurate than Models CBX and BHS
Hewlett-Packard	623 B	5925-7725 mc (in 3 ranges)	0 to -70 dbm	Int: fm Ext: Pulse, fm, square wave	-6 to +3 dbm	±1 db	5925-7725 mc	±0.1%	\$1750	Output continuously variable, accurate to ±2 db; unit supplied with klystron for any one of the three operating ranges
	624C	8500-10,000 mc	0 to -100 dbm	Int: Pulse, fm Ext: Pulse, fm, square wave	-6 to +28 dbm	±1 db	8500 to 10,000 mc	±0.03%	\$2265	Output continuously variable, accurate to ±2 db
Kearfott Co., Inc.	W309-1B-2	5200-5900 mc	20 MW max	Int: cw, fm, Pulse square wave	0 to +33 dbm	±2 db	(same as frequency range of signal generator)	±0.05%	—	These units contain built in spectrum analyzers with 3 inch CRT for display; output power of signal generator continuously variable; See also under Spectron Analyzers
	W109-2C-2	8500-10,000 mc	20 MW max							
	W509-1B-2	15,500-17,000 mc	10 MW max							
New London Instrument Co.	TS-155C/UP	2700-3400 mc (in 3 ranges)	-20 to -100 dbm	Int: Pulsed	Up to 200 mw	—	—	—	—	Does not have frequency meter; contains internal pulse and delay generator; output power continuously variable
Polarad Electronics Corp.	SG-1218	12,400-17,500 mc	-10 to -90 dbm	Int: cw, square wave Ext: Pulse, fm	+10 to +30 dbm	±2 db	12,400-17,500 mc	±20 mc	\$4330	Output power continuously variable, accurate to ±2 db
Sperry Gyroscope Co.	38A	8500-9600 mc	-42 to -85 dbm	Int: cw, fm Ext: Pulse	+7 to +30 dbm	±1.5 dbm	8500-9600 mc	±2.5 mc	—	Output power continuously variable
	590	2700-3550 mc	+3 to -100 dbm	Int: cw, fm, Pulse	+5 to +30 dbm	±1 db	2700-3550 mc	±1 mc	—	These units contain built in spectrum analyzers which can also be used as synchrosopes; contain internal pulse
	570	8500-10,000 mc	+3 to -100 dbm	Int: cw, fm, Pulse	+5 to +30 dbm	±1.5 db	8470-10,500 mc	±3.5 mc	—	and delay generators; output power continuously variable, calibrated from -5 to -100 dbm, accurate ±1 db

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Long, Long life
Higher capacity
No dead break



T3 series **sub-sub-miniature** basic switch

extreme small size--may be ganged
in minimum space

long, long mechanical life--
2½ million cycles

longer electrical life than switches
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no dead break--perfect for super
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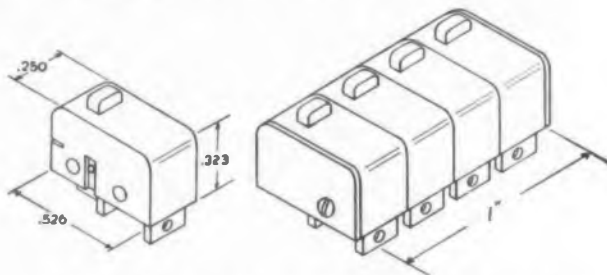
high repeatability--only one moving
part besides button

consistent, close-tolerance mounting--
in single or ganged set-ups

rugged, durable high temperature and
impact resistant case

wide range standard actuators available
in leafs, toggles, pushbuttons, etc.

super long life model available with
limited overtravel



OPERATING CHARACTERISTICS

Base Size.....	.526" long, .250" wide, .323" high
Weight.....	1.6 grams (.057 oz.)
Contact.....	SPDT, fine silver std. (others to order)
Operating Force.....	200 grams (7.05 oz.) max.
Pretravel.....	approx. .010"
Contact Pressure.....	50 grams (1.76 oz.)
Overtravel.....	.005" min.
Movement Differential.....	.003" max.
Release Force.....	30 grams (1.06 oz.)
Mechanical Life.....	2,500,000 cycles, approx.
Ambient Temperature.....	-65° to +250°F. std. (350° to order)
Terminals.....	solder standard (spade type available)
Electrical Life Rating.....	6 amps, 125/250 VAC, 30 VDC resistive
	3.5 amps, 30 VDC inductive sea level
	3.0 amps, 30 VDC inductive 50,000 ft.
	2.5 amps, 30 VDC inductive 100,000 ft.

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tions and communications equipment, as well as general tests.

Accessory Units

The equipment and units listed in Tables 9, 10, and 11 are not strictly microwave test instruments, but are rather accessory units used in most measurement setups. These units include: microwave attenuators (both fixed and variable); impedance matching devices; terminations; and directional couplers. Since they are primarily measurement accessories, their characteristics are not listed in the same detail as the major types of microwave test instruments. The listing is primarily one of manufacturers and of the different types of units which they manufacture as stock items. There are other manufacturers of many of these various types of units, but the listing has arbitrarily been restricted to manufacturers of test instruments listed in other tables in this series.

Since there are such a wide variety of accessory units, having only slight differences in characteristics, they are simply listed by type of unit and frequency band for which they are used. Thus, a single manufacturer may make a series of fixed attenuators having 3, 6, 10 and 20 db attenuation in each frequency band from L to E band. These are listed only by frequency bands, and any further information should be obtained from the individual manufacturers.

Attenuators

Many microwave measurements require attenuation of the power in a transmission system. Attenuators may be used: as standards in power and attenuation measurements; as a means of extending the range of available equipment; to vary signal level by a known amount; to reduce the power level of available sources; for isolating different parts of the setup from one another; and for many other purposes which arise in the course of making microwave measurements. There are, in general, two different types of attenuators for use at microwave frequencies: the waveguide-beyond-cutoff type, and the dissipative type.

The waveguide-beyond-cutoff attenuators make use of the exponential attenuation characteristic of a waveguide below its cutoff frequency, and have excellent accuracy and stability characteristics. Their prime advantages:

The rate of attenuation is known analytically and can be calculated to a high degree of accuracy.

The power level at which they operate is not limited by the heat dissipation of a resistive element. Because of the latter characteristic, they are useful in coupling from the output of a high-level microwave generator.

The more widely used type of attenuator makes use of a resistive strip inserted into the waveguide (or coaxial line) to absorb part of the power. The resistive element may be inserted into the waveguide in a number of different ways. In fixed attenuators, the amount of insertion and position of the element are fixed. Variable attenuators may be either the flap or the vane type. In the flap attenuator, a resistive strip is inserted in the broad face of the waveguide, and the amount of attenuation is varied by changing the amount of the strip insertion. The more accurate calibrated attenuators make use of a resistive vane whose position or orientation in the waveguide can be precisely varied. Dissipative types of attenuators are generally designed for maximum average input power of the order of 1 to 2 w.

Fixed attenuators are generally available in attenuation values of 3 to 40 db, and are particularly useful in applications requiring a fixed accurately known attenuation, for reducing the power flowing in a waveguide system, for reducing reflections of loads or sources, or for isolating parts of a waveguide system. Variable attenuators have ranges of 0 db to about 50 db maximum, depending upon the type. Uncalibrated and general-

purpose calibrated variable attenuators are useful for power level adjustments and applications where the attenuation need not be accurately known, or need not be known. Precision calibrated attenuators are designed for applications requiring a highly accurate and reliable knowledge of attenuation.

Impedance Matching Devices

Impedance matching devices are used in microwave measurements for correcting discontinuities or "flattening" waveguide systems, as well as to match loads, terminations, bolometer mounts or antennas to the characteristic admittance of the waveguide.

Slide-screw tuners consist of a waveguide slotted section upon which is mounted an adjustable probe whose position and depth of insertion can be varied. They are useful in determining experimentally the position and magnitude of matching structures required in waveguide systems. E-H tuners consist of a straight section of waveguide to which series and shunt tuning arms with movable short circuits are attached. They are particularly useful when low power leakage and high power handling capacity are required. Phase shifters provide accurate, controllable phase variation, and

Table 9. Microwave Attenuator

Manufacturer	Fixed attenuators	Variable attenuators		
		Uncalibrated	Calibrated, general purpose	Calibrated precision or high-stability
Admittance-Namco Corp.	X, coax	X	—	X
Amerac, Inc.	S,C,XN,XB,X,KU,K,V,M	S,C,XN,XB,X,KU,K,V,M	—	—
B J Electronics	—	—	10-3000 mc	—
De Mornay-Bonardi	all bands from S to E	S,C,J,H,X,KU	18.0 to 90 kmc	all bands S to E
Diamond Antenna & Microwave Corp.	S,C,XN,XB,X,KU,K,V, coax	S,C,XN,XB,X,KU,K,V, coax	X,KU, coax	S,C,SN,SB,X,KU,K,V
F-R Machine Works, Inc.	L,S,C,XN,XB,X,KU	all bands L to E	—	all bands L to E
General Radio Co.	coax	coax	coax	—
Hewlett-Packard Co.	S,C,XN,XB,X,KU,K,V	—	S,C,XN,XB,X,KU,K,V	S,C,XN,XB,X,KU,K,V
Lisco, Inc.	—	all bands S to E	—	all bands S to E
Microwave Associates, Inc.	L,XB,X,KU,K,V,M	X,KU,K,V,M	X,KU,K,V,M	—
Narda Microwave Corp.	all bands S to E; coax	all bands S to E	coax	S,C,XN,XB,X,KU
Polarad	—	—	coax	—
Polytechnic Research & Dev.	X, coax	XN,X,K,V,M	X,M, coax	S,C,XN,XB,X,KU,K,V
Radiation, Inc.	—	—	coax	—
Radio Corp. of America	coax	—	—	—
Radar Design Corp.	coax	—	—	—
Sivers Lab.	—	X	—	—
Sperry Gyroscope Co.	X	X,KU,V	X	—
Waveline, Inc.	S,C,XN,XB,X,KU,K,V	S,C,XN,XB,X,KU	S,C,XN,XB,X,KU	S,C,XN,XB,X,KU,K,V
Weinschel Engineering	S, coax	—	—	—
Roger White	—	—	S,C,XN,X,KU,K, coax	—

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- Contact Resistance 9.7 millivolts @ 7.5 amps
- Meets or exceeds requirements of MIL-C 5015C

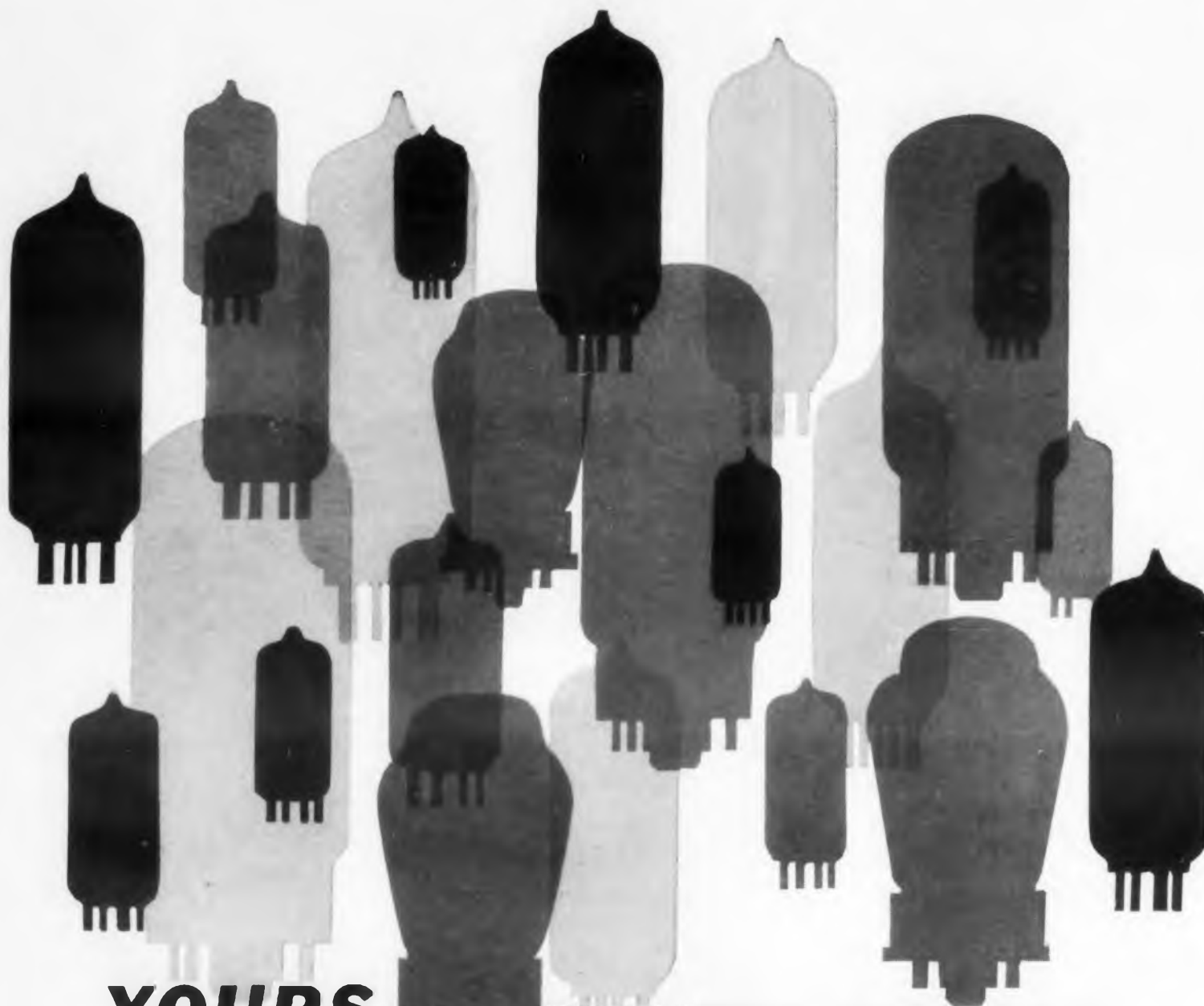
Electrical wizards can get the inside information on these 3, 7, 12, 19, 27, 37, and 61 contact Deutsch miniature plugs—and their stellar partners, the DM9600 series miniature push-pull receptacles and DM5600 series miniature hermetic receptacles—just as quick as a wink.

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are useful in measurement of transmission, attenuation and impedance in microwave systems, in introducing differential phase shift, and in otherwise studying the design of microwave systems and antennas. Adjustable shorts consist of a section of waveguide containing a movable short-circuiting plunger, and are useful for introducing a variable element in waveguide systems.

Directional Couplers

A directional coupler extracts a small amount of energy from a waveguide system. It consists of a main waveguide which is inserted in the system, with another waveguide section coupled to it. The important characteristics of directional couplers are the coupling factor which may range from 3 db to 30 db and the directivity which is generally at least 20 to 40 db.

Directional couplers are either of the cross-guide or the multi-hole type. The former consists of two waveguide sections joined at right angles across their broad faces. The latter consists of two parallel joined waveguides coupled together through a series of holes in their common wall. The multi-hole type has better coupling and directivity characteristics, while the cross-guide type is useful in applications which do not require the precision of the multi-hole coupler.

Directional couplers are useful for extracting a known fraction of the power flowing in a transmission line, or for introducing power into a line without disturbing its characteristics. They are used in measuring and monitoring power and frequency, mixing signals, isolating signal sources or wavemeters, and a variety of other applications requiring the connection of auxiliary equipment to a transmission line. Because of their directional characteristics, they are extremely useful in measuring reflections in waveguide systems.

Terminations

Terminations are used for absorbing the power in a microwave system, and are designed to absorb virtually all the power and assure a low SWR. They consist of a section of waveguide containing a tapered dissipative element which absorbs the power. Low-power terminations (up to 2 w average power) and high-power terminations (up to 600 w average power in some bands) are commercially available in all the microwave band.

A moving load consists of a section of waveguide in which is mounted a sliding tapered low-reflection load, and permits the accurate determination of the reflection coefficient of the termination itself. Standard reflections are precision loads used to set up exact reflections for standardizing SWR measurement setups.

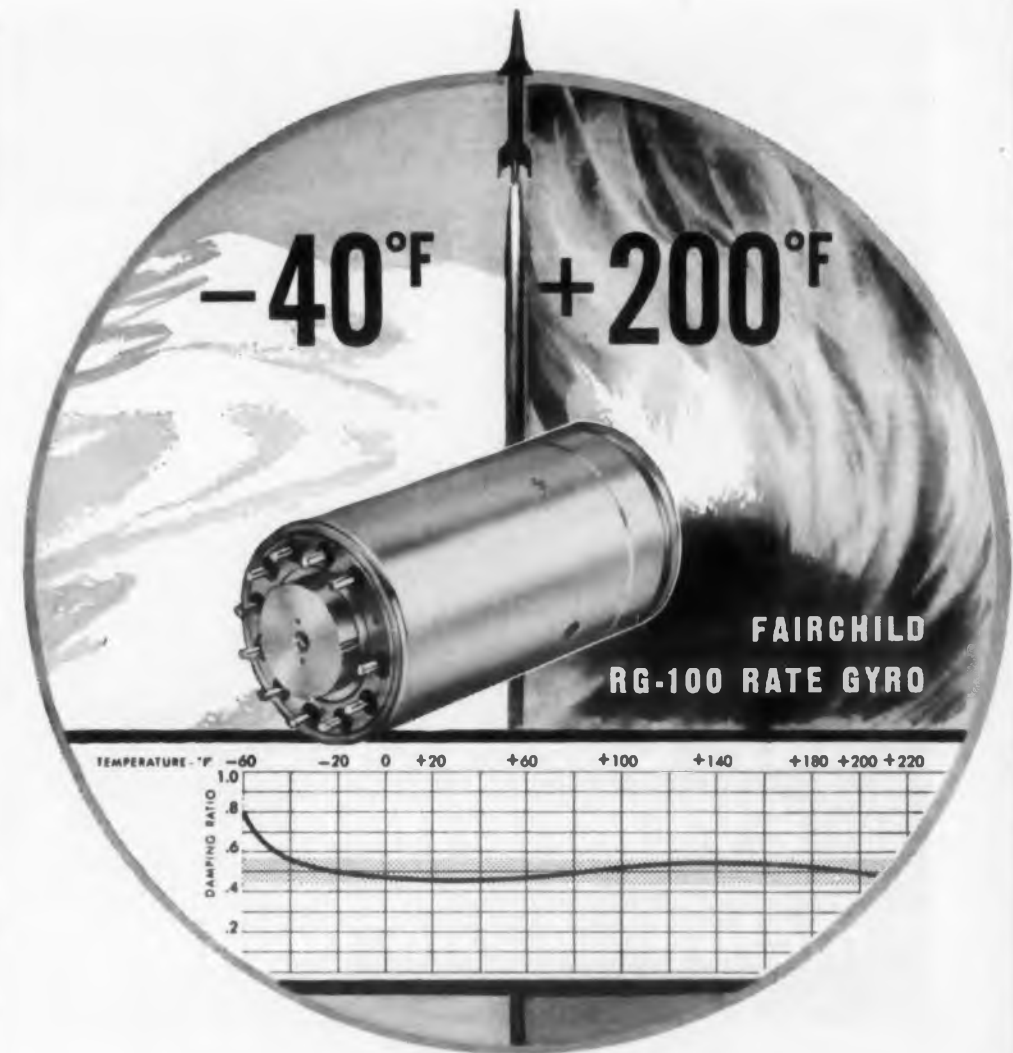
Table 10. Impedance matching Devices

Manufacturer	Slide-screw tuners	E-H tuners	Adjustable shorts	Phase shifters	Stub tuners
Admittance-Namco Corp.	X	X	X	—	coax single, double, triple stub
De Mornay-Bonardi	—	all bands from S to E	all bands from S to E	all bands from S to E	all bands from S to E
Diamond Antenna & Microwave Corp.	L,S,C,XN,XB,X,KU	S,C,XN,XB,X,KU,K,V	L,S,C,XN,XB,X,KU,K,V, coax	—	coax double stub
F-R Machine Works, Inc.	L,S,C,XN,XB,X,KU	all bands S to E	bands L to E	—	coax double stub
General Radio Co.	—	—	coax	—	coax
Hewlett-Packard Co.	S,C,XN,XB,X,KU,K,V	X,KU,K,V	S,C,XN,XB,X,KU,K,V	XN,X,KU	—
Lieco, Inc.	—	all bands S to E	all bands S to E	—	—
Microwave Associates, Inc.	—	X,KU,K,V,M	X,KU,K,V,M	—	V,M
Narda Microwave Corp.	L,S,C,XN,XB,X,KU	all bands S to E	all bands S to E	C,XN,XB,X,KU	coax
Polytechnic Research & Dev.	S,C,XN,XB,X	KU,K,V,M	—	—	coax double stub
Radar Design Corp.	—	—	S,C,XN,XB,X,KU,K	—	coax double stub
Sierra Electronic Corp.	—	—	—	XB,X	coax double stub
Sivers Lab.	S,C,XN,XB,X,KU	—	S,C,XN,XB,X,KU	—	coax single, double, triple stub
Sperry Gyroscope Co.	—	—	C,XN,X,KU,K, coax	S,C,X	S,C,XN,XB,X, coax, double, triple stub
Waveline, Inc.	—	S,C,XN,XB,X,KU,K,V	S,C,XN,XB,X,KU,K,V	S,C,X,K	XN,XB,X,KU,K,V
Weinschel Engineering	—	—	—	—	coax double stub

Table 11. Terminations and Directional Couplers

Manufacturer	Terminations				Directional couplers	
	Moving loads	Standard reflections	Low or medium power terminations	High-power terminations	Cross-guide	Multi-hole
Admittance-Namco Corp.	coax	—	X, coax	—	X, coax	—
Airtro, Inc.	—	—	—	S,C,XN,XB,X,KU,K,V	—	—
Amerac, Inc.	—	—	S,C,XN,XB,X,KU,K,V,M	C,XN,X	—	S,C,XN,XB,X,KU
Bird Electronic Corp.	—	—	—	to 3300 mc	—	—
Bogart Mfg. Corp.	—	—	—	L,S,C,XN,XB,X	L,S,C,XN,XB,X	S
California Technical Industries	—	X	—	—	—	X
Chemalloy Electronics	—	—	—	L,S,C,XN,XB,X,KU,K,V, and coax	—	—
Cubic Corp.	—	—	—	to 6000 mc	—	—
De Mornay-Bonardi	all bands from S to E	—	all bands from S to E	all bands from S to E	all bands from S to E	—
Diamond Antenna & Microwave	S,C,XN,XB,X,KU,K,V, coax	—	L,S,C,XN,XB,X,KU,K,V, coax	—	L	S,C,XN,XB,X,KU,K,V,M
F-R Machine Works, Inc.	L,S,C,XN,XB,X,KU,K,V	S,C,XN,XB,X,KU,K,V	all bands from L to E	—	X	S,C,XN,XB,X,KU,K,V
General Radio Co.	coax	—	coax	—	coax	—
Hewlett-Packard Co.	S,C,XN,SB,X,KU,K,V	X	S,C,XN,XB,X,KU,K,V	S X	S,C,XN,XB,X	S,C,XN,XB,X,KU,K,V
M. C. Jones Co.	—	—	—	coax	—	coax
Lieco, Inc.	—	—	all bands L to E	all bands L to E	S,C,XN,XB,X,KU,K,V, coax	S,C,XN,XB,X,KU,K,V
Microwave Associates, Inc.	—	—	L,X,KU,K,V,M	L,S,C,XB,X,KU,K,V,M,E	L	X,KU,K,V,M
Narda Microwave Corp.	all bands L to E; coax	S,C,XN,XB,X,KU	all bands L to E; coax	L,S,C,XN,XB,X,KU, coax	L,S,C,XN,XB,X,KU	all bands S to E; coax
Polytechnic Research & Dev.	—	—	S,C,XN,XB,X,KU,K,V, M, coax	—	—	S,C,XN,XB,X,KU
Radar Design Corp.	S,C,XN,XB,X,KU,K; coax	coax	S,C,XN,X,KU,K, coax	—	S,C,XN,X,KU,K,V, coax	S,C,XN,X,KU
Sierra Electronic Corp.	—	—	coax	XB, coax	—	coax
Sivers Lab.	—	—	S,C,XN,XB,X,KU	—	S,C,XN,XB,X,KU	—
Sperry Gyroscope Co.	X	—	S,C,XN,X,KU,K,V, coax	S,C,XN,XB,X	S,C,XN,XB,X,KU,K,V	V, coax
Telrad Mfg. Corp.	—	—	—	—	all bands	all bands
Waveline, Inc.	S,C,XN,XB,X,KU,K,V	—	S,C,XN,XB,X,KU,K,V	C,XN,XB,X,KU	S,C,XN,XB,X,KU,K,V	C,XN,XB,X,KU,K,V
Weinschel Engineering	—	—	coax	—	—	—

The tabulation of accessories as attenuators, impedance matching devices, terminations and directional couplers are restricted to manufacturers of test instruments mentioned in other tables in this series.



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Only Fairchild's Rate Gyro—has uniform, constant damping for any required percentage of critical within $\pm 15\%$ and over the entire operating temperature range of -40° to $+200^\circ\text{F}$. This is accomplished by varying the damping area, using the damping medium as a sensing device which varies with temperature changes.

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INPUT RATES (Full Scale)	± 20 to ± 800 degree/second	OUTPUT	6 volts, 400 cps, phase sensitive
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MOTOR	2 or 3 phase; 6.3V or 26V AC	NULL	15 to 40 mv total depending upon maximum rate and damping.



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in missiles

**UAP CAN COOL
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including the mouse!**

TI 2N559 mesa transistor offers high switching speeds, high alpha cutoff frequency along with high collector dissipation. (Opposite)

Mesa Switching Transistor Reaches Millimicrosec Range

	missile type	Surface-Surface	Air-Surface	Air-Air	Surface-Air	ICBM	IRBM	IGBM	Drone	Tactical	Unknown	service use	Army Ordnance	USAF	NAVY	Army Sig. Corps	Bur. Aeronautics	Unknown	propulsion	Liq. Fuel Rocket	Solid Fuel Rocket	Booster	Ram Jet	Turbo Prop	Gas Turbine	Unknown	guidance	Radar	Inertial	Infra Red	Radio	Unknown	ground support	
cooling systems	Mechanical Refrigeration																																	
	Expendable Refrigeration																																	
	Cryogenic																																	
	Heat Transport																																	
	Console Cooling																																	
heat exchangers	Evaporative																																	
	Liquid/Air																																	
	Ammonia/Glycol																																	
	Liquid/Gas																																	
	Evaporative																																	
	Liquid/Liquid																																	
	Liquid Ammonia/Liq. Oxygen																																	
	Hot Gas/Nitrogen Tetroxide																																	
valves	Ammonia/Air																																	
	Cold Plate																																	
	Rupture																																	
	Explosive																																	
	Bleed																																	
	Bypass																																	
	Temperature Control																																	
hand pumps	Pressure Control																																	
	Solenoid																																	
	Thermostatic																																	
oil tanks	All-Attitude																																	

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FOR THE first time a mesa transistor is in production that can reliably offer:

- Switching speeds of 275 millimicrosec max total.

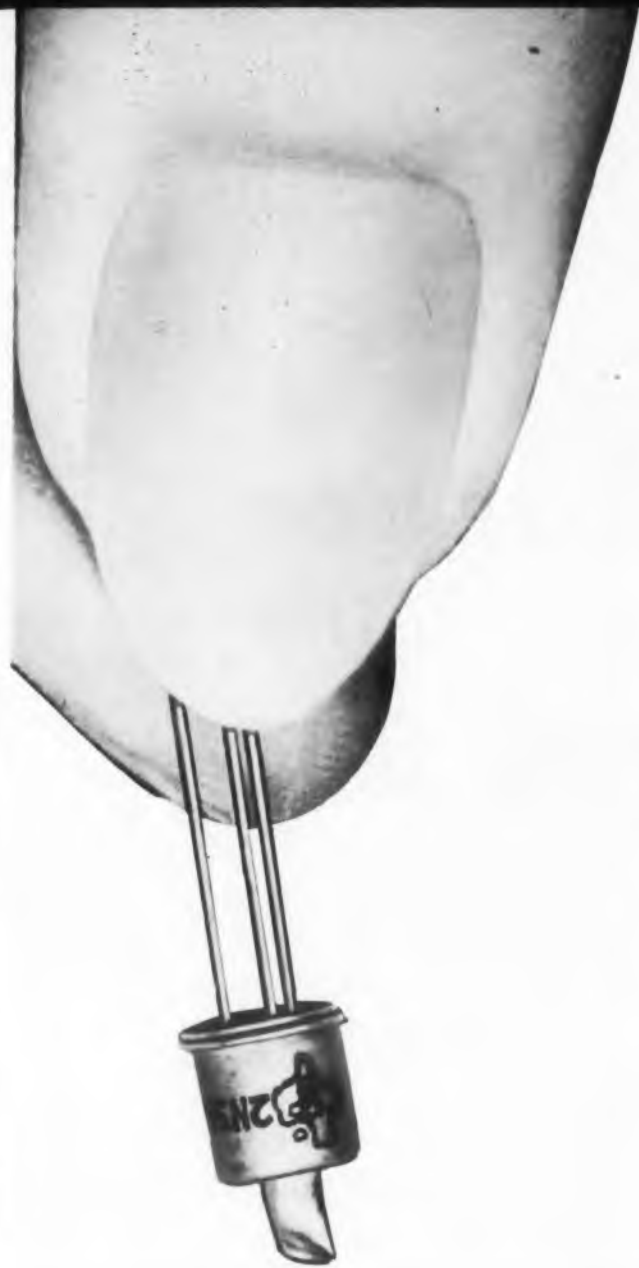
- Alpha cutoff frequency of 250 mc.

- Collector dissipation in excess of 150 mw in free air.

- Operating temperatures up to 100 C.

In our Design '59—a *challenge* report elsewhere in this issue, such an advance in mesa techniques was predicted, it was not visualized as coming quite so soon. Although there are semiconductor devices with higher switching speeds, higher alpha cutoff frequencies or higher power capabilities, the TI 2N559 is the first transistor to offer all three characteristics in a package not very much bigger than the size of a small diamond. Tested for high reliability, it is designed for use in advanced missile and airborne electronic circuitry.

Designed by Texas Instruments Inc., P. O. Box 312, Dallas, Tex., the TI 2N559 is packaged in a miniature round-welded case less than half the size of the standard JETEC-outline TO-5 unit. The case is compatible with the 100-mil grid mounting system. Its germanium wafer is



mounted directly on a gold header and the active area of the wafer is about the size of the diameter of one of the leads. High dissipation is obtained through direct contact between header and element consisting of just three materials—germanium, aluminum and gold.

The TI 2N559 has a switching range of 275 millimicrosec max total. The rise, storage and fall time was measured in a hard saturated circuit with parasitic capacitance. Although it is rated at 100 C, all units are stabilized well above their rated junction operating point.

The 2N559 is produced by gaseous diffusion and high-vacuum techniques similar to those used for the 2N623 90-megacycle germanium transistors introduced by TI in March, 1958. This type of construction, called the "mesa" configuration, provides the highest frequency response, switching speeds and power capabilities now attainable. These parameters, combined with high mechanical stamina to resist impact, acceleration and vibration, make the TI 2N559 well suited for military applications in missile and airborne electronics.

For more information about this mesa transistor, turn to Reader's Service Card and write in 104.

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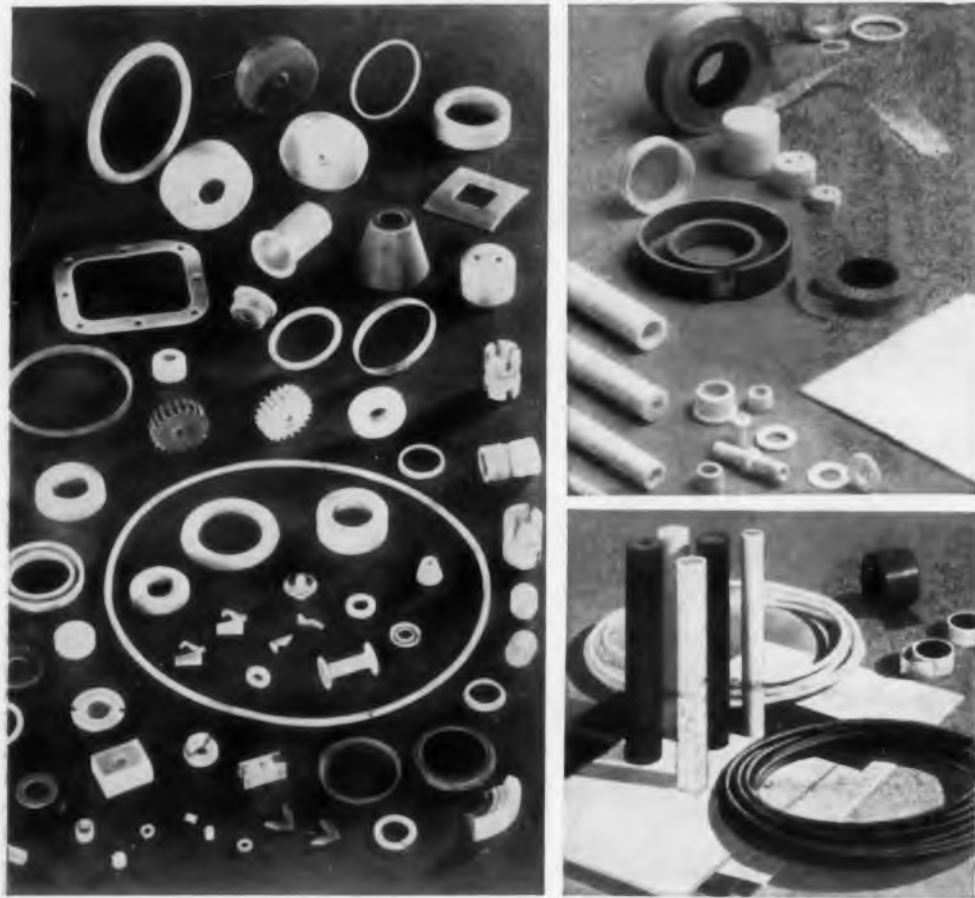
RC-32
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RC-42
(2-watts)

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DESIGN FORUM

Many Money-Saving Ideas in this FM TUNING UNIT

DOZENS of cost-saving features, both mechanical and electrical, were designed into this fm tuning assembly and receiver. Chassis knockouts serving as tuning pads are but one example. The unit represents the imaginative design thinking so essential today to meet the threat of the cheap foreign import market. Since hourly labor costs and component prices are continually moving upwards, savings were brought about by multipurpose use of parts, circuit simplification, and reduction of assembly time.

Padders Eliminated

It's quite a trick, and a healthy saving, to eliminate padder capacitors or coil slugs necessary for alignment of the low

end of the band. This is cleverly accomplished by Granco Products, Long Island City, N. Y., by the use of chassis knockouts bent up adjacent to the end turns of the rf and oscillator coils. During alignment, the technician simply alters the spacing of the "shorted-turn" to obtain the proper inductance.

Mechanical Savings

"Why spend money to chop metal out of a chassis and then spend more money to buy it back in the form of brackets and shields?"—This question was posed and then investigated by Seymour Napolin, chief engineer of Granco. His answer came in the form of knockout dies inserted during chassis fabrication to:

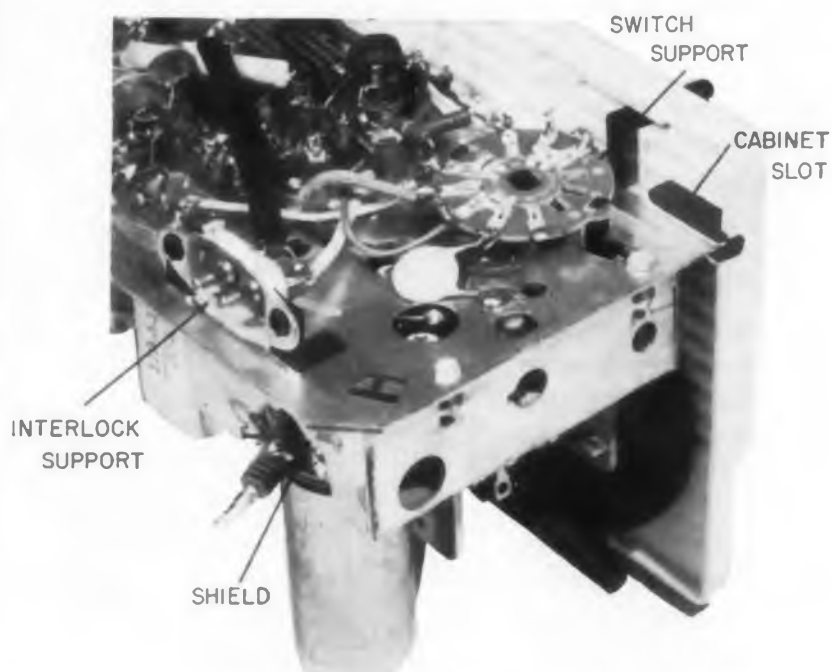


Fig. 2. Note use of chassis knockouts to support interlock and switch wafer. Chassis slides into slots along front panel for ease of assembly.

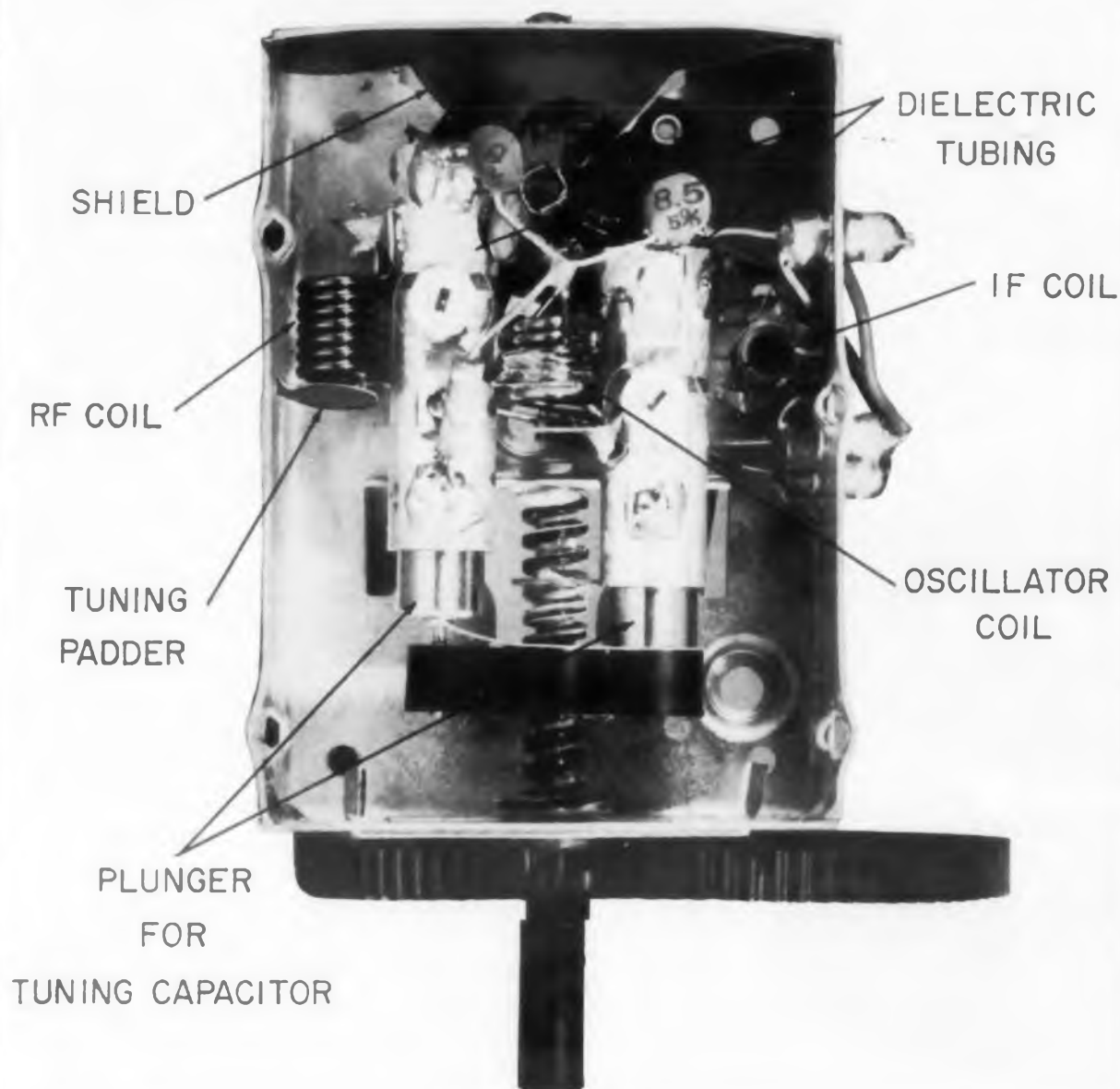


Fig. 1. Note dielectric tubes, chassis "bulge-in" for circuit shielding, and "shorted-turn" adjacent to each coil. During alignment, "shorted-turn" is adjusted for proper inductance.

- "Bulge-in" a section so as to magnetically shield the tuner input from the rest of the circuit.
- Form a retaining grip for the tube shield, thereby eliminating the need for a special, more expensive socket.
- Provide a bracket to hold the glass dielectric tubes.
- Support the interlock assembly in the complete am-fm receiver.
- Mount the am-fm selector switch wafer.

Simple Cabinet Assembly

Final assembly time is reduced to a minimum by having the cabinet molded as a two-piece assembly with slots or runners along the inner edge of both sections. The chassis is slid into the front panel runner and secured by means of a single screw, see Fig. 2. The rear section is then slipped along the chassis and the entire assembly is firmly fastened together with one screw.

No Mess, No Fuss Dial Drive

Complicated drive pulleys, springs, and lengths of dial cord are not to be found in this unit. Instead, a simple lead-screw, direct-drive arrangement is used. Five complete revolutions of the drive gear covers the entire fm band with ample smoothness to separate even the closest of adjacent stations. A concentric slot along the face of the driven gear allows sufficient pliability during gear teeth engagement so that backlash is eliminated without using close tolerance parts. Dial scale figures are molded onto the driven gear thereby eliminating the need for a separate escutcheon plate.

Coaxial Tuning

Side-stepping the traditional variable capacitor, with its inherent disadvantages of large size and cost, microphonic and temperature-sensitive characteristics, and mechanical wiper noise, was the first



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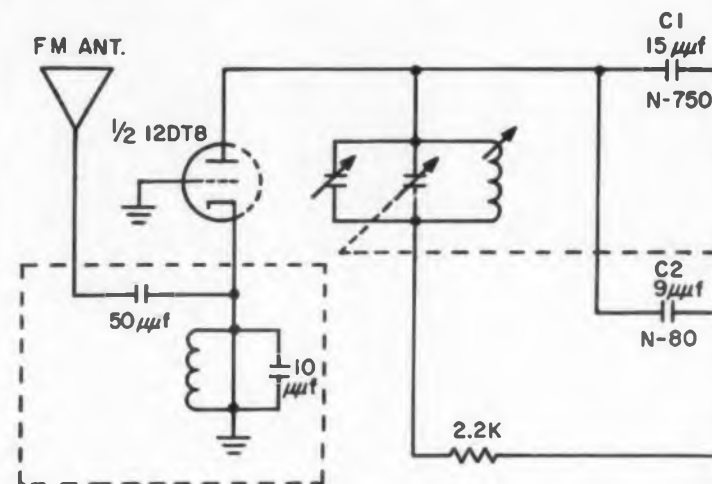
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Fig. 3. (Below) Schematic diagram of tuning section. A single tube performs function of rf amplifier, oscillator, and mixer.



move by Granco. Instead, coaxial tuning, using the travel of a metallic plunger in a low-loss glass dielectric tube, was adopted. Cylindrical end sleeves on the glass tube act as plates of a capacitor; their relative spacing determines the minimum capacity. Capacitance is increased as the plunger is inserted into the tube to apply greater coupling between end sleeves, see Fig. 1.

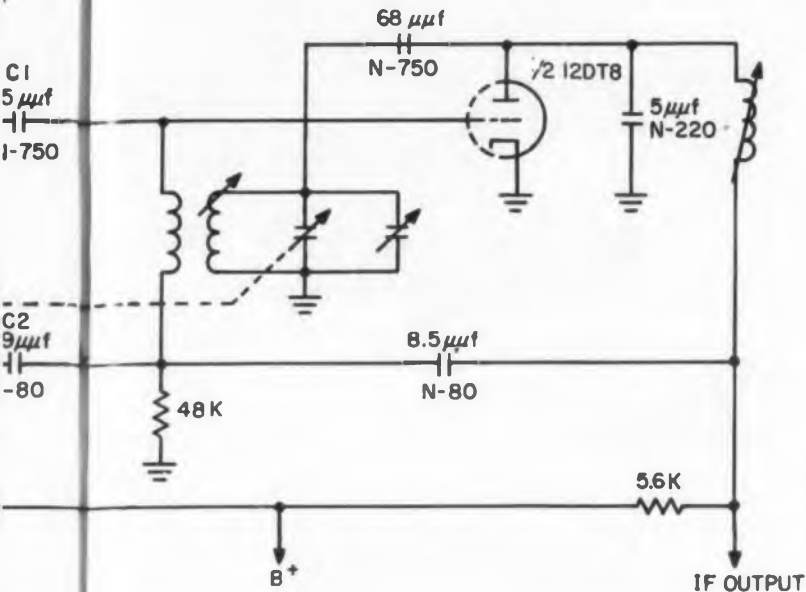
Many Advantages Offered

Since the glass cylinders and metallic plungers can be machined with a high degree of accuracy at nominal cost, a close fit can be obtained with resultant absence of microphonics. Noise problems are nonexistent since mechanical wiper contact is not involved. Use of a low temperature-coefficient glass material provides excellent stability characteristics. Size is substantially reduced.

The tuning element for the unit covers 88-108 mc, the standard fm band. By altering the dielectric tube and coil structure, operation up to 1200 mc is possible for uhf tuners and test equipment.

Simple, One-Tube Circuit

One tube, double-triode tuners are not new in fm and TV design. However, use of conventional L-C circuits cannot achieve the optimum gain and stability demanded and compromise performance

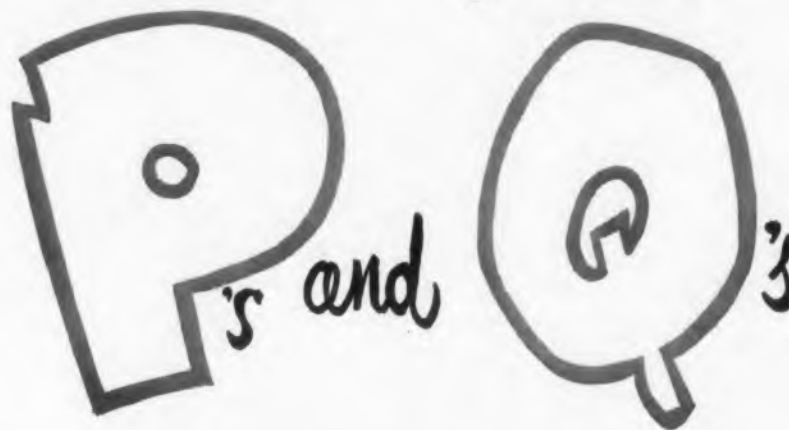


must be accepted. Coaxial tuning, with a higher effective circuit Q due to the low-loss dielectric, provides superior tuner gain with excellent oscillator stability in this unit. Frequency drift after several hours is less than 20 kc from initial power application eliminating the necessity for a complex and costly afc system.

The first triode section of the 12DT8 is a grounded-grid rf amplifier, plate tuned with one section of the coaxial assembly. The amplified rf output is capacitively coupled to the grid of the combination mixer-oscillator triode, as shown in Fig. 3. To eliminate the annoying "pulling" effect generally encountered in fm receivers, balanced-bridge oscillator design was selected. Oscillator coupling back to the rf plate coil takes place through capacitors C1 and C2; since their signals are 180 deg out of phase, cancellation results and interaction is at a minimum. Oscillator tuning is varied by plunger movement in the second section of the coaxial assembly.

While the "gimmicks" outlined have a strong bearing in consumer product design where economy is a prime requisite, the ideas may be applied where compact space and unit simplicity are mandatory. Re-evaluation of existing equipment may well result in substantial cost and size reduction. ■ ■

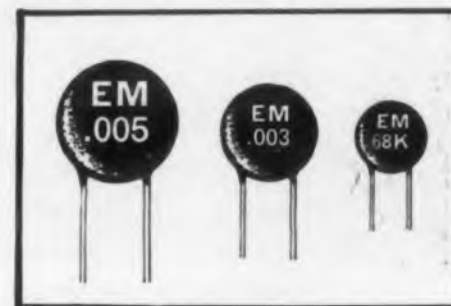
remember your...



call on **EL-Menco** for capacitors
... with proved **P**erformance and **Q**uality!

CERAMIC DISC CAPACITORS with TEST-PROVED RELIABILITY!

In the field of capacitors, the name of El-Menco stands head and shoulders above all others. Its ceramic disc capacitors dominate in quality . . . in performance . . . in creative engineering . . . are unmatched for high Q value, high insulation resistance, high dielectric strength.



WRITE TO EL-MENCO for latest bulletin and samples on Ceramic Disc Capacitors . . . the Mighty Midgets with EXTRA Ruggedness and Stamina.
Superior Features of El-Menco Ceramic Disc Capacitors . . .
• Working V.D.C. 500 . . . available also in 1,000 working volts and 2,000 test volts D.C. per E.I.A. specs. RS-165.

- Wax impregnated with low-loss phenolic coating.
- Flat design assures reduced self-inductance.
- Insulation resistance far exceeds the 10,000 megohm minimum requirements.
- Available with straight leads 1/4" minimum. Or manufactured with crimped leads for printed circuit applications.



MIGHTY MIDGETS BY EL-MENCO INCLUDE:

- El-Menco TC — Temperature Compensating — for resonant circuit application.
- El-Menco TS — Temperature Stable — designed for applications where a minimum capacitance change with temperature is required.
- El-Menco SS — Semi-Stable — general purpose with stability.
- El-Menco GP — General Purpose — for bypassing, coupling or filtering applications . . . space saving, provide high capacity in relation to size.

EL-MENCO CERAMIC DISC CAPACITORS MEET OR EXCEED E.I.A. SPECS. RS-198.

LOOK TO THE LEADER . . . LOOK TO EL-MENCO . . . for capacitors to serve all your needs. Investigate, too, El Menco Dur-Mica Capacitors, the longest-living capacitors ever made.

El-Menco
Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.

WILLIMANTIC CONNECTICUT

Manufacturers of El-Menco Capacitors

- molded mica • dipped mica • mica trimmer • dipped paper
- tubular paper • ceramic • silvered mica films • ceramic discs

Arco Electronics, Inc., 64 White St., New York 13, N. Y.
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada
WRITE IN 36 ON READER-SERVICE CARD

First family of power triodes made specifically for series regulation!



Tung-Sol/Chatham power triode family covers every series regulator need!

Now designers can specify a premium quality Tung-Sol/Chatham tube for all series regulator sockets. Tung-Sol/Chatham's family of power triodes—the first designed and produced specially for series regulator service—meets all design requirements and assures maximum reliability and life at all times.

Types include the new 100 Watters, 7241 and 7242, medium mu or low mu-high current, 12 or 26 Volt

heater versions available on most types. All embody sturdy construction features that contribute to overall ruggedness and long hours of heavy-duty operation.

Compare the ratings below against your particular application! If you desire complete data sheets . . . or you have a specific design problem, contact us today! We'll be glad to give whatever assistance we can. Just write: Tung-Sol Electric Inc., Newark 4, N. J., Commercial Engineering Offices: Bloomfield and Livingston, N. J., Culver City, Calif., Melrose Park, Ill.

TYPICAL VALUES			
Total Plate Current	Range of Tube Voltage Drop	Minimum Tube Drop	Grid Voltage Swing
200 ma	80 v	45 v	20 v
400	65	70	10
600	80	70	13

PERTINENT CHARACTERISTICS PER TUBE			
Max. Plate Current	Max. Plate Voltage	MU	Gm
280	275	5.5	28,000 umhos
600	400	9.0	74,000 umhos
900	400	9.0	111,000 umhos

TUNG-SOL

TUBE TYPES BY PLATE DISSIPATION RATINGS			
Total Plate Dissipation	26 to 30 W	60 W	100 W
6AS7G, 6082	6336A	7241	
6080WA, 7105	6394A		
5998	6528	7242	

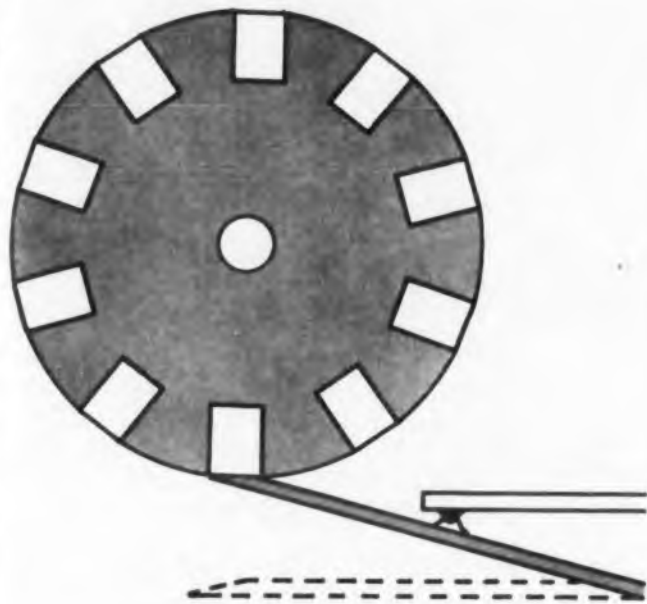
WRITE IN 38 ON READER-SERVICE CARD

Rotating Magnets Close Switches Rapidly

HIGH-SPEED, low-torque switching is achieved by placing a number of small ceramic magnets on a rotor and allowing them to rotate past sealed magnetic switches in this new switch type. Switches can operate as high as 250 closures per sec with appreciable contact bounce at 120 closures per sec with no contact bounce. Current ratings as high as 3 amps at 120 v ac are available.

Designed by Summers and Mills, Inc., 911 W. Commerce St., Dallas 8, Tex., the switch, containing 12 magnets, can be used to step a 30 deg stepper motor to produce economical torque amplification. Closures of the magnetic switches actuate the stepper motor providing intermittent unidirectional high level follow-up torque at the output of the motor. Had nine magnets been used the follow-up torque would have been at three-fourths synchronous speed. Ways are available to make the follow-up bidirectional.

The switch can be also used for mounting purposes. In Fig. 1 an operational switch is coupled by bevel gears to the output shaft of a ball disc integrator. The integrator reads the area of a curve plotted on the front side of the recorder. The operational switch closes ten times for each rotation of the output shaft and for each ten square inches of area. The switch closures are used to operate a "kick pen" and to plot the integrand as a series of pips alongside the curve. By the simple expedient of making one of the



The rotating magnets, attracting the contact arm, close the switch rapidly.

magnets of double width every tenth pip is of double width, thus providing easy counting of the area accumulated between any two points on the curve.

For more information about this low-torque switch, turn to Readers Service Card and circle 103.

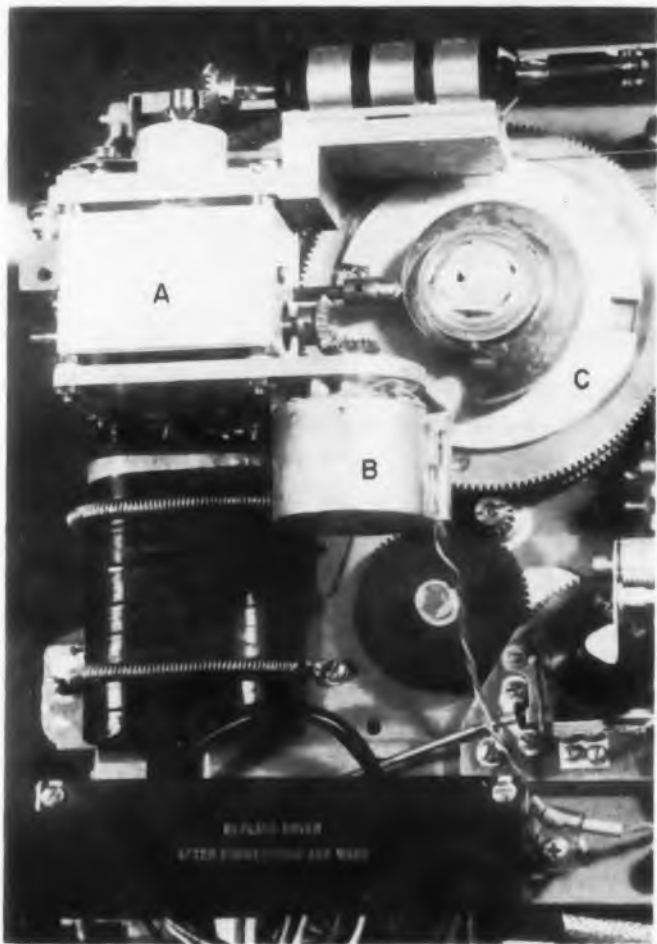
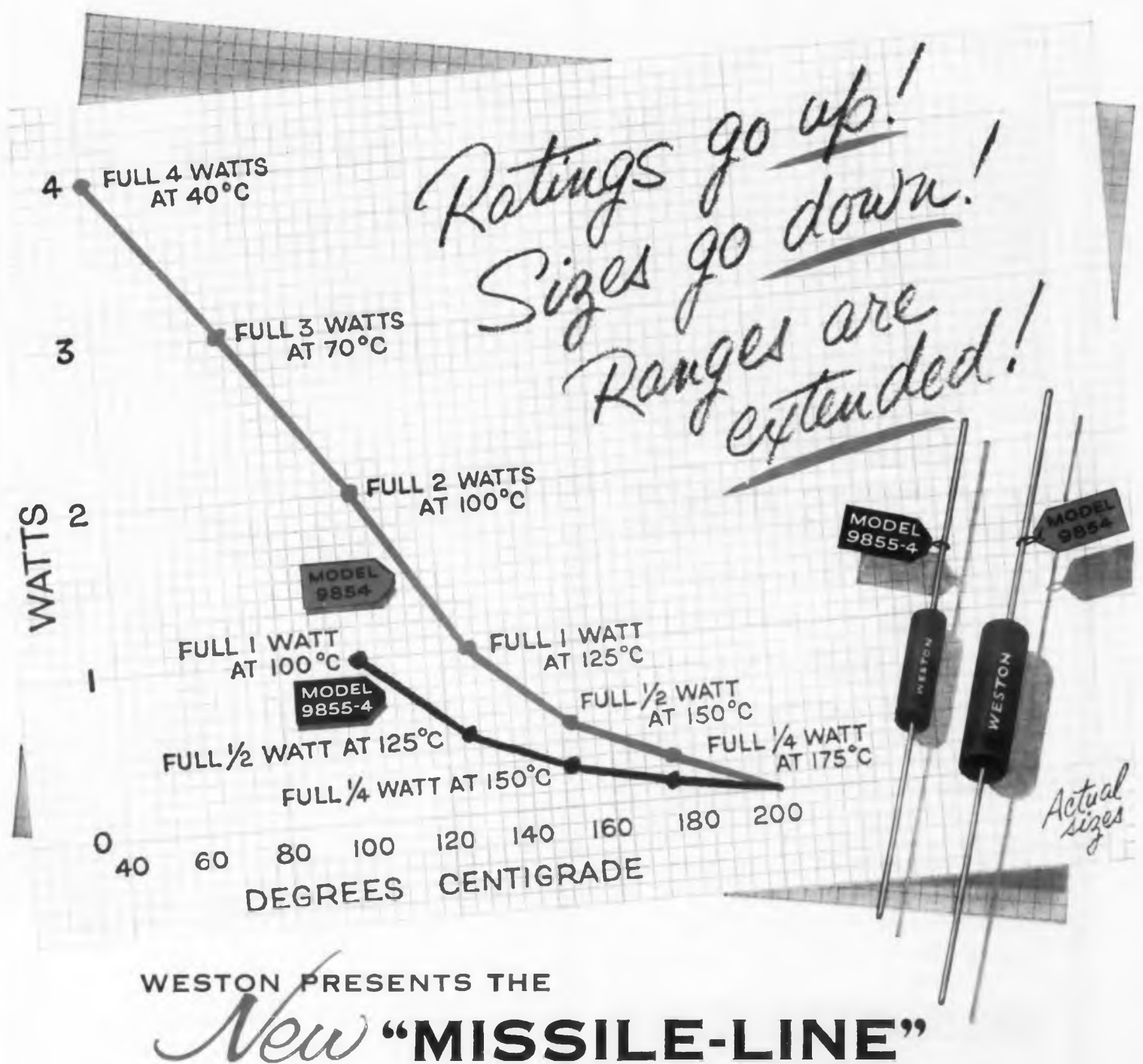


Fig. 1. Low-torque switch coupled by bevel gears to the output shaft of a ball-disc integrator. A—ball-disc integrator; B—operational switch; C—motion converting cam.

WESTON RESISTORS: STANDARDS OF STABILITY IN SCIENCE AND INDUSTRY



WESTON PRESENTS THE

New "MISSILE-LINE"

The new "Missile-Line" of Weston Vamistor® type metal film resistors is truly a major step in miniaturization. An inert gas-sealed within the hollow body of the resistors—permits rating increases that make all existing resistor specs obsolete. Because of the exceptional performance of these resistors at high ambient temperatures, the series has been named the "Missile-Line."

For example: a resistor the size of the former ½-watt-at-125°C unit can now dissipate 1 full watt at 125°C—with less than 0.5% change in 1000 hour load life test. This RN-70 size resistor will outperform any existing RN-75 size. Likewise, the RN-65

size unit will outperform any existing RN-70 size.

Resistance ranges have also been extended. The range of Model 9854 (red curve above): 100 ohms through 2 megohms. Model 9855-4 (black): 100 ohms through 500 K.

For further information about these revolutionary Vamistors, contact your local Weston representative . . . or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l. 100 Empire St., Newark 12, N. J.



WESTON

Metal-film Resistors

WRITE IN 39 ON READER-SERVICE CARD

Digital



MODEL
400B

V T V M

±0.1% comparative accuracy

0 to 1000 V ac or dc

0 to 1 megohm

Franklin's all-electronic Model 400B provides a new standard of dependable, repeatable accuracy. In comparing one measurement against a reference, the 400B gives an accuracy of better than ±0.1%. For example, it will measure the voltage difference between several 7.5 V batteries, with an accuracy of better than ±0.0075 V.

Available for rack or table mounting.

Request Data Sheet 40B. OEM request Data Sheet 31A also.

BRIEF SPECIFICATIONS

D-C RANGE 0 to 10, 100, and 1000 V.	ABSOLUTE ACCURACY ±0.3%, 0 to 10 volt range; ±0.5%, all other ranges. INPUT IMPEDANCE 20 megohms.
A-C RANGE 0 to 10, 100, and 1000 V.	ABSOLUTE ACCURACY ±1%, all ranges (at 60 cps and voltages greater than 0.5 V). FREQUENCY RESPONSE ±0.5 db, 50 cps to 100 KC. INPUT IMPEDANCE 20 megohms shunted by 200 mmf.
OHMS RANGE 0 to 10 K, 100 K, and 1 meg.	ABSOLUTE ACCURACY ±0.2% all ranges.

COMPARATIVE ACCURACY ±0.1%, all ranges.



FRANKLIN
electronics, inc.

BRIDGEPORT • PENNA.

NEW PRODUCTS

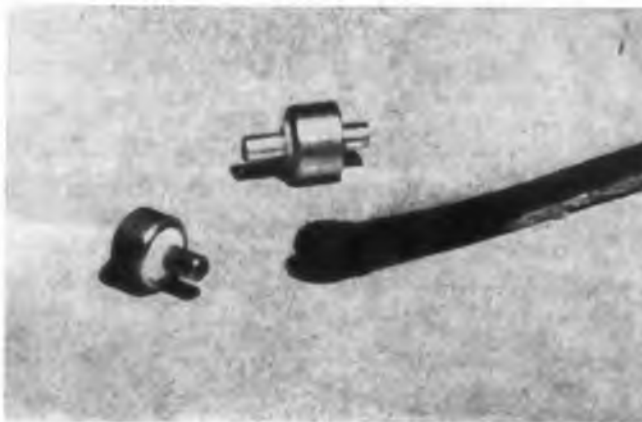
Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.



PANEL METERS

Measuring 1-1/2 in. sq., these meters are accurate to within 2%. They have a front zero adjustment and a scale length of 1-3/4 in. Units are available from 100 µa. And, using an external shunt, they can be rated at over 5 amp. As self-contained rectifier types, they can be used as voltmeters up to 300 v. Hoyt Electrical Instrument Works, Inc., Dept. ED, 42 Carleton St., Cambridge 42, Mass.

WRITE IN 41 ON READER-SERVICE CARD



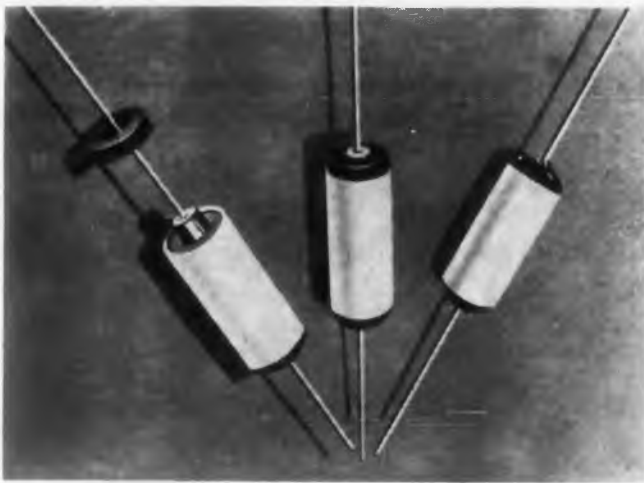
THERMAL SWITCH

This thermal switch is normally open and non-repetitive. After switching it maintains a closed circuit regardless of subsequent temperature changes. Current rating is 5 amp, ac or dc continuous duty. Maximum working voltage is 220 v. Called the MiniTherm, it is available for switching temperatures of 150, 175, 200, 225, 250, 275, 300, 325, and 500 F. Accuracy is ±2%. Applications include operation of power devices and telemetering.

MiniTec, Dept. ED, 5423 Delaware Ave., Los Angeles 41, Calif.

WRITE IN 42 ON READER-SERVICE CARD

WRITE IN 40 ON READER-SERVICE CARD



PREFORMED EPOXIES

These preformed epoxies permit uniformity of appearance and performance in seals and bonds. They are premolded, or pre-cut, to the exact shape, and formulated to flow and cure at specified temperature requirements. Filmex, Series 800-D, comes in sheet or film form. It ranges in thickness from 0.0015 to 0.02 in. Pressex, Series 800-C, is made from prepressing of epoxies in powder form. They range in thickness from 0.02 in. up. Use of a Pressex preform is shown in the photograph. The catalyst or hardening agent is embodied in the preforms. Both materials have excellent storage characteristics and shelf life.

Mansol Ceramics Co., Dept. ED, 140 Little St., Belleville, N.J.

WRITE IN 43 ON READER-SERVICE CARD



SYNCHRO RECEIVER

Designed for indicator applications, this size 10 synchro receiver meets MIL-I-7057. Type 10-4085-19 has a -55 to $+71$ C ambient temperature range. The unit has a 1 deg dynamic test accuracy and 5 sec damping. Internal damping is by rotor bar technique. Rotor moment of inertia is 2 gm-cm², input voltage is 26 v, 400 cps and the output is 11.8 v.

John Oster Mfg. Co., Dept. ED, 1 Main St., Racine, Wis.

WRITE IN 44 ON READER-SERVICE CARD

ELECTRONIC DESIGN • January 7, 1959



VERSATILE, RELIABLE DIGITAL INSTRUMENTS

*DC digital voltmeter
offers maximum reliability...
0.01% accuracy...
single-plane readout... and
many other advanced features*

The Model 401B offers four-digit display with automatic polarity indication and decimal placement... Measures .0001 to 999.9 volts with 0.01% ± 1 digit accuracy... Gain $\div 10$ and least digit sensitivity settings of .1, 1, 10 mv... Average reading time of one second... Continuous, automatic standard cell calibration... 10 megohms input impedance... Built-in printer drive... 10 times longer readout bulb life... No circuitry in readout for easy remote mounting... Extra long relay life assured by DC drive. Price: \$2450.

KIN TEL manufactures an exceptionally complete line of digital instruments. These "digital building blocks" permit measurement of AC, ohms, ratios, and automatic scanning of multiple inputs. Preamplifiers increase digital voltmeter sensitivity to 1 microvolt DC and 10 microvolts AC. Buffers permit driving typewriters, tape punches and printers. Complete digital systems for data logging, missile checkout and production testing are also available. The reliability and accuracy of these precision instruments are assured by KIN TEL's experience in designing and manufacturing more than 10,000 "standard cell accuracy" DC instruments. Sales and service are available nationwide. KIN TEL Engineering Representatives in all major cities.

*All-electronic
digital voltmeter
measures millivolt to kilovolt
with 0.1% accuracy
... costs only \$1260*

Four ranges: 0.000 to 1.599; 00.00 to 15.99; 000.0 to 159.9; 0000. to 1000 volts (manual ranging and polarity)... No moving parts... Digital in-line readout... 70 millisecond conversion time... Adjustable display time... Input completely floating and isolated... 0.1% of full scale accuracy... Direct voltage conversion circuit... Wide range of models.

KIN TEL's Model 801A all-electronic digital voltmeter measures DC from 0.001 to 1000 volts with 0.1% of full scale accuracy... and in less than 1/10 second, presents the measured voltage clearly on an in-line digital readout that even unskilled personnel can read with ease. Direct voltage measurement by successive approximation provides accuracy and sensitivity previously obtainable only in delicate, complex and expensive instruments. Extremely stable operation—continuous calibration against an internal reference. (Input impedance of the Model 801A is 20,000 ohms per volt. The Model 802A, priced at \$1460, has an input impedance of 10 megohms on all ranges. In other models, the binary coded decimal and decimal outputs are externally available to permit driving printers and tape punches.)

KIN TEL
A DIVISION OF
COHU
ELECTRONICS, INC.

Write today for descriptive literature or demonstration. 5725 Kearny Villa Road, San Diego 11, California

WRITE IN 45 ON READER-SERVICE CARD

NEW PRODUCTS

Blower Unit

For aircraft use



For ventilating and cooling aircraft enclosures and electronic equipment, the SK 1991 high altitude blower unit meets all environmental conditions of MIL-E-5272A. Also suited for ground and marine use, it is furnished with a fully enclosed, explosion proof aircraft motor rated at 1/3 hp and 27 v dc. Air delivery is 500 cfm at a static pressure of 2.4 in. of water at 65,000 ft. A 400 cps ac motor is optional.

The Torrington Mfg. Co., Dept. ED, Torrington, Conn.

WRITE IN 46 ON READER-SERVICE CARD

Silicon Transistors

High power

Rated at 2 and 5 amp, types WX1015 and WX1016 are high power npn silicon transistors for switching and amplifier use. They have a collector-to-emitter voltage range from 30 to 300 v and can switch up to 1 kw. Their respective saturation resistances are 0.7 and 0.5 ohms maximum. Up to 150 C, they have small case-to-junction temperatures. In hermetically sealed, stainless steel cases, they are designed for mounting on an external heat sink by a threaded stud. The units are 1-1/4 in. in diameter and 1-7/64 in. high.

Westinghouse Electric Corp., Dept. ED, P.O. Box 2099, Pittsburgh 30, Pa.

WRITE IN 47 ON READER-SERVICE CARD

ANACONDA ANATHERM



First polyester high-temperature magnet wire in full range of sizes

— — ROUND



— — SQUARE



— — RECTANGULAR



Anatherm, Anaconda's Class 155°C polyester film-coated magnet wire is now available in single, heavy, triple and quadruple grades of round wires (sizes 8 through 46) and in a full range of sizes of squares and rectangulars. This is the first time a complete range of sizes and shapes has been offered in this type wire.

Fully tested for use at temperatures up to 155°C, Anatherm was also the first film-coated wire to meet the newly adopted AIEE 155°C (Class F) rating.

Anatherm gives you greater thermal stability—plus excellent abrasion-resistance, chemical stability and dielectric strength. Thus Anatherm is ideally suited for manufacturers seeking maximum per-

formance and reliability from smaller and smaller equipment operating at higher and higher temperatures.

As a polyester magnet wire, Anatherm can be used equally successfully at any "hottest-spot" temperatures over the range of 105°C to 155°C. If you're on the spot about high-temperature magnet wire, ask the Man from Anaconda about Anatherm.



Write for free Anatherm technical bulletin: Anaconda Wire & Cable Co., 25 Broadway, New York 4, New York.

5K364



SEE THE MAN FROM **ANACONDA**[®]
FOR ANATHERM MAGNET WIRE

FROM ANACONDA...THIS WIDE VARIETY OF TOP-QUALITY MAGNET WIRES—

ANALAC (Class A-105 C)
solderable magnet wire

VITROTEX (Class B-130 C)
glass-insulated, high heat resistance

PLAIN ENAMEL (Class A-105 C)
low-cost enameled magnet wire

NYFORM (Class A-105 C)
high resistance to winding hazards

EPOXY (Class B-130 C)
all-round compatibility



Power Supply Transistorized



Model M102 transistorized power supply provides an output of 0.5 to 30 v, continuously variable. Output current is 0 to 1 amp maximum. Regulation from 0 to 1 amp is 0.6% or 50 mv, whichever is greater; from 0 to 250 ma it is 0.4% or 30 mv, whichever is greater. The unit is protected from load shorts by fuses in the output and line input leads. Stabilization is $\pm 1\%$ for line voltage variation of 105 to 125 v, and ripple voltage is less than 10 mv.

Alto Scientific Co., Inc., Dept. ED, 855 Commercial St., Palo Alto, Calif.

WRITE IN 49 ON READER-SERVICE CARD

Analog-Digital Converter

Provides six selectable output codes

The Radicon converter, for use in modular data systems, converts analog information to digital, and digital to analog. It provides visual display and six selectable output codes compatible with most commercial digital computers. Operation is asynchronous at word rates up to 24 kc, and accuracy is $\pm 0.025\%$ full scale. With companion modular blocks, the unit can perform many on-line computation functions such as scale factoring, linearization, and zero correction. It features compact, solid-state construction.

Radiation, Inc., Dept. ED, P.O. Box 37, Melbourne, Fla.

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← WRITE IN 48 ON READER-SERVICE CARD

THOMAS A.

EDISON electronic controls and components for aircraft, missiles and industry

STANDARD AND CUSTOM- DESIGNED MINIATURE, HI-TEMP SERVO SYSTEMS AND COMPONENTS

The Edison Instrument Division is now offering design engineers an extensive line of miniature and subminiature Hi-Temp Servos Motors and Servo Components . . . in addition to a complete facility for custom designed units and servo sub-systems.

Precision production and rigid quality control inspection have made these "customized" components possible. In addition to these special units, Edison also manufactures an extensive line of standard servo motor and servo motor-generator combinations from size 8— up.



EDISON SIZE 8 SERVO MOTOR

SPECIFICATIONS:

1. Type of motor: Two phase servo
2. No load speed (min. RPM): 6500
3. Stalled torque (min. oz. in.): 30
4. Power input at stall (nom. watts/phase): 3.1
5. Speed at max. power output (RPM): 4000
6. Torque at max. power output (oz. in.): .18
7. Theoretical acceleration at stall: 20,600 radians/sec.²
8. Time constant: .036 sec.
9. Duty: Intermittent at stall



EDISON GEAR HEADS
SIZE 8 TO 18

SPECIFICATIONS

CHARACTERISTICS	STANDARD EDISON GEAR HEADS				
	8	10	11	15	18
Size					
Part Number					
Pinion Data:					
Number of Teeth	12	13	13	15	15
Diametral Pitch	120	120	120	96	96
Pressure Angle	20°	20°	20°	20°	20°
Pitch Diameter	.1050"	.1083"	.1083"	.1562"	.1562"
	+0 -0005	+0 -0005	+0 -0005	+0 -0005	+0 -0005
Gear Ratio to Length "L"	Ratio "L"	Ratio "L"	Ratio "L"	Ratio "L"	Ratio "L"
	17 0.750	31 0.781	36 0.781	40 0.812	60 0.812
	42 0.812	93 0.954	108 0.954	140 1.000	240 1.000
	104 1.000	280 1.054	324 1.054	490 1.100	960 1.100
	252 1.070	840 1.116	972 1.116	1715 1.162	3840 1.162
	615 1.204	2521 1.266	2916 1.266	6000 1.320	15,360 1.320
	1494 1.347	7565 1.409	8748 1.409	21,000 1.487	61,440 1.487
	2629 1.421	22,696 1.500	26,344 1.500	73,500 1.600	245,760 1.600
Moment of Inertia GM CM ²	.01	.018	.02	.05	.08
Maximum Running Torque in oz.	15	15	20	25	25
Maximum Stall Torque in oz.	35	35	40	50	50
Breakdown Torque in oz.	.01	.01	.012	.015	.018
Backlash maximum	30'	30'	30'	30'	30'



EDISON SIZE 15 MOTOR
GENERATOR MG-15001-11

SPECIFICATIONS:

1. Type of motor: Two phase servo motor-tachometer generator
2. No load speed (min. RPM): 4500
3. Stalled torque (min. oz. in.): 1.45
4. Power input to motor at stall (nom. watts/phase): 6.5
5. Speed at max. power output (RPM): 2600
6. Torque at max. power output (oz. in.): .8
7. Theoretical acceleration at stall: 19,500 radians/sec.²
8. Time constant: .024 sec.
9. Power input to generator at stall (nom. watts): 5.4
10. Output volts at 0 RPM (max. RMS): .013
11. Output volts at 0 RPM (max. fund): .008
12. Output volts per 1000 RPM: 3.1
13. Phase Shift: 4.5 degrees ± 1 degree lagging
14. Max. speed for linear output (RPM): 5500
15. Duty: Continuous at stall
16. Government designation: MK 12 Mod. 0
17. Applicable specification: MIL-S-17806

Edison also manufactures a quality line of synchro control transformers, synchro transmitters, synchro receivers, synchro resolvers, and synchro differentials.

NEW EDISON MINIATURE TIME DELAY RELAY—MODEL 250

One of the oldest names in relays continues to improve the state of the art . . . now from Edison, a new miniature time delay relay specifically designed for missile and jet aircraft applications. This vibration resistant unit incorporates many design features.



MODEL 250

SPECIFICATIONS:

1. Virtual elimination of contact chatter up to 1500 cps at 10 g's.
2. No resonance to 500 cps.
3. Ambient compensation between -65°C and +85°C . . . operation at higher temperatures when necessary.
4. Contacts rated for 1 ampere at 27.5V d-c or 3 amperes at 115 volts a-c.
5. Extra-rigid construction for exceptionally high contact pressure.
6. Can be mounted in any position without affecting operating characteristics. 7-pin plug-in or solder hook base.
7. Hermetically sealed.

For more information, write for Bulletin #3046.

NEW PRODUCTS

Transistorized Pre-amplifier

Low noise



Low noise, transistorized pre-amplifier model TA-2 is designed mainly for use with low impedance infrared detectors such as indium antimonide cells and thermocouples. It is also suitable for use with transducers with impedances from 5 to several thousand ohms. The unit has a maximum gain of about 100,000, frequency response from 5 cps to 10 kc, and noise equivalent resistance of 5 ohms. The amplifier package measures 2.75 x 2.25 x 2.25 in.

Radiation Electronics Corp.,
Dept. ED, 8241 N. Kimball Ave.,
Skokie, Ill.

WRITE IN 52 ON READER-SERVICE CARD

Dry Air Supply

For electronic equipment

Providing clean air with a dew point of -100 F, the DASR-1030 dry air supply is designed for electronic equipment such as pressurized waveguides and enclosed chambers. It supplies 30 psi discharge air at flow rates to 4 cu ft per min. A continuous duty, self-contained unit, the supply automatically reactivates itself. It has a weather-proof housing that is easily removed for servicing.

Wells Industries Corp., Dept.
ED, 6880 Troost Ave., North Hollywood, Calif.

WRITE IN 53 ON READER-SERVICE CARD

← WRITE IN 51 ON READER-SERVICE CARD

Thomas A. Edison Industries
INSTRUMENT DIVISION

55 LAKESIDE AVENUE, WEST ORANGE, N. J.

EDISON FACTORY OFFICES ARE LOCATED IN: PARK RIDGE, ILL.; DALLAS, TEX.; DAYTON, OHIO; SHERMAN OAKS, CALIF.



Automatic Cycling Switch

Generates pulses of 10 amp



Suited for driving stepping motors, relays, or solenoid actuators, model 24 transistorized cycling switch generates current pulses of up to 10 amp. It is designed to operate from a nominal 28 v dc and will deliver a 15 cps square wave of 28 v peak to peak. The unit has no contact arcing or bounce and operates under severe vibration. Sealed in a 1.5 in. diameter case, it weighs about 6 oz.

Crane Electronics Co., Dept. ED,
4345 Hollister Ave., Santa Barbara,
Calif.

WRITE IN 54 ON READER-SERVICE CARD

Switching Transistors

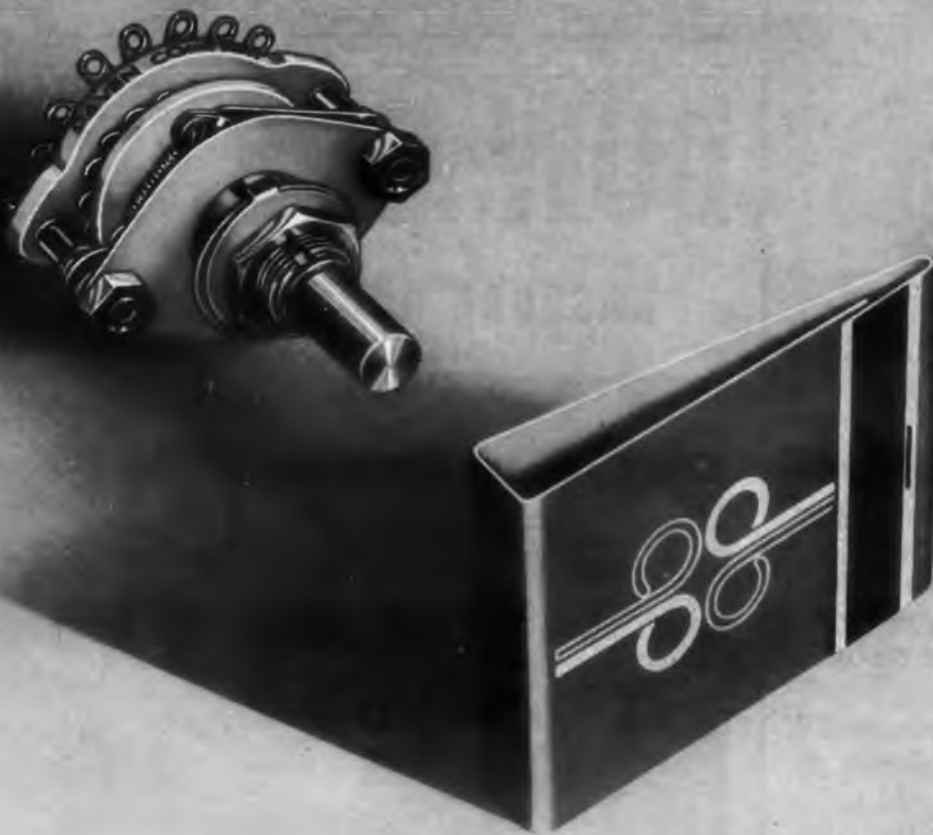
Dissipate up to 150 mw

In hermetically sealed, inverted base TO-5 packages, these pnp switching transistors offer heat dissipation up to 150 mw at 25 C. Type 2N404 has a collector to base voltage of -25 v, a junction temperature of -65 to +85 C, and controlled leakage current. Types 2N425 through 2N428 have -30 v collector to base voltage, 150 mw power dissipation, and -65 to +85 C junction temperature. All units pass MIL-T-19500A electrical, mechanical, and environmental tests.

Sylvania Electric Products Inc.,
Semiconductor Div., Dept. ED,
Woburn, Mass.

WRITE IN 55 ON READER-SERVICE CARD

WRITE IN 56 ON READER-SERVICE CARD



DID YOU SAY small?

Occupying less than 1½ square inches of panel space, this Miniature Ceramic Switch nevertheless contains as many as 18 positions on a single wafer. And it's rugged! Solid silver alloy contacts, rotors, and slip rings provide low and uniform contact resistance. Ceramic parts are silicone impregnated to function under extreme humidity. Sturdy solder terminals are supplied for wiring. This miniature switch meets and exceeds the electrical and environmental requirements of Mil-Spec S-3786. Flashover voltage at 60 cycles is 1000 volts peak . . . current carrying capacity is 2 amperes.

For guided missiles, airborne radar equipment, portable and mobile ground equipment . . . for any application that requires an extremely small and rugged switch, specify Daven's Series M Miniature Ceramic Switches.

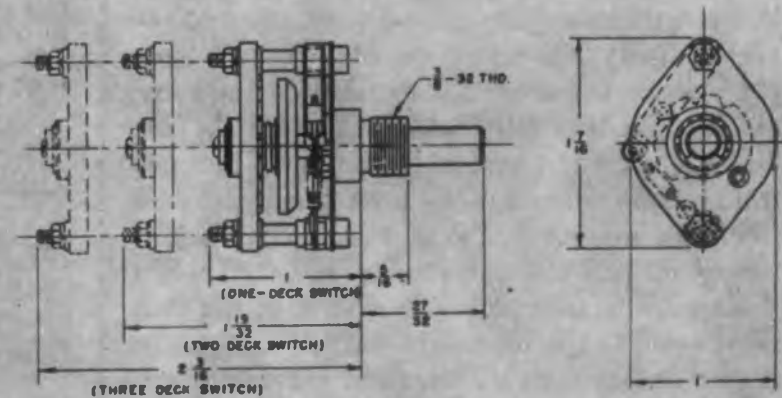
These units can be "ganged" with up to 8 decks with slight mechanical modifications. 2 or 3 poles per deck may also be obtained as standard. Prototypes can be delivered within 2 weeks.

Write for complete information.



THE **DAVEN** CO.

524 West Mt. Pleasant Ave.
Route 10, Livingston, N. J.



TODAY, MORE THAN EVER, THE DAVEN © STANDS FOR DEPENDABILITY!

NEW PRODUCTS

Generator Pulse and square wave



Model PSG-1 pulse and square wave generator is designed for frequencies of 1 cps to 1 mc with pulse widths of 0.1 μ sec to 0.3 sec. The rise and fall time is 0.02 μ sec with a 10 v, 100 ohm output, and 0.1 μ sec with a 50 v, 500 ohm output. Calibration accuracy is 2%.

Available for use with the PSG-1 is the model DG-1 double pulse adapter (shown above). It provides a variable, time-delayed second pulse of the same width and amplitude as the main pulse output.

Gruen Applied Science Labs, Inc., Dept. ED, 60 Hempstead Ave., Hempstead, N.Y.

WRITE IN 57 ON READER-SERVICE CARD

DC Power Supply

Rated 5 ma at 120 v

For industrial and experimental applications, model 120-5-1 dc power supply operates on a standard 115 v, 60 cps line and is rated 5 ma at 120 kv. Output is delivered through a shielded polyethylene cable. In a steel cabinet 33.25 x 21.5 x 61 in., the unit has a three range milliammeter and a three range kilovoltmeter, both with 4.5 in. scales. Its ripple is less than 2% rms. Selenium rectifiers provide rectification, and plug-in internal connections are easily changed to reverse polarity. For safety, the high voltage components are mounted in a metal frame and immersed in a tank filled with insulating oil. This tank is enclosed in a metal housing with the control section mounted on its front panel. External interlocks are provided so that the high voltage is turned off and the output short-circuited when these circuits are open. The control of the unit is arranged to provide coarse and fine adjustment of the output voltage. Overload relays are settable over the full range from 5% to 115% for both current and voltage.

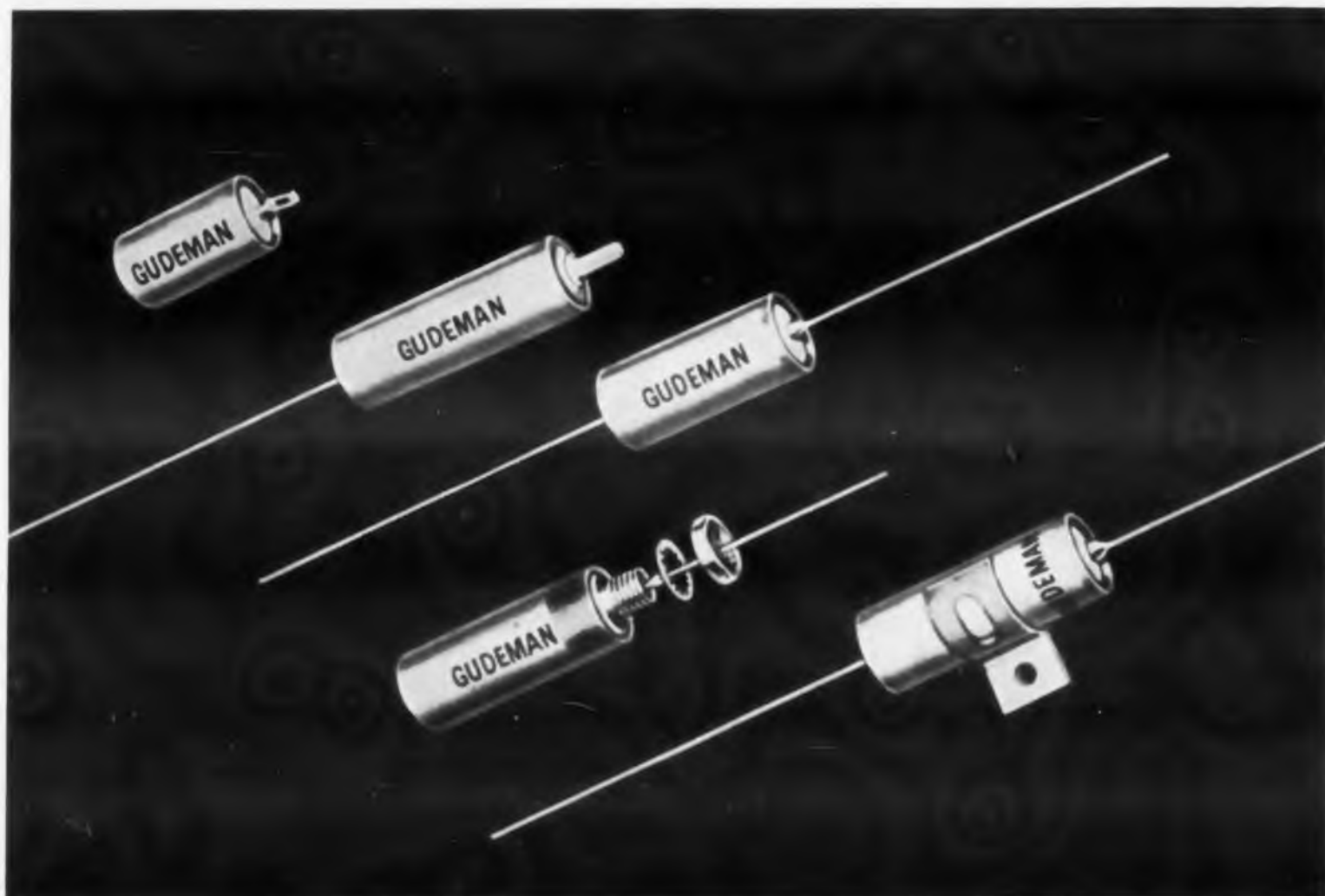
Del Electronics Corp., Dept. ED, 521 Hempstead Ave., Mt. Vernon, N.Y.

WRITE IN 58 ON READER-SERVICE CARD

Design better products with

DOW CORNING 200 FLUIDS

... ASSURE ADDED RELIABILITY AT EXTREME TEMPERATURES



These miniature capacitors made by Gudeman Company for filter, by-pass and blocking service, are impregnated with silicone fluids to decrease electrical losses and increase permissible operating temperatures. Designed to meet all specifications of characteristic "K" MIL-C-25A, they have an operating temperature range of -55 to 125 C.

Property	Temperature		
	-55 C	23 C	200 C
TYPICAL DIELECTRIC PROPERTIES OF 200 FLUID, 100 CSTK.			
Dielectric Constant,			
1.0 kcs.	3.1	2.7	2.3
0.1 mcs.	3.1	2.7	2.3
Dissipation Factor,			
1.0 kcs.	0.0005	0.00004	0.001
0.1 mcs.	0.0002	0.00001	0.0003
Resistivity, ohm-cm.	10×10^{14}	2.0×10^{14}	1.0×10^{13}
Electric Strength, dc, 20 mil gap			
v/mil	700	650	550

As a liquid dielectric and coolant for electronic components and assemblies, Dow Corning 200 Fluid aids miniaturization and makes higher temperature operation possible. For example, paper capacitors impregnated with 200 Fluid have almost constant capacitance over an extremely wide temperature range... help assure reliable equipment performance. Heat stable electrical grade Dow Corning 200 Fluids show little change in electrical and physical properties over a wide range of frequencies and environmental conditions. Available in 20, 50, 100, 500 and 1000 centistokes viscosity grades, they are finding growing use as a means of increasing the reliability of capacitors, transformers, filter networks and other electronic devices.

WRITE IN 59 ON READER-SERVICE CARD



Dow Corning CORPORATION
MIDLAND, MICHIGAN

th Dow Corning Silicone Dielectrics



Electronic "Package" on B-58 by Emerson Electric.

SILASTIC PROTECTS ELECTRONIC "PACKAGES"

Silastic® the Dow Corning silicone rubber, remains resilient from -70 to 250 C, has excellent dielectric strength and offers superior resistance to moisture, ozone, corona and corrosive atmospheres. Available in many forms, including molded parts, extrusions, tapes, sheets and pastes, Silastic is ideal for insulating, sealing and cushioning delicate electrical and electronic equipment.

WRITE IN 60 ON READER-SERVICE CARD

Shift Register Elements

Need minimum driving power

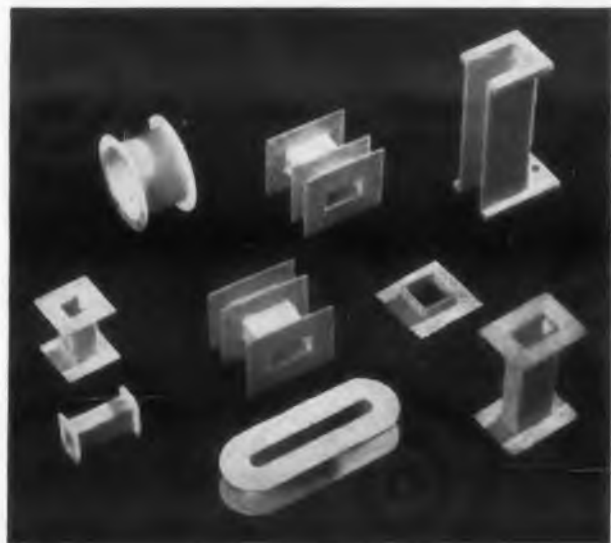


One 50 mw low voltage transistor will drive 16 of these miniature core-transistor magnetic shift register elements in series. The units operate from a 6 to 12 v unregulated power supply. In three ranges from 0 to 250 kc, they have a 30 to 1 signal to noise ratio and occupy 0.39 cu in. They last 40,000 hr.

Di-An Controls, Inc., Dept. ED, 40 Leon St., Boston 15, Mass.

WRITE IN 63 ON READER-SERVICE CARD

**SILICONE
GLASS
LAMINATES
HAVE
HIGH ARC
RESISTANCE,
STRENGTH**



Silicone-glass laminates are easily molded into one-piece core and flange structures. Strong even at flange joints, they are lightweight and moisture-resistant, retain excellent physical and dielectric properties at 250 C. Finished shapes are available from leading laminators.

WRITE IN 61 ON READER-SERVICE CARD

Solenoid Valves

For missile use

Designed for missile applications, series V-27200 in-line solenoid valves have Teflon bubble-tight sealing and operate from -320 to $+500$ F. They can be used with cryogenic fluids, ethylene oxide, jet fuels, high pressure pneumatics, liquefied gases, and hydraulic oils. Media contacts are made of Teflon, stainless steel, and nickel-plated steel. In various orifice sizes, units are available for operation from 750 to 4500 psi. Response is 15 msec, and voltage ranges are from 18 to 30 v dc. The units are 1.25 x 2.6 in. and come in two-way, three-way, and diverter configurations. The coil bobbin assembly is inert gas welded, and the coil construction is potted in high temperature epoxy resin.

Valcor Engineering Corp., Dept. ED, 5370 Carnegie Ave., Kenilworth, N.J.

WRITE IN 64 ON READER-SERVICE CARD

SILICONE VARNISH MAKES MOTORS TOUGHER, MORE DEPENDABLE

Dipped or impregnated with Dow Corning 997 Varnish, the insulating components of motors, servos, generators, transformers and other assemblies are bonded into an integrated moisture resistant insulation system with high dielectric strength. This silicone varnish combined with other silicone components permits operating temperatures up to 250 C . . . protects against moisture, many chemicals and corrosive atmospheres.

WRITE IN 62 ON READER-SERVICE CARD



Research miniature motors for B-52A Bomber.

For further information on these products, write Dept. 1613

Power Supply

Provides constant dc voltage

From a 115 v ac source, this small supply provides a constant, calibrated dc voltage. Its output stays within $\pm 0.05\%$ for $\pm 20\%$ voltage changes, and within $\pm 0.0015\%$ for each degree C of ambient change. Drift is $\pm 0.08\%$ for 10,000 hr. Standard output is 1 v dc at 2 ma into a 500 ohm load.

The Hays Corp., Dept. ED, Michigan City, Ind.

WRITE IN 65 ON READER-SERVICE CARD



EMCOR®

STANDARD CABINETS

provide compact
centralized
laboratory
control center



Testing performance of experimental oils in five single-cylinder Caterpillar Diesel engines provides a unique application of EMCOR enclosures at the Socony Mobil Oil Company, Inc. Research and Development Laboratory, Paulsboro, New Jersey. The installation offers the unique advantage of compactness and centralization of all operating and indicating instruments providing ease of observance and control. Standard, stock frames of the EMCOR MODULAR ENCLOSURE SYSTEM provide comparable design flexibility to custom-made units. Provisions for expansion or exchange of equipment can be made at a small additional cost compared to extensive modification or replacement of units of custom-type construction.



Your Copy of Catalog 105 is available upon request.

*Registered Trademark of Elgin Metalformers Corporation

Originators of the Modular Enclosure System



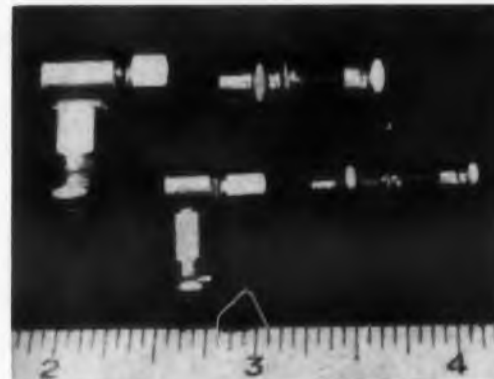
ELGIN METALFORMERS CORP.
630 CONGDON, DEPT. 1221 • ELGIN, ILLINOIS

WRITE IN 66 ON READER-SERVICE CARD

NEW PRODUCTS

RF Cable Connectors

75 and 95 ohm sizes



The 75 and 95 ohm ConheX rf cable connector series include cable plugs and jacks, bulkhead receptacles and jacks, cable feedthroughs, and right-angle plugs. The units feature strong pull-out resistance and captivated contacts.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.

WRITE IN 67 ON READER-SERVICE CARD

DC Power Supplies

0.1% regulation

Series T-200 transistorized power supplies provide suitable outputs for both transistor and vacuum tube circuitry. The eight standard models have output ranges of 0 to 10 v at 0 to 3, 0 to 10, or 0 to 30 amp; 0 to 32 at 0 to 1, 0 to 3, or 0 to 10 amp; and 5 to 150 v at 0 to 0.75 amp or 0 to 2 amp. Regulation for line or load is 0.1% or 30 mv, whichever is greater; recovery time is 50 μ sec; ripple is 1 mv rms or 0.01%; and 24 hour stability is 0.2%. The units feature forced air cooling and short circuit proof design.

Armour Electronics, Inc., Dept. ED, 4201 Redwood Ave., Los Angeles 66, Calif.

WRITE IN 68 ON READER-SERVICE CARD

Zener Diodes

Dissipate 500 mw

These double-ended miniature zener diodes dissipate 500 mw. Types PS6465 through PS6470 have a zener voltage range from 2 to 8 v; types PS6313 through PS6318, 7.5 to 27 v; types PS6319 through PS6327, 25 to 145 v. Except for their higher power dissipation, the units are equivalent to EIA types 1N465 through 1N470, 1N1313 through 1N1318, and 1N1319 through 1N1327 respectively.

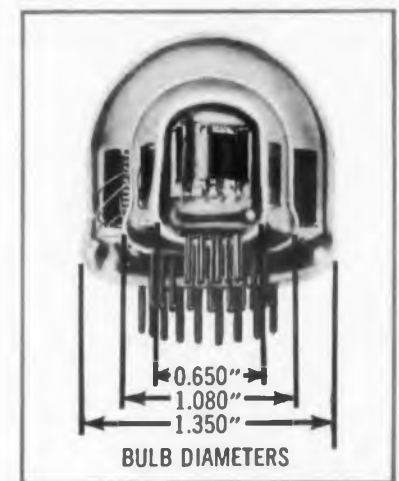
Pacific Semiconductors, Inc., Dept. ED, 10451 W. Jefferson Blvd., Culver City, Calif.

WRITE IN 69 ON READER-SERVICE CARD

Burroughs

NUMERICAL
READOUT TUBE
NIXIE®

smallest volume
any
number size



ALL ELECTRONIC IN LINE READOUT
CONTAINING TEN DIGITS "0" THRU "9"

SUPER

75 feet visibility
(1) Type 7153
(BD206)

STANDARD

40 feet visibility
(2) Type 6844A
(3) Type B5023
(BD204)
Transistor
Operation

(4) Type B5031
Ultra Long Life

MINIATURE

20 feet visibility
(5) Type 7009
(BD200S)
(6) Type B4021
(BD244)
Transistor
Operation

**NIXIE TUBE EXCLUSIVE
FEATURES**

- ALL ELECTRONIC
- LOWEST COST
- LIGHTEST WEIGHT
- LOWEST POWER
- MOST READABLE FOR
NUMBER SIZE
- MAXIMUM TEMPERATURE
SHOCK AND VIBRATION
SPECS

ELECTRONIC CONTRIBUTIONS BY
Burroughs Corporation

ELECTRONIC TUBE DIVISION
Plainfield, New Jersey

WRITE IN 70 ON READER-SERVICE CARD

ELECTRONIC DESIGN • January 7, 1959

Solid-State Switch

Senses metal proximity



The nearness of metal triggers this solid-state switch. Called the Proxor, the unit puts out a continuous dc voltage which drops to zero and stays there when a metal object enters its sensing zone. A screwdriver adjusts the sensing zone over a range of 100 to 1. The switch can furnish voltage steps at low rates down to a standstill and also distinguish magnetic metals from others. It can serve as a digital tachometer, a shaft position indicator, a noncontacting limit switch, and a control. There are two models, the P-1 12 F for magnetic, the P-1 12 N for nonmagnetic metals.

Parametrics, Dept. ED, P.O. Box 629 Costa Mesa, Calif.

WRITE IN 71 ON READER-SERVICE CARD

Flight Simulator

Accurate within 15 sec of arc

This two-axis flight simulator permits control of a wide range of rates and amplitudes from 0.004 to 240 deg and 0.01 to 30 cps. Its total error is below 15 sec of arc. The unit will test components or systems up to 12 x 12 x 14 in. and 50 lb, subjecting them to rates of 200 deg per sec and accelerations of 6×10^4 deg per sec². The complete equipment includes a 60 hp, 1500 psi hydraulic unit and an electronic control system.

Task Corp., Dept. ED, 1009 E. Vermont Ave., Anaheim, Calif.

WRITE IN 72 ON READER-SERVICE CARD
WRITE IN 73 ON READER-SERVICE CARD

use beam switching tubes for DISTRIBUTING
use beam switching tubes for .. SWITCHING
use beam switching tubes for ... SAMPLING
use beam switching tubes for CODING
use beam switching tubes for TIMING
use beam switching tubes for **counting**

Beam Switching Tubes are 10-position high vacuum electronic tubes. Each tube may replace twenty or more transistors, tubes, or other components since a single cathode controls an electron beam to any one of the ten constant current output positions each with "Automatic" memory and high impedance switching.

BEAM SWITCHING TUBES CAN:

- switch sequentially or at random.
- be reset from any position in less than $1 \mu\text{sec}$.
- be preset to any position.
- be interconnected as a distributor of ANY number of positions.
- be operated as a word generator.
- be used as a wide band noise generator to 1000 Mcs.
- operate as a static device or at speeds over 20 Mcs.
- operate compatibly with tubes, transistors, cores and relays.
- directly operate BOTH local and remote Nixie® tube readout.
- directly supply outputs of several hundred volts.
- meet severe shock, vibration and temperature requirements.
- meet long life requirements (potential of 10,000-50,000 hours).
- convert binary to decimal and binary to analogue.

Catalog No. 1158 covering tube types and available literature will be sent by return mail on request.

In contrast to other types of components, Beam Switching Tubes will directly operate both Master and Remote Nixie indicator tubes at a lower cost and higher reliability. Even "all" transistor systems are using Beam Switching Tubes to perform digital functions.



ANOTHER ELECTRONIC CONTRIBUTION BY
Burroughs Corporation

ELECTRONIC TUBE DIVISION

Plainfield, New Jersey



Heterodyne converters extend range of EPUT® Meter to **1000 Mc**

Model 7570 Series Amplifier & Converters (bottom cabinet) used with Model 7170 EPUT Meter (top cabinet) or with Model 7370 EPUT & Timer (not shown).

Frequency measuring range with EPUT meter:

Model 7571 converter only dc to 110 Mc
7571 & 7572 converters dc to 220 Mc
7571, 7572 & 7573 converters dc to 1000 Mc

Sensitivity (rms) & input impedance:

dc to 10 Kc 100 mv into 1M ohm
10 Kc to 10 Mc 1 mv into 1M ohm
10 Mc to 220 Mc 10 mv into 50 ohm
220 Mc to 1000 Mc 1 mw into 50 ohm

Video amplifier:

All converters are installed in the Model 7570 cabinet which includes a video amplifier used independently to increase the sensitivity of the counter. See 10 Kc to 10 Mc sensitivity above.

Prices:

Model 7570 . . . \$300	Model 7573 . . . \$ 500
Model 7571 . . . \$250	Model 7370 . . . \$1975
Model 7572 . . . \$250	Model 7170 . . . \$1675

Shown above measuring the output frequency of a 1000 Mc cavity resonator is a full complement of frequency converters operated with a 10 Mc counter. The bottom cabinet *permanently* houses all three converters covering the full range from 10 Mc to 1000 Mc. Initial requirements for a more limited range can be accommodated by installing only one or two converters — without affecting the ease of future expansion. Extraordinary sensitivity (see specs.) insures that loading effects will not distort measurements of weak signals.

Measurements are extremely easy to make. No tuning is required up to 220 Mc. Simply select range, couple signal, adjust output level with aid of "low-satisfactory-high" meter and read counter indication, adding reference frequencies. Percentage accuracy exceeds that of counter alone.



For more information on this and other recent advances in digital frequency measuring techniques, write for the new Data File 111. Address department D-1.

Beckman

Berkeley Division

2200 Wright Avenue, Richmond 3, California

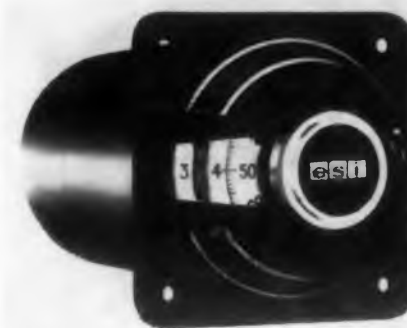
a division of Beckman Instruments, Inc.

WRITE IN 74 ON READER-SERVICE CARD

NEW PRODUCTS

AC Voltage Divider

Has 0.01% accuracy



The DT-35 Dekatran, accurate to 0.01%, is an ac voltage divider with high input impedance, low output impedance, and small phase shift. It has a two-decade ratio transformer and an interpolating potentiometer which gives four-place readings of voltage ratio. The circuit design provides for the suppression of switching transients, and a brake locks the interpolating potentiometer. The unit is 4.5 in. long with a 2.25 in. diameter. It has a panel mounting plate which may be removed and replaced by the panel itself.

Electro Measurements, Inc., Dept. ED, 7524 S.W. Macadam Ave., Portland 1, Ore.

WRITE IN 75 ON READER-SERVICE CARD

Scalers

Have interchangeable plug-in components

These scalars are composed of interchangeable slide-out units that plug in quickly to give any combination of features. Amplifier input sensitivities range from under 1 mv to 9 v for binary or decade scaling units, allowing any scalar function within the limits of binary 64 to 4096 and decade 100 to 1 million. Individual units available include 3 amplifiers, 4 binary scalars, 6 strip or glow tube decade scalars, 5 registers, 6 timers, 2 high voltage supplies, and an analytical ratemeter.

Nucleonic Corporation of America, Dept. ED, 196 DeGraw St., Brooklyn 31, N.Y.

WRITE IN 76 ON READER-SERVICE CARD
WRITE IN 77 ON READER-SERVICE CARD ➤

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One Pallet of Quality -Coming Up!



Whatever packaging you choose for the Roebing Magnet Wire you buy, you are certain the wire is of *unsurpassed quality!*

Modern manufacturing methods... quality ingredients... wire-making skill based on decades of experience... exacting testing and inspection—all these factors combine to assure this one high standard. Yet *quality* Roebing Magnet Wire costs no more than others!

Roebing Magnet Wire comes in types



and sizes exactly suited to your applications... and packaged to give you utmost flexibility, efficiency, economy. Write Electrical Wire Division, John A. Roebing's Sons Corporation, Trenton 2, New Jersey, for all the facts.

ROEBLING

Branch Offices in Principal Cities

Subsidiary of The Colorado Fuel and Iron Corporation



Need a Fastener that Hasn't Been Invented?

*Chances are you'll pay top price for it.
But by following these six rules you can
avoid the high cost of becoming an inventor!**

IT'S natural to assume that, after designing a piece of equipment, you'll have no trouble finding standard fasteners to fit it. Usually such fasteners will be readily available. But what happens when you find yourself with a finished design that doesn't lend itself to any known fastening method?

The most expensive thing you can do at this point is to start inventing fasteners. Valuable man hours go into research, design, prototypes and testing. And unless you can make these fasteners in very large quantities the unit cost will be high, particularly if tooling is necessary.

Now, here are six tips that can get you out of trouble—and keep you out:

1. Remember—not all standard specialty fasteners are listed in fastener manufacturers' catalogs. The fastener company that serves you is probably tooled up for hundreds of non-standard devices, designed and produced to solve problems like yours for other customers. Maybe one would meet your requirements. You'd save the development and tooling charges.

2. There may be a stock fastener available for this job that hasn't come to your attention. Discuss the problem with the fastener manufacturer. If he has nothing in stock, he may be able to modify one of his standard devices at very nominal extra cost.

3. Don't overlook free professional help! Your fastener manufacturer will be glad to offer advice and design service—he does it for everyone else. Unload the problem on him, and let his experience work for you.

But you'll save money if you avoid specifying the fastener that hasn't been invented. By following the next three rules you can usually keep from reaching the point where a non-standard device might be necessary.

4. Go into the fastening problem during the early stages of design. Design your closures with standard fastenings in mind. You won't be left with the costly choice of inventing a fastener or redesigning your product.

5. Keep a complete file of fastener manufacturers' catalogs. Your product designers seldom are fastener specialists too, but they can have complete information available when they need it—at the design level.

6. Work closely with the Fastener Sales Engineer who calls on you. He's trained and paid to help solve your problems. Take full advantage of this service.

Whether you need a standard specialty fastener or the one that hasn't been invented, Southco is well qualified to invite your inquiries. There's no obligation on your part. It's part of our business to offer free consultation at the design or production levels, on items of your own product line, or on those involving military specifications.

Send today for our forty-four page Fastener Handbook No. 8, just printed. Write to Southco Division, South Chester Corporation, 235 Industrial Highway, Lester, Pa.



© 1958

* Reprints of this page are available on request.

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Plastic Capacitors

High voltage

Silicone impregnated, type AG Glasscon capacitors have a plastic film dielectric and glass or steatite tube construction. For high voltage dc or low voltage ac current, they have 0.001 to 1 μf capacitances for use from 600 v to 60 kv dc. They operate from -60 to $+125$ C.

Electronic Fabricators, Inc., Dept. ED, 682 Broadway, New York 12, N.Y.

WRITE IN 79 ON READER-SERVICE CARD

Automatic Insulation Tester

Meets 30 ASTM specifications

Automatic insulation materials tester model 4501 meets 30 American Society for Testing Materials specifications for electrical insulating materials. These materials include varnishes, paper, tape, glass, phenolics, and rubber in rod, tube, and sheet form. The output of the 35 kv unit terminates in a test fixture contained in a transparent, safety interlocked test cage. Additional interchangeable plug-in testing fixtures are available. The tester features a motor driven rate-of-rise with a manual override and a return of output voltage. The panel has a 4.5 in. kilovoltmeter connected directly across the output for accurate test voltage measurement.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

WRITE IN 80 ON READER-SERVICE CARD

Rheostat

Dissipates 12.5 w at 40 C

Capable of 12.5 w dissipation at 40 C, model E rheostat is 7/8 in. in diameter and extends 11/16 in. behind the mounting panel. It comes in 23 resistance values with linear winding.

Ohmite Mfg. Co., Dept. ED, 3698 Howard St., Skokie, Ill.

WRITE IN 81 ON READER-SERVICE CARD

← WRITE IN 78 ON READER-SERVICE CARD

WRITE IN 82 ON READER-SERVICE CARD →



When your project calls for

SMALLEST PACKAGING

LIGHTEST WEIGHT

TIGHTEST COUPLING

LOWEST PHASE SHIFT

LOWEST NULLS

HIGHEST ACCURACY

IN

SYNCHROS

Look to CPPPC Size 8's



ACTUAL SIZE

SYNCHRO FUNCTION	CPPPC TYPE	PRIMARY		B. C. RESISTANCE			IMPEDENCE			Max. Null Voltage (MV)	ACCURACY Max. Error (Min.)			
		Input Voltage (400-)	Input Current (Amps.)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/deg.)	Phase Shift (deg. lead)	Rotor (Ohms)	Stator (Ohms)			Z _{ro} (Ohms)	Z _{oo} (Ohms)	Z _{rs} (Ohms)
Torque Transmitter	CGC-8-A-7	26	.100	.54	11.8	206	8.5	37	12	54 + j260	12 + j45	80 + j20	30	7
Control Transformer	CTC-8-A-1	11.8	.007	.21	23.5	411	9	143	24	210 + j690	28 + j114	250 + j73	30	7
Control Transformer	CTC-8-A-4	11.8	.030	.073	22.5	393	8.5	365	64	470 + j1770	81 + j330	590 + j190	30	7
Torque Receiver	CRC-8-A-1	26	.100	.54	11.8	206	8.5	37	12	54 + j260	12 + j45	80 + j20	30	30 sp.
Electrical Resolver	CSC-8-A-1	26	.038	.39	10.8	189	20	230	27	270 + j630	39 + j142	340 + j67	30	7
Electrical Resolver	CSC-8-A-4	26	.038	.39	26	454	20	230	170	270 + j630	250 + j830	340 + j67	30	7
Control Differential	CDC-8-A-1	11.8	.007	.21	11.5	204	9	36	24	38 + j122	28 + j114	47 + j13	30	7
Vector Resolver	CVC-8-A-1	26	.100	.54	11.8	206	8.5	37	16.5	54 + j260	19 + j60	80 + j20	30	7

CLIFTON PRECISION PRODUCTS CO., INC.

cppe
Clifton Heights, Pa.



FOR COMMUNICATIONS

VARIAN

KLYSTRONS

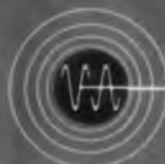
VA-833
685 TO 985 Mc

WIDE TUNING RANGE, WITH HIGH GAIN, HIGH POWER

Now, one Varian Klystron tunes the range 685 to 985 Mc . . . another tunes from 1700 to 2400 Mc. Both feature integral cavities and non-critical magnetic focussing to assure simple installation, reliable operation, ease of maintenance and long life — all of which mean low operating costs.

Varian makes a variety of Klystrons for both Forward Scatter and Line of Sight Communications. And all offer the finest performance and dependability. Over 100 tubes are described and illustrated in our new catalog. Write for your copy.

VA-800 . . . 1700-2400 Mc . . . 10 kW cw . . . 50 db gain VA-833 . . . 685-985 Mc . . . 10 kW cw . . . 50 db gain



VARIAN associates
TUBE DIVISION
PALO ALTO 31, CALIFORNIA
Representatives thruout the world

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, R. F. SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES



WRITE IN 83 ON READER-SERVICE CARD

NEW PRODUCTS

Current Governor

From 1 μ a to 100 ma



Model CS-11 Current Governor furnishes currents from 1 μ a to 100 ma in steps of 1 μ a at load voltages from 0 to 50 v. Current is set to 5 places by decade knobs arranged to provide a digital readout. Accuracy at any setting is 0.02% \pm 0.1 μ a. Short term stability is 0.001%, line regulation better than 0.005%, load regulation better 0.002%.

North Hills Electric Co., Inc., Dept. ED, 402 Sagamore Ave., Mineola, N.Y.

WRITE IN 84 ON READER-SERVICE CARD

Reversible DC Motor

1/150 hp



A two-lead reversible dc motor with an air stabilized Alnico permanent magnet field, model M-114 is rated at 1/150 hp for continuous duty or 1/75 hp intermittent duty. Speed range is 3000 to 20,000 rpm. Available for 6, 12, 24, 28, 32, or 48 v input, the units are 1.3 in. in diameter and 2.75 in. long, including shaft extension. They have precision machined aluminum bodies and dynamically balanced armatures. An extra output dc generator winding is provided for tachometer-generator or control circuits.

Carter Motor Co., Dept. ED, 2759 W. George St., Chicago 18, Ill.

WRITE IN 85 ON READER-SERVICE CARD

Controlled Infrared Source

200 to 600 C temperature range



Made in two separate units, a source and a controller, the PE521-1 is an adjustable source of infrared radiation. It can be used as a secondary standard of radiant energy either by comparison with a primary source or by auxiliary temperature measurement of the conical radiating cavity. A closed loop servo system which senses the radiating core temperature and maintains it by proportional control, the instrument has a range of 200 to 600 C. The source has a temperature stability of ± 1.5 C for ambient variations from 16 to 38 C and line voltage variations from 105 to 125 v. It provides radiation distribution over a 20 deg. field of view for the standard apertures of 0.04 or 0.015 in. diameter. The controller consumes 300 w maximum and contains no relays or mechanical contacts.

Perkin-Elmer Corp., Dept. ED, Norwalk, Conn.

WRITE IN 86 ON READER-SERVICE CARD

Amplitude Modulator

Range of dc to 1000 mc



A battery powered, transistorized amplitude modulator, the Megalator provides 100% modulation over both cw and fm ranges. Modulating frequencies are continuously variable from 15 cps to 15 kc, and rf range is dc to 1000 mc. Input impedance is 50 ohms; insertion loss, about 15 db.

Kay Electric Co., Dept. ED, 14 Maple Ave., Pine Brook, N.J.

WRITE IN 87 ON READER-SERVICE CARD

Inside ESC: Number One



RESEARCH KEEPS ESC FIRST in custom-built delay lines!

From the research laboratories of ESC come pathfinding prototypes that keep ESC first in custom-built delay lines. As America's largest producer of delay lines, ESC has constantly assumed leadership in the vital area of research and development, creating delay lines that have met the most stringent requirements of military and commercial applications.

But there is more to ESC leadership. Its production and quality control facilities are unequalled in the field. ESC submits complete and definitive laboratory reports with all custom-built prototypes which include submitted electrical requirements, photo-oscillograms, the test equipment used, and an evaluation of the electrical characteristics of the prototype.



ESC

CORPORATION

534 Bergen Boulevard, Palisades Park, New Jersey

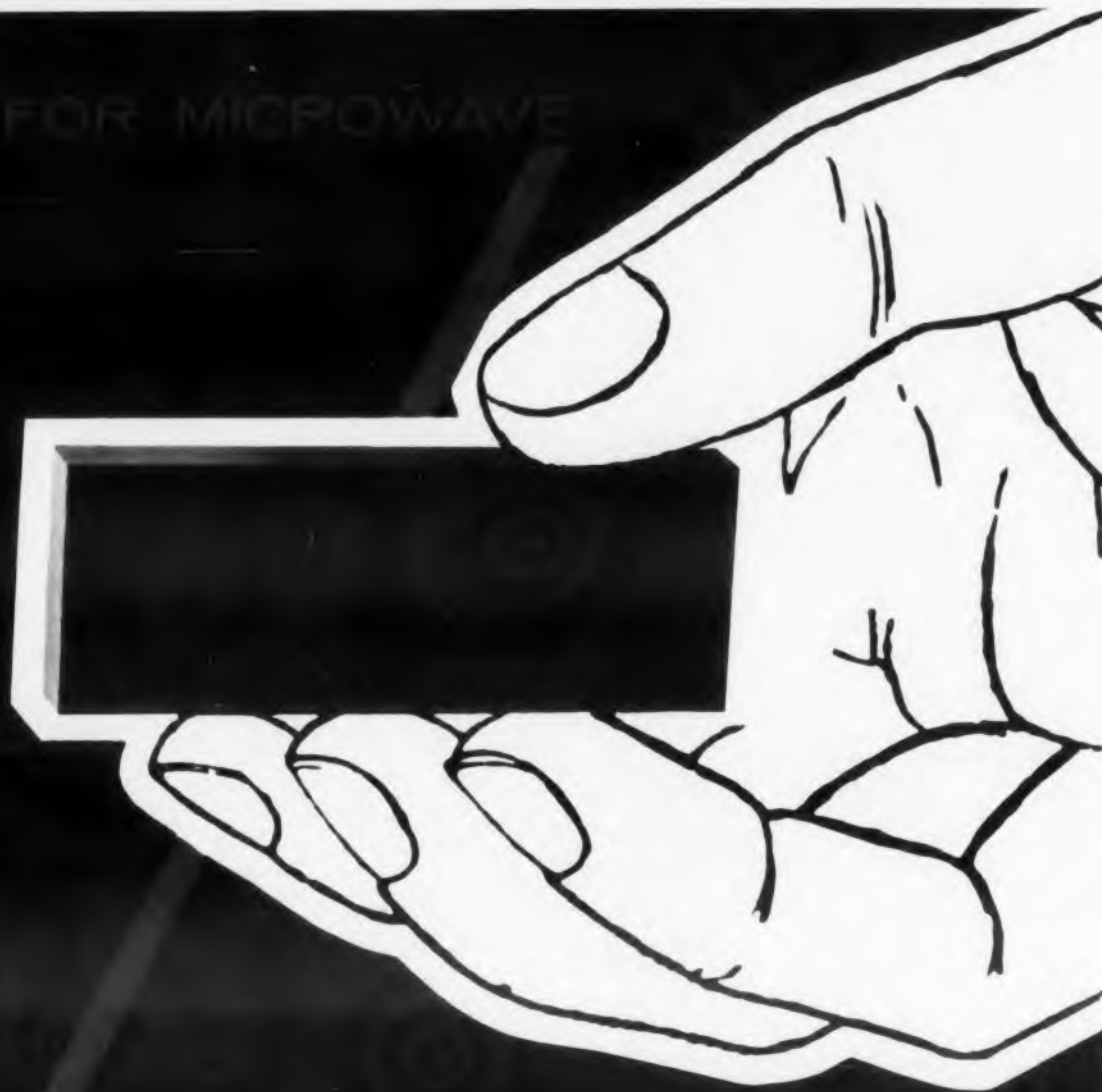
Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines • Shift registers • Pulse transformers • Medium and low-power transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

WRITE TODAY FOR COMPLETE TECHNICAL DATA.

exceptional employment opportunities for engineers experienced in computer components...excellent profit-sharing plan.

WRITE IN 88 ON READER-SERVICE CARD

GARNETS FOR MICROWAVE



Polycrystalline **YIG**
(Yttrium-Iron Garnet)

for
ISOLATORS, ROTATORS, PARAMETRIC AMPLIFIERS and Other Microwave Applications!

- Lower loss than ferrites in the microwave region.
- Typical Line Widths - 55 oersteds at 9,000 mc.; 30 oersteds at 3,000 mc.
- 100% Ultrasonic Inspection.
- Available in Rectangular or Cylindrical Shapes.

YIG (Yttrium Iron Garnet), one of a group of rare earth polycrystalline materials, has been found far superior to conventional microwave ferrites in certain applications where extremely low-loss characteristics and a narrow resonance line-width are advantageous. Results heretofore unobtainable can now be commercially achieved.

Microwave Chemicals Laboratory, Inc. also custom produces garnets to meet specific requirements.

Write for Details!

MICROWAVE
CHEMICALS LABORATORY, INC.
282 SEVENTH AVENUE • NEW YORK 1, N. Y.

WRITE IN 89 ON READER-SERVICE CARD

NEW PRODUCTS

Pushbutton Switches

Piano type



Made by Rudolf Schadow of West Germany, these piano type pushbutton switches are supplied in any ganging arrangement. They are available with up to 15 stations per switch, and with 2, 4, 5, or 6 sets of spdt contacts per station. The contacts are easily removed for cleaning without breaking soldered connections. Maximum contact ratings are 500 ma, 500 v ac or dc, 50 w load. Contact pressure is 100 g. Short or long levers are optional with exchangeable buttons which may be illuminated.

International Electro Exchange, Dept. ED, 2307 Foshay Tower, Minneapolis 2, Minn.

WRITE IN 90 ON READER-SERVICE CARD

In-Line Display

For distances to 100 ft



For use in process, production, and supervisory control panels, this in-line display can be easily read 100 ft away. The characters, 3-3/4 in. high and 2 in. wide, are available in a variety of styles and colors. Rear-projected onto the front viewing screen of the unit, they are of uniform size and intensity. Featuring in-plane presentation, the display can be seen from any angle. Made of aluminum, the body cases are 3-1/4 x 5-1/4 x 11-1/2 in.

Industrial Electronic Engineers Inc., Dept. ED, 3973 Lankershim Blvd., North Hollywood, Calif.

WRITE IN 91 ON READER-SERVICE CARD

Anemometer

Accuracy of 1%



Model 60B hot wire anemometer makes use of the ability of an air stream to absorb heat from an electrically heated thin wire filament. The wire filament forms one leg of a Wheatstone bridge which is driven by a dc amplifier. A feedback circuit maintains constant resistance and temperature in the wire, and the energy input to the wire goes directly into the air stream. The wire current is a measure of instantaneous velocity. For studying airflow in jet engine components, fans, pumps, and similar components, the unit has a dc to 10 kc frequency response. Accuracy is 1%, and noise level is less than 0.03% of wire voltage or 0.3 mv, whichever is greater. Maximum wire current is 300 ma. Power requirements are 115 v at 4 amp.

Shapiro & Edwards, Dept. ED, 1130 Mission St., South Pasadena, Calif.

WRITE IN 92 ON READER-SERVICE CARD

Plug-In VTVM Circuit

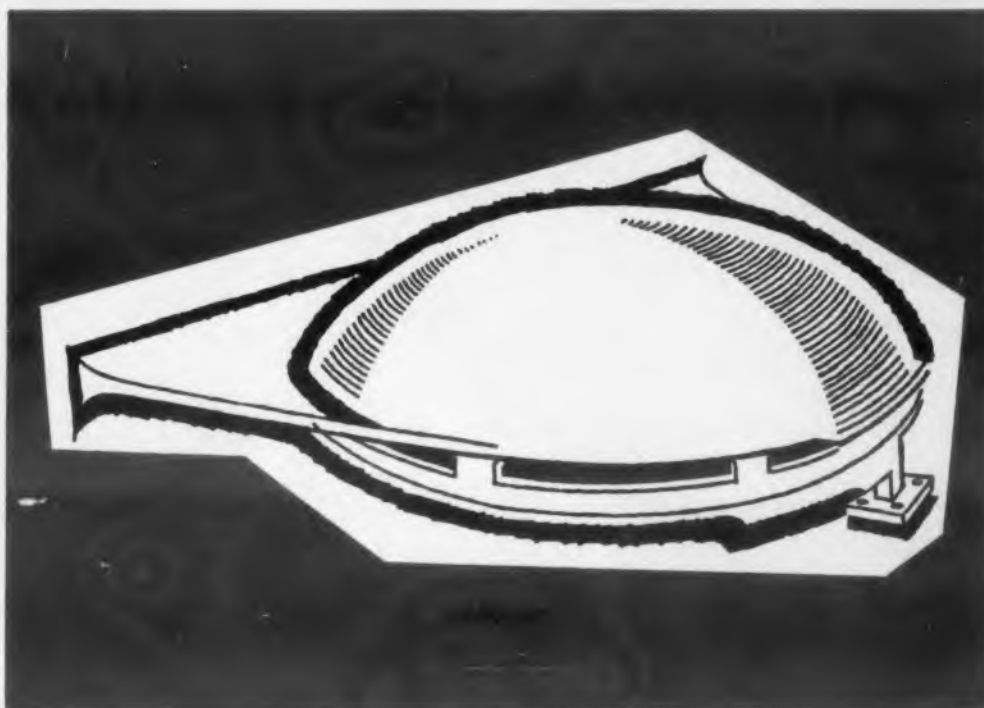
For remote metering



A plug-in vtvm circuit, the SPD-21 dc package is meant for use where metering and range switching must be remote. With other components, it measures 1 to 1000 v. Input resistance is 10 meg, and accuracy is $\pm 3\%$. The unit is 2 x 2.25 x 5.25 in.

Metronix, Inc., Dept. ED, Chesterland, Ohio.

WRITE IN 93 ON READER-SERVICE CARD



ANTENNAS

Sperry can help you suppress side lobes, improve resolution, scan at higher speed



Sperry microwave antennas are currently used in a wide number of highly specialized military, naval and aviation applications — from missile guidance to electronic countermeasures.

If your project requires microwave antenna design or production, Sperry can help you.

Right now, in a completely equipped new plant at Clearwater, Florida, Sperry antenna engineers are busy designing and producing many new advanced types of microwave antennas, such as 70 kmc geodesic antennas and dielectric rod arrays. Backing them up, in addition to complete laboratory and production facilities, is a new antenna range equipped with the latest automatic recording equipment which is capable of handling large apertures and aircraft model pattern work. Supporting the antenna engineers are highly qualified engineers and physicists

specializing in the related fields of electronics, mechanical design, electromagnetic physics and advanced system techniques.

With sunny weather the year round, Clearwater weather permits running radiation patterns nearly every day. We have engineers, facilities and the weather—all necessary factors for solving your problems. Write us for more information on any phase of microwave antenna development.

SPERRY

SPERRY MICROWAVE ELECTRONICS COMPANY, CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATION
Address all inquiries to Clearwater, Florida, or Sperry Gyroscope offices in New York • Cleveland • New Orleans • Los Angeles • San Francisco • Seattle

WRITE IN 94 ON READER-SERVICE CARD

“LOW
DOWN”

*Low Hum *Low Noise



...outstanding features of the

NEW **RCA-7199 FOR HI-FI!**

Here's the "low-down" on a most unusual triode-pentode, the RCA-7199. Unusual, because it's a triode-pentode that features low hum and noise. RCA engineers developed the 7199 to be a hard-working "silent partner" in your tone-control amplifier, phase-splitter, and high-gain voltage-amplifier circuits.

To be more specific, let's outline a typical Hi-Fi audio amplifier circuit employing the RCA-7199. First, we'll use two 6973's, new beam power tubes by RCA of course, in the output stage. Then, with the pentode unit of the 7199 as a voltage-amplifier and the triode unit as a phase-splitter, we have a circuit that can provide a sensitivity of 1.2 volts for a power output of 15 watts with a distor-

tion of less than 0.5%.

Some of the design features of the 7199 include the use of special heaters to reduce hum and noise. An exceptionally sturdy cage structure mounted on short stiff stem leads effectively lowers noise and microphonic effects. Separate cathodes for the triode and pentode units and an internal shield to minimize electrical coupling between the units permit greater flexibility of circuit design.

That's just part of the "low-down" on the 7199. Your RCA Field Representative can give you much more information. Ask him or write RCA Commercial Engineering, Section A-18-Q-1, Harrison, N. J.



RADIO CORPORATION OF AMERICA
Electron Tube Division
Harrison, N. J.

EAST: 744 Broad Street, Newark 2, N.J.
HUMboldt 5-3900

MIDWEST: Suite 1154,
Merchandise Mart Plaza
Chicago 54, Ill., WHitehall 4-2900

WEST: 6355 E. Washington Blvd.
Los Angeles 22, Calif.
RAYmond 3-8361

NEW PRODUCTS

Silicon Rectifiers

400 and 500 piv ratings



Of wire-in construction, types 1N1763 and 1N1764 are small in size and suitable for high temperatures. Low cost, they can be used in a variety of commercial and entertainment equipment. The 1N1763 has a piv rating of 400 and a dc load current rating of 500 ma at 25 C. The ratings for the 1N1764 are identical except for a 500 v peak inverse. Both types have a maximum reverse current of 100 μ a at the peak inverse voltage.

Raytheon Mfg. Co., Semiconductor Div., Dept. ED, 55 Chapel St., Newton 58, Mass.

WRITE IN 95 ON READER-SERVICE CARD

Voltage Regulator Unit

Static exciter-magnetic amplifier type

This voltage regulator unit is a static exciter-magnetic amplifier type that replaces conventional rotating exciters and electromechanical regulators. It is designed for use with a line of the company's ac and dc generators, frequency changers, and synchronous and induction motors. The unit consists of a power magnetic amplifier, a transistorized dc amplifier, and a sensing circuit with a zener diode reference.

Kato Engineering Co., Dept. ED, Mankato, Minn.

WRITE IN 96 ON READER-SERVICE CARD

Crystal Oscillators

Have zero warm-up

Without oven control, these crystal oscillators have near zero warm-up time. Designed by Automatic Telephone and Electric of England, they provide a stability of ± 5 ppm over the range -20 to $+70$ C with aging characteristics of less than ± 0.2 ppm. Temperature coefficient is 0.04 ppm per deg C. Any frequency in the 4 to 16 mc range can be supplied, as can multiple frequency units. Of rugged construction, the oscillators withstand accelerations to 10 g. They weigh 9 oz.

Marconi Instruments, Dept. ED, 111 Cedar Lane, Englewood, N.J.

WRITE IN 97 ON READER-SERVICE CARD

Broadband Antennas

For telemetry

For telemetry, countermeasures, and other uses, these broadband, conical helix antennas operate in the 20 to 6000 mc spectrum. Their range can be extended to 10,000 mc. Bandwidths of 10 to 1 are obtainable with these units, and gains of 8 db are normal.

American Electronic Labs, Inc., Dept. ED, 121 N. 7th St., Philadelphia 6, Pa.

WRITE IN 98 ON READER-SERVICE CARD

Matching Network

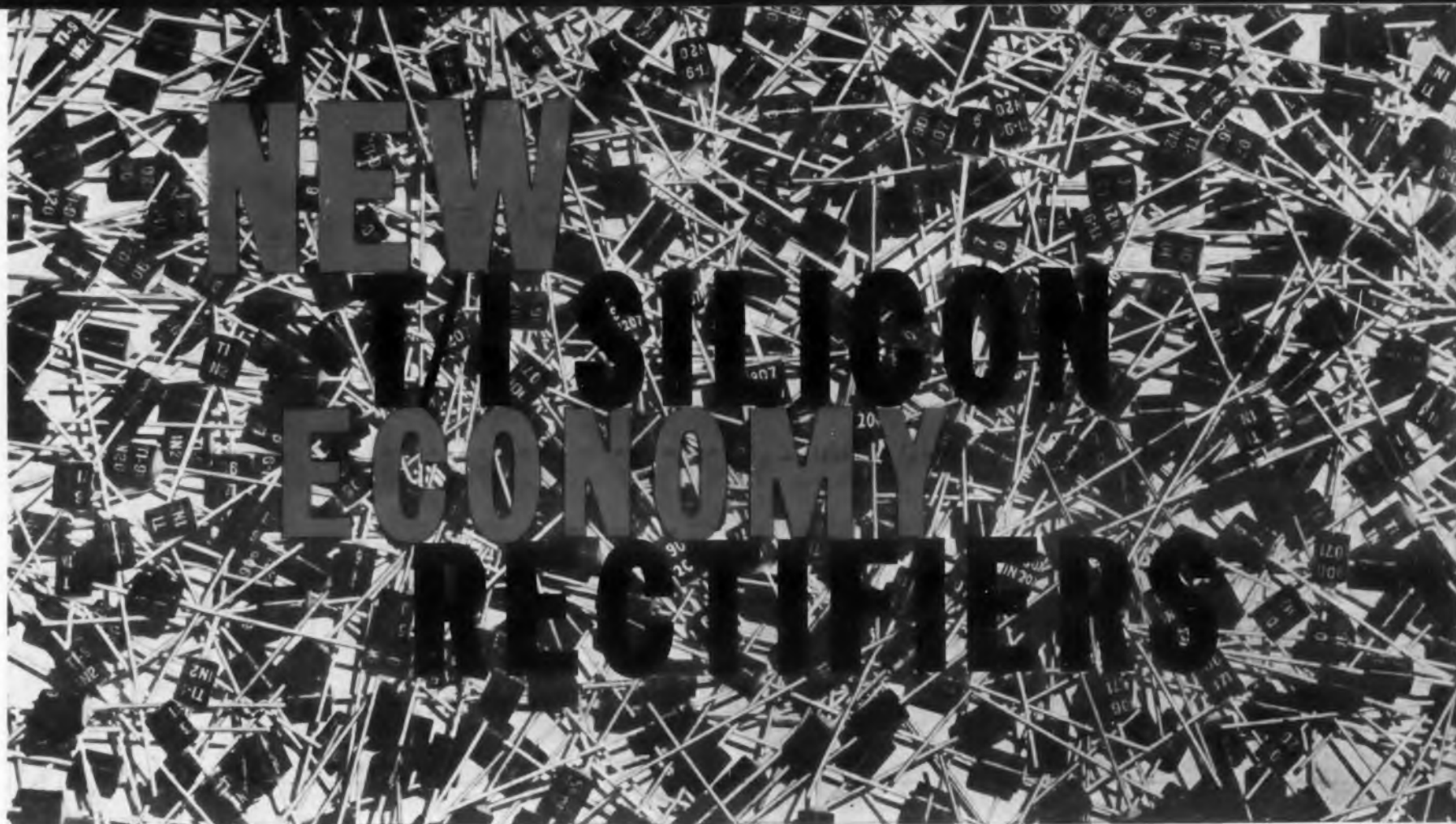
Adjustable

"Easymatch" is an adjustable matching network that changes approximate matches into accurate matches. The input impedance varies slowly with frequency. The units are available in four frequency ranges: 45 to 85 mc; 85 to 150 mc; 150 to 300 mc; and 300 to 700 mc. Nominal impedance is 50 ohms. The networks will match any 1:1 to 1 mismatch regardless of phase.

Alford Mfg. Co., Dept. ED, 299 Atlantic Ave., Boston 10, Mass.

WRITE IN 99 ON READER-SERVICE CARD

WRITE IN 106 ON READER-SERVICE CARD



ACTUAL SIZE PHOTO

... give you 750 mA at 200, 400 and 600 PIV

IMMEDIATE DELIVERY! You get the inherent high reliability of silicon with new TI silicon economy rectifiers now available in commercial production quantities!

These newest TI rectifiers withstand a surge current of 32 amps up to one millisecond and operate at temperatures up to $+100^{\circ}\text{C}$. Miniature nylon-epoxy case, 0.25 inch long and 0.20 inch in diameter, meets the rugged environments of MIL-STD-202A.

Priced competitively with selenium and germanium rectifiers, the new TI series is ideal for use in your low current power supplies, computer circuits... for your large volume applications where small size, reliability and low cost demand important consideration.

Check the specifications below for the unit most suited to your particular requirements.

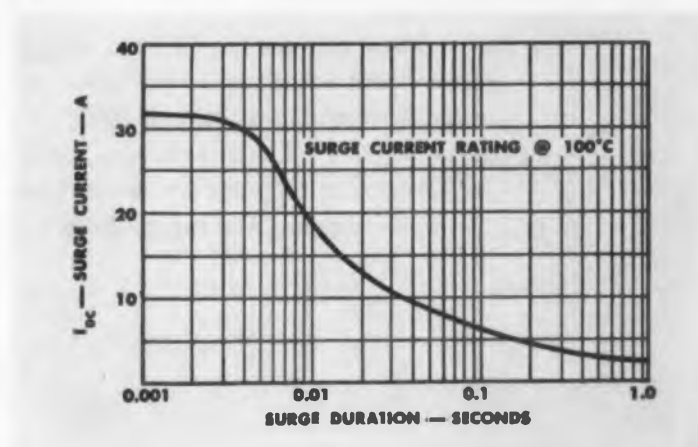
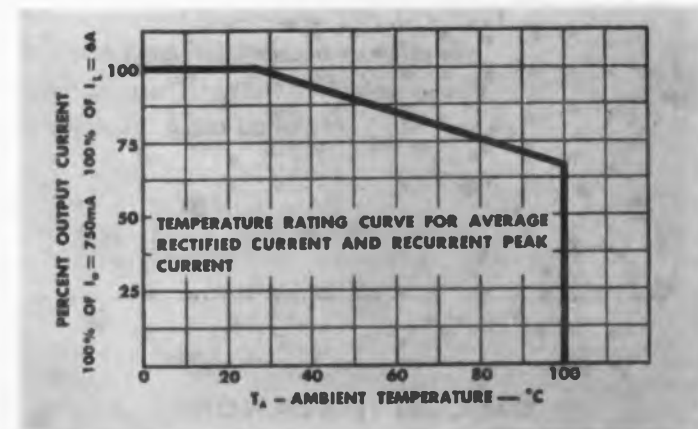
Quantities to meet your immediate needs are now in stock at TI distributors or through your nearest TI sales office.

Max Ratings at 25°C

	1N2069	1N2070	1N2071	
PIV	200	400	600	V
Vrms	140	280	420	V
I_o	750	750	750	mA
i_f	6	6	6	A
T_A	to $+100$			$^{\circ}\text{C}$

Electrical Specs at 100°C

Maximum Dynamic Reverse Current	.2	.2	.2	mA
Maximum Dynamic Forward Voltage Drop	.6	.6	.6	V



WORLD'S LARGEST SEMICONDUCTOR PLANT

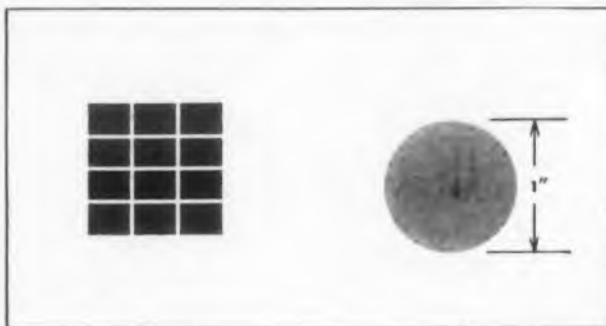


TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
POST OFFICE BOX 312 • 13500 N. CENTRAL EXPRESSWAY
DALLAS, TEXAS

HOW ONE CONCEPT IN POTENTIOMETER DESIGN SOLVES THREE BASIC PROBLEMS

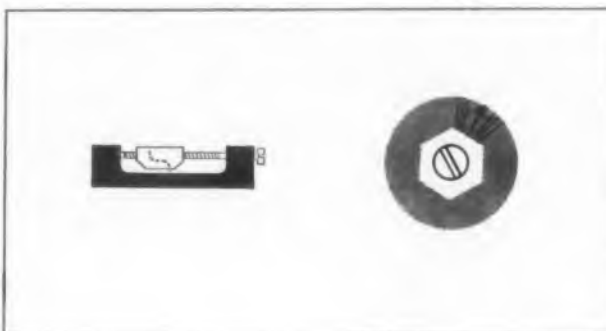
SPACE-SAVING SIZE AND SHAPE

You can pack a lot of Bourns potentiometers into a small space—12 in one square inch of panel area (or 17 TRIMPOT JR.* units!) Fit them into corners, between other components, flat against chassis or printed circuit boards. Mount them individually or in stacked assemblies.



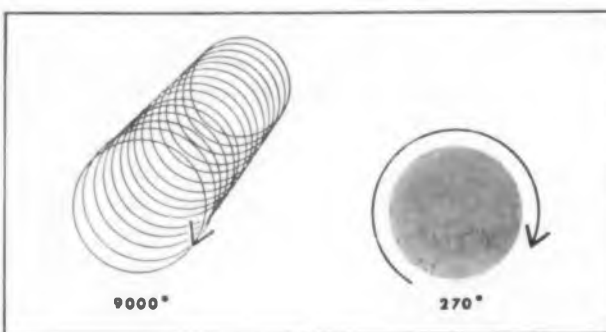
ADJUSTMENT STABILITY

Bourns potentiometers are *self-locking* (no lock nuts required). Any adjustment *remains stable*. Shock, vibration or acceleration can't affect a setting. Bourns potentiometers are helping thousands of engineers make reliability a reality.



CIRCUIT BALANCING ACCURACY

Bourns potentiometers are 33 times as accurate as conventional single-turn rotary types—the screw-actuated mechanism provides 9000° of rotation instead of only 270°. Circuit balancing, calibration—adjustments of all types are easier, faster, more precise. And repeatability is assured.



BOURNS

Laboratories, Inc.

P. O. Box 2112 • Riverside, California

In Canada: Douglas Randall (Canada), Ltd., licensee

ORIGINATORS OF TRIMPOT® TRIMIT® AND POTENTIOMETER INSTRUMENTS

*Trademark

WRITE IN 107 ON READER-SERVICE CARD

NEW PRODUCTS

Primary Phase Standards

For any frequency from 20 to 200 kc



Type 706-A ultrasonic primary phase standards generate two sinusoidal voltage signals whose phase difference can be varied smoothly from 0 to 360 deg with an accuracy of 0.1 deg. Units are built for any single frequency from 20 to 200 kc. They can be used for calibrating high frequency phase meters and detectors, and phase shifting devices in general. Operation is based on the interpretation of a multiple-frequency Lissajous pattern which is the same at every 5 deg phase interval. Calibration of the phase shifter removes the ambiguity of the pattern repetition on the scope. Between 5 deg points, a vernier phase shift dial is used to set incremental angles within ± 0.1 deg.

Acton Labs, Inc., Dept. ED, 533 Main St., Acton, Mass.

WRITE IN 108 ON READER-SERVICE CARD

Control Amplifier

Has stabilized circuit



For contactor regulators and servos, this control amplifier has a Varigain circuit that automatically changes the system gain to meet varying dynamic requirements. Threshold sensitivity is 1 mv into a 1.5 K load. Output is 115 v at 2 amp for a power gain of 110 db. The unit operates from -65 to +200 F.

Parameters, Inc., Dept. ED, 195 Herricks Rd., New Hyde Park, N.Y.

WRITE IN 109 ON READER-SERVICE CARD

Antenna Switching Relay

For mobile communications



For mobile communications in the 180 mc range, type FAS 5000 antenna switching relay comes with one or two poles that are normally open, normally closed, or double throw. The contacts, spaced to achieve low cross talk, are palladium in standard units and rated at 3 amp, non-inductive load at 115 v ac, 60 cps, or 24 v dc. Silver contacts rated at 5 amp may be ordered. The stack insulation and armature pusher are of Nema grade melamine glass, and the contact arm pusher is ceramic. Designed to withstand a minimum of 3 million operations, the relay has a temperature range of -30 to $+85$ C. With two 6-32 tapped holes on one side and two 4-40 on the other, it can be mounted from either of two positions.

F. A. Scherma Mfg. Co., Inc., Dept. ED, 424 Broome St., New York 13, N.Y.

WRITE IN 110 ON READER-SERVICE CARD

Trimmer Potentiometer

Rated at 2 w to 70 C



In 11 resistances from 100 ohms to 30 K, the 750 wirewound potentiometer is rated at 2 w to 70 C and operates from -55 to $+175$ C. It meets MIL-R-19A, MIL-R-12934A, MIL-E-5272A, and MIL-STD-202A specifications. Tolerance is $\pm 5\%$ and resolution 0.1 to 1%. The unit has an 18 turn trimming adjustment screw.

Dale Products, Inc., Dept. ED, Columbus, Nebr.

WRITE IN 111 ON READER-SERVICE CARD

TIMING ACCURACY



AND REPEATABILITY

AT A MOST



PRACTICAL COST:

NEW TRANSISTORIZED



TIME-DELAY RELAY

If you've been cost-stymied in your shopping for an accurate, thoroughly reliable time-delay relay, have a look at Heinemann's new Trans-O-Netic*. Remarkably low priced for its class, it offers repeatability of better than $\pm 5\%$ of the set delay over an operating range of 0.5 to 30 seconds. Reset is instantaneous; S.P.D.T. switching is extremely fast and

decisive. Temperature effects on time delay are negligible. Manufactured in knob-set or screwdriver-set models, the Trans-O-Netic Relay comes to you all wrapped up in a phenolic housing compact enough to fit neatly in the palm of your hand. Sound interesting? Then send today for Bulletin 5300; it gives the essential details and specifications.

HEINEMANN ELECTRIC COMPANY  **156 PLUM ST., TRENTON 2, N.J.**

*Trans-O-Netic is a trade name of the Heinemann Electric Company.

U.S.A. 1958

WRITE IN 112 ON READER-SERVICE CARD

VARACTORS NOW!

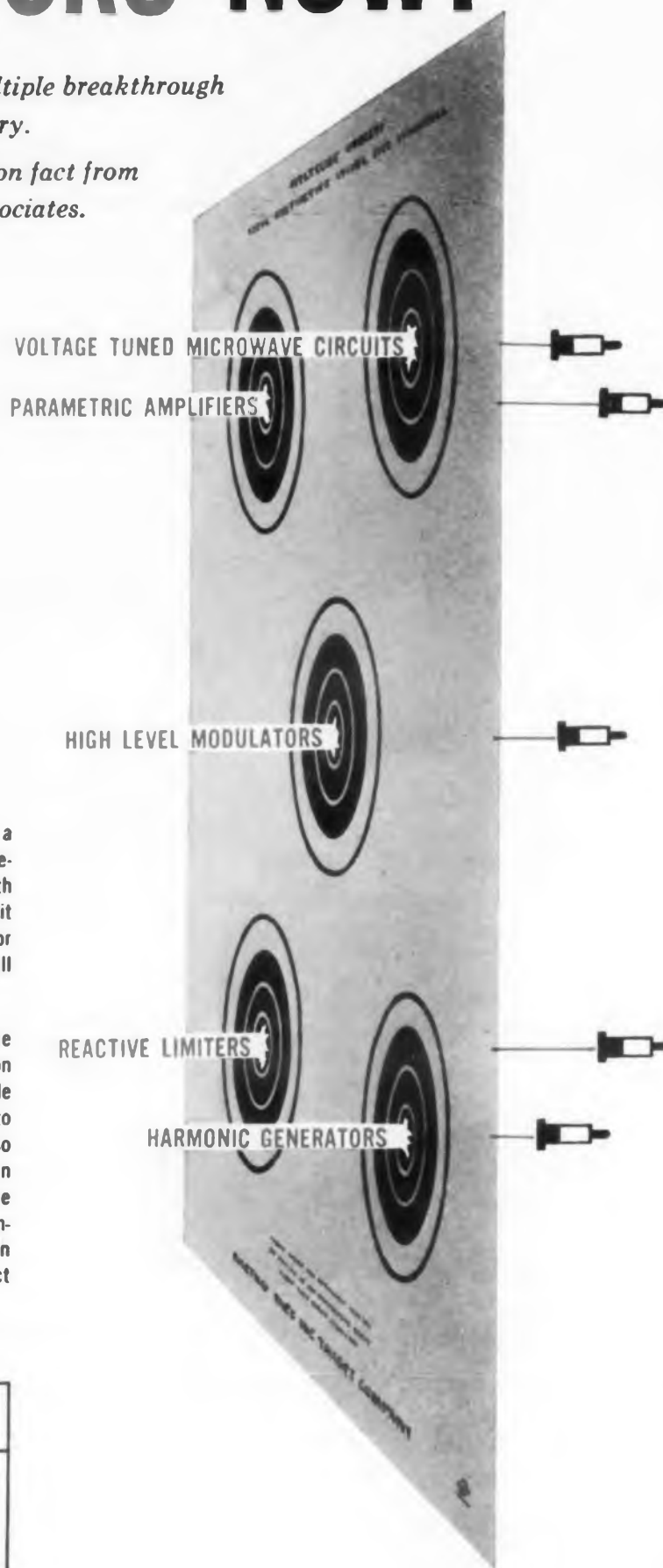
**YESTERDAY . . . a multiple breakthrough
in the laboratory.**

**TODAY . . . a production fact from
Microwave Associates.**

This Microwave Associates varactor is a diffused silicon PN junction diode designed to be a variable capacitance with low loss at high frequencies. The unit complies with MIL-E-1 outline 7-1 for cartridge type crystal rectifiers and will fit most standard crystal holders.

In the standard form, the pin end of the diode is connected to P-type material on the top of a small "mesa" and the N-side of the silicon element is connected to the base. Reverse polarity units are also available. Mechanically reversible units in both polarities may be ordered but the single-ended units are generally recommended because they insure placement in holders with the proper end in contact with a heat sink.

TYPE	CUT OFF FREQUENCY (kMc)	CAPACITY AT ZERO BIAS ($\mu\mu\text{f}$)
MA-460A	20	8
MA-460B	30	6
MA-460C	40	4
MA-460D	50	4
MA-460E	60	3



VOLTAGE TUNED MICROWAVE CIRCUITS

The high Q of the varactor at microwave frequencies and its voltage variable capacitance provide excellent qualities for use in circuits as AFC, voltage variable filter networks, tuned microwave oscillators.

PARAMETRIC AMPLIFIERS

The varactor used in very simple circuits requiring no refrigeration has demonstrated low noise, high gain performance from 1 to 6000 mc. Noise figures of approximately 1 db at UHF and 5 db at 6000 mc. are typical. We believe the varactor will be the component of choice for receiver inputs from 30 to 6000 mc.

HIGH-LEVEL MODULATORS

For the difficult problem of imposing VHF and UHF intelligence on a microwave carrier, the varactor is a top performer. The varactor accomplishes the mixing function with signal gain in the side bands as opposed to present low efficiency techniques.

REACTIVE LIMITERS

The varactor has been used as a passive reactive limiter at UHF frequencies. It is believed that the varactor will be an ideal "receiver protector" as an adjunct to present UHF radar duplexing systems.

HARMONIC GENERATORS

The unique properties of the varactor provide highly efficient harmonic generation. Useful harmonics have been generated up to 100 kMc. With inputs at HF, VHF, UHF and lower microwave frequencies, conversion losses of considerably less than 1 db per harmonic have been observed. The varactor driven by transistor or tube oscillators appears very promising as a signal source in the microwave region.

NEW PRODUCTS

Oscilloscope Panel mounted



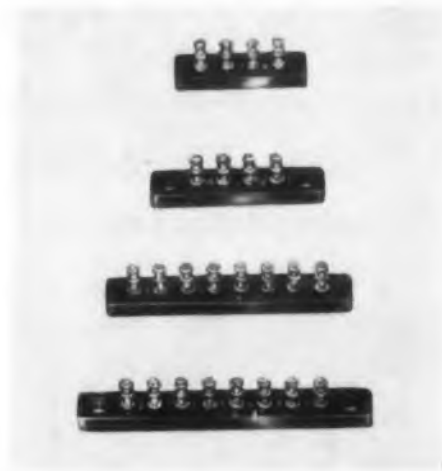
This 3 inch oscilloscope is panel mounted. It is complete with low and high voltage power supply and identical vertical and horizontal push-pull amplifiers. Its sensitivity is 0.1 v rms per in.

Building Blocks Electronic Co., Dept. ED, 2172 E. 36th St., Brooklyn 34, N.Y.

WRITE IN 115 ON READER-SERVICE CARD

Terminal Boards

Voltage breakdown of 2500 v rms



Series MT terminal boards have four or eight turret terminals which are molded directly into the body material. Either size can be supplied with or without 1/8 in. diameter mounting holes. Mineral filled Melamine, MIL-M-14E, Type MME, is the standard molding compound. Also available are glass reinforced Plaskon, MIL-M-14E, Type MAI-60; glass reinforced Diallyl Phthalate, MIL-M-19833, Type DGI-30; and mineral filled Diallyl Phthalate, MIL-M-14E, Type MDG. Voltage breakdown is 2500 v rms at sea level, 600 v rms at 60,000 ft. Minimum creepage path between contacts is 5.64 in.

DeJur-Amsco Corp., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N.Y.

WRITE IN 116 ON READER-SERVICE CARD

Send for catalog 59V



MICROWAVE ASSOCIATES, INC.

BURLINGTON, MASSACHUSETTS • Telephone: Browning 2-3000

WRITE IN 114 ON READER-SERVICE CARD

Rotary Switch

Has eight positions per wafer



Rated at 5 amp, 208 v dc, 400 cps, series M rotary switch has eight positions. Up to six wafers can be combined for a total of 48 separate circuits. Individual wafers, which may be bussed externally for any sequence, have from one to four rollers, permitting four poles and two positions. Explosion proof under MIL standards, Procedure 2, the switch withstands 60 g acceleration from 2 to 2000 cps and operates at 60,000 ft. Contact resistance averages 0.0005 ohms, and temperature rise at 208 v, 5 amp averages 7 deg F. The unit shows no wear after 250,000 operations. It is 1-7/8 in. in diameter.

Mason Electric Corp., Dept. ED, 3839 Verdugo Rd., Los Angeles 65, Calif.

WRITE IN 117 ON READER-SERVICE CARD

Relays

Have sealed coils



The coils of series 250 relays are sealed with fused wraps. Rated at 8 amp, 110 v ac or 10 amp 28 v dc, noninductive, the relays can be furnished with any coil resistance to 16 K. The armatures are locked to the frames so that they cannot be shocked out of place.

F & B Mfg. Co., Omega Electric Div., Dept. ED, 4248 W. Chicago Ave., Chicago 51, Ill.

WRITE IN 118 ON READER-SERVICE CARD

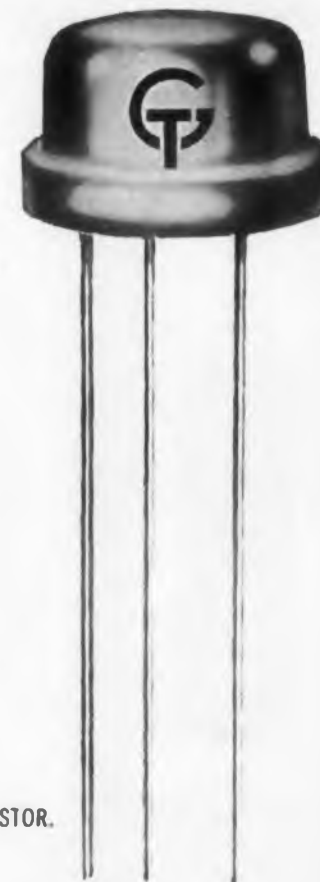
ready to go in

either direction



another

QUALITY PRODUCT FROM GENERAL TRANSISTOR.



NEW PNP AND NPN BILATERAL TRANSISTORS

HAVE EMITTER
AND COLLECTOR

INTERCHANGEABILITY

General Transistor has developed another new transistor series—the Bilateral PNP 2N592, 2N593 and NPN 2N594, 2N595, 2N596. These germanium alloyed junction transistors have been designed to allow current to flow in either direction—valuable in medium speed switching applications as in computers, communications equipment, multiplexing devices, and for bi-directional switching and phase detection systems.

The characteristics of these transistors are guaranteed in both directions. Their symmetrical design allows extremely low saturation resistances and switching properties. Ordinary uni-directional types lack this advantage. The NPN types have an alpha cutoff frequency range of 1.5 to 10.0 megacycles.

For complete technical specifications write for illustrated brochure G-170.



GENERAL TRANSISTOR CORPORATION

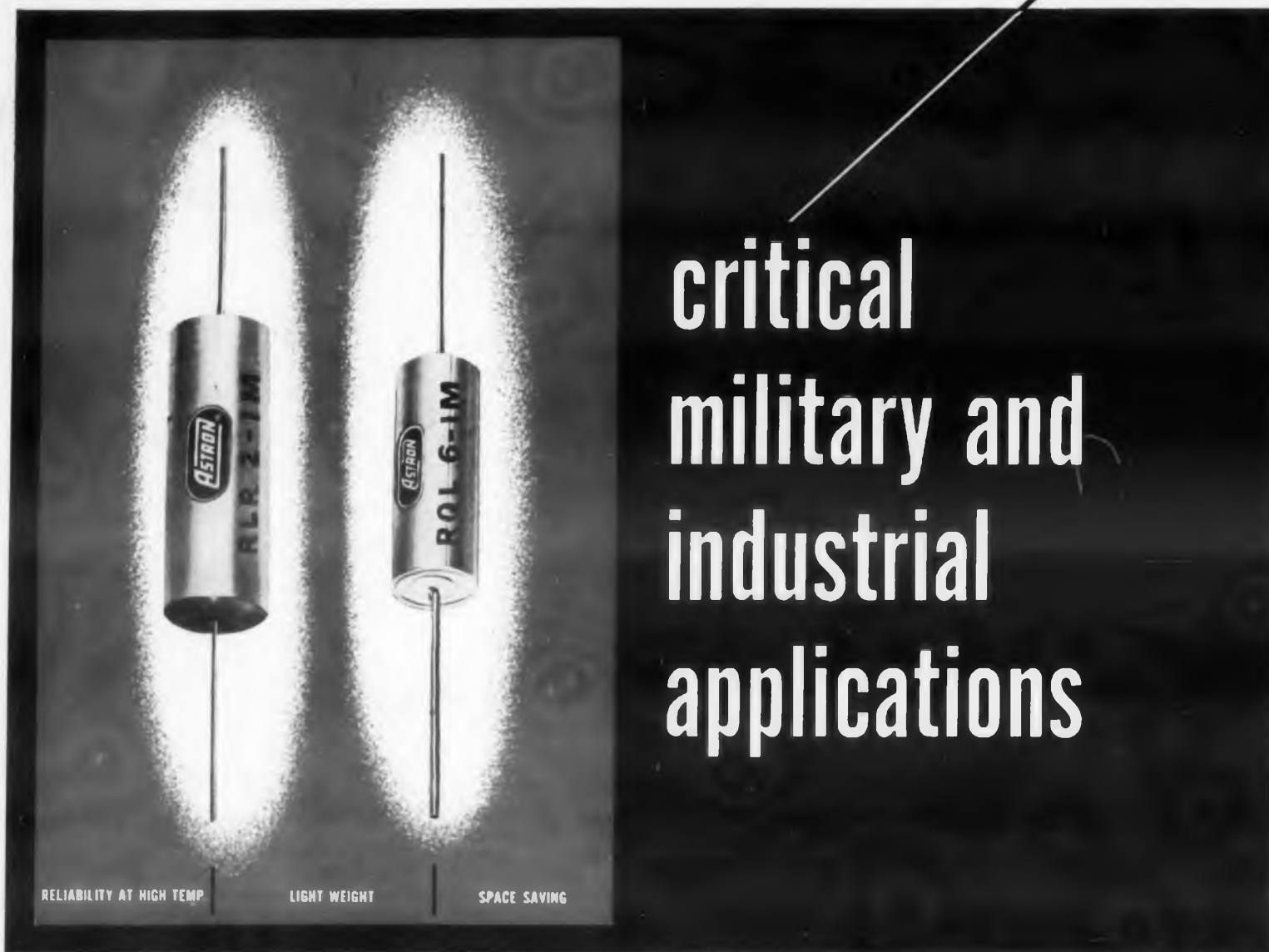
91-27 138TH PLACE, JAMAICA 35, NEW YORK

In Canada: Desser E-E Ltd., 441 St. Francis Xavier, Montreal 1, Quebec
FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED
GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING
CORP., 95-27 SUTPHIN BLVD. JAMAICA 35, NEW YORK FOR EXPORT: GENERAL
TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE JAMAICA 35, NEW YORK

WRITE IN 119 ON READER-SERVICE CARD



**RELIABILITY IS ONE REASON WHY ENGINEERS SELECT
ASTRON METALLIZED MYLAR* CAPACITORS FOR**



**critical
military and
industrial
applications**

MYLAR* METALLIZED, ASTRON TYPE RQL

A remarkably versatile unit in a miniature, hermetically sealed, metal case . . . assured reliability at high temperatures . . . to $+125^{\circ}\text{C}$ without derating . . . designed in a variety of military type cases and mounting styles . . . far superior to conventional metallized paper capacitors. For military reliability equipment . . . missiles . . . critical industrial uses.

METALLIZED MYLAR*, ASTRON TYPE RLR

A small size, uncased durable unit in a tough Mylar* wrap with epoxy end seal . . . reliable performance at high temperatures . . . to $+125^{\circ}\text{C}$ without derating . . . low cost unit for potted and hermetically sealed assemblies . . . military high reliability equipment . . . communications . . . noise suppression systems . . . superior unit to conventional cardboard cased metallized tubulars.

WRITE TODAY FOR COMPLETE SPECIFICATIONS ON ASTRON'S RELIABILITY SERIES OF METALLIZED MYLAR* CAPACITORS, MYLAR* CAPACITORS, PAPER DIELECTRICS, METALLIZED PAPERS AND SAFETY MARGIN** ELECTROLYTICS.

*REGISTERED DUPONT TRADEMARK
**TRADEMARK

ASTRON BULLETIN
RM-300
FOR TYPE RQL

WRITE IN 120 ON READER-SERVICE CARD

ASTRON
CORPORATION

255 GRANT AVENUE, E. NEWARK, N. J.



EXPORT DIVISION:
ROCKE INTERNATIONAL CORP.
13 EAST 40TH ST.
NEW YORK, N. Y.

IN CANADA:
CHARLES W. POINTON
6 ALCINA AVE.
TORONTO, CANADA



ASTRON BULLETIN
RM-375
FOR TYPE RLR

ON THE WEST COAST
QUICK DELIVERY OF
ASTRON PRODUCTS IS
AVAILABLE THROUGH
AUTHORIZED ASTRON
STOCKING DISTRIBUTORS.

NEW PRODUCTS

Dip Meter

Covers 1.75 to 260 mc

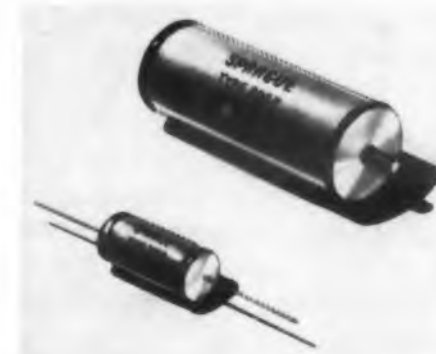
Equipped with color coded coils, model 600 dip meter covers the frequency spectrum from 1.75 to 260 mc. A self-contained unit, it is useful in determining the resonant frequency of tuned circuits such as traps, chokes, tank circuits, and antennas. It can also be used as a signal generator and absorption wave meter.

Barker & Williamson, Inc., Dept. ED, Bristol, Pa.

WRITE IN 121 ON READER-SERVICE CARD

Plastic-Paper Capacitors

High Voltage



For high voltage use, type 205P glass encased tubular capacitors have a dual dielectric of polyester plastic film and paper. Their glass-to-metal end seal practically eliminates impregnant leaks. They are especially suited for solving corona problems in airborne equipment.

Sprague Electric Co., Dept. ED, 347 Marshall St., North Adams, Mass.

WRITE IN 122 ON READER-SERVICE CARD

ERASE HEADS.—Double-gap, laminated heads for use with magnetic tape equipment. ME-100 is a two-track unit, SE-100 is a stacked stereo two-track unit, and SE-50 is a stacked stereo four-track unit. All produce 56 db erasure.

The Nortronics Co., Inc., Dept. ED, 1015 S. Sixth St., Minneapolis 4, Minn.

WRITE IN 123 ON READER-SERVICE CARD

MINIATURE HIGH MU TRIODE.—Type NU 7235 for amplifier and voltage regulator applications where up to 10 kv are used. General characteristics: μ , 550; transconductance, 850 μmhos ; plate dissipation, 10 w; height, 2-3/4 in.; OD, 7/8 in.

National Union Electric Corp., Electronics Div., Dept. ED, Bloomington, Ill.

WRITE IN 124 ON READER-SERVICE CARD

HANDLES.—Vinyl coated aluminum handles immune to corrosion and humidity. Type H-5371 has heat treated mounting plate, carries 125 lb, and conforms to MIL-T945A. Type H-5372 is for nonswing fixed mounting on top or sides of cabinets, or front panel protection.

National Radiac Inc., Dept. ED, 475 Washington St., Newark 2, N.J.

WRITE IN 125 ON READER-SERVICE CARD

10 KW KLYSTRON AMPLIFIER.—Model 1042-J for use in multichannel tropospheric scatter communication systems. Available in two ranges: 750 to 958 mc and 1700 to 2400 mc.

National Co., Inc., Dept. ED, 61 Sherman St., Malden 48, Mass.

WRITE IN 126 ON READER-SERVICE CARD

PHENOLIC LAMINATE.—No. 4012-42 Lamicaid has good electrical properties and high impact and flexural strength. Readily machined, it can be punched into intricate parts with conventional equipment. Suitable as a base material for printed circuits.

Minnesota Mining & Mfg. Co., Mica Insulator Div., Dept. ED, Schenectady 1, N.Y.

WRITE IN 127 ON READER-SERVICE CARD

RADIATION MONITORING SYSTEM.—Gamma remote system AMS-II consists of 10 individual stations, alarm system, and centralized power supply. One or more channels can be removed from the circuit without disturbing the others. Accuracy of $\pm 10\%$.

Riggs Nucleonics Corp., Dept. ED, 717 N. Victory Blvd., Burbank, Calif.

WRITE IN 128 ON READER-SERVICE CARD

SOLDER BATH DECONTAMINANT.—When stirred into a molten solder bath, Rowex-29 permits removal of dissolved copper. An 8 oz. carton contains enough decontaminant for 800 lb of solder.

Rowe Engravers, Inc., Dept. ED, 262 E. 16th St., Paterson 4, N.J.

WRITE IN 129 ON READER-SERVICE CARD

FLEXIBLE CABLE.—Has interwoven twisted figure 8 weave which restricts magnetic field normally radiated from a current carrying wire. Does not unravel. Presently available in No. 24 wire, it can also be furnished in other sizes.

Perfection Mica Co., Magnetic Shield Div., Dept. ED, 1322 N. Elston Ave., Chicago 22, Ill.

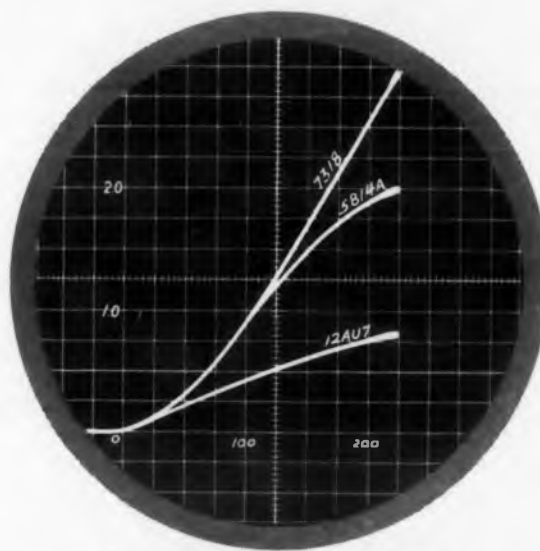
WRITE IN 130 ON READER-SERVICE CARD

OPTICAL TRANSDUCER.—Model TL-2 for use with electronic tachometers. Measures rotational speeds above 1 million rpm and also linear speeds. Accuracy is 1%.

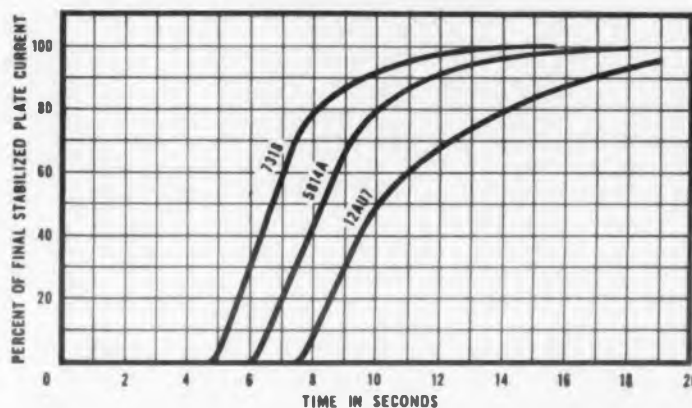
Southwestern Industrial Electronics Co., Dept. ED, 2831 Post Oak Rd., Houston 19, Tex.

WRITE IN 131 ON READER-SERVICE CARD

ELECTRONIC DESIGN • January 7, 1959



"Y" Axis Peak Cathode Current in Amperes
"X" Axis Grid Drive in Volts



Warm-up characteristics of 7318 • 5814A • 12AU7

New 7318 miniature pulse tube offers...

... 2 AMPERES PEAK CURRENT

The compact CBS-Hytron 7318 will provide, for example, 2 amperes peak current in 1.5-microsecond pulses at 2300 p.p.s.

... FAST OPERATIONAL WARM-UP

In less than 10 seconds the 7318 reaches 80% of steady-state plate current.

... ENVIRONMENTAL TESTS

EXCEEDING MIL-E-1

Severe environmental tests and factory stabilization insure dependability of the 7318.



COMPARE THESE ENVIRONMENTAL TESTS

Test	CBS-Hytron 7318	JAN 12AU7 JAN 5814A
High-frequency vibration	✓	None
High-frequency fatigue	✓	None
Low-frequency vibration	✓	✓
Linear acceleration	✓	None
Temperature cycling	✓	None
Shock (JAN-5-44)	✓	None

CBS-Hytron 7318 exceeds MIL-E-1 standard environmental requirements, most of them by factors of 3 or 4 times.

More
Reliable Products
through Advanced-
Engineering



CBS-HYTRON, Danvers, Massachusetts
A Division of Columbia Broadcasting System, Inc.

WRITE IN 132 ON READER-SERVICE CARD

MANY USES for this rugged 9-pin medium-mu twin triode include: industrial, computer, missile, satellite and manned-aircraft applications. The CBS-Hytron 7318 is ideal for blocking oscillators, square-wave modulators, multi-vibrators and hybrid tube-transistor circuits.

Write for Bulletin E-318. It gives complete technical and application data, characteristic curves and environmental ratings on the CBS-Hytron 7318.



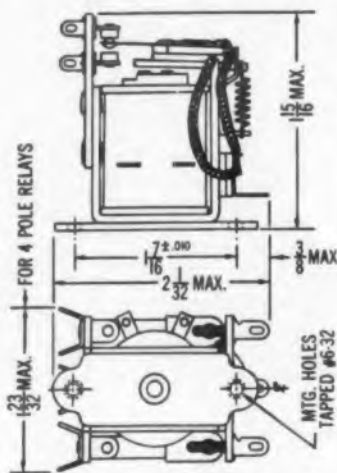
KL-A VERSATILE, RELIABLE, LOW COST P & B RELAY for communications and automation

ECONOMY and versatility distinguish our KL series relays. Contact arrangements are available up to 4 pdt in either AC or DC versions. Sensitivity of 100 milliwatts per movable arm is available.

Stationary contacts and terminals are mounted on a phenolic front of high dielectric strength, thus adding to the utility of the relay. Conveniently located terminals and easy-to-mount base greatly simplify installation on long production runs.

KL relays may be hermetically sealed or furnished in metal dust covers.

This is one of a "family" of fine P&B relays. Others, with similar configurations but various electrical and switching capacities, are shown below. Write or call for more information or see the complete P&B catalog in Sweet's Product Design File.



KL ENGINEERING DATA

GENERAL: Breakdown Voltage: 500 volt rms, 60 cycle between all elements standard 4 pole relay; 1500 volts rms, 60 cycle on special 3 pdt relay.

Temperature Range: -45°C. to +85°C.

Pull-In: Approx. 75% of nominal dc voltage.
Approx. 78% of nominal ac voltage.

Terminals: Pierced solder lugs for two #20 AWG wires.

Enclosures: Metal can 2 3/4" high x 2 3/8" long x 2 1/2" wide with octal plug or multiple solder header.

CONTACTS: Arrangements: up to 4 pdt.

Material: 1/8" dia. gold-flashed silver. (Others available.)

Load: 5 amps @ 115 volts, 60 cycle resistive loads.

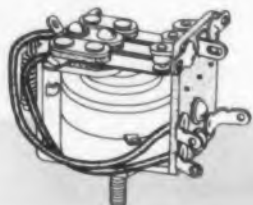
COILS: Resistance: 60,500 ohms max.

Power: 100 milliwatts per movable arm.

Duty: Continuous; coils will withstand 6 watts @ 25°C.

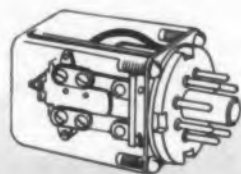
Voltages: up to 110 volts dc.
up to 230 volts ac.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



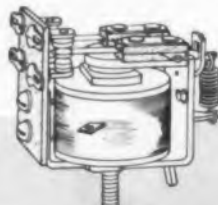
KR SERIES: SMALL, 5 AMP RELAY

Ruggedly constructed for long life and dependability. Available up to 3 pdt.



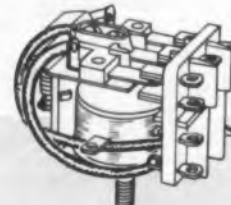
KCP SERIES: SENSITIVE 3 PDT RELAY

For plate circuit applications requiring low cost, sensitive relay. Polyethylene dust cover.



KT SERIES: ANTENNA RELAY

Insulated to minimize RF losses. Designed to switch 500 watts RF input to 300 ohm line.



KA SERIES: GENERAL PURPOSE

Compact, light-duty relay. U/L approved. Meets 1500 volts rms breakdown requirement.



POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

NEW PRODUCTS

Transistor Radiator

Reduces temperature by 30 C

A heat dissipation device for diamond shape power transistors, model 3B-663 radiator helps prevent thermal runaway. It consists of a series of black ebanol-finished metallic radiating fins mounted on a base plate which is interposed between the transistor and the chassis. It may be used with or without a mica insulating washer. Attached to the chassis with four bolt posts, the radiator does not interfere with servicing or operation of the transistor. Especially for use above ground potential, it reduces transistor operating temperatures as much as 30 C. It complies with MIL-E-5272A and MIL-STD-202A requirements.

The Birtcher Corp., Industrial Div., Dept. ED, 4371 Valley Blvd., Los Angeles 32, Calif.

WRITE IN 134 ON READER-SERVICE CARD

Modular Power Supplies

0.5% regulation

Subchassis units designed for use as components in original equipment, power supplies 22-111 through 22-117 provide 0.5% regulation for line and load combined. Fully transistorized, they are available in seven voltage ranges from 5 to 7 v at 3 amp to 27 to 32 v at 1 amp. Maximum transient no to full load is 200 mv; ripple, 2 mv rms; maximum operating temperature, 50 C. The units are short-circuit proof and can be operated in series to supply higher voltages. Extending about 4.5 in. above the chassis and 1.75 in. below, they are 4 in. wide and 12 in. long. They can be provided on panels for standard rack mounting.

Dressen-Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena, Calif.

WRITE IN 135 ON READER-SERVICE CARD

← WRITE IN 133 ON READER-SERVICE CARD

Selenium Rectifiers

Have low temperature rise

Cooled by both convection and radiation, Venticool high-density selenium rectifiers have a low temperature rise. The double cooling is effected by spacers mounted between the unit's six vacuum processed plates. The same height as the plates, these spacers extend about 1/4 in. beyond the plate width to form radiating fins. Running vertically up the center of the spacers are multiple corrugations that act like chimneys to draw up surrounding air in continuous cooling convection currents. Designed for compact television sets, the units measure 1.33 x 1.5 x 1.875 in.

Electronic Devices, Inc., Dept. ED, 429 12th St., Brooklyn 15, N.Y.

WRITE IN 136 ON READER-SERVICE CARD

Ultrasonic Cleaner

Stands high temperature

The DR-500-AL ultrasonic cleaning system handles 500 w and can be used at high temperatures. It removes excess solder flux, radioactive soils, etching resists, lint, waxes, and other soils. Tank sizes are 0.5 to 2 gal.

Acoustica Associates, Inc., Dept. ED, 26 Windsor Ave., Mineola, N.Y.

WRITE IN 137 ON READER-SERVICE CARD

Heat Exchanger

Dissipates up to 17 kw

Depending on the coolant used, this heat exchanger can dissipate up to 17 kw. Measuring 24 x 36 x 30 in., the laboratory unit is designed to operate on 208 or 220 v, 3 phase, 60 cps power. It can accommodate large electronic equipment and features variable fluid flow for simulating operating conditions.

The Hallicrafters Co., Dept. ED, 4401 W. Fifth Ave., Chicago 24, Ill.

WRITE IN 138 ON READER-SERVICE CARD

WRITE IN 139 ON READER-SERVICE CARD ➤

expanding the
frontiers of
technology...
over the full
spectrum
of advanced
electronics



BRUBAKER ELECTRONICS, INC.
subsidiary of
TELECOMPUTING CORPORATION

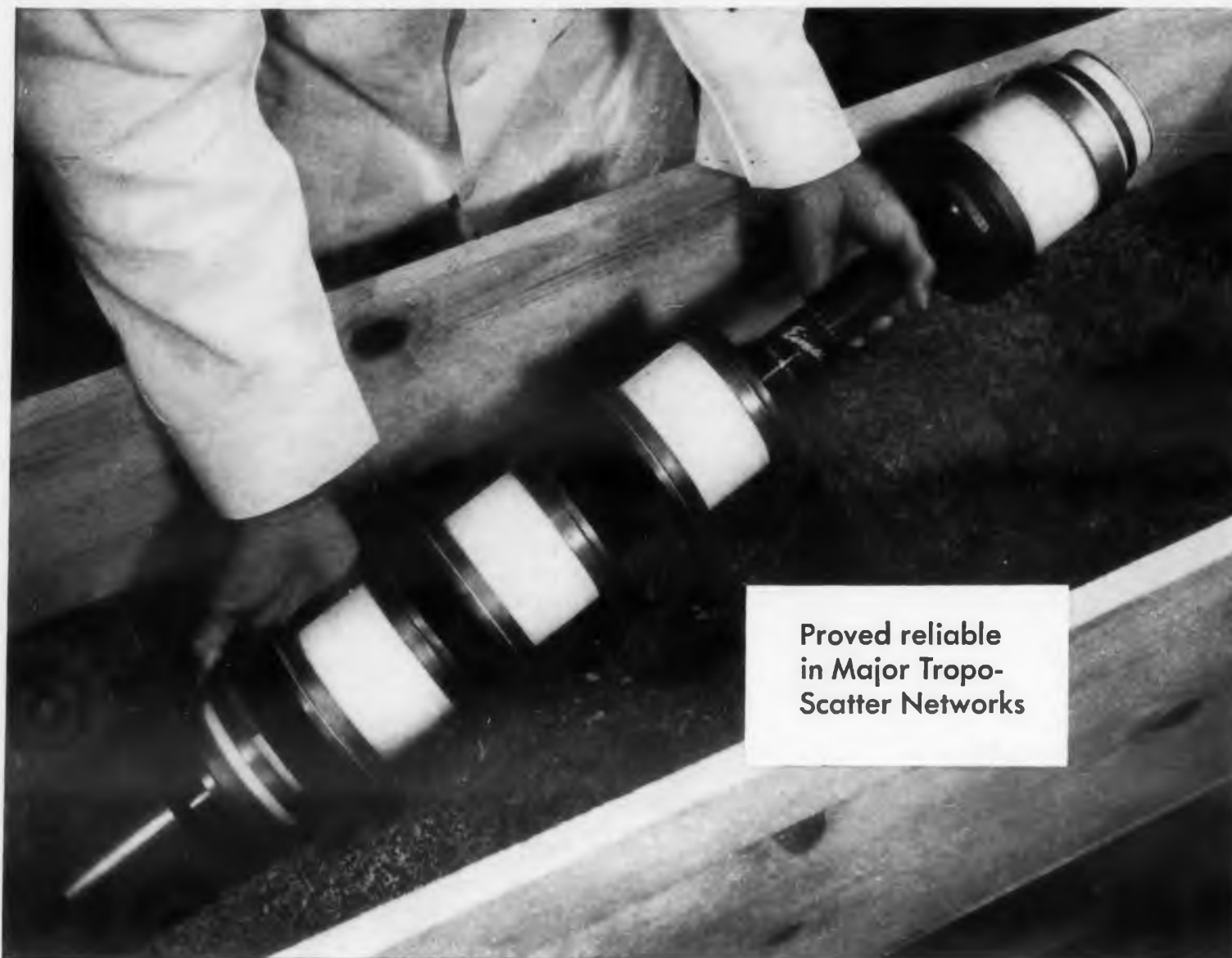
Brubaker scientists and engineers are dynamically attacking and overcoming the highly specialized electronic barriers associated with space-age technology. A skillful blending of technical ability, competitive production capabilities, and extensive testing facilities has established Brubaker Electronics as top-flight experts in the research, design, and development of complex electronic systems and components for both military and industrial applications. Brubaker's experience, personnel, and capabilities, together with a well-integrated research program, are the reasons why Brubaker equipment is operational on so many of the nation's vital weapons systems.

Past achievements show why Brubaker is superior in the area in which it operates: coding and decoding systems, radar, radar beacons, IFF, telemetering, communications and custom test equipment, highly classified military electronic systems—and such components as networks, delay lines, pulse transformers, switches and relays.

If you have a problem in advanced electronics, Brubaker engineers have a solution! Wire, write or phone:

Royal Keeran
Berne Fisher
Gene Fredericks
BRUBAKER ELECTRONICS, INC.
subsidiary of
TELECOMPUTING CORPORATION
3652 Eastham Drive
Culver City, California
Telephone: TEXAS 0-6441
TWX Culver City, Calif. 7239





Proved reliable
in Major Tropo-
Scatter Networks

Field experience indicates

15,000 hours from now, this Eimac 2KW KLYSTRON will still be in service

After three years of widespread service in such tropo-scatter systems as Dew Line, White Alice and Texas Towers, typical life of Eimac 3K3000LQ klystrons is nearing 15,000 hours and still increasing. Experience with Eimac klystrons in these and other tropo-scatter systems indicates that the 3K3000LQ will easily exceed 15,000 hours typical life. This exceptional record of long life and high performance is the result of Eimac's conservative design and advanced manufacturing techniques.

The Eimac 3K3000LQ is a 2 kilowatt klystron covering the frequency range of 610 to 985 megacycles. It will tune over the entire frequency range with one set of

external cavities and is capable of meeting the bandwidth requirements of modern tropo-scatter systems.

Eimac's external-cavity design permits this wide tuning range and bandwidth, and also eliminates problems inherent in flexible vacuum seals. Systems' operating costs are significantly lowered since tuning circuitry need not be repurchased when tubes are replaced.

The 3K3000LQ is typical of the Eimac family of 1 and 2 kilowatt klystrons. Other tubes in this family, such as the 3KM3000LA, 4KM3000LQ, 3K2500LX and 3K2500SG, cover virtually all the frequencies from 375 to 2400 megacycles. For complete technical data on these exceptional power amplifier klystrons, write the Eimac Application Engineering Department.

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

Eimac First with ceramic tubes that can take it



Cable address
EIMAC
San Carlos

WRITE IN 140 ON READER-SERVICE CARD

NEW PRODUCTS

SILICON INSULATED CABLE.—"Simconex" wires and cables operate continuously at 200 C, maintain flexibility at -75 C.

Simplex Wire & Cable Co., Dept. ED, Cambridge 39, Mass.

WRITE IN 141 ON READER-SERVICE CARD

LAMP SOCKET.—Type LT-47 Lamp Jax mounts singly or on standard switchboard panels, accepts standard switchboard lamps. Nylon lamp housing is molded directly to frame, completely insulating lamp from mounting frame.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

WRITE IN 142 ON READER-SERVICE CARD

ON-OFF TEMPERATURE CONTROLLER.—Has sensing element that continuously measures temperature and turns heat on or off when it becomes too high or too low. Controls temperatures within ± 3 F between 200 and 1000 F. On and off difference is under 1 F.

Electronic Processes Corporation of California, Dept. ED, 2190 Folsom St., San Francisco 10, Calif.

WRITE IN 143 ON READER-SERVICE CARD

SEMICONDUCTOR LIFE TESTER.—Equipment for measuring minority carrier lifetime, drift mobility, and photoeffects in semiconductors. Consists of a 3 μ sec spark gap light source intense enough to inject 10^{13} carriers per cu cm.

Electro Impulse Lab, Dept. ED, 208 River St., Red Bank, N.J.

WRITE IN 144 ON READER-SERVICE CARD

TELEMETRY DATA SYSTEM.—PDM-to-digital Mark I system receives pdm flight test data directly or from an analog tape, converts it to digital form, and records it on a magnetic tape in a format compatible with digital computers. Performs with $\pm 0.1\%$ accuracy.

Epsco, Inc., Dept. ED, 588 Commonwealth Ave., Boston 15, Mass.

WRITE IN 145 ON READER-SERVICE CARD

MINIATURE TUBE SHIELDS.—Series T5P and T6P have a pull tab on top of the spring clip to facilitate its removal. Any piece of wire or instrument that will fit into the loop can be used to lift the spring.

International Electronic Research Corp., Dept. ED, 145 W. Magnolia Blvd., Burbank, Calif.

WRITE IN 146 ON READER-SERVICE CARD

FLUXED SOLDER PREFORMS.—Coated with rosin flux, these preforms eliminate the need for separate fluxing operations. Variety of sizes, shapes, and thicknesses.

Hi-Grade Alloy Corp., Dept. ED, 3034 E. 95th St., Chicago, Ill.

WRITE IN 147 ON READER-SERVICE CARD

EXPANDING
THE FRONTIERS
OF SPACE
TECHNOLOGY



Studying results of antenna pattern measurements -- part of the activity of the Space Communications laboratory.



Lockheed Q-5 target missile features telemetry that registers miss-distance and theoretical hits in testing accuracy of other missiles.

Lockheed

MISSILE SYSTEMS DIVISION

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO

Lockheed maintains extensive research capabilities for the development of antennas and telemetering systems and spacecraft applications.

Laboratory studies in antennas and electromagnetic propagation include the application of solid state materials to microwave transmission line components; the design of antennas to survive the rigors of space flight; the effects of space on radio signals and radar detection; and the scattering from missile shapes and space vehicles. Research is also being conducted in the application of ferrites and MASERS; on problems of radio transmission between space vehicles and Earth, re-entry scattering and diffraction by man-made objects and ionized gases; and development of antennas for data link systems between satellites and ground stations.

Telemetering has been brought to a high degree of successful application in the integration of

circuits and components into high-performance systems. A completely sub-miniaturized FM-FM system has been developed, along with a complete PAM-FM system characterized by highly efficient band-width utilization, low power consumption and economy of size and weight. This represents a significant achievement in the field of high capacity telemetry.

Scientists and engineers of outstanding talent and inquiring mind are invited to join us in the nation's most interesting and challenging basic research and development programs. Write: Research and Development Staff, Dept. A-21, 962 W. El Camino Real, Sunnyvale, California, or 7701 Woodley Avenue, Van Nuys, California. For the convenience of those living in the East or Midwest, offices are maintained at Suite 745, 405 Lexington Avenue, New York 17, and at Suite 300, 840 N. Michigan Avenue, Chicago 11.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics." NATIONAL MISSILE INDUSTRY CONFERENCE AWARD



See the air-gap on this new lamination for miniaturization

Look at the air-gaps on this new performance-guaranteed lamination we have developed and are stocking. The F-187's fixed air-gap provides constant inductance or linear inductance, as needed, because it prevents d-c saturation of the stacked core.

The F-187 $\frac{3}{16}$ " wide center leg is designed for miniaturized filter circuits for communication applications. It is ideal for carrier equipment, and can be used most successfully for microwave, computer or other applications where frequency control is critical.

Being an "F" shape, the new standard stacks more easily than E1-187, and thus offers welcome savings on the production line. There can be advantages to you, too,

in being able to order any quantity, prototype or production, directly from stock.

There's more detailed information on this new member of Magnetics, Inc. family of "Performance-Guaranteed" laminations—and all of our other standard laminations. Just write—*Magnetics, Inc., Dept. ED-49, Butler, Pa.*



WRITE IN 148 ON READER-SERVICE CARD

NEW PRODUCTS

AIR FILTER.—Uses filter cartridges with 10, 25, and 40 micron ratings. Cartridges can be changed without removing filter from the line.

Perfecting Service Co., Dept. ED, 332 Atando Ave., Charlotte, N.C.

WRITE IN 149 ON READER-SERVICE CARD

CIRCUIT BREAKER.—Has pushbutton reset which puts mobile radio systems back on the air instantly when main cable fuses fail. Smaller than a silver dollar.

General Electric Co., Communication Products Dept., Dept. ED, Syracuse, N.Y.

WRITE IN 150 ON READER-SERVICE CARD

INTEGRATING SERVO.—Designed for use in a missile integrating system, this assembly incorporates a size 8 servo motor generator, a precision potentiometer, and a high ratio gear reducer.

Thomas A. Edison Industries, Instrument Div., McGraw-Edison Co., Dept. ED, West Orange, N.J.

WRITE IN 151 ON READER-SERVICE CARD

ROSIN FLUX.—Type 77 contains activating agent that gives rapid fluxing action, leaves no corrosive residue. Suited for automatic soldering operations and printed circuits.

Hi-Grade Alloy Corp., Dept. ED, 3034 E. 95th St., Chicago, Ill.

WRITE IN 152 ON READER-SERVICE CARD

BREAK-PROOF METER CASE.—Made of glass-reinforced polyester plastic, this multimeter case is practically indestructible. Its resilience cushions shocks, reduces meter damage. Variety of shapes and sizes.

Instrument Control Co., Dept. ED, 1556 Nicollet Ave., Minneapolis 3, Minn.

WRITE IN 153 ON READER-SERVICE CARD

AUDIO TUBE.—Model ECF80/6BL8 nine-pin miniature triode-pentode functions as high gain af amplifier and phase inverter.

International Electronics Corp., Dept. ED, 81 Spring St., New York 12, N.Y.

WRITE IN 154 ON READER-SERVICE CARD

RIGHT ANGLE MINIATURE TUBE SHIELDS.—Series T3 assemblies have integral military sockets: MS 35407-1 for round button tubes and MS 35408-1 for flat press tubes. Units withstand 200 C.

International Electronic Research Corp., Dept. ED, 145 W. Magnolia Blvd., Burbank, Calif.

WRITE IN 155 ON READER-SERVICE CARD

HIGH VOLTAGE TRANSFORMERS.—For custom installation. Voltages of 1 to 15 kv with power ratings from 10 to 250 w.

James Vibrapowr Co., Dept. ED, 4050 N. Rockwell, Chicago, Ill.

WRITE IN 156 ON READER-SERVICE CARD

CLOSED-CIRCUIT TV.—Camera features electronic light compensator with no moving parts which instantly and automatically adjusts to light changes. Maximum theoretical control limit is 10,000 to 1 without change in iris setting.

International Telephone and Telegraph Corp., Dept. ED, 15191 Bledsoe St., San Fernando, Calif.

WRITE IN 157 ON READER-SERVICE CARD

FOOT SWITCH.—"Hi-treadlite" switch comes in spdt, spdt double break, or simulated dpdt arrangements. Measures 3.5 x 2.5 x 1.25 in.

Linemaster Switch Corp., Dept. ED, 432 Woodstock Terrace, Woodstock, Conn.

WRITE IN 158 ON READER-SERVICE CARD

PACKAGED VLF TRANSMITTER.—High power output unit in one self-contained cabinet. Uses building blocks to provide outputs from 33 kw to 2 megawatts with one coordinating control console. Transmitters operate from 1 to 50 kc.

Ling Electronics, Inc., Dept. ED, 9937 W. Jefferson Blvd., Culver City, Calif.

WRITE IN 159 ON READER-SERVICE CARD

PANEL VTVM's.—Have 5-1/8 in. scale arc in 6 in. case. Model 300 dc units have $\pm 3\%$ accuracy, 10 meg input resistance. Available in 7 discrete ranges from 1 to 1000 v. Model 310 ac units have 20 cps to 100 kc response and 10 ranges from 10 mv to 300 v rms. Input impedance is 1 meg, 30 μ f.

Metronix, Inc., Dept. ED, Chesterland, Ohio.

WRITE IN 160 ON READER-SERVICE CARD

HEAT-RESISTANT PLASTIC.—Asbestos-filled Diall FS-6 stands up to 500 F, has good electrical properties and stability, does not crack around metallic inserts. For use as an insulator in connectors, switches, and other electrical components.

Mesa Plastics Co., Dept. ED, 11751 Mississippi Ave., Los Angeles 25, Calif.

WRITE IN 161 ON READER-SERVICE CARD

HIGH FIDELITY SPEAKERS.—Model F-8-HF has single cone, frequency response of 60 cps to 12 kc ± 5 db. Model F-8-HFD has dual cone and frequency response of 60 cps to 17 kc ± 5 db.

Minneapolis Speaker Co., Dept. ED, 3806 Grand Ave S., Minneapolis 9, Minn.

WRITE IN 162 ON READER-SERVICE CARD

RINGS.—Line of Teflon "O" and spiral back-up rings that conform to AN and MS specifications. Can be fabricated to customer requirements.

Allegheny Plastics, Inc., Dept. ED, 105 Thorn Run Rd., Coraopolis, Pa.

WRITE IN 163 ON READER-SERVICE CARD

STROBOSCOPE.—Model 304 Pulse-Strob for visual motion study provides adjustable flashing rate neon light source. A 5 to 1 vernier control adjusts rate in two ranges: 8 to 30 and 32 to 100 pulses per sec.

Aerotron Associates, Inc., Dept. ED, Concord, N.H.

WRITE IN 164 ON READER-SERVICE CARD

ELECTRONIC DESIGN • January 7, 1959

FREQUENCY STANDARDS



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

*3 1/2" high
400 - 1000 cy.



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

*3 1/2" high
400 to 500 cy.
optional



FREQUENCY STANDARD

TYPE 2007-6

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

NEW



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.



ACCESSORY UNITS

for TYPE 2001-2

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.

FREQUENCY STANDARD

TYPE 50L

Size 3 3/4" x 4 1/2" x 5 1/2" High

Weight, 2 lbs.

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.)



FREQUENCY STANDARD

TYPE 2005

Size, 8" x 8" x 7 1/4" High

Weight, 14 lbs.

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)



FREQUENCY STANDARD

TYPE 2121A

Size
8 3/4" x 19" panel
Weight, 25 lbs.

Output: 115V
60 cycles, 10 Watt

Accuracy:
 $\pm 0.001\%$ from 20° to 30°C

Input, 115V (50 to 400 cycles)



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.

Frequencies: 50 to 1000 cycles

Accuracy: ($\pm 0.002\%$ at 15° to 35°C)

Output: 115V, 75W. Input: 115V, 50 to 75 cycles.



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.

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.

Watch Master

Timing Systems

Telephone: PLaza 7-1430

580 Fifth Ave., New York 36, N. Y.

WRITE IN 165 ON READER-SERVICE CARD

Narda SonBlasters offer the most complete line of lowest-cost mass-produced ultrasonic cleaners!

Narda's mass-production techniques assure you the most complete line of ultrasonic cleaners at the lowest prices in the industry! From the smallest 35-watt to the amazing 2500-watt unit with a tank capacity of 75 gallons, Narda's SonBlasters are available now—off-the-shelf—for immediate delivery. And with a full 2-year warranty besides!

What do you want to clean? Transistors, semi-conductors, other electronic, automotive, missile and avionic components, instruments, timing mechanisms—Narda's SonBlasters clean

'most any mechanical, electrical or horological part or assembly you can think of—and clean faster, better and cheaper.

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. ED-19.



Generator G-202 35 watts Transducerized Tank NT-202 Capacity: 1/4 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 200 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.

\$695



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.

\$1325



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.

\$130



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 150 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.



the narda ultrasonics corporation

625 MAIN STREET, WESTBURY, L. I., N. Y.
Subsidiary of The Narda Microwave Corporation

WRITE IN 166 ON READER-SERVICE CARD

NEW PRODUCTS

VEHICULAR ROOFTOP ANTENNA.—Model ASP-177 1/2 wavelength antenna covers 144 to 174 mc; has 4 db receiving gain. Installs through 3/4 in. hole with solderless mounting system.

The Antenna Specialists Co., Dept. ED, 12435 Euclid Ave., Cleveland 6, Ohio.

WRITE IN 167 ON READER-SERVICE CARD

THIN FOILS.—For use in radiation measurement. Thicknesses from 0.01 to 0.00005 in. Copper, beryllium copper, gold, lead, nickel, palladium, platinum, tantalum, titanium, zinc, and stainless steel.

American Silver Co., Dept. ED, 36-07 Prince St., Flushing 54, N.Y.

WRITE IN 168 ON READER-SERVICE CARD

PRECISION GEARS.—Offered from stock in 32, 48, 64, 72, 96, and 120 diametral pitches of 14.5 and 20 deg pressure angles. Available in 303 stainless steel and 24S-T4 aluminum, units are built to A.G.M.A. standards and tolerances.

Atlas Precision Products Co., Dept. ED, 3810 Castor Ave., Philadelphia 24, Pa.

WRITE IN 169 ON READER-SERVICE CARD

HIGH SPEED PRINTER.—Solid state line printer which selects, edits, and prints out data from a computer or magnetic tape at rates up to 1500 lines per min. Operates on-line or off-line with the company's 220 electronic data processing system.

Burroughs Corp., ElectroData Div., Dept. ED, 460 Sierra Madre Villa, Pasadena, Calif.

WRITE IN 170 ON READER-SERVICE CARD

LOAD DISTRIBUTION ANALOG COMPUTER.—Housed in compact portable cabinet, Belac computer provides instant, visual interpretation of operating data in public utility electric power systems. Does away with need for load slide rules and consultation of charts.

Belock Instrument Corp., Dept. ED, 111th St. and 14th Ave., College Point 55, N.Y.

WRITE IN 171 ON READER-SERVICE CARD

SOLENOIDS.—Using machine tool type bearing as a plunger guide, units survive 100 million operations.

Automatic Switch Co., Dept. ED, Florham Park, N.J.

WRITE IN 172 ON READER-SERVICE CARD

HANDLE.—Space-saving model 1250 is 2 in. across and 1-15/16 in. high.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

WRITE IN 173 ON READER-SERVICE CARD

QUICK RELEASE FASTENER.—"Pres-Loc" fasteners lock or unlock with a press of the thumb. For securing inspection ports, modular units, and panels.

Deutsch Fastener Corp., Dept. ED, P. O. Box 61072, Los Angeles 61, Calif.

WRITE IN 174 ON READER-SERVICE CARD

DIGITAL PROCESSOR.—"MicroSADIC" handles up to 10,000 analog signals per sec, converting, programming, and recording in digital form on magnetic tape.

Consolidated Electrodynamics Corp., Dept. ED, 300 N. Sierra Madre Villa, Pasadena, Calif.

WRITE IN 175 ON READER-SERVICE CARD

HUMIDITY PROOF COATING.—"Humiseal" type 1F12 has infinite pot and shelf life, withstands -60 to +150 C. May be applied by dip, spray, or brush to glass, ceramic, plastic, and metal. Humidity cycling meets MIL-STD-202A specifications.

Columbia Technical Corp., Dept. ED, 16-02 31st Ave., Woodside 77, N.Y.

WRITE IN 176 ON READER-SERVICE CARD

DIAZO SENSITIZED FILM.—For producing duplicate originals, Perma-Scale intermediate film has Mylar base, erases easily and repeatedly. Retains original flexibility and transparency almost indefinitely and is impervious to water.

Eugene Dietzgen Co., Dept. ED, 2425 N. Sheffield Ave., Chicago 14, Ill.

WRITE IN 177 ON READER-SERVICE CARD

SILICONE RUBBER.—Liquid Silastic RTV 502 vulcanizes to a rubber in 30 min at room temperature. Retains flexibility from -70 to +500 F; has good electrical properties. Suitable for sealing, caulking, potting, and encapsulating. Dow Corning Corp., Dept. ED, Midland, Mich.

WRITE IN 178 ON READER-SERVICE CARD

AUTOMATIC ANALYTICAL BALANCE.—Model 301A features 1 sec measurement time and 0.2% accuracy in five ranges from 30 to 3000 mg. Meter can be zeroed with container on the balance, thus showing weight of added contents directly.

E-H Research Labs, Dept. ED, 2161 Shattuck Ave., Berkeley 4, Calif.

WRITE IN 179 ON READER-SERVICE CARD

SERVO MOTORS.—Incorporate inertial damper within size 10, 11, or 15 frame. Units are ruggedly constructed and operate to 150 C.

Eastern Air Devices, Inc., Dept. ED, 391 Central Ave., Dover, N.H.

WRITE IN 180 ON READER-SERVICE CARD

PUMP AND MOTOR ASSEMBLY.—Model 1213-HBG-221 is designed to drive the nose antenna in a missile. Assembly operates from -65 to +165 F, weighs 8 lb.

Eastern Industries, Inc., Dept. ED, 100 Skiff St., Hamden 14, Conn.

WRITE IN 181 ON READER-SERVICE CARD

100 KV X-RAY SPECTROGRAPH.—Analyzes metals, alloys, minerals, ores, chemical mixtures, and compounds. Covers a range of 87 elements in the atomic scale extending from magnesium to californium. Has stepless voltage control with 15 to 100 kv range.

Philips Electronics, Inc., Instruments Div., Dept. ED, 750 S. Fulton Ave., Mt. Vernon, N.Y.

WRITE IN 182 ON READER-SERVICE CARD

ELECTRONIC DESIGN • January 7, 1959

Some Ideas

for your file of practical information on drafting and reproduction from

KEUFFEL & ESSER CO.

One of the ways to judge a skilled craftsman is by the tools he uses. They're invariably the best he can find—chosen to lighten his work, sharpen his skills. And, if the craftsman is a draftsman, they are, more often than not, products of K&E.

It may be that some of these products have escaped your attention (after all, we offer something over 8000 items). That's why we suggest you pay a visit to your K&E dealer whenever you can. It's a liberal education on what's new—as well as what's tried and true—in drafting equipment.

You'll find many products like these which can be highly useful in your work...

K&E "Quick Set" Bow Compass

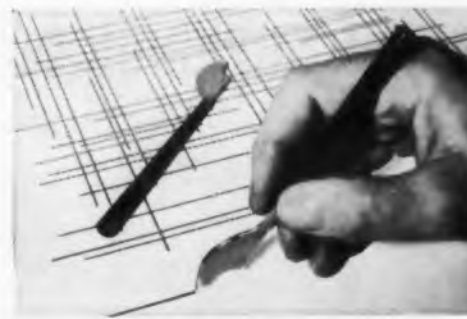
The most remarkable feature of this compass is the speed and ease with which you can change settings—from diameters of 12 inches to 1/16 inch. With one hand, you can increase or decrease radii instantly and exactly. To go from small to larger radius, just press a spring release, and the legs will



expand automatically. Stop approximately where you want, and make precise adjustments with a micrometer screw. To go from large to small, simply squeeze the legs of the compass together, then adjust precisely.

The K&E Quick Set combines the rigidity and precise adjustment of a standard bow compass, the simplicity and speed of a friction type compass, plus the finger tip control of K&E's unique design. You have to try the Quick Set to appreciate it fully. Two types are available. The N1071 fixed

leg pencil compass, and the N1070 combination with interchangeable pen and pencil inserts. Both come with a box containing leads and spare needles. And with the N1070, a pen handle is provided for the pen insert which permits its use as a ruling pen. The compass can also be used as a divider by substituting one of the spare needle points for the lead in the pencil insert.



Marathon® Ruling Pens

K&E Marathon Long Line and Wide Line Ruling Pens (1092) hold an extra large

ink supply—draw lines up to eight times longer than ordinary ruling pens. And because they are pre-set, line widths are always uniform, easy to match with complete accuracy. Ink flow is regular and even, lines are always sharp and clean edged.

An important feature of K&E Marathon Ruling Pens is that they will *not leak*. They can be laid on the work surface without risk of ink flowing out. That means you can fill several pens of different widths, use them as freely as you'd use pencils. They're easy to clean, too.

K&E Marathon Long Line Ruling Pens are available individually in line widths of .006, .009, .013, .020 inch—or in sets of three pens in line widths of .009, .013, .020 inch in a Leatherite case. Marathon Wide Line Ruling Pens come in line widths of .030 and .060 inch.

Leroy® Height and Slant Control Scriber

A versatile new Leroy scriber is now available which greatly expands the variety of lettering possible from a standard Leroy template.

Now, with the new Height and Slant Control Scriber (3237-12), you can form characters from vertical to slanting at any angle up to 45° forward. You can vary height from 60% to 150% of the size of letters on the template used. The width of letters remains the same.



Combinations of height and slant can be set quickly and easily. You just loosen the knob, move the scriber arm to the desired combination of height and slant, and tighten. That's all there is to it.

Stop in to see your nearest K&E dealer and ask to see these three products—small, perhaps, but mighty handy in the drafting room. Or drop us a line by mailing the coupon below...

KEUFFEL & ESSER CO., Dept. ED-1, Hoboken, N. J.

I'd like more information on:

- K&E Quick Set Compass Leroy Height and Slant Control Scriber
 Marathon Ruling Pens
 Please send me the name and address of my nearest K&E Dealer.

Name & Title _____

Company & Address _____

WRITE IN 183 ON READER-SERVICE CARD

The Difference is in the Quality

Four and Five-Digit Transistorized

DC VOLTAGE INSTRUMENTATION

For Rapid, Precise Voltage Measurement

Designed for Versatility
Engineered for Reliability
Precision Built, yet Rugged
Easy to Use, Easy to Maintain

NOT JUST A 'VOLTMETER' . . .

. . . this superior Cubic instrument can measure with great accuracy every phenomenon of science which can be converted to a usable DC voltage level . . . pressure, temperature, depth, volume, salinity, etc. Great economy can be effected through use of the Digital Voltmeter in applications which require precise, legible readings to the unskilled worker without danger of costly operator error. Outstanding engineering and design talents have been combined to produce this fine DC Voltmeter, the most reliable Digital instrumentation available today.

SPECIFICATIONS

Available with 4 digit (Model V-41) or 5 digit (Model V-51) display, the Digital Voltmeter is powered by Control Unit Model C-1, which includes a power supply, precision reference and differential amplifier, and which, separately housed, supplies power to as many units as are required in a Digital System. The Cubic Voltmeter provides an accuracy of .01% plus or minus 1 digit, between $\pm .0001V$ and $\pm 999.9V$ (Model V-41) and $\pm 0.0001V$ and $\pm 999.99V$ (Model V-51). Low level voltages ± 10 microvolts may be measured by the addition of the Pre-amplifier unit, Model PA-1.



THE SUPERIOR DIGITAL INSTRUMENT

Space Age know-how that goes into Cubic Corporation's missile tracking systems is also an important engineering and production component of Cubic DC Voltage instrumentation. The 4-digit and 5-digit Voltmeters, powered by the Cubic Control Unit, offer such quality features as unit plug-in construction, a precise two-part filter that eliminates the effect of AC ripple on DC readings, shock-mounted stepping switches with "controlled drive," in which the switch turns off the drive circuit part way through its cycle, ending overdrive and eliminating impact wear. Clear visual display is provided by an ultra-brilliant, edge-lighted read-out containing in-line numerals one inch high. Transistorization ends warm-up time, lengthens instrument life. Cubic's attention to fine detail increases the precision, reliability and functional capability of each instrument and at the same time provides such outstanding features of standardization as printed circuit boards that are interchangeable

and stepping switches that swing up and out for ease of routine maintenance. Cubic quality is your guarantee of truly fine instrumentation.



Unit construction of the Cubic Voltmeter and other Digital instruments provides maximum flexibility in creating "systems that design themselves." Inter-case wiring and standard-size plug-in units make every Cubic System a customized system using standard units. "Building Block" units which can be added easily to increase systems capabilities are the DC Preamplifier, AC-DC Converter, Digital Ohmmeter, Ratiometer, Master and Auxiliary Scanners and Printer Control Units. Write today for further information.



CUBIC CORPORATION

5575 Kearny Villa Road, San Diego 11, Calif.

ELECTRONIC ENGINEERING WITH A DIMENSION FOR THE FUTURE

WRITE IN 184 ON READER-SERVICE CARD

Metal Marking Machine

All pneumatic

An all pneumatic bench model, the 501 metal marking machine makes permanently indented inscriptions. The die head is vertically adjustable and the gap can be varied for small or large parts. The marking head is variable up to 1 in. Marks can be up to 2.5 in. long.

Noble & Westbrook Mfg. Co., Dept. ED, Westbrook St., East Hartford 8, Conn.

WRITE IN 185 ON READER-SERVICE CARD

Surface Grinder

For close tolerance work



This small precision surface grinder has a wheel head elevation control that reads to 0.0001 in. on a vernier scale. The transversal vernier reads to 0.0005 in. The magnetic chuck has fine laminations for holding small parts securely, and the wheel head elevating mechanism is sealed against grit and dirt. The unit has a built in demagnetizer. Magnetic chuck surface is 4-1/8 x 6 in.; transversal table travel is 4-1/4 in.; and longitudinal table travel is 8 in. Vertical movement of the wheel head is 5 in., and the maximum height between chuck and wheel is 4 in. The grinding wheel is 4-3/4 in. in diameter.

American LIP Corp., Dept. ED, 610 Fifth Ave., New York 20, N. Y.

WRITE IN 186 ON READER-SERVICE CARD

Sleeving Cutter

Handles up to 1/4 in. OD

Hand or power operated, these sleeving cutters handle dimensions up to 1/4 in. OD and will cut in lengths from 1/4 to 8 in. They can be used for all types of insulation tubing including Fiberglas and silicon coated nylon, and also for wires that are no. 16 or smaller. The hand models are designated 101 and 141; the powered models, 201 and 241. All units are bench type and can be anchored with two screws. The steel cutting knives are easy to remove and the adjustment screws can be set instantly for any cutting length. Dimensions are from 5 x 5.5 x 6 in. to 8 x 11 x 7 in.

Macdonald & Co., Dept. ED, 1324 Ethel St., Glendale 7, Calif.

WRITE IN 187 ON READER-SERVICE CARD

Coil Winding Machine

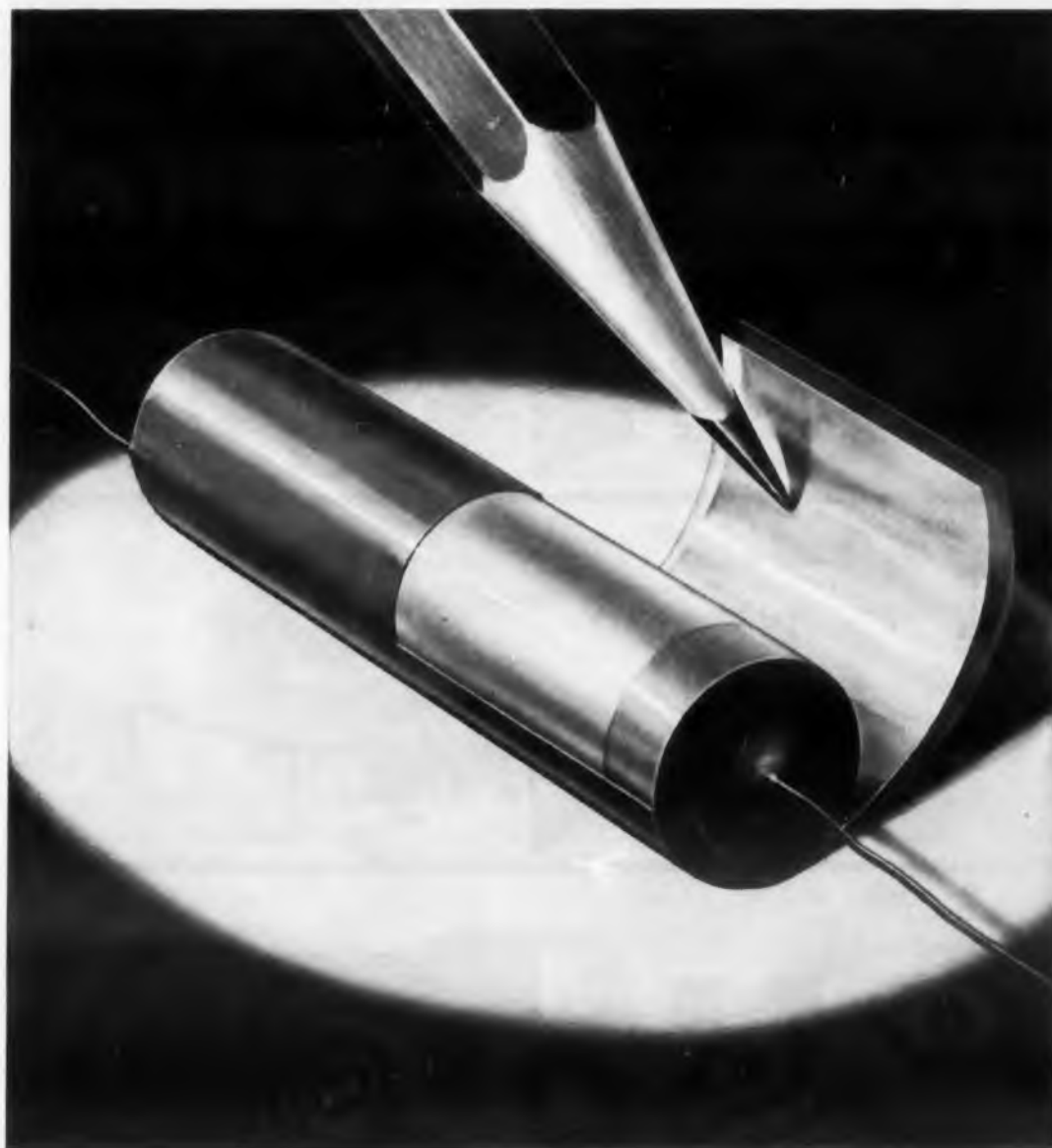
Has 30 speeds to 5000 rpm



Made by Frieseke & Hoepfner of West Germany, the FH 88 K56 coil winding machine uses a stepless wire-feed control to handle wire sizes from 52 to 17 AWG. It incorporates a transformer rectifier operated dc motor which provides 30 winding speeds to 5000 rpm. With special purpose, easily affixed attachments, one machine can make many coil types, including layer, universal, strip, subminiature, thread-interlaced, yoke, small rotor, trapezoidal, bifilar, and relay. The unit has a built in wire break detector and an electronic control panel which can be used to program stops or slowdowns at layer ends for paper insertion or taps.

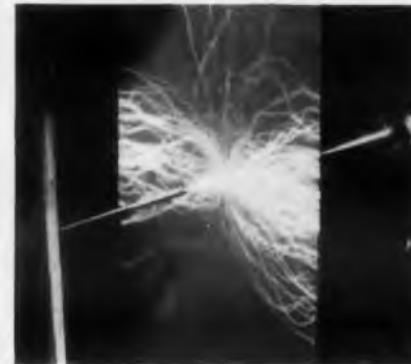
Electromatic Equipment Co., Dept. ED, 175 Fifth Ave., New York 10, N. Y.

WRITE IN 188 ON READER-SERVICE CARD



PROPERTIES OF "MYLAR"

"Mylar" offers a unique combination of properties that may help you improve performance and lower costs of your product. Here are two of the many important properties for evaluation.



HIGH DIELECTRIC STRENGTH: Average of 4,000 volts per mil . . . average power factor of 0.003 at 60 cycles.



SUPERIOR CHEMICAL RESISTANCE: Unaffected by oils, grease, most acids and alkalis, moisture and solvents.

Western Electric reports . . .

Du Pont MYLAR® cuts capacitor costs

PROBLEM: Western Electric was searching for a dielectric material which, when used in film-foil construction, would lower manufacturing costs.

SOLUTION: Du Pont "Mylar" polyester film. According to Western Electric, the moisture resistance of "Mylar" minimized the need for costly encapsulation; high dielectric and physical strength in thin gauges helped reduce over-all size;

capacitance stability under normal voltage stress maintains long life.

RESULTS: Capacitors insulated with "Mylar" provide excellent performance for selected types of equipment produced by Western Electric. These new capacitors achieve high reliability and long life. Materials savings have been realized through reductions in size and use of less costly encapsulation.

HOW CAN "MYLAR" HELP YOU? Whether your product uses miniaturized capacitors or heavy-duty cables, it will pay you to investigate the performance benefits of "Mylar" . . . and products made with "Mylar". Component makers find this tough, thin polyester film will often cost less on an area basis than present insulating materials. For more detailed information, send in the coupon.



BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY

DU PONT
MYLAR
POLYESTER FILM

"MYLAR" is Du Pont's registered trademark for its brand of polyester film

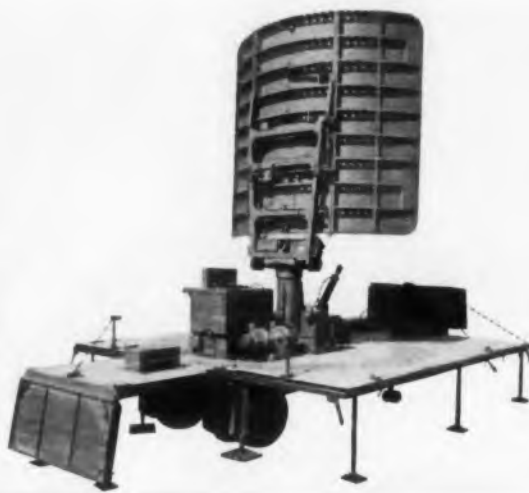
E. I. du Pont de Nemours & Co. (Inc.)
Film Dept., Room ES-1, Nemours Bldg., Wilmington 98, Del.

Please send booklet listing properties, applications and types of "Mylar" polyester film available.

Application _____
Name _____ Title _____
Company _____
Address _____
City _____ State _____

WRITE IN 189 ON READER-SERVICE CARD

3-D



RADAR



ON



WHEELS



How to conceive a radically improved radar scanning technique. How to integrate this technique into a superior data handling system. How to make the complete scanning and data handling system mobile.

These were the problems faced by engineers at the Hughes Ground Systems Division in Fullerton, California. Utilizing a completely new engineering concept, these engineers developed a radar scanning system which positions beams in space by electronic rather than mechanical means...thereby providing three-dimensional radar protection.

They developed high-speed data processors which monitor the action of hundreds

of aircraft and store the shifting tactical situations for high-speed assignment of defense weapons. They produced compact electronic display systems which present the tactical information in symbolic and language form.

And then they made this complete radar and data handling system mobile. The radar scanning antennas (shown above) can be converted for travel on the road in minutes. The complete data processing and radar scanning systems, with all of their wide capabilities, have been engineered to occupy only a few standard size army van trucks.

The research, development and production of this advanced system is typical of

the creative engineering now underway at Hughes in Fullerton. If creative engineering is your forte, you will find abundant aesthetic and monetary reward at Hughes. To investigate write to Mr. L. S. Wike at the address below.

HUGHES

GROUND SYSTEMS
Personnel Selection and Placement
Hughes Aircraft Company
Fullerton, Orange County, California

SERVICES FOR DESIGNERS

Branch Service Expansion

One of the West's leading Electronic Manufacturers' Representatives organizations with home offices in Los Angeles has established five new factory authorized Service Departments. Located in San Carlos, Sacramento, San Diego, Phoenix and Albuquerque, they are strategically located to serve the four state area of California, Arizona, Nevada and New Mexico. Each new department is staffed with factory trained technicians and is equipped with the finest electronic instrumentation. Customers are assured of prompt service, maintenance, and calibration on all in-and-out of warranty repairs.

Neely Enterprises, Dept. ED, 3939 Linkershim Boulevard, North Hollywood, Calif.

WRITE IN 191 ON READER-SERVICE CARD

R & E Office Opens

A new research and engineering organization, Flight Sciences Laboratory, Inc., was formed on the Niagara Frontier recently to engage in theoretical and experimental research, advanced engineering analysis, and selected development work in aerophysics, aerodynamics and related technical areas of aeronautics and astronautics. They will deal directly with government and military agencies on contractual research, as well as supplying advisory and consulting services to aircraft, missile and related equipment manufacturers in the aircraft and rapidly growing spacecraft fields.

Flight Sciences Laboratory, Inc., Dept. ED, 1965 Sheridan Drive, Buffalo, N.Y.

WRITE IN 192 ON READER-SERVICE CARD

Information Center

A central source of welding news and information has been established by the American Welding Society to disseminate data relating to the welding industry as a whole. Products, equipment, and personnel will not be included, but handled by the individual companies. It is felt that both the industry and the press will gain by the establishment of this fact-checking center.

American Welding Society, Dept. ED, 33 W. 39th St., New York 18, N.Y.

WRITE IN 193 ON READER-SERVICE CARD

Rare Earth Metals Supplied

Now you can obtain these rare earth metals in commercial quantities—praesodymium, neodymium, terbium, holmium, thulium, ytterbium, and lutetium. Other rare earth metals such as europium and samarium will be supplied on a custom basis by Michigan Chemical Corp., which has made gadolinium, dysprosium, erbium, and yttrium similarly available for about a year. These rare earth metals are cast in ingots 1, 1-1/2, 2, 3, and 3-1/2 in. in diameter. Custom ordering of special shapes is possible. Purities of these metals is 99+%. The entire group of rare earth metals supplement the company's high-purity rare earth oxide products.

Address questions about prices and quantities to Rare Earths and Thorium Division, Dept. ED, Michigan Chemical Corp., St. Louis, Mich.

Vibration Tests for Missile Parts

Test equipment which simulates the random and complex waveform vibration of rocket engines has been installed at Wyle Research Corp. The new types of vibration can be combined with the natural environments along with electrical, electronic, mechanical, pneumatic, hydraulic, or cryogenic functional tests. The system includes an MB C-25 3500-lb exciter powered by a Ling 20/20C amplifier, Ling peak-notch filters and broadband equalizers, a General Radio random noise generator, and a Moseley x-y plotter. The C-25 exciter is available for sinusoidal as well as random vibration.

Wyle Research Corp., Dept. ED, 128 Maryland St., El Segundo, Calif.

WRITE IN 234 ON READER-SERVICE CARD

Assuring Reliability

In response to a growing need for component reliability assurance processing equipment, The Daven Company has created a Reliability Assurance Division, which will provide the equipment required by the "meantime-to-failure" contract provisions now in effect in a majority of weapons systems programs.

Daven's modular design is an integrated system utilizing novel component part-holding modules, automated test sets, automatic data recording and data reduction devices, and unique environmental chamber designs. Except for variations in circuitry and test instrumentation, the system can be employed to process large quantities of any type of component.

Address inquiries to Mr. Richard J. Newman, General Manager, Reliability Assurance Division, The Daven Co., Livingston, N.J.

Temperature Compensated PRECISION TACHOMETER

- .16% Linearity 0-3600 RPM
- .05% Output Voltage Tolerance at 3,000 RPM
- 2V per thousand RPM voltage gradient
- 15°C to 75°C temperature range
- 0° ± 6 minutes 3000 RPM phase shift
- 10 mv max. null voltage
- 3 mv max. in phase axis error
- 115V 400 cycle input, 8 watts
- Size 20 illustrated (Type 20TG-6777-01.) Other sizes with similar or greater accuracies can be designed to your requirements. Write or call your nearest Oster office for further information today.

Oster

Precision Tachometer
Production Testing



actual size
Type 20TG-6777-01

Burton Browne Advertising

Other products include servos, synchros, resolvers, motor-gear-trains, AC drive motors, DC motors, servo mechanism assemblies, reference and tachometer generators, servo torque units, actuators and motor driven blower and fan assemblies.

John Oster

MANUFACTURING CO.
Your Rotating Equipment Specialist
Avionic Division
Racine, Wisconsin

NEW YORK
OFFICE

237 North Main Street
Hempstead, L.I., New York
Phone: IVanhoe 3-4653
TWX Hempstead N. Y. 705

NEW JERSEY
OFFICE

517 Lyons Avenue
Irvington, New Jersey
Phone: ESsex 3-2361

WESTERN
OFFICE

5333 So. Sepulveda Blvd.
Culver City, California
Phones: EXmont 1-5742
TEXas 0-1194
TWX S. Man 7671

Engineers For Advanced Projects:

Interesting, varied work on designing transistor circuits and servo mechanisms. Contact Mr. Robert Burns, Personnel Manager, in confidence.

WRITE IN 235 ON READER-SERVICE CARD

NEW CMC DUAL PRESET COUNTER FOR
coil winding . . . motor speed control . . . shearing to length
. . . batching, packaging, and stacking by number . . . vari-
able pulse interval generation . . . process programming . . .
measurement of elapsed time between selected number of
events . . . and used with a CMC frequency meter, very
accurate frequency measurements.



Model 324A

Only CMC's new Dual Preset Counters have 4 Modes of Operation

New CMC Dual Preset Counters provide output information at any two pre-selected counts within the capacity of the unit up to 40 kc. Input pulses are obtained from any standard transducer. With an 0.05 v rms input sensitivity, external amplifiers are seldom necessary.

CMC's unique digit circuitry prevents miscounting and extends the capacity of the instrument beyond its apparent range — in some applications, a 4 decade CMC instrument offers the same operating performance as other 5 decade types.

KEY SPECIFICATIONS

DECADES 3, 4, 5 or 6 • **COUNT CAPACITY** Up to 1,000,000
INPUT FREQUENCY To 40 kc • **OUTPUT** Pulse and relay simul-
taneously • **OPTIONS** Rack mount, 400 cps operation, 5 digit
mechanical register, 5 mv preamp, digital printer or inline read-
out output • **PRICE** 3 decade \$615; 4 decade \$715; 5 decade \$815;
6 decade \$915.

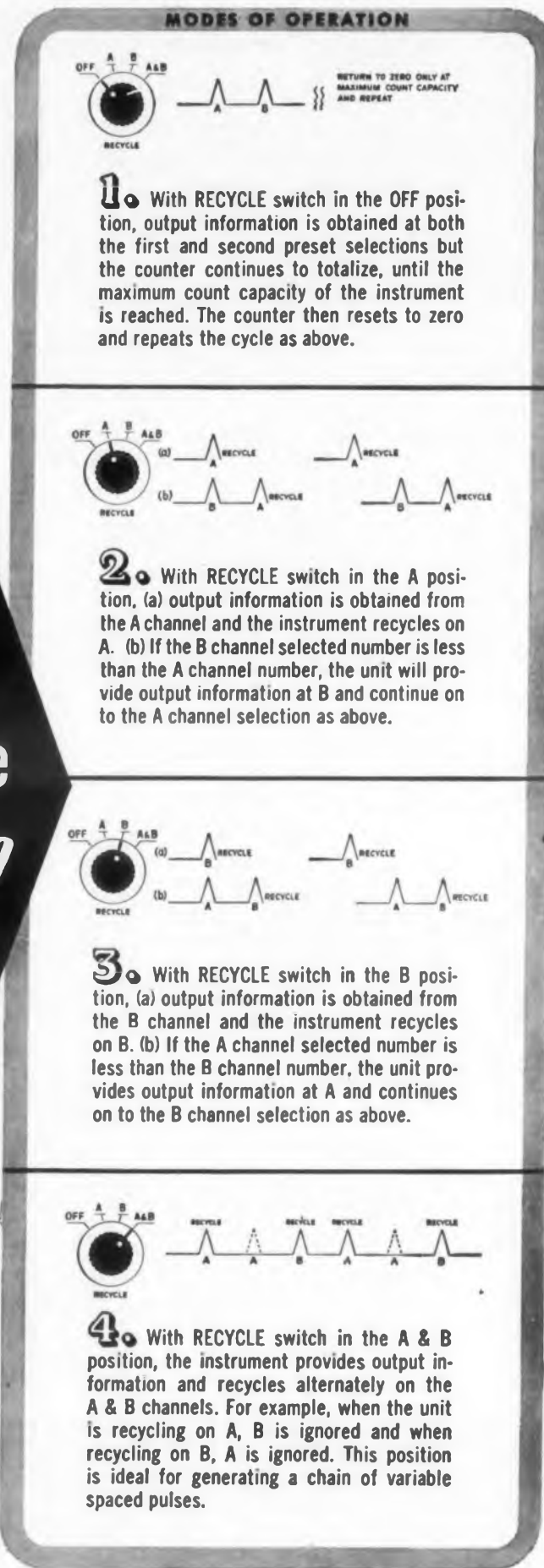
CMC engineering representatives are located in principal cities. After you've checked the key specifications, give your nearest CMC representative a call. He'll be happy to arrange a demonstration. For complete technical information, please write Dept. 191.



Computer-Measurements Corporation
A Subsidiary of Hancock Industries, Inc.

5528 Vineland Ave. • No. Hollywood, Calif.
Phone STanley 7-0401 • TWX: NHOL 8290

WRITE IN 236 ON READER-SERVICE CARD



NEW LITERATURE

Metal Degreasing

237

Methods of degreasing metal surfaces are examined in the bulletin. The methods utilize emulsion cleaners which eliminate the fire hazards of older methods and are more effective in removing dirt and soil. The bulletin also discusses the principles and how they should be used. L. Sonneborn Sons, Inc., 300 Fourth Ave., New York, N.Y.

Missile, Rocket Valves

238

Illustrated product manual gives data on high-pressure hydraulic and pneumatic valves for aircraft missiles and rockets. Dimensional drawings, flow charts, and production test specifications of 48 different solenoid valves are included. Production specifications include dielectric and resistance data for coil and connector; and tests on cycling, pull-in voltage, proof pressure, and minimum operating line pressure. For multiple-position valves, schematic material is included with solenoid data. Skyvalve, Inc., 831 West Fayette St., Syracuse, N.Y.

Gas-Vapor Chromatography

239

Bulletin No. 838 gives facts about temperature control in gas and vapor chromatography. In 8 pages, illuminated by tables and curves, questions are posed and answered about column temperature, retention time, detector temperature, resolution and temperature programming. Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Electronic Go-No-Go Gage

240

Four page bulletin describes electronic go-no-go gage. It is designed for frequency stability and comparison checks, motor speed control, pressure and flow control, material flow control, and other limiting situations occurring between 1 and 40,000 times per sec. Computer Measurements Corp., 5528 Vineland Ave., North Hollywood, Calif.

Soldering Tools

241

Catalog illustrates and describes the complete line of Vulcan electric soldering tools. Vulcan Electric Company, 88 Holten St., Danvers, Mass.

ELECTRONIC DESIGN • January 7, 1959

Servo Calculator

242

"Servo Calculator" is used as plotting tool aid in the solution of network problems in servo analysis. Design engineers may obtain the aid at no charge by writing on company letterhead to Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N.Y.

Test Equipment

243

Brochure #2060 covers the complete line of test equipment, volt-ohmmeters, vacuum tube volt-ohmmeters & microtesters. Simpson Electric Co., 5200 W. Kinzie, Chicago 44, Ill.

Thermocouples

244

Complete description and specifications of Bristol's new ARMOROX Thermocouples are given in bulletin P1281. Available types, materials sizes and thermocouple curves are detailed, and applications are suggested. The Bristol Co., Waterbury 20, Conn.

Communication Accessories

245

A 20-page catalog features illustrations of products, dimensional drawings, performance curves and general environmental information on toroidal coils, filters, magnetic amplifiers, dc to dc converters and laminated transformers. Communication Accessories Co., Lee's Summit, Mo.

Panel Instruments

246

General Electric's new "Big Look" in small panel instruments, dc and ac is described in booklet GEA-6678, a 6-page brochure of text, pictures and tables. Information is given on ratings, dimensions, size and panel drilling plans. General Electric Co., Schenectady 5, N.Y.

Synchro Test Sets

247

Bulletin describes and specifies the various integrated units which test synchros for electrical error, fundamental null, total null, phase shift, and transformation ratio. Theta Instrument Corp., 48 Pine St., E. Paterson, N.J.

Miniature Threads

248

Catalog No. 98 contains dimensions, tables, and other data on miniature threads between 56 and 160 per inch as well as prices for stock taps, dies, screws and tools. J. I. Morris Co., Southbridge, Mass.

Note—Commercial and Military Packaging Engineers:

LINK-LOCK

...is the rugged answer to your exacting container closure problems

*LINK-LOCK plays
an important role
in the design
of this container*

Simmons' LINK-LOCK provides pressure-tight, impact-resistant closure, plus quick closing and opening, on this reinforced fibrous plastic product made by the new automatic pre-form process developed by Pressurform Container Corp. The two-section container will be used by the Light Military Electronic Equipment Dept. of General Electric Company for shipping airborne radar jamming units to the Air Force.

Of prime importance are the container's lightness, strength, rust- and mildew-resistance, ability to withstand high pressures without distortion, ease of locking and opening, and low cost.

Here's why LINK-LOCK is ideal for use on military cases produced to exacting specifications as well as on inexpensive commercial containers:

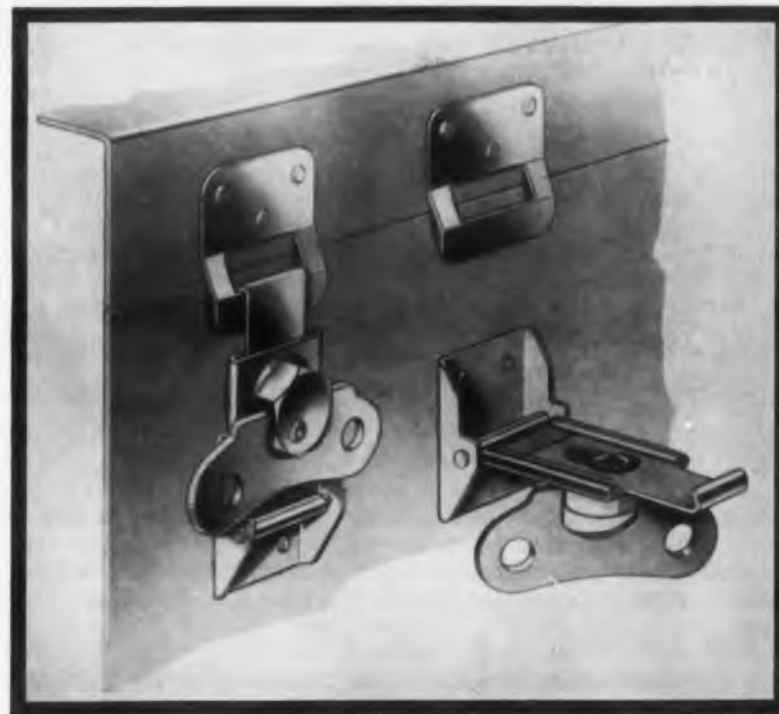
- High closing pressure with light operating torque...insures pressure-tight seals where required.
- Impact and shock resistant (positive-locking).
- Compact design...lays flat against case even when unlocked.
- Available in 3 sizes, for heavy, medium, and light duty.
- Opening and closing by wing-nut, screwhead, or hex nut.
- Flexible engagement latch design...can be varied to suit different conditions.

Also available! Spring-Loaded LINK-LOCK...ideal for less expensive containers where costs won't permit precision production. Spring provides take-up to compensate for set in gasketing, irregularities of sealing surfaces, and mounting inaccuracies.

Where does the versatile Simmons LINK-LOCK belong in your design? For full information and specifications, send for LINK-LOCK DATA SHEETS today. Samples and engineering service available upon request.



Courtesy of Pressurform Container Corp., and the LME Dept. of General Electric Co.



SIMMONS FASTENER CORPORATION

1763 North Broadway, Albany 1, New York

QUICK-LOCK SPRING-LOCK ROTO-LOCK LINK-LOCK DUAL-LOCK

See our 8 page Catalog in Sweet's Product Design File

WRITE IN 249 ON READER-SERVICE CARD

IMPULSE

A DIGEST OF NEW DEVELOPMENTS
IN ELECTRONICS AND AUTOMATION

PUBLISHED BY ROME CABLE CORPORATION, ROME, N. Y.
PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

BRUSSELS SCOREBOARD. With the Brussels World's Fair past, the big question is: How did we do? Answers can't be measured, of course, but the U.S. provided the world with an interesting look into the future—as well as a dazzling impression of American life today—mainly through the efforts of electronics companies. One fifth of the 50 U.S. firms participating in the Brussels Fair were electronics companies. Two of the 55-foot spheres within the 320-foot Atomium, symbol of the Fair, were occupied by U.S. electronics firms. A good indication, we think, of the growing role electronics is playing in civilization today.

STRIPE TELLS TYPE. One way of making quick, positive circuit identification of multi-conductor instrumentation cables is by the tracer method. Tracers are colored stripes or bands marked on the surface of the insulation or jacket of the Rome instrumentation cable shown here. It affords distinctive circuit coding throughout the entire length of each wire. Other color-coding methods—plus a basic run-down on the types of insulation and jacketing materials suitable for instrumentation cable—are all explained in Rome's Bulletin RDC-400: "Instrumentation Cables for Telemetry, Data Recording, Circuit Control Testing, and Electronic Computers." Write for your copy.



BILLION-DOLLAR BACKSTOP. Ground-support equipment for modern weapons systems will cost over \$1.5 billion in 1959, according to an aviation publication source (name furnished on request). That means more and more business for electronics—as electronic support gear becomes more and more an integral part of the weapons system. Main role of electronics in GSE: testing, controlling, computing, simulating.

"ELECTRONIC" CONTRACTORS WANTED. "Electronic" (electric-electronic) control and instrumentation systems are opening up new opportunities for electrical contractors. Contractors team up with electronic equipment manufacturers to install electronic systems, then maintain them as well. As the demand for automatic controls in industry grows, the electrical contractor is offered a new, rapidly developing market. An analysis of that market—plus a description of the basic types of control systems involved—is all reported in an article that appeared recently in a publication of a field unrelated to electronics. In case you missed it, write to IMPULSE, c/o Rome Cable Corporation, 421 Ridge Street, Rome, New York and ask for a reprint of the article.

CABLEMAN'S CORNER. Since 1932, polyvinyl compounds have become one of the most popular insulating and jacketing materials available. In 1954, over 100 million pounds were used by the wire and cable industry alone. In the fields of automation and instrumentation, where greater stress is being put on both smaller and more complex cable constructions, the use of polyvinyl chloride components has become more and more important.

These compounds consist of polyvinyl, or a co-polymer of polyvinyl chloride and polyvinyl acetate, thermoplastic resins mixed with plasticizers for flexibility, fillers for strength, pigments for color, and stabilizers for resistance to aging and acidation. The combined properties of the ingredients determine the properties of the components.

Because polyvinyl chloride insulations and jackets derive their properties from the materials they contain, it is possible, through proper ingredient selection, to "engineer" compounds for specific end uses. Here are a few special applications:

- cold—low-temperature applications—down to -54°C .
- heat—high ambient temperatures—up to 105°C .
- environmental hazards, i.e., oils, solvents, chemicals
- deformation—special compounds or special cable design can reduce this effect.

(As we've said before, when you need reliability—call on a Cable Specialist.)

WRITE IN 250 ON READER-SERVICE CARD

NEW LITERATURE

Synchros and Resolves 251

Two new reference sheets for design engineers, covering general mechanical and electrical specifications for synchros and resolvers, discuss application of synchros and resolvers in design of control systems, computers, fire control mechanisms & missile settings. Induction Motors of California, 6058 Walker Ave., Maywood, Calif.

Pulse Generators 252

Four-page two-color brochure covering specifications and prices for line of pulse generators, block units for special purpose pulse instrumentation, magnetic core testing equipment, and electronic counters. Electro-Pulse Inc., 11861 Teale St., Culver City, Calif.

Plastics 253

"A Ready Reference for Plastics" is the eleventh revision of a nontechnical book on plastics which brings out essential facts. How they come about, how they are used and why, physical properties, types of molding, elements of part design, designing pitfalls, notes on machining and inserts on almost every type of plastic material included. Available with letterhead request to Boonton Molding Co., 326 Myrtle Ave., Boonton, N.J.

Frequency Shift Equipment 254

A 2-color, 64-page catalog on line of frequency shift terminal equipment contains 34 items. The line includes multi-channel FS & AM tone systems, telemetry systems, twinplex equipment, frequency shift keyers, monitors, diversity receivers, frequency shift converters and master oscillators. Northern Radio Co., Inc., 149 W. 22nd St., New York 11, N.Y.

Retainers 255

Catalog No. 2-TT covers top holding tube and component retainers. Specifications for three types of top holding retainers are listed in the 12-page catalog: Top Tainers, Type 2 Tube Clamps, and Type 2 Crystal Clips. Sizes and modifications are available to retain every miniature and standard tube and nearly every cylindrical, rectangular, and wafer shaped component in present usage. The Bircher Corp., Industrial Div., 4371 Valley Blvd., Los Angeles 32, Calif.

NEW TWIN CONTACT MINIATURES



DC-AC CHOPPERS

- Eleven types, both single and double pole.
- Long life.
- Low noise level.
- Extreme reliability.

Write for
Catalog 515.

**STEVENS
INCORPORATED
ARNOLD**

7 ELKINS STREET
SOUTH BOSTON 27, MASS.

S/A-14

WRITE IN 256 ON READER-SERVICE CARD

ELECTRONIC DESIGN • January 7, 1959

Save

DATA PLOTTING TIME
with L&N's SPEEDOMAX[®]G

X-Y

RECORDER

In scores of research and testing applications, this Speedomax X-Y Recorder is saving valuable time and manpower by continuously measuring two variables and plotting the relation between them. One measuring circuit controls the pen travel across the chart (X axis) . . . a second circuit, the chart paper travel (Y axis). Use this recorder to plot stress vs strain, vacuum tube characteristics, computer outputs, rpm's vs motor load, etc.



List No.—69950-N3-Q1-961 Speedomax G Recorder, normally available for stock delivery.
Measuring Circuits—Two d-c potentiometers for X and Y axes. Circuits arranged for moving X axis from zero at left of chart to zero at chart center, and Y axis from zero at bottom of chart to zero at center of chart.

Record—Draws continuous curve on Chart No. 961. 100 uniform div. in $9\frac{1}{2}$ " x $\frac{3}{8}$ " over-travel at high and low end of X and Y axes.

Accuracy Rating—X axis: $\pm 0.3\%$. Y axis: $\pm 0.4\%$.

Dead Band—X axis: 0.2% of range span or 10 μ v, whichever is larger. Y axis: 0.3%.

Span Step Response Time Rating—X axis: 1 sec. nominal. Y axis: $\frac{1}{4}$ sec. nominal.

Electrical Ranges—10 mv d-c on X and Y axes; with zero shifted, -5 to 0 to +5 mv on both axes.

Y Axis Indicator Scale—Calibrated 0 to 10 over 6". Mounted on right side.

Current Standardizers—2, manually adjusted.

Operating Aids—Chart tear-off device and solenoid-operated pen-lifter.

Power Supply—120 v, 60 or 50 cycles.

Price—\$2160.00, f.o.b. Phila. or North Wales, Pa. (subject to change without notice). Order 69950-N3-Q1-961 from L&N, 4908 Stenton Ave., Phila. 44, Pa., or nearest L&N Office.



WRITE IN 257 ON READER-SERVICE CARD

ELECTRONIC DESIGN • January 7, 1959

Environment Chambers 258

Four-page, two-color, photo-illustrated Bulletin #6 describes new line of environmental test equipment designed for mass-testing of production components. Among environments obtainable are high-low temperature altitude, humidity, vibration, shock, and immersion. Elmer R. Easton, Gen. Mgr., Wyle Associates, 128 Maryland St., El Segundo, Calif.

Batteries 259

Design improvements in new line of stationary batteries reviewed in 8-page bulletin. Among the innovations are new corrosion-resistant positive grids made of Silvium, a patented alloy 100% more corrosion-resistant than pure lead. Bulletin 6205, Exide Industrial Div., The Electric Storage Battery Co., P.O. Box 8109, Philadelphia 1, Pa.

Beryllium-Copper Tubing 260

Small-diameter beryllium-copper tubing described in Data Memorandum No. 7 which includes mechanical and physical properties, applications, corrosion resistance, production limits, heat treatment, fabrication and standard size tolerances of the tubing. Superior Tube Co., 1521 Germantown Ave., Norristown, Pa.

Electronics Catalog 261

The 1959 catalog, 192 page volume, includes components and equipment for service and industrial use. Electronic Publishing Co., Inc., 180 North Wacker Drive, Chicago 6, Ill.

Electronic Flash Tubes 262

Uses, physical make-up and typical control circuits of electronic flash tubes described in 4-page brochure. Standard units, limitations of special units listed. Kemlite Laboratories, Inc., 1819 W. Grand Ave., Chicago 22, Ill.

Magnetic Core Testing 263

A new 12-page Technical Bulletin, MM-2, covers testing of rectangular hysteresis loop magnetic cores. The bulletin includes an analysis of the parameters of core characteristics and the test requirements that must be met to ensure the selection of cores to specific levels of performance. General Ceramics Corp., Keasbey, N.J.

NWL TRANSFORMERS

Outstanding in their fields for continuous research, development and design



Filament transformer for insulation up to 80 KV AC Test. Low secondary capacitance from 6 to 30 mmfd.



Same as opposite except with 2 or more secondary windings.



High impedance type transformer from 0.01 to 50 KVA and up to 10 KV. This unit is used for applications where short circuit current must be limited.



High voltage plate transformers up to 30 KV for floating secondary and up to 50 KV with start of secondary c.t. at or near ground. Sizes to 300 KVA.



This transformer features low voltage high current secondary windings up to 4000 amps., and up to 300 KVA. Taps on the primary windings afford a wide range secondary current.



Through type instrument current transformer. Available in ranges from 1000 to 10,000 amperes.

NWL custom-built Transformers are made to fit the particular needs of the user. Each Nothelfer transformer is individually tested for core loss, polarity, voltage, corona, insulation breakdown and aging characteristics and must meet all customer's requirements before shipment. We shall be glad to receive your specifications and quote you accordingly.



ESTABLISHED 1920



Nothelfer

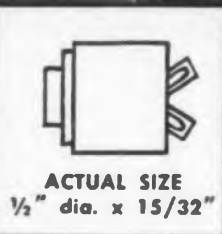
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NOTHELPER WINDING LABORATORIES, INC., P. O. Box 455, Dept. ED1, Trenton, N. J.

Specialists in Custom-Building

WRITE IN 264 ON READER-SERVICE CARD

*...tighter than a
duck's back!*
Waters APH 1/2 POT



This new APH 1/2 Hermetical Seal Precision Potentiometer has been proven by Mass Spectrometer, "Radiflo" and other rigid leak detection tests.

Why pay extra for epoxy encapsulation, when Waters seals both ends of the APH 1/2 so tight that leakage is reduced as close to zero as you need. Its "O" ring shaft seal dams out moisture and salt spray. Its glass-to-metal seal minimizes leakage at the terminal lugs. Its pre-tinned flange eases air-tight soldering into the panel. It's a "hot" pot, too! APH 1/2 derates to zero watts at 150°C. 1 1/2 watts may be dissipated at 125°C. . . . 4 watts at 80°C.

Resistance range is from 1/2 to 100,000 ohms with a tolerance of ±5%. Linearity tolerance is ±3% . . . tighter on request. Meets military specifications: MIL-E-5272A, MIL-R-19, MIL-STD-202 and others as applicable. Bulletin APH 1/2 gives you complete details about standard and optional electrical and mechanical specifications. Write:



Waters MANUFACTURING, INC.

BOSTON POST ROAD, WAYLAND, MASSACHUSETTS

WRITE IN 265 ON READER-SERVICE CARD

NEW LITERATURE

Instruments and Apparatus 266

This new, 175-page catalog illustrates and describes more than 450 different pieces. The 1959 catalog covers such items as constant temperature baths; drying ovens; environmental units for humidity, altitude and low temperatures; ovens; and meters. Labline, Inc., 3070 W. Grand Ave., Chicago 22, Ill.

Laminates 267

Technical Data Bulletin 4.5.1 gives the minimum and maximum property values for sheet stock, rolled tubes and molded rods made from Grade G-5. It also gives the size range, color and finish for these forms and also for molded tubing. Taylor Fibre Co., Norristown, Pa.

Analog Computer 268

Fully-illustrated 18-page brochure and folder describes the MC-5800 Master Precision Analog Computer. Specifications and descriptions are included. Mid-Century Instrumatic Corp., 611 Broadway, New York 12, N.Y.

Relays 269

Twenty-page catalog includes illustrations, specifications and dimensional diagrams of the latest developments in microminiature rotary relays and extremely sensitive telephone type relays having long life. Magnecraft Electric Company, 3350 D, West Grand Ave., Chicago 51, Ill., Attention: H. D. Steinback.

Fiberglas Sleeving and Tubing 270

Selection guide for the electrical trade includes a Selection Factor Chart, charts showing "Nema Standard Sizes" and "Identification of Grades and Summary of Performance Characteristics," photographs of typical applications, government specification information and types of Fiberglas sleeveings and tubings. Textile Products Div., Owens-Corning Fiberglas Corp., Dept. 860, 598 Madison Ave., New York 22, N.Y.

Power Supplies 271

A two-page catalog sheet illustrates and describes standard line of zero to 32 volt dc power supplies. Eight models are covered, for both rack and bench use. Opad Electric Co., 69 Murray St., New York 7, N.Y.

PRECISION RESISTORS

Type P. wire wound, encapsulated, miniature single ended units for mounting on printed circuit with no support other than wire leads. Resistor element is insulated by Teflon from lead wire, increasing voltage breakdown. Can be operated in ambient temperatures up to 125°C. 7 sizes, from 1/4" to 3/4" diam. Rated from .1 to .4 watt. Resistance values to 2 meg. Tolerance from 1% to .05%. Meets requirements of MIL-R-938.

Other PRECISION WIRE WOUND RESISTORS: Type L with radial lugs, radial or axial wire leads; Type S, hermetically sealed, with axial wire leads.



RESISTANCE PRODUCTS COMPANY

914 S. 13 St. Harrisburg, Pa.

Specialists in manufacturing quality resistors: Precision Wire Wound — High Voltage — High Megohm — High Frequency. Our test equipment and standards for checking and calibrating are matched only by leading laboratories. Write for more information.

HIGH MEGOHM RESISTORS

Type H. For electrometer circuits, radiation equipment and as high resistance standards. Resistance available to 100 million megohms. Voltage rating to 15,000 volts. Low temperature and voltage coefficient. Seven sizes, from 1/4" to 3" long, of which 2 meet requirements of MIL-R-14293A. Standard resistance tolerance 10%. Tolerance of 5% and 3% available. Also matched pairs with 2% tolerance.



WRITE IN 272 ON READER-SERVICE CARD
ELECTRONIC DESIGN • January 7, 1959

PHILCO

P A L O A L T O

on the beautiful
San Francisco Peninsula

urgently needs senior
and project engineers

for expanding operations

MISSILE TRACKING SYSTEMS

Pulse Tracking Radar
C W Tracking Systems
Conical Scan Tracking
Interferometers
Doppler Receivers

GROUND-SPACE COMMUNICATIONS

Airborne Data Transmitters
Ground Data Receivers
Airborne Command Receivers
Data Receiving Antennas
Telemetry
Microwave Relay System

DATA PROCESSING

PHILCO S-2000 Transac digital
computer entirely transistorized
central computer facility.

Data Recording Devices
Computer input, output
equipment design

U. S. citizenship required.
Your inquiry confidential.

Send resume to
Mr. H. C. Horsley,
Dept. D

PHILCO

Government & Industrial Div.
Western Development
Laboratories
3875 Fabian Way
Palo Alto, California

Coatings

273

A new 36-page brochure on clear and colored "Coatings" for use on metal, plastics, glass, and wood. Information on numerous coatings for application to the various surfaces by spraying, screening, and roller coating is provided. Data is given on standard colors available. Bee Chemical Co., 12933 South Stony Island Ave., Chicago 33, Ill.

Medical Electronics

The 91-page "Bibliography on Medical Electronics" is organized into three sections. The main section groups related topics with arbitrary numbers. The subject index is cross-referenced and a section listing authors is included. Cost of the bibliography is \$2.50 and available from the Institute of Radio Engineers, 1 E. 79th St., New York 21, N.Y.

Resistance Welding Equipment

274

A new 16-page catalog describes complete line of resistance welders, welding heads, power supplies, handpieces, and accessories. Sections devoted to basic resistance welding, a comparison of stored-energy vs ac welding, and points to consider in selecting the proper equipment. Weldmatic, Div. of Unitek Corp., 380 North Halstead Ave., Pasadena, Calif.

Electronics Catalog

275

Over 32,000 items listed in 452-page general catalog. Among the items listed are standard and special-purpose electronic tubes, transistors, semiconductors and diodes, test instruments, transformers, resistors, capacitors, printed circuit components, rheostats, relays, switches, rectifiers and fuses. Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

Pilot Lights

276

Latest advances in pilot light and lamp design offered in following technical bulletins: High Brightness Neon Lamps (#100); Heavy Duty Oil Tight Pilot Lights (#101); Dialites—the Ultra-Miniature Indicator Lights (Form L-160); 2-Terminal Sub-Miniature Indicator Lights (Form L-156-C); 1-Terminal Sub-Miniature Indicator Lights (Forms L-157-A and L-158-A). Available from: Mr. R. E. Greene, Dialight Corp., 60 Stewart Ave., Brooklyn 37, N.Y.



Type FC-4 4-pole
double-throw.



Type FC-6 6-pole
double-throw.

These Improved MISSILE RELAYS
withstand 30G vibration
at 2,000 cycles

... up to 60G shock without contact opening

... and 2,000 ft.-lbs. shock without
contact transfer

Backed by more than ten years of intensive development and refinement, these rugged, precision-built Struthers-Dunn FC relays have the high reliability required for missile uses. The outstanding characteristics indicated above typify performance that meets or exceeds the operational and environmental requirements of MIL-R-5757C and MIL-R-25018. Thanks to simplified design, S-D FC Relays, are priced materially lower than other types frequently used to meet these exacting specifications.

MAKERS OF THE
WORLD'S LARGEST
ASSORTMENT OF
RELAY TYPES



NEW BULLETIN AVAILABLE...
giving full details and electrical and mechanical specifications. Ask for FC Relay Bulletin.

STRUTHERS-DUNN, Inc.

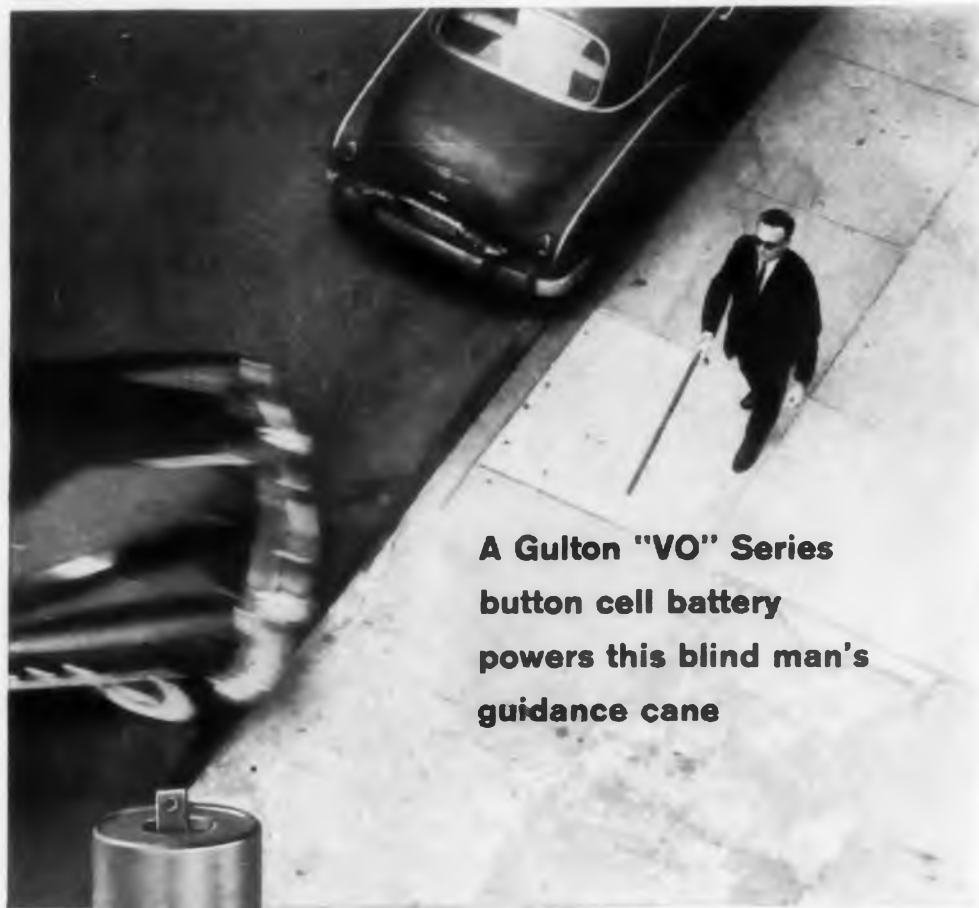
Pitman, N. J.

Sales Engineering Offices in: Atlanta • Boston • Buffalo • Chicago • Cincinnati
Cleveland • Dallas • Dayton • Detroit • Kansas City • Los Angeles • Montreal • New
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WRITE IN 277 ON READER-SERVICE CARD

CIRCLE 562 ON READER-SERVICE CARD

ELECTRONIC DESIGN • January 7, 1959



**A Gulton "VO" Series
button cell battery
powers this blind man's
guidance cane**



rugged...reliable ...rechargeable!

The cane in the man's hand is a proximity guidance device designed by Franklin Institute for the blind.

Requirements called for the power supply to be small enough to fit in the handle of the cane, rugged enough to perform well under abuse, and... to be rechargeable.

After extensive testing, designers chose the Gulton "VO" sealed nickel cadmium button cell battery to do the job.

How Can You Use These Batteries?

Powering this and other prosthetic devices is only one of many imaginative uses for these rechargeable batteries. Engineers have already designed them into transistorized radios, photo-flash power packs, missiles - wherever *small size, strength, light weight, long life, complete reliability, no maintenance and easy recharging are desired.*

Most Complete Line Available

"VO" cells are available in capacities of 100, 180, 250, 500 and 1750 mah; have a nominal 1.2 voltage; can be packaged in any combination to meet your voltage specs. Patented sintered plate construction provides exceptional cycling characteristics; highest capacity per unit size. Like more information? Write us for Bulletin No. VO-103.



ALKALINE BATTERY DIVISION
Gulton Industries, Inc.
Metuchen, New Jersey

WRITE IN 278 ON READER-SERVICE CARD

NEW PRODUCTS

Electrical Tape 279

Pocket data book provides technical and comparative cost information on new Hesgon line of Fibreglas electrical tapes. Comparative data on Fibreglas and other fibers included. Horace Linton Div., Hess, Goldsmith & Co., 1400 Broadway, New York 18, N.Y.

Power Supplies 280

Bulletin 350 A is an up-to-date version of the original four-page bulletin. Models listed according to application: transistor and lab work, automatic control, computer, and general utility. Electronic Measurements Co., Inc., Eatontown, N.J.

Computers 281

Detailed, colorfully illustrated booklet, describes analog computing equipment installed at company's computation centers in Princeton, N.J. Substantial list of problems suitable for solution by analog computation are included to aid individuals and firms seeking possible application of analog simulation to their engineering problems. Electronics Associates Inc., Long Branch, N.J.

Dry Batteries 282

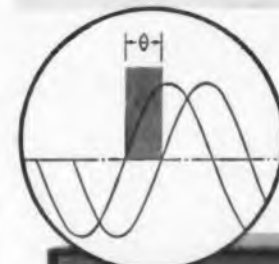
Comprehensive manual of 100 pages covers use and selection of dry batteries for industrial designers and research specialists. Types of dry cells described in literature include familiar cylindrical cells such as those used in flashlights, rectangular-shaped cells and wafer cells. Engineers engaged in the design of battery-powered equipment can write to: Burgess Battery Co., Dept. PR-1, Freeport, Ill.

Magnetic Amplifiers

A 36-page illustrated bulletin covers the construction, operation, and uses of magnetic amplifiers. Bulletin 1105-1 has performance curves to illustrate operating characteristics. Simplified schematic drawings show how the amplifier is incorporated into such equipment as autopilots, servo systems, and speed regulators.

A copy of the bulletin is available on company letterhead request only from Vickers Inc., Electric Products Div., Dept. ED, 1815 Locust St., St. Louis 3, Mo.

**MEASURES
PHASE ANGLE
instantly!**



**0° to 360°
±1°
ACCURACY
20 cps to
20,000 cps**



DIRECT READING MOD. 120

PHASE ANGLE METER & MONITOR

ADVANTAGES

- **Direct Reading Without Ambiguity:** Phase angle is read directly on a large 4 1/2" meter. The Coarse Meter Scale is graduated from 0° to 360° in 5° divisions. A selector switch cancels out all but the last 30° of any measured phase angle, providing a vernier reading on a 0° to 30° scale which is graduated in 0.5° divisions.
- **High Accuracy Over a Wide Frequency And Amplitude Range:** An accuracy of ± 1 degree is obtained over the frequency range of 20 cps to 20,000 cps and from 2 to 30 volt peak input. At frequencies of 20,000 to 100,000 cps phase measurements can be made at slightly reduced accuracy.
- **Accepts Sinusoidal or Complex Wave Forms:** Since the method of phase detection is based on the point of zero cross-over, any type of wave form is acceptable which does not cross the zero axis more than once in a given direction per cycle.
- **Recorder Output:** An output is available which is suitable for use with recording equipment. It provides 0 to 10 volts DC corresponding to a phase angle of 0 to 360°.
- **Rugged:** Originally designed for Military use, as Monitor, Phase AN/URM-67.

USES

- Accurate and rapid measurement of phase difference.
- Continuous, unattended monitoring of phase angle by use of chart recorder.
- VHF omnirange measurements.
- Measurement and adjustment of LC filter networks.
- Measurement and adjusting of phase shift networks.

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Missile Accessories 285

Basic types of air valves and actuators manufactured by company described in 4-page brochure. Temperature control and positioning systems, and specialized electrical test equipment included. Bulletin F 5910-1, Barber-Colman Co., 1400 Rock St., Rockford, Ill.

Miniature Transformers 286

This circular fully describes and illustrates a new line of mu-metal shielded, epoxy impregnated miniature transformers explicitly designed for transistor application. This literature gives features of thirteen basic types of input, driver, output and interstage transformers which can be used in 90 different impedance matching circuits. Amplifier Corp. of America, Transformer Div., 398 Broadway, New York 13, N.Y.

Transit Cases 287

The catalog describes all kinds of Transit cases, which are essentially custom built containers or shipping cases especially designed to protect electronic equipment and built to military specifications: T4734, C4150, and T945. Basic construction is of laminated sheet aluminum and plywood, or all aluminum. White Aircraft Corp., Palmer, Mass.

Adjustable Speed Drives 288

Bulletin GEA-6234B, 8 pages, describes General Electric's general-purpose Thymotrol adjustable speed drives, one horsepower half-wave and one to four horsepower full wave. The bulletin fully explains standard and optional features, electrical and performance characteristics. General Electric Co., Schenectady 5, N.Y.

Preamplifiers 289

New four-page brochure illustrates and gives detailed electrical and mechanical data on a complete line of low noise, high frequency preamplifiers. Special models are also described. A.R.&T. Electronics, Inc., Sub of Baldwin Piano Co., 1101 McAlmont St., P. O. Box 627, Little Rock, Ark.

Light Metal Castings 290

"Light Metals" brochure describes light alloy castings of particular interest to electronics producers. The brochure lists the mechanical properties of other aluminum and magnesium casting alloys. American Brake Shoe Co., Dept. A, 530 Fifth Avenue, New York 36, N.Y.

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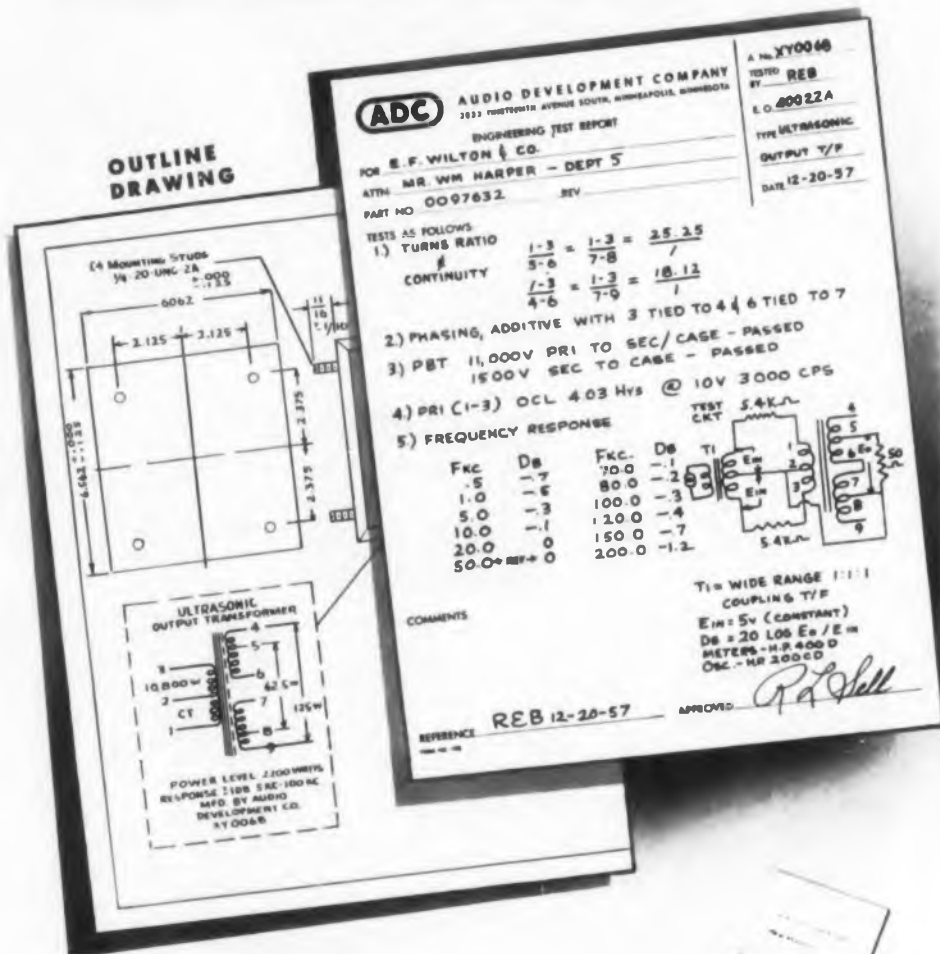
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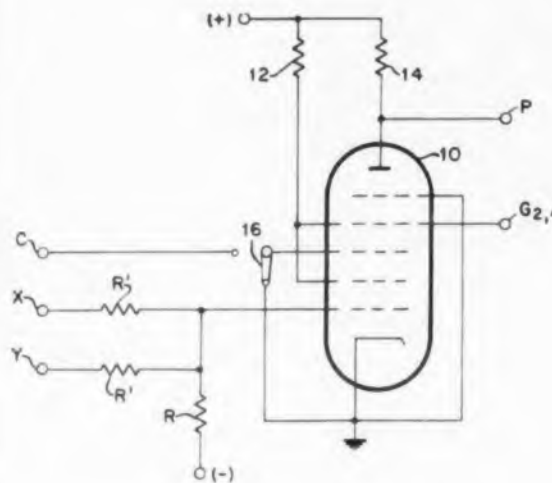
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PATENTS



Electronic Logical Circuits

Patent No. 2,841,708. Leonard R. Harper (Assigned to International Business Machines Corp.)

The special characteristics of a pentagrid tube such as a 6BA7 are essential in this simple and inexpensive logical circuit. Plate current in the pentagrid tube is less than the saturation current when either the control grid or suppressor or both are beyond cut off, or when

the control grid is driven positive to a point where the plate current is reduced to 10 per cent of saturation.

The circuit arrangement is shown. Initially, switch 16 may tie the suppressor to ground. The circuit is the OR type since a voltage may be applied to either the X or Y input to produce saturation. However voltages applied simultaneously to both X and Y produce less than saturation current. Cut off is thus effected in this AND NOT condition.

Now if the suppressor grid is connected to terminal C and a negative voltage is applied to the grid, the tube will cut off. This is the BUT NOT condition.

When the suppressor is positive, a positive impulse to X or Y will cause saturation: the OR condition. Similarly, positive voltages applied simultaneously to C, X and Y will reduce the plate current to less than saturation.

Typical circuit components are illustrated and operating voltages are suggested in the patent.



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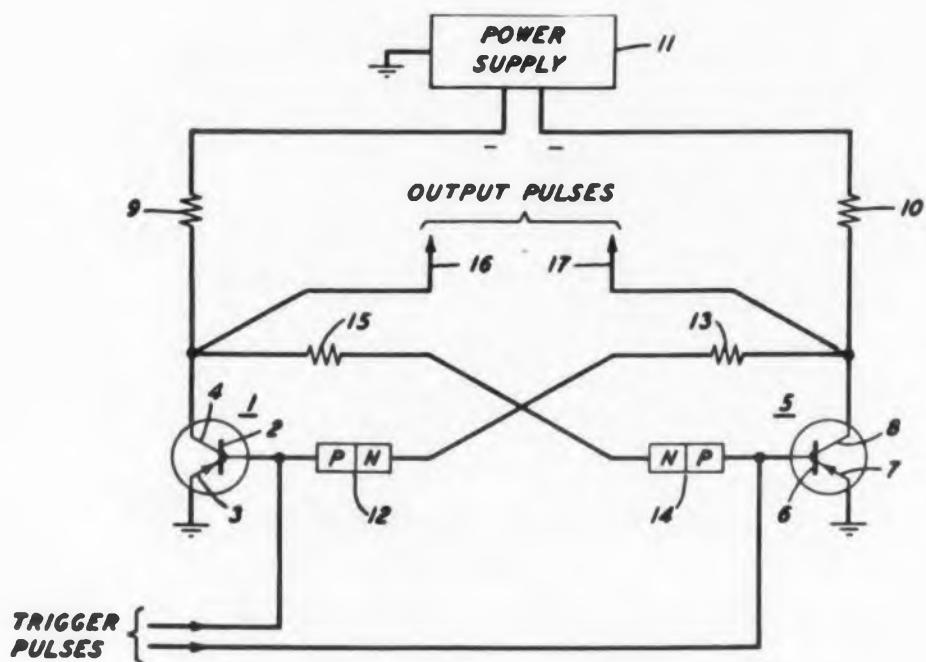
This new miniature toggle switch meets the most exacting requirements of the electronics industry and the military. For further information, write Dept. A-217.
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Semiconductor Trigger Circuit

Patent No. 2,831,986. Eric E. Sumner.
(Assigned to Bell Telephone Laboratories, Inc.)

This bistable high speed transistor multi-vibrator has high current sensitivity and stability even without a separate source of bias voltage. Cut-off of the non-

conducting transistor is obtained by means of a silicon diode operated below the critical conduction voltage.

The circuit consists of transistors 1 and 5 which are cross-coupled through diodes 12 and 14. Initially, transistor 1 may be conducting. The voltage on collector 4 will approximate 0.2 v when the power supply is set at 10 v and resistor 9



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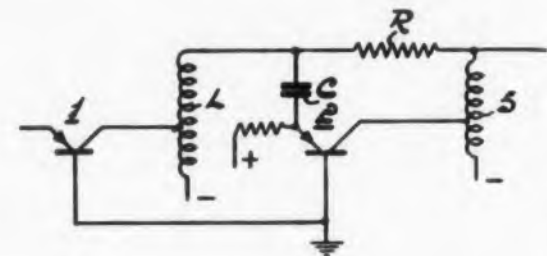
PATENTS

(as resistor 10) is fixed at 1000 ohms. For forward conduction the diode voltage must be at least 0.5 v. Hence transistor 5 is cut off, since with diode 14 open-circuited, base 6, current is zero. The multi-vibrator will flip to the second stable state with transistor 5 conducting when a negative trigger of at least 0.5 v in magnitude is applied to base 6. Maximum current will flow into base 2 causing transistor 1 to rapidly cut off. A subsequent negative impulse applied to base 2 will flop the multivibrator back to the initial state.

Transistor Amplifier

Patent No. 2,843,681. A.J.W.M. Van Overbeek (Assigned to North American Phillips Co. Inc.)

When common base transistor amplifiers in cascade are operated at high frequency the output ordinarily reacts on the input because a leading voltage is fed back in the collector-base circuit.



Placing a resistor between collector and emitter introduces a lagging voltage which compensates for this leading voltage.

Pulse Generator

Patent No. 2,843,743. Douglas J. Hamilton (Assigned to Hughes Aircraft Company.)

The transistor pulse generator consists of two relaxation oscillators. They generate 1 μsec pulses having rise and fall times of 0.3 μsec. The load is a capacitor of 0.01 μf.

When switch 17 is closed, capacitor 15 charges until emitter 12 rises above the voltage of base 14. Pnp transistor 11

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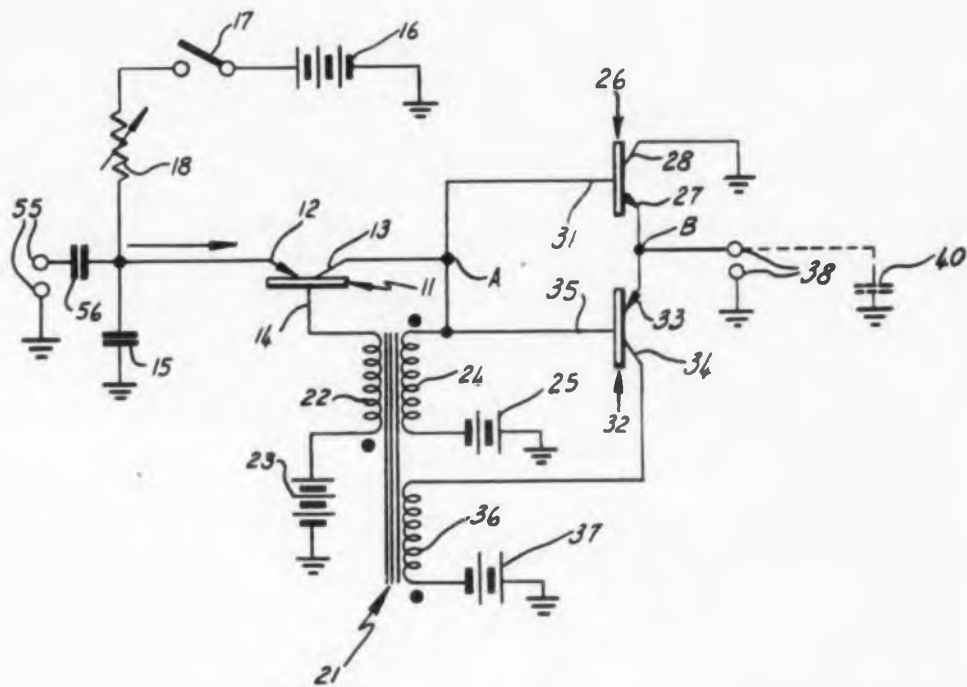
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Design and Manufacture of Electro-Mechanical Timing Devices



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ELECTRONIC DESIGN • January 7, 1959



conducts due to regenerative feedback in transformer 21. Voltage of base 31 connected to 13 moves to ground level. This forward biases npn transistor 26 which immediately goes into saturation and charges load capacitor 40 to peak voltage.

Thereafter capacitor 15 discharges through transistor 11 and inductance 22

until capacitor 15 can no longer supply the required current. Transistor 11 regeneratively cuts off and collector 35 tied to collector 13 moves towards ground. Pnp transistor 32 conducts. Load capacitor, 40, discharges.

Transistor 11 cuts off and open circuits transistors 26 and 32. The cycle may then be repeated.

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This new liquid oxygen probe operates within the extraordinary working range designated by the drawing at right. Applications at even lower and higher temperatures are anticipated. We expect the probe to be useful down to the liquid helium range. Model 134 provides 100 ohm variation in the range from -270 to -300° F, which corresponds to pure platinum wire having a resistance of 1380 ohms at 0° C. The high impedance level together with a capability for large power dissipation permits large voltage variations to be developed for telemetering purposes.

Contact us for Bulletin No. 5581. Also, we will be glad to propose on variations in calibration, calibration interchangeability, mounting and electrical connection provisions.

REC MODEL 134 SPECIFICATIONS—

- Sensing Element. Pure platinum wire with strain-free mounting and protected by ceramic coating.
- Resistance. 1380 ohms at 0° C is standard; lower and somewhat higher also possible.
- Calibration Stability. After 50 cycles from boiling water to LN₂, R₀ drifts less than 0.1 ohms which is equivalent to 0.02° C.
- Interchangeability. Standard adjustment is within 10 ohms (1.7° C) at 0° C to 2 ohms (0.3° C) at LN₂. On special order, far greater interchangeability (or reproducibility) is possible.
- Time Constant. 0.1 seconds in water at 3 ft. per second.
- Self Heating Effect. 2 watts per ° C in water at 3 ft. per second.
- Vibration. 1/2" DA to 30 g's and 30 g's to 2000 cps.
- Pressure Test. 6,000 psi. std; up to 16,000 psi is possible.
- Thermal Shock. May be plunged from boiling water into LN₂ and back to boiling water repeatedly.

ENGINEERS—Is your data file on temperature probes up to date?

We will welcome your inquiry for information on the REC 134 (Bulletin No. 5581) or any of the many other temperature probes we manufacture; also for research and development or consultation.



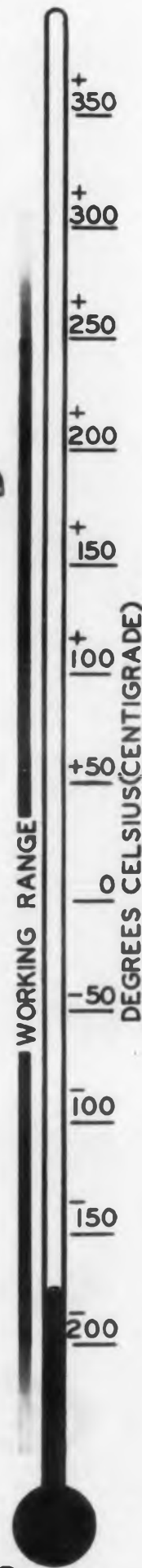
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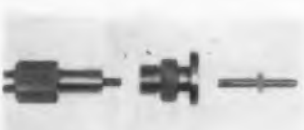
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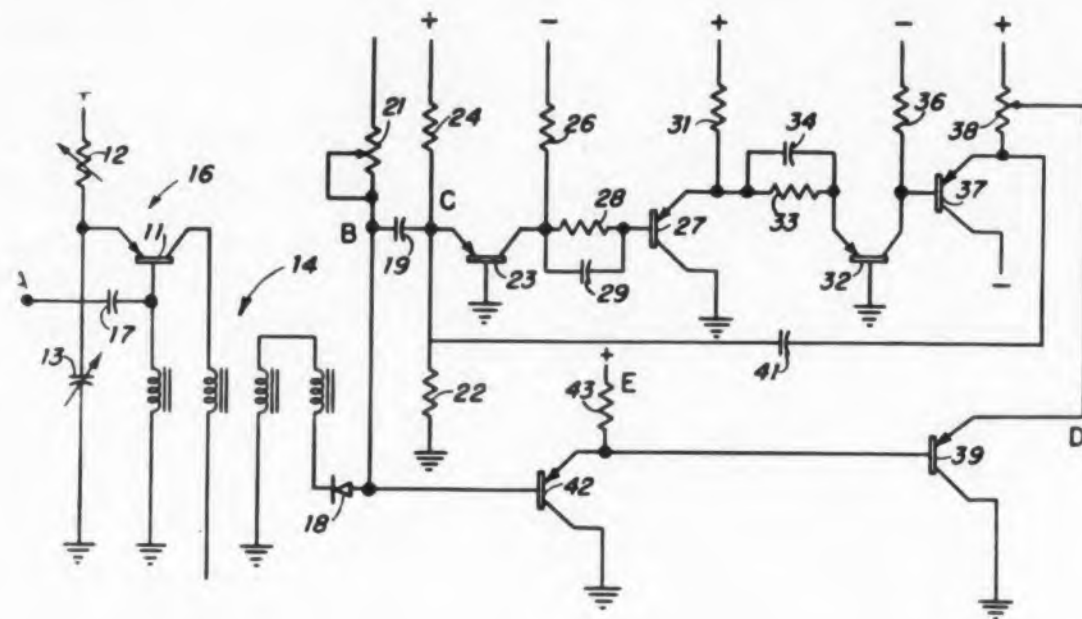
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PATENTS



Variable Time Base Generator
Patent No. 2,845,547. Charles F. Althouse
(Assigned to United States of America.)

A transistor blocking oscillator combines with a diode pick-off arrangement and a clipping amplifier to produce a continuously variable time base having constant width. The time-base is not

sensitive to the triggering input frequency.

Blocking oscillator 16 triggers in response to a negative impulse applied through capacitor 17. The peak negative voltage is passed by diode 18 to charge capacitor 19. Then capacitor 19 discharges through variable resistor 21 and

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the sawtooth waveform is clipped as it passes through the dc coupling limiting amplifier stages. When capacitor 19 reaches ground voltage, diode 18 rapidly discharges the remaining charge and transistor 23 cuts off sharply to develop a negative impulse which couples back through transistor 39. As a result a sawtooth waveform is produced having a period fixed by the time constant determined by capacitor 19 and resistor 21 and independent of the rate of the input trigger.

Temperature Stabilized Transistor Amplifier

Patent No. 2,848,564. Edward Keonjian. (Assigned to General Electric Co.)

When several transistor stages are cascaded, temperature changes may cause considerable variation in output current of the output stage quite independent of any signal change at the input section.

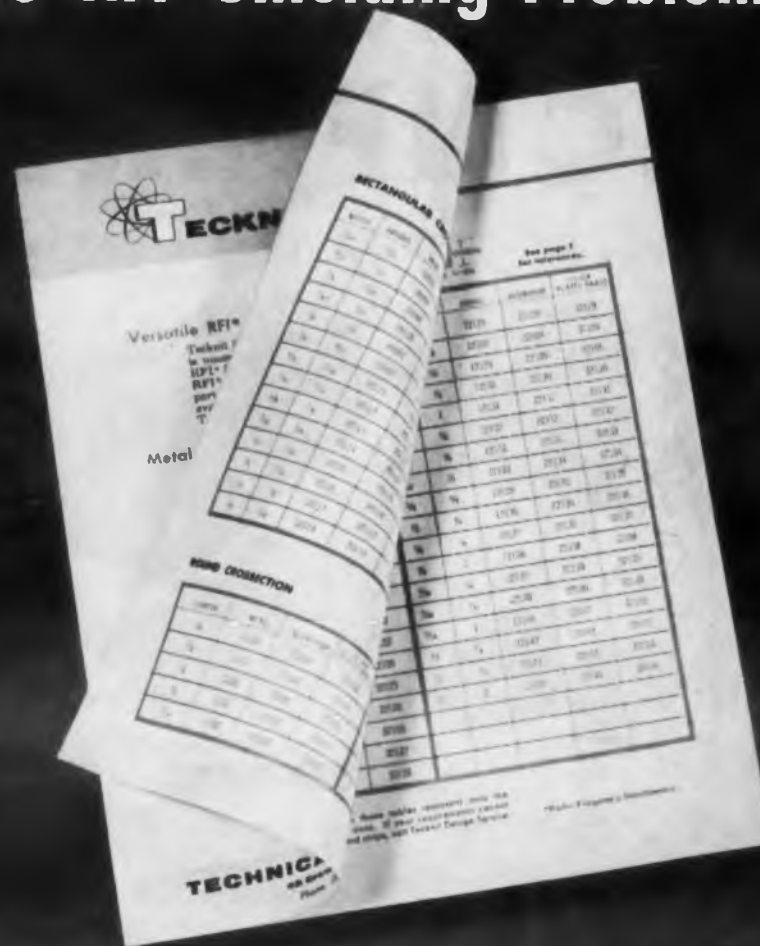
In the circuit shown, current flows from emitter to base of transistor 10 in the absence of any signal applied to

input terminals 12 and 16. The large collector current flow causes the base of transistor 28 to become positive resulting in reduced emitter current in transistor 28. Negative signals applied to the input terminals cause the collector of transistor 10 and emitter of transistor 28 to become more negative; this results in increased current flow through resistor 32 and indicating device 30.

As ambient temperature rises, assuming no signal input, collector current in transistor 10 increases due to increased intrinsic thermal condition. This tends to decrease the emitter and collector current of transistor 28. At the same time the increased temperature tends to increase the collector current of transistor 28. The net effects are compensated by a decrease in resistance presented by the network in rectangle 34, resulting in relatively constant current flow in the collector circuit of transistor 28 with no input signal applied.

An equation is presented expressing the temperature-resistance characteristic of a network to be placed between the emitter of transistor 28 and the negative supply in order to achieve immunity

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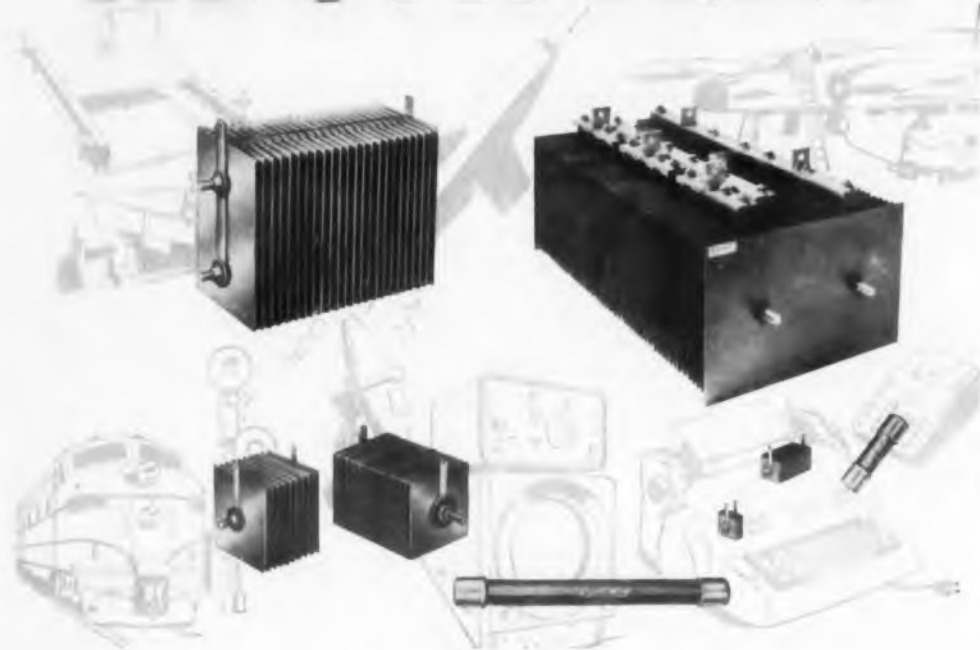
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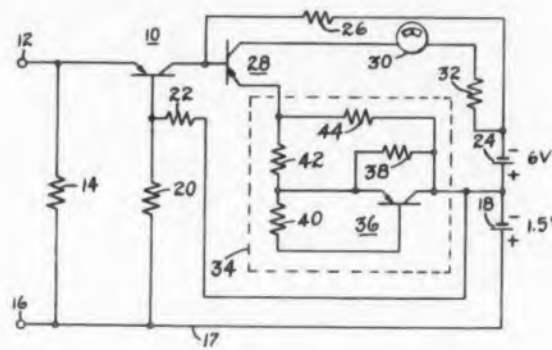
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PATENTS



from ambient temperature changes.

Network 34, consisting of transistor 36 and its associated components, is connected between the emitter of transistor 28 and the negative supply source and acts as a temperature variable emitter resistance.

A graph is included to show the comparison between an uncompensated and compensated amplifier in terms of output vs variation of ambient temperature.

Frequency Modulating Transducer

Patent No. 2,850,631. Robert M. Tillman.
(Assigned to Burroughs Corp.)

Low frequency subcarrier oscillators,

used for telemetering applications, are handicapped by the bulk of the tuning components, limited range of linear frequency variation, and "pull-in" effects between adjacent channel oscillators.

Transistor 20, is an npn type in a common base oscillator circuit with resonant frequency set by inductance 21 and capacitors 22 and 23. Emitter resistor 37 is unbypassed; therefore, the rf voltage across capacitor 23 is effectively across this resistor.

Transistor 30 is connected to an almost identical type oscillator circuit, with inductance 31 and capacitors 32 and 33 determining the resonant frequency. The emitter returns to the supply through resistor 37 common to transistor 20.

The first transistor oscillator, 20, is adjusted to optimize the second harmonic voltage across resistor 27 while transistor 30 is tuned to the subcarrier frequency difference. For example, if a 22 kc subcarrier frequency is desired, transistor 20 oscillates at 40 kc with a second harmonic output across resistor 37 of 80 kc; transistor 30 is tuned to 102 kc. Their difference frequency, 22 kc, is produced by heterodyning action in transistor 40,

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Sweep Rate: Variable around 60 cps. Locks to line frequency.

RF Output: 0.5 V rms into nom. 70 or 50 ohms, higher for lower frequency units. Output held constant to within ± 0.5 db over widest sweep by AGC circuit.

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Markers: Up to 30 crystal-controlled positive-pulse markers at customer-specified frequencies. Accurate to $\pm 0.05\%$. Up to three markers per band (more at lower frequencies) are available; no individual switches on markers.

Marker Amplitude: Continuously variable, zero to 10 V peak.

Sweep Output: Regular sawtooth synchronized with sweeping oscillator.

Power Supply: Input approx. 150 watts, 117 V ($\pm 10\%$) 50-60 cps ac. B+ electronically regulated.

Dimensions: 8 $\frac{3}{4}$ " x 19" rack panel, 13" deep. Supplied with cabinet.

Weight: 34 lbs. approx.

Price: \$695.00 f.o.b. factory plus \$15. per crystal marker.

Write for New Kay Catalog

KAY ELECTRIC COMPANY

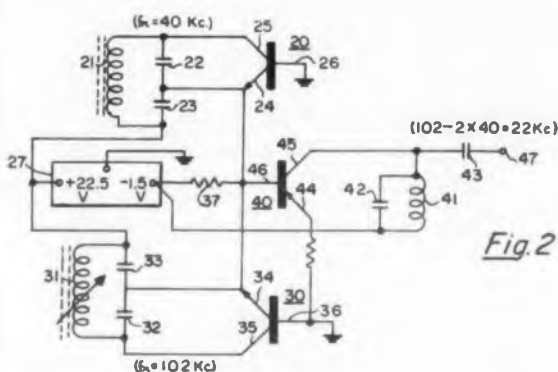
Dept. ED-1 • Maple Avenue • Pine Brook, N.J. • Capital 6-4000

WRITE IN 305 ON READER-SERVICE CARD

ELECTRONIC DESIGN • January 7, 1959

which is a pnp type, common emitter amplifier. Emitter 44 is grounded and positive with respect to base 46. This produces nonlinear response to base input signals with subsequent rectification and amplification of the products developed.

Signals appearing across resistor 37 are applied to base 46 where rectification occurs; the subcarrier component, 22 kc in the example given, appears in amplified form across the collector tuned circuit of inductance 41 and capacitance 42. The tuned circuit, being in an amplifier rather than an oscillator, is not high "Q" permitting the use of compact parts.



Inductance 31 of transistor 30 is varied by the parameter to be telemetered, and frequency-modulates the subcarrier output. Variations of coil 31, operating at 102 kc, produce a small percentage but linear change in frequency. The resultant variation on the 22 kc subcarrier developed is of relatively greater percentage.

Since a fairly large and nonharmonic frequency difference exist between oscillators 20 and 30, there is no "pull-in" effect encountered.

An entire telemetering subcarrier transducer has been provided in the same space previously occupied by the inductance section of a low-frequency subcarrier oscillator.

Also discussed is a circuit utilizing two similar oscillators whose fundamental frequencies differ by the subcarrier frequency. Since their frequencies are fairly similar, 100 kc and 122 kc for the example given, their physical structure and temperature drift is similar. Thus, fundamental frequency changes for both are about the same which results in a constant frequency difference.



ET TUBE RUTAY?

The recent advent of Cadmium Sulfide cells stirred up the photoelectric street light control business for a fare-thee-well. All hands got busy dumping tubes and producing small controls activated by CdS. Lights were blinking all over the country.

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The relay had to switch 1000 watt lamps, handle inrush up to 100 amperes, yet operate on 100 milliwatts. And it had to do it 5000 times with no failures and exact, stable pull-on and drop-out. You don't get relays like this out of a barrel.

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BOOKS

Aircraft Communications Systems

J. H. H. Grover, *Philosophical Library Inc.*, 15 E. 40th St., New York 16, N.Y., 127 pp, \$4.75


A compilation of the details of modern British airborne radio communications equipment, this volume deals specifically with equipment carried for air-to-ground communications. Catering to the student and serving as a reference guide for the veteran flight radio operator, this book is divided into three parts: Part I contains theoretical circuit descriptions of contemporary equipment; Part 2, setting up and practical operating instructions; Part 3, brief details of vhf transmitter receivers, contemporary American equipment, and auxiliary equipment.

Transistor Technology Vol. 3

F. J. Biondi, Editor, *D. Van Nostrand Co., Inc.*, Princeton, N.J., 416 pp, \$12.50.

Representing a five-year compilation of data, this final volume of a transistor series is equally divided between general technology and that which is specific to germanium and silicon. Subject matter is separated into four areas: the preparation of junction structures, fabrication technology, measurements and characterizations, and transistor reliability.

Reports on the principles and methods of impurity control, their formation by variation of crystal growth parameters, redistribution of solutes, temperature gradient zone processing and their formation by diffusion techniques, includ-

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ELECTRONIC DESIGN • January 7, 1959

ing silicon diffusion technology, are covered in the preparation of junction structures.

Chemical processing methods are detailed in the discussion of fabrication, which includes several papers on etching techniques, ohmic contacts to silicon and germanium, alloying, and important diffused devices.

The measurements and characterization of transistors incorporate materials properties measurement, and such device measurement as transistor meteorology, methods of testing and IRE standard on solid state devices.

Reliability is highlighted by laboratory studies and reports on use in the field.

Volume 3 is dependent on the first volume, which develops the fundamental concepts and descriptions of earlier techniques and processes, and is supplementary to Volume 2, which contains recent material on technology of materials and design principles.

Electronics of Microwave Tubes

W. J. Kleen, Academic Press Inc., 111 Fifth Ave., New York 3, N.Y., 349 pp, \$9.00.

This presentation of the fundamentals of microwave tube physics answers the need for a consolidated source of information in this rapidly developing field. The author concentrates on the qualitative and quantitative explanation of effects governing the operation of those microwave tubes now used in telecommunications. Tubes in circuits, properties of resonant circuits and delay lines used as tube elements, and production and focusing of electronic beams are topics included. Physical and mathematical presentation on the post-graduate level serves as a daily reference guide for the specialist. First published in a German edition in 1952, the revision has been updated to include latest developments in the field.

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RR 205								No		3 1/2 x 1 9/16 x 8 5/8	69.50
RS 305					225-325	0-50	6.3/3	No	6 1/2 lbs	5 x 4 1/8 x 6 1/2	49.50
RM 305								3 1/2"		3 1/2 x 1 9/16 x 8 5/8	99.50
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RS 217A					150-225	0-175	6.3/8	No	12 1/2 lbs	6 1/2 x 5 1/2 x 7 1/4	79.50
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RS 317					225-325	0-175	6.3/8	No	12 1/2 lbs	6 1/2 x 5 1/2 x 7 1/4	79.50
RM 317								4 1/2"		5 1/4 x 1 9/16 x 9 3/4	134.50
RR 317								No		5 1/4 x 1 9/16 x 9 3/4	99.50
RS 410A					400-550	0-100	6.3/8	No	12 1/2 lbs	6 1/2 x 5 1/2 x 7 1/4	105.00
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RS 110					0-110	0-100	6.3/3	No	7 1/2 lbs	5 3/4 x 5 1/4 x 7 1/4	103.00
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RR 110								No		5 1/4 x 1 9/16 x 9	128.00

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Back Current Tester Model BT1	0-100 V, 0-300 V 0-300 V, 0-1000 V	0.1%	0.1%	0.1%	0-10-30-100-300-1000 V UA, MUA	\$75.00
Combination Back-Forward Tester Model 997	0-5 VDC 0-1000 VDC	2 MVPP	10 MV	10 MV	0-10-30-100-300-1000 V, MA, UA, MUA	\$95.00
Peak Inverse Voltage Tester Model PIV 1					Linear voltage rise of 90 volts/sec to 400 volts. Automatic shut-off when dynamic impedance equals zero.	\$90.00

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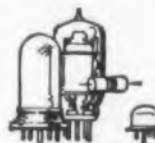
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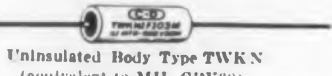


Uninsulated Body Type CPM08



Insulated Body Type CPM09

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Breadboarding The Easy Way

A BREADBOARD setup that is easy to build and use was developed after many different methods of jungle wiring were tried. It has many desirable features.

- Solderless connections
- Circuit components which may be used and reused without deterioration
- Ease of circuit construction
- Ease of dismantling circuit
- Ease of changing circuit components
- Small size and orderly arrangement of circuit layout
- Low cost
- Most circuit components need no special mounting before use.
- Clip leads may be attached to each other or directly to components.

Construction

The clip leads are constructed from commercially available material. They cost about five cents each, and take about three minutes to construct. Their construction is shown in Fig. 1. Clip leads vary in length from two to six inches, in

half-inch increments, and are color coded by length. Soldering should be done carefully as the solder flows easily and may flow up into the spring portion of the clip, rendering it useless.

The circuit board needs only one, one-inch mount in each of the four corners and it is ready for use.

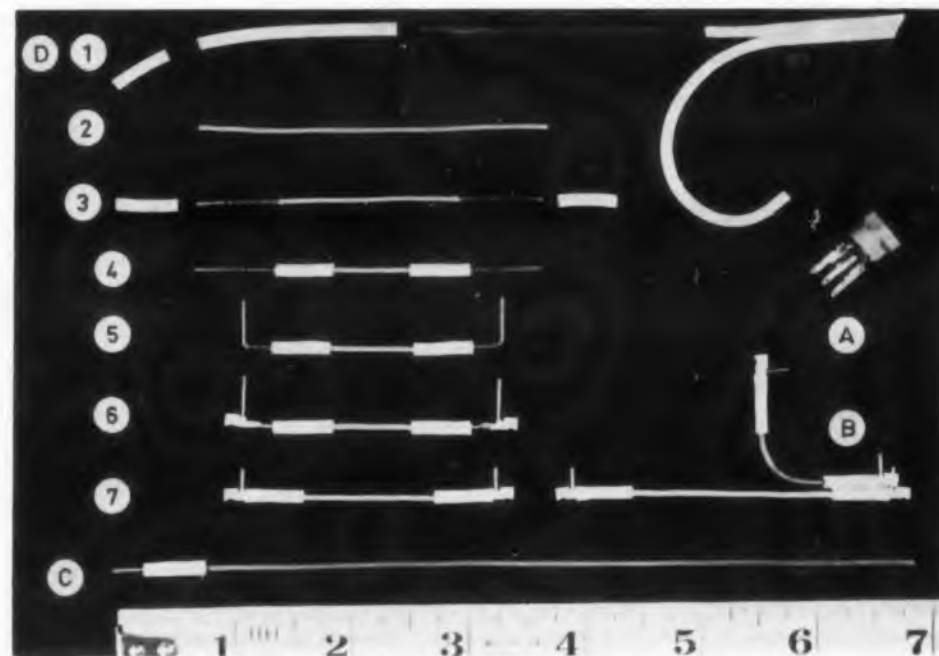
The circuit component leads should be left long enough to enable sliding the components in and out of their mountings on the circuit board. Similar components such as resistors, should all be of the same overall length if possible, for interchangeability in the completed circuit.

Use of Breadboard Materials

Since the breadboard is small, it should be used carefully. The clips break easily if forced in the wrong direction.

Mounting of circuit components on the top of the circuit board is illustrated in Fig. 2.

Use of clip leads in wiring the circuit



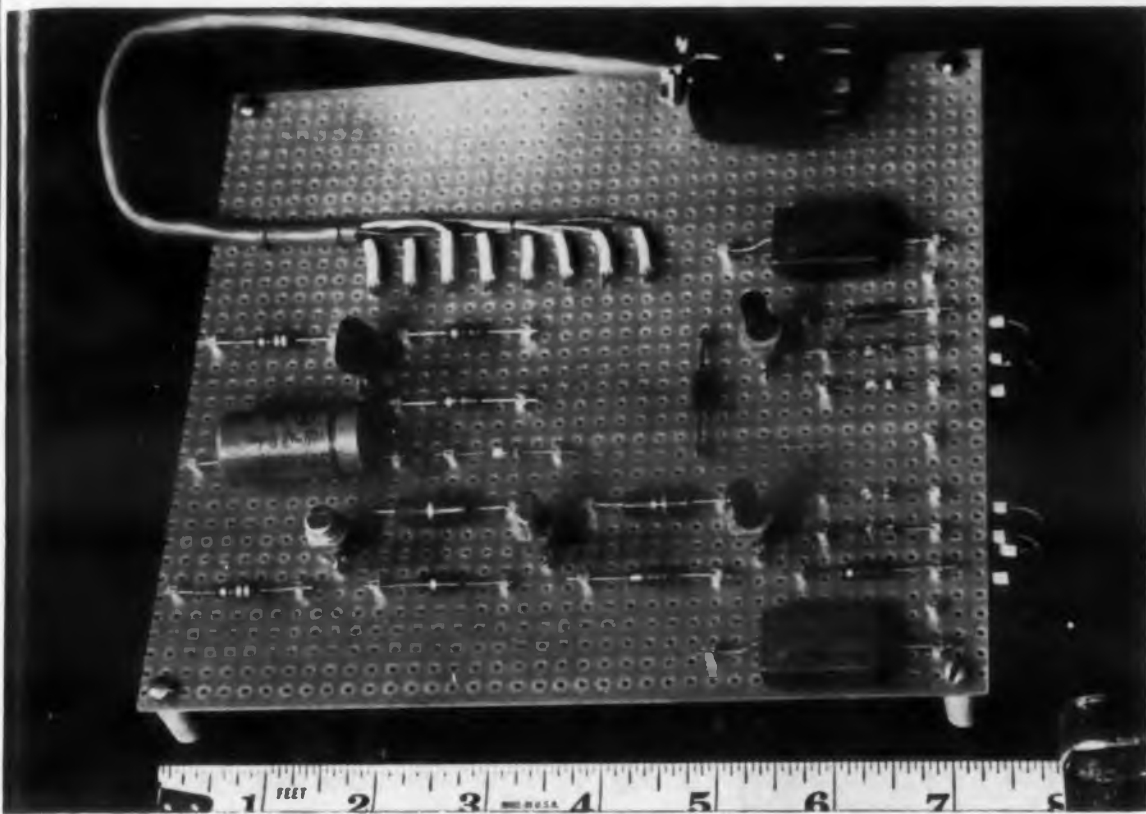


Fig. 2. The components of a test circuit mounted in their final positions. Plug at rear is for connecting the power supply.

is shown in Fig. 3 and is done on the reverse side of the board. The clip leads should be oriented carefully when connected to the ends of the clips protruding from the board as the clips are just barely long enough.

Parts are obtainable from most distributors and are inexpensive. The specific parts used here were ordered from Lafayette Radio, 165-08 Liberty Ave., Jamaica, N. Y. Prices and order numbers from their Catalog 305 (1958) are shown in the accompanying table.

- Fig. 1.** (Facing) Breadboard components
- (A). Transistor socket for mounting on the circuit board.
 - (B). Connection of clip leads to one another.
 - (C). A plug for use on the top side of the circuit board.
 - (D). Clip lead construction.
 - (1) Insulators for clip leads with soft plastic insulation on white extension cord.
 - (2) Blank piece of flexible, stranded wire.
 - (3) Stripped and tinned ends of wire.
 - (4) Insulation on the wire, over other insulation.
 - (5) Wire with bent up ends.
 - (6) Clip soldered to the wire.
 - (7) Insulation over the solder with ends of the wire cut off, leaving the ends just long enough to accommodate another clip lead as shown in (B).

Wayne A. Kearsley, Electronics Engineer, Edgerton, Germeshausen & Grier, Inc., Boston, Mass.

Parts List

Perforated Bakelite Boards

MS-304	2-7/16 x 3-3/8	\$0.25
MS-305	3-11/16 x 6-3/4	0.40
MS-306	7-3/8 x 6-3/4	0.75
	Flea Clips	
MS-263	package of 12	0.25

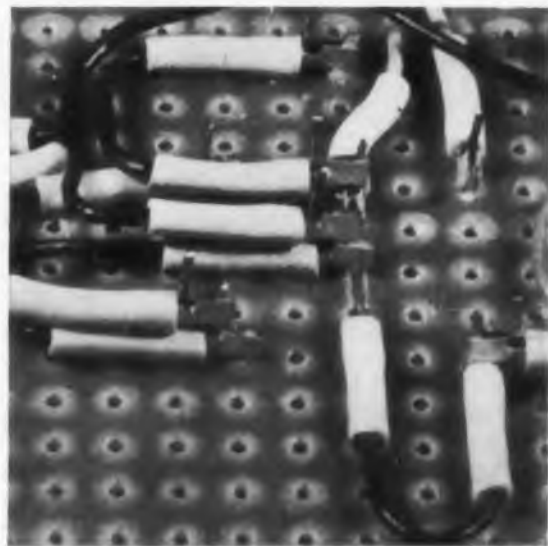
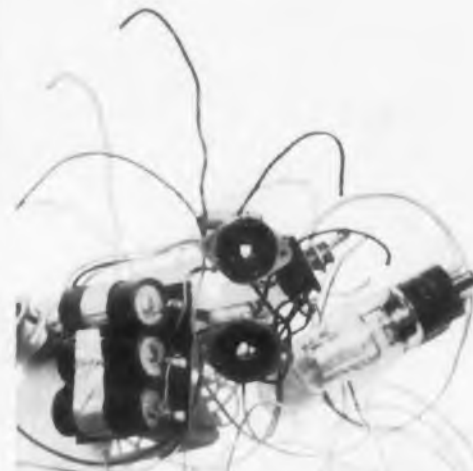


Fig. 3. Wiring is on the under side of the circuit board with clip leads.



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*Names of companies now using these Beckman units are available on request.

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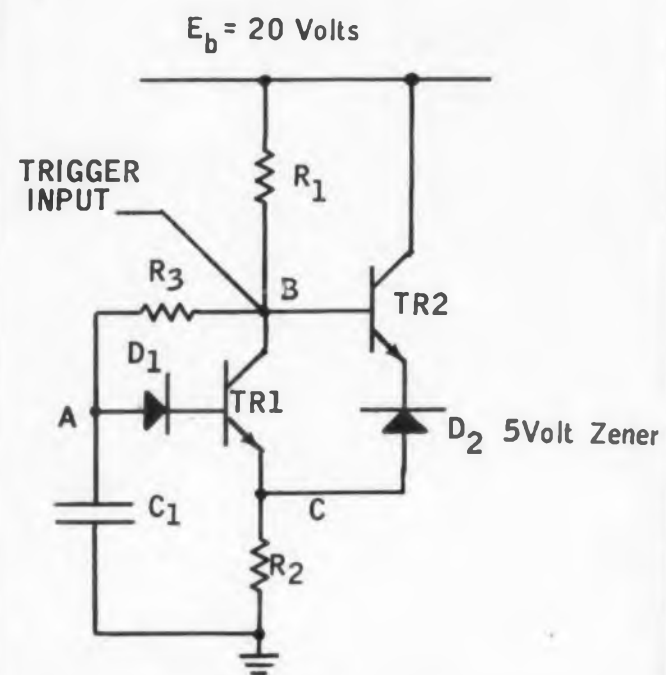


Fig. 1. In this monostable multivibrator, the timing capacitor C_1 , can be charged or discharged readily.

Flexible Monostable

Transistorized Multivibrator

The problem is to build a monostable multivibrator, using transistors, in which the timing capacitor can readily be charged or discharged by an external source. In a normal multivibrator circuit, which uses differentiator timing, it is very difficult to change the charge on the timing capacitor with an external source.

The circuit of Fig. 1 uses integrator timing. It is relatively simple and has an added advantage of having a low output impedance.

Transistor TR_1 is normally "ON" and the collector to emitter voltage is less than five volts. Since the zener diode D_2 is back biased, transistor TR_2 is biased "OFF."

The circuit is triggered with a positive pulse at point B . As TR_2 goes "ON" the voltage at point C rises, and since the base of TR_1 is held constant by the capacitor charge, TR_1 is turned off.

The capacitor then charges toward the supply voltage (minus a small amount due to TR_2 base current flow through R_1) with a time constant of $C_1 (R_1 - R_3)$. As the waveform crosses the voltage on the emitter, TR_1 starts to conduct and the circuit regenerates back to its stable state.

Diode D_1 is required to keep from breaking down the base to emitter junction of TR_1 .

An analysis of the "ON" condition of TR_1 results in the following equation.

$$V_{ce} = \frac{Eb}{K(B+1)+1}$$

where $K = (R_1 + R_2) R_3$, $B =$ dc beta of $TR1$, and $V_{ce} =$ collector to emitter voltage on $TR1$.

From this relationship the resistor values can be established. $TR1$ must be kept out of saturation and V_{ce} must not exceed 5 volts under the extremes of variation in beta.

J. R. Siconolfi, Farnsworth Electronics Co., Ft. Wayne, Ind.

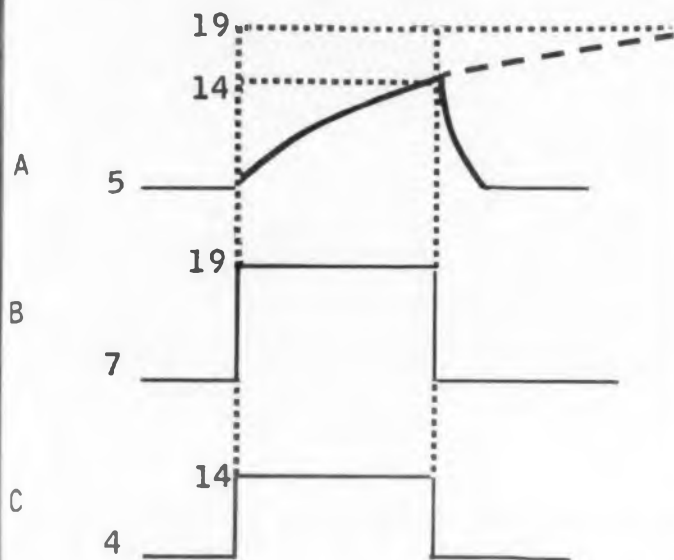


Fig. 2. Representative waveforms and voltage levels for the monostable multivibrator.

Build Your Own Tiny Mercury Switch

With the corner of a file, scratch the glass of an NE-2 neon lamp near the tip just below the solid part of the end. The tip can now be broken off with pliers. This leaves a tiny opening thru which a few drops of mercury can be introduced with an eye dropper (with a pumping action). The correct amount of mercury can be ascertained by holding the opening closed with the finger and visually determining the least amount that will consistently make contact when the tube is tipped upright and still allow an open condition with the tube in the opposite position. Excess can be removed with a salt-shaker action.

The tiny hole in the end is then sealed with a torch, being careful to pre-heat the glass before applying the direct flame to the end of the tube. Holding the tube upright by its connecting wires in a vise will reduce the expansion cracking during the re-sealing.

After sealing, allow the tube to cool slowly. The connecting wires can then be used in the switching circuit.

Heri T. Schulze, Los Alamos Scientific Lab., Los Alamos, N. Mex.

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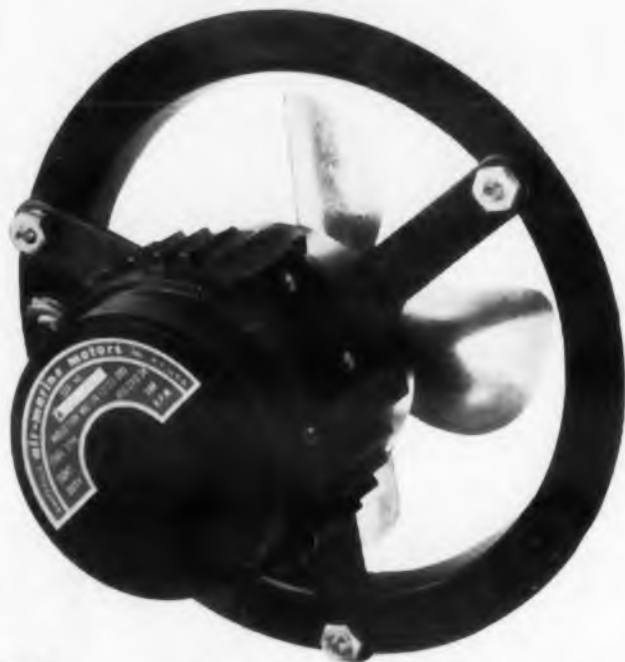
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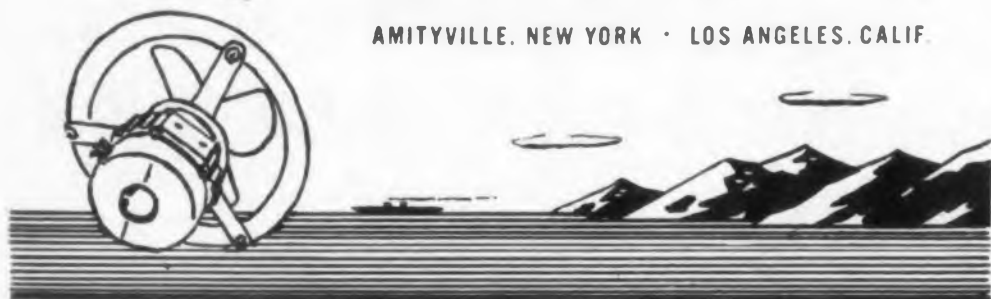
New, improved, high-speed, high-slip motor design changes speed with lower densities (higher altitudes) to maintain constant cooling efficiency. These high-slip motors are rated at a minimum of 1,000 hrs. @ 125° C.; longer life expectancy at lower ambients. Choice of 400 cps or Variable at 1 ϕ , or 400 cps at 3 ϕ . Prototypes delivered in 2-6 weeks; Production deliveries 6-8 weeks. Circle card for data sheets and performance curves.

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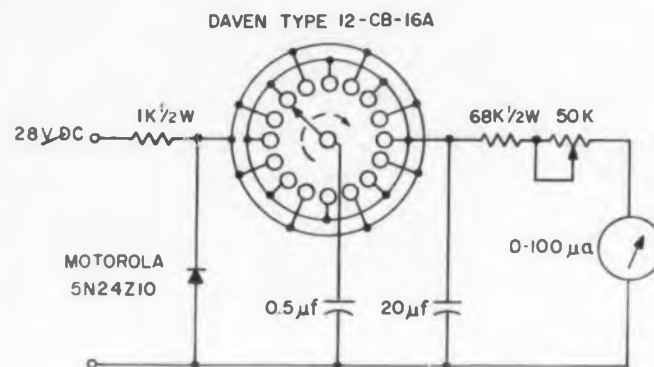
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IDEAS FOR DESIGN



Slow speed tachometer. Only the switch need be mounted on the shaft.

Small, Low Cost Tachometer

We needed a small, low-cost, electromechanical tachometer for direct indication of shaft speeds from 0 to 120 rpm.

The circuit shown solved the problem. We used a long life single pole 16 position rotary switch measuring only 1-3/4 diam by 1-1/4 long, mounted on the shaft, to commutate a 28 vdc supply. The rest of the circuit was placed elsewhere.

Since the power supply varied by as much as 20 per cent, a zener diode was used for voltage stabilization. The output of a charge-discharge capacitor was integrated and displayed on a 100 μ a meter with a special direct reading dial.

The circuit is linear to 30 rpm, and can be made linear throughout its range. It presents a stable output and is accurate to better than 5 per cent of full scale. Total cost of components is about \$35.

Leo L. Grinius, Engineer, Motorola, Inc.,
Riverside, Calif.

Pulsing Latching Relays With Little Power

When available power is limited, it's hard to pulse most latching relays. Normally, only half the coil is used at a time, as in Fig. 1, one bucking and the other aiding the permanent magnet in the relay. With the typical coil resistances shown in Fig. 1, one requires a current pulse of about 100 ma.

But with the circuit arrangement of Fig. 2, only half the normal current pulse is required. In each pulsing position, one half of the coil is used in the proper direction while the other half is used with the opposite intent. The result is



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Milliammeters • Voltmeters • Millivoltmeters
Megohmmeters • Multimeters

Combining the revolutionary BIFILAR frictionless movement with a weightless LIGHT-BEAM pointer, Greibach Precision Meters represent the most important advance in meter design in over 50 years. The patented Bifilar Movement replaces jewels, pivots and hair springs to provide virtually indestructible accuracy and sensitivity.

ONLY GREIBACH PRECISION METERS

offer these NEW STANDARDS of performance:

- ACCURACY to 0.25%, indefinitely
- SENSITIVITY to 1/4 microampere, full scale (25 x 10⁻⁶ amps.)
- OVERLOAD up to 100,000 %
- SHOCK up to 500 g's on meter movement
- VOLTMETERS up to 5,000,000 ohms/volt
- ENERGY DISSIPATION as low as 1.2 x 10⁻⁹ watts
- REPEATABILITY of 0.1% or better without tapping

TRUE direct measurement for even the most hypercritical uses and conditions. Exclusive features now make GREIBACH Meters THE most reliable way to:

- check transistors, diodes, tubes, amplifiers
- test ionization and grid circuits
- meter extremely high voltages
- control by light-beam photocell operation

Greibach Precision Meters, for portable, bench or panel use, are available in 3 case models and with a wide selection of single and multiple ranges. Write for complete specification sheets.

GREIBACH INSTRUMENTS CORPORATION
315 NORTH AVE., NEW ROCHELLE, N.Y. • NE 3-7900



WRITE IN 317 ON READER-SERVICE CARD

Telonic
SWEEP GENERATORS
with
NEW
SWEEP-LINE
DESIGN



- new cabinet
- new circuits
- greater than ever performance
- smart appearance
- faster delivery schedules

Telonic Sweeps feature 5% flatness, less than 10 microvolt leakage. Dependable for production, precise for engineering. Variety of markers. Crystal controlled single or harmonic plug-in with external marker provisions on all models. Variable markers available on many models.

Telonic Sweep-Line cabinet features hinged top for easy accessibility, slide-track mounting, perforated top and cooling vents. Dimensions — 20" x 10" x 15". Attractive two-tone finish is satin black and aluminum grey.

All models previously available are now included in the new Sweep-Line

MODEL NO.	SWEEP RANGE
H-3	1 mc to 300 mc
H-D Models	10 kc to 100 mc
L-D Models	3.5 mc to 140 mc
S-D Models	85 mc to 1260 mc

Many other Telonic instruments are available, including variable sweep rates and WATTS of power.

Delivery of Telonic Sweeps is 3 to 6 weeks. Prices range from \$645 to \$745—optional fixed marker plug-ins and variable markers extra.

Telonic
INDUSTRIES, INC.
BEECH GROVE, INDIANA

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ELECTRONIC DESIGN • January 7, 1959

either a total bucking or a total aiding magnetic field.

The disadvantage of this scheme, though, is that it requires a set of contacts and a small current limiting resistor.

R. C. Van Dick, Test Engineer, Convair, Pomona, Calif.

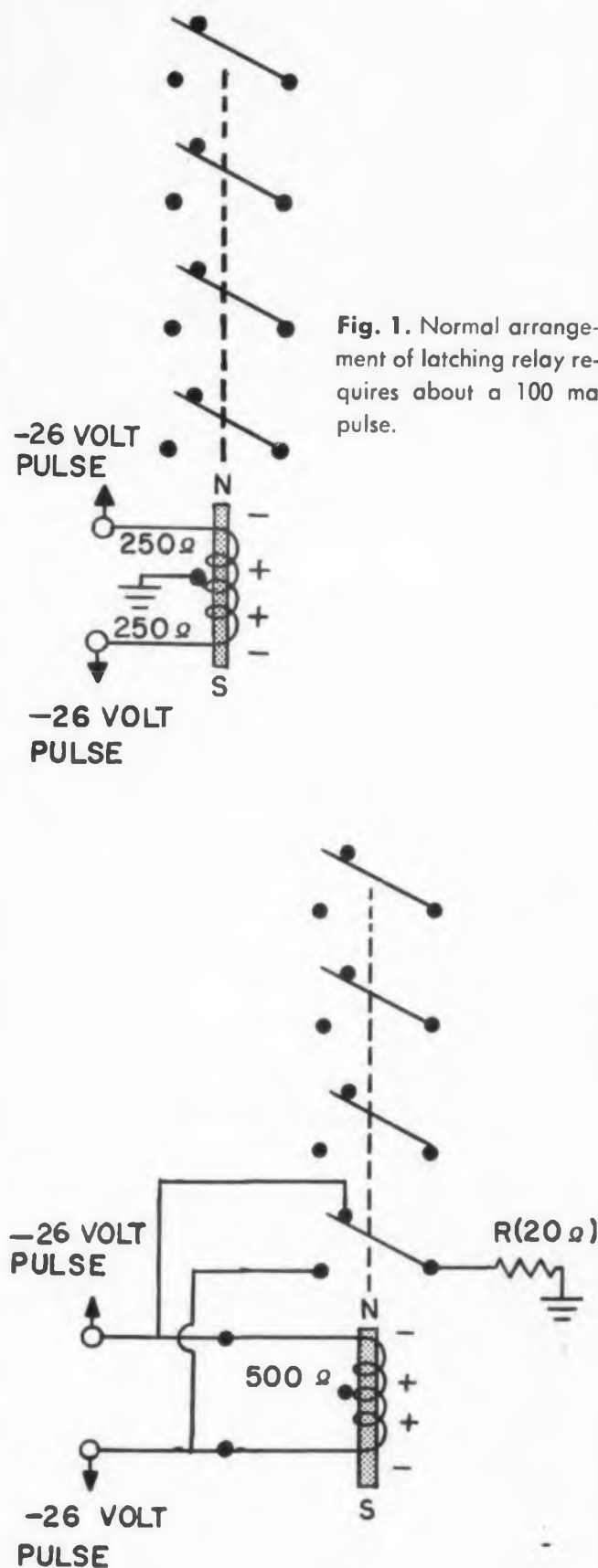
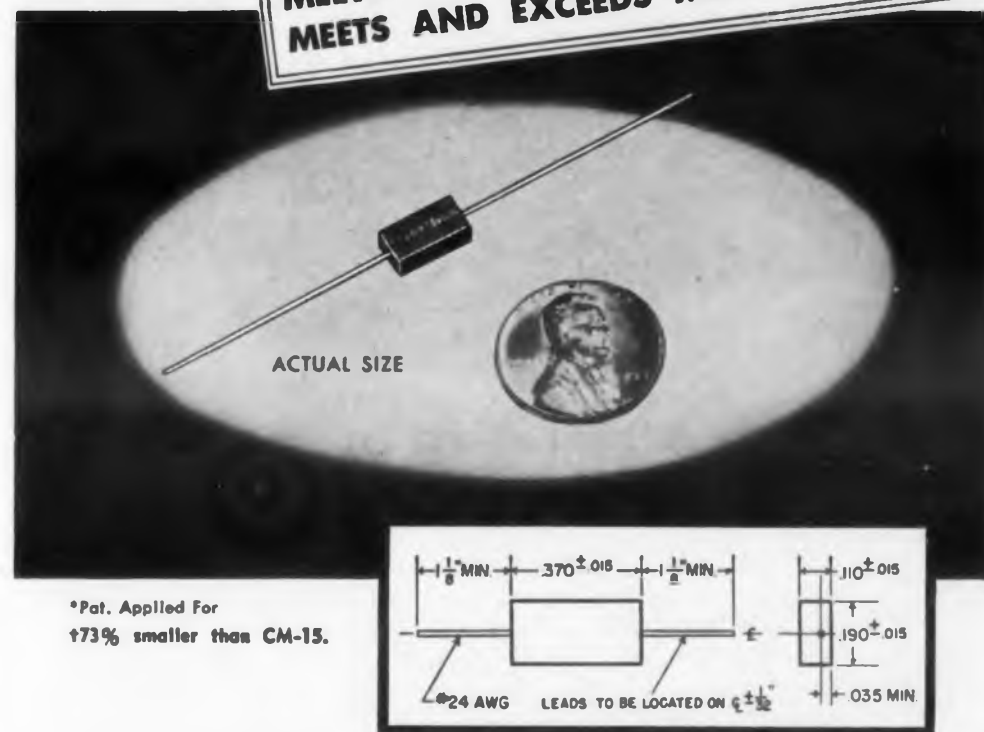


Fig. 1. Normal arrangement of latching relay requires about a 100 ma pulse.

Fig. 2. This latching relay arrangement requires only about half the normal current, but uses a set of contacts.

*Smallest MOLDED**
MICA CAPACITOR
73% Smaller†
Micamold Missilmite
for 55°C to 125°C operation

MEETS AND EXCEEDS MIL-C-5A
MEETS AND EXCEEDS MIL-C-11272A



*Pat. Applied For
†73% smaller than CM-15.

Micamold's Missilmite subminiature molded mica capacitors are the Smallest Molded Mica Capacitors Ever Produced...73% SMALLER! Due to radically new engineering design, new materials and assembly methods, Perfectly Symmetrical Missilmites MEET and EXCEED MIL-C-5A and MIL-C-11272A, Characteristics "C," "D" and "E." These subminiature molded mica capacitors will withstand operating temperatures of -55°C to +125°C (standard range is from -55°C to +85°C), and weigh only ½ gram.

Reliable and stable Missilmites permit greater design flexibility to the engineer, and are especially desirable in critical miniaturized assemblies. Recommended for use in missiles, delay lines, pulse networks, computers, transistorized assemblies...or wherever minimum size and weight, with stability, are required.



General Instrument Corporation
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Radio Receptor Co., Inc.
(subsidiary)

Send for Bulletin 114A to:

MICAMOLD ELECTRONICS MANUFACTURING CORP.
(Subsidiary of General Instrument Corp.)

1087 FLUSHING AVENUE, BROOKLYN 37, NEW YORK • HYacinth 7-5400
WRITE IN 319 ON READER-SERVICE CARD

Improve Your Memory



with a standard multiple purpose off-the-shelf drum

The 512-A Bryant general purpose magnetic storage drum meets the exacting requirements of a production component, yet has the versatility necessary for laboratory work. This standard 5" dia. x 12" long drum is stocked for immediate shipment, complete with standard components such as general storage brackets, recirculating register brackets and magnetic read/record heads. Its low price reflects the benefits of Bryant's 25 years' experience in the efficient design and production of high speed precision spindles.

Features:

- Guaranteed accuracy of drum run-out, .00010" T. I. R. or less
- Integral drive—Bryant precision motor (1200 to 12,000 R. P. M.)
- Capacities to 625,000 bits
- Accommodates up to 240 magnetic read/record heads
- High density ground magnetic oxide coating
- Super-precision ball bearing suspension
- Vertical mounting for trouble free operation

Special Models: If your storage requirements cannot be handled by standard units, Bryant will assist you in the design and manufacture of custom-made drums. Speeds from 60 to 120,000 R. P. M. can be attained, with frequencies from 20 C. P. S. to 5 M. C. Sizes can range from 2" to 20" diameter, with storage up to 6,000,000 bits. Units include Bryant-built integral motors with ball or air bearings. Write for Model 512-A booklet, or for special information.



Remember . . . you can't beat a Bryant drum!

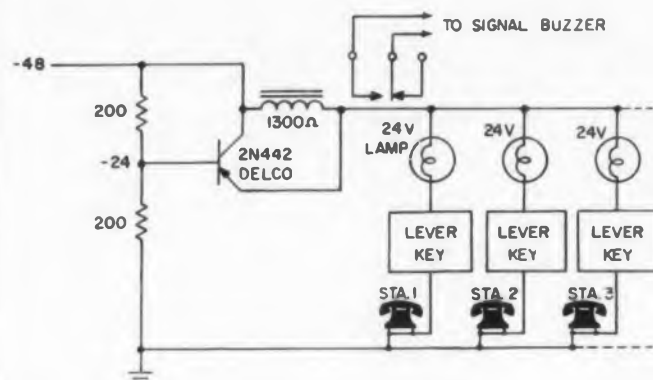
BRYANT COMPUTER PRODUCTS DIVISION

BRYANT CHUCKING GRINDER CO.

P. O. Box 620-M, Springfield, Vermont, U.S.A.

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IDEAS FOR DESIGN



This simple switchboard circuit does away with an expensive, sensitive relay.

Simple Circuit Replaces Expensive Signalling Relay

A sensitive (expensive) signalling relay had to be replaced in a cordless switchboard. The new circuit had to operate reliably with a one-lamp circuit, yet provide low enough resistance to preserve the voltage regulation (hence the lamp brilliance), when a group of calls is made simultaneously.

In the diagram, the transistor is cut off when the phones are idle. One phone and lamp draw enough current to drop the emitter voltage to -23.5 v, at which point the transistor conducts, stabilizing the signalling voltage.

The relay operates from the collector to emitter voltage which remains essentially constant regardless of the number of lamps (calls being made). The total lamp load must not exceed the transistor current or dissipation.

Elbert S. Kennedy, Chief Engineer, E. S. Kennedy & Assoc., Kansas City, Mo.

Pressure Scanner Checks 12 Pressures

This pressure scanner sends data from up to 12 sources to one transducer for conversion into electrical output. It uses 1/8 in. tubing to feed pressure to one point and avoids the need for calibrating 12 different transducers.

Designed by Datex Corp., a Division of Gianini, 1307 S. Myrtle Ave., Monrovia, Calif., it consists of a stator with 12 input ports and a rotor to connect any of the inputs to a single output.

A 12 position switch inside the scanner is connected to the same kind of switch outside the unit so that when both switches are in the same position, the motor circuit is broken and the motor stops. An additional bank of contacts can



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PRINTED CIRCUIT BOARDS

from Stromberg-Carlson

Expanded facilities now make it possible for you to get the same high quality printed circuit boards we produce for our own telecommunication and electronic applications.

We print and etch one or two sides; we provide eyelets or terminals and can provide gold plating where desired.

All boards will be manufactured with the same rigid process control demanded by our electronic switchboard, automatic toll ticketing, carrier and other precision equipment. In addition, you get these chief advantages:

1. **Quality:** assured by rigid control over incoming materials as well as process.
2. **Low Cost:** low tooling cost on quality short-run precision work means lower cost to you.
3. **Volume:** screen printing makes volume production economical. Delivery to meet your scheduling.
4. **Excellent Solderability** is assured without the need for costly solder plating.

Tell us about your particular job requirements. We will furnish price and delivery information immediately.

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION
Telecommunication Industrial Sales
116 Carlson Road, Rochester 3, N. Y.



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ELECTRONIC DESIGN • January 7, 1959

CEC CUSTOM & STANDARD

Delay Lines

Control Electronics Co., Inc. is a leading designer and mass producer of electromagnetic Delay Lines. A representative group is shown here with the available ranges of delays, bandwidths and impedances. Further information is readily available from our Engineering Dept.

BUILT TO MIL SPECS. FAST PROTOTYPE SERVICE . . . DELIVERY 1 TO 3 WEEKS.

Distributed Constant Delay Lines



CEC DISTRIBUTED CONSTANT DELAY LINE FEATURES

- Lowest cost — reliable performance
- Maximum delay to rise time ratios
- Maximum delay per cubic inch
- Delays to 30 μ secs.
- Impedances: 200 to 10,000 Ω
- Bandwidths to 20 mcs
- Linear phase shift



Variable Delay Lines

Infinite, incremental or decade variable delay lines available in any range of delays and impedances.



Lumped Constant Delay Lines

DELAYS TO 20,000 MICROSECONDS.
BANDWIDTHS TO 500 MCS.
Z₀ FROM 50 TO 10,000 OHMS.



Multi-tapped Lumped Constants available in many configurations

System Delay Lines

Complete delay and pulse systems designed to your needs.



NOTE: Data Sheets on request

CONTROL ELECTRONICS CO., INC.

10 Stepan Place
Huntington Station, New York



Pressure scanner feeds 12 pressures to a common transducer.

be used to provide a visual or digital indication of the rotor position.

By hooking up 12 scanners to a thirteenth, 144 pressures can be measured by one transducer.

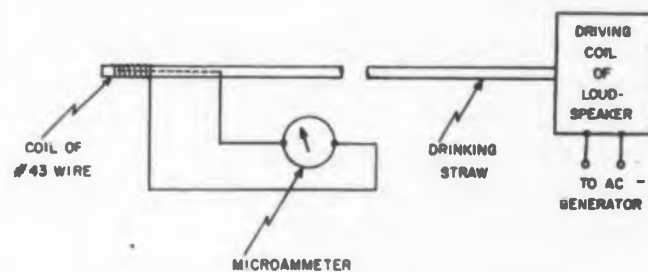
Inexpensive Flux Meter For Deep Recesses

It's difficult to investigate the flux distribution in deep recesses with standard magnetometers. Furthermore, the price of adequate instruments of this type is often prohibitive.

The simple scheme shown in the diagram solves the problem neatly. A drinking straw is fastened to and vibrated by a loudspeaker. An aluminum tube, such as is used for ammeter pointers, may be used instead. A miniature fine wire coil is wound around the protruding end of the tube.

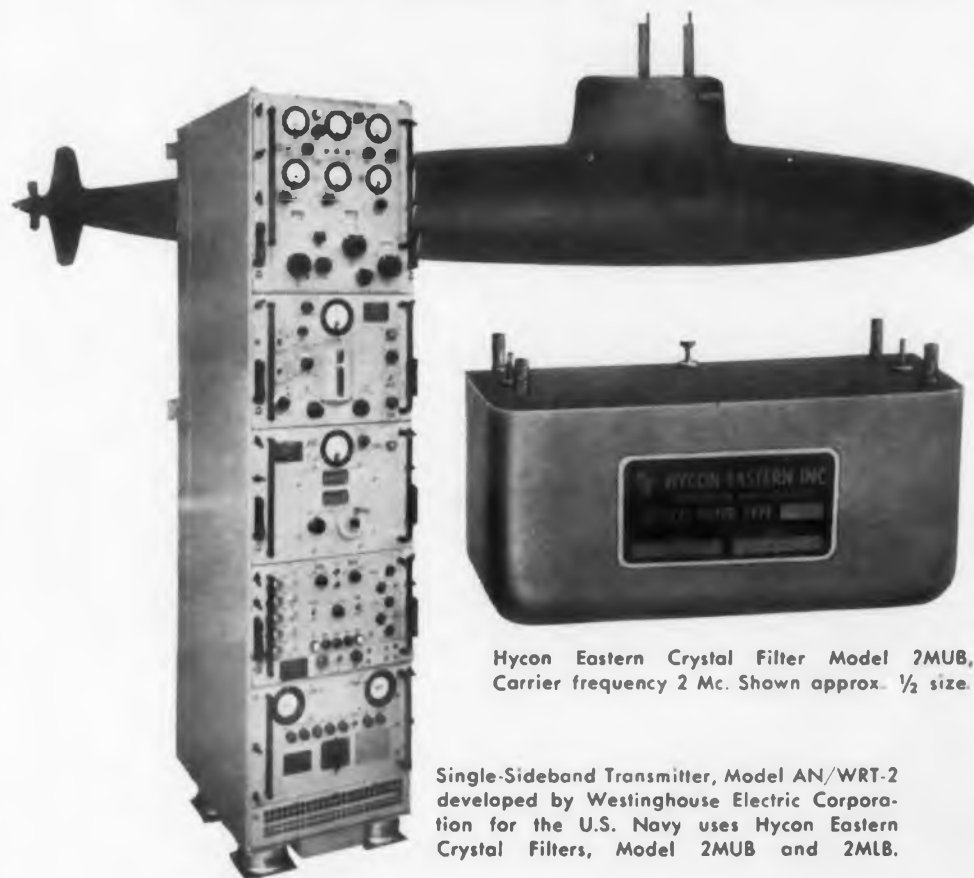
Current induced in the coil by its movement in the magnetic field is read on a sensitive microammeter. For weak fields, an amplifier may be used ahead of the microammeter.

Dr. Erwin J. Saxl, President, Tenistron, Inc., Harvard, Mass.



Vibrating coil fluxmeter for deep fields.

FIRST Navy Militarized SSB Transmitter Generates Cleaner Signal Using HYCON EASTERN CRYSTAL FILTERS



Hycon Eastern Crystal Filter Model 2MUB, Carrier frequency 2 Mc. Shown approx. 1/2 size.

Single-Sideband Transmitter, Model AN/WRT-2 developed by Westinghouse Electric Corporation for the U.S. Navy uses Hycon Eastern Crystal Filters, Model 2MUB and 2MLB.

Recently installed on the atomic submarine SKIPJACK (SSN585), the Westinghouse Electric AN/WRT-2 SSB Transmitter is soon to be standard Navy equipment.

Single sideband signals are generated in the AN/WRT-2 by the selective filter method employing Hycon Eastern 2MUB and 2MLB Crystal Filters. These 2.0 Mc Crystal Filters not only offer all the basic advantages of the filter SSB generation method, but reduce the number of heterodyning stages required to translate the modulated signal to the required output frequency. The attendant decrease in unwanted signal generation results in a cleaner signal. The AN/WRT-2 is also a more reliable transmitter because fewer components are used.

In addition to the 2.0 Mc Crystal Filters, Hycon Eastern has also supplied SSB units at 100 Kc, 1.75 Mc, 3.2 Mc, 10 Mc and 16 Mc. These Crystal Filters are presently installed in airborne HF, mobile VHF and point to point UHF SSB systems.

Whether your selectivity problems are in transmission or reception, AM or FM, mobile or fixed equipment, you can call on Hycon Eastern engineering specialists to assist you in the design of your circuitry and in the selection of filter characteristics best suited to your needs. Write for Crystal Filter Bulletin to Hycon Eastern, Inc., 75 Cambridge Parkway, Cambridge, Mass.

A limited number of opportunities are available to experienced circuit designers. Send resume to Dr. D. I. Kosowsky.



HYCON EASTERN, INC.

75 Cambridge Parkway

Dept. F

Cambridge 42, Mass.

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U.S.G. Solves Tough Molding Problems with *Teflon** & KEL-F†

Our specialty is precision molding where close tolerances, intricate shapes, and where thin wall sections are involved. Garlock's United States Gasket Plastics Division has the personnel, the facilities, the unequalled experience in handling tough fluorocarbon plastics.

Guarantee yourself the best parts, and the right price—ask for a quote on any molding problem concerning TEFLON T.F.E. and KEL-F. Call us, too, for fluorocarbon and nylon sheets, discs, tape, rods, tubing, bars, and cylinders from the world's largest and most complete stock.

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S
G** **nited
tates
asket**

For Prompt Service, contact one of our 30 sales offices and warehouses in the U.S. and Canada, or write The Garlock Packing Company, Palmyra, New York.

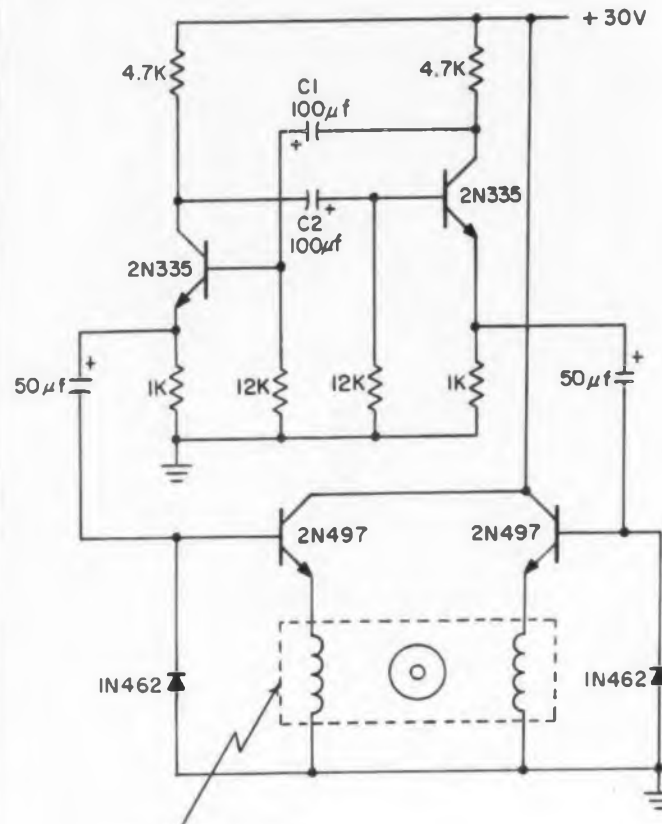
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Plastics Division of
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WRITE IN 324 ON READER-SERVICE CARD

IDEAS FOR DESIGN



SIGMA CYCLONOME
STEPPING MOTOR.

Slow speed multivibrator takes only 50 mw to drive stepping motor.

A Slow Turn With Little Power

We needed to rotate a commutator assembly at 2 rpm, but the available power was very limited.

We used a Sigma Cyclonome stepping motor to provide the mechanical force to actuate the commutator. The Cyclonome delivers torque in discrete steps on command. The motor has two 13.5 ohm coils. Pulsing the coils alternately causes the motor to move 18 degrees per pulse.

The driving circuit uses two 2N335 transistors as a slow speed multivibrator. Output from the multivibrator emitters, drives a pair of 2N497 medium power transistors. They send current pulses to the Cyclonome coils, in step with the multi.

Speed can be regulated by varying *C1* and *C2* in the multi circuit. With the components shown in the circuit, the Cyclonome motor rotates at 2 rpm, but the speed can be varied by changing the multi frequency. The 1N462 diodes prevent a dc voltage buildup on the 50 µf coupling capacitors.

The entire device consumes 50 mw, quite a bit less than the 4 or 5 watts needed for conventional motor and gear drives.

Jeffrey Wisnia, Jr. Engineer, Comstock & Westcott, Inc., Cambridge, Mass.

THE "HOT" POT

We received an urgent telephone call, a few weeks ago, from the fellow who does the purchasing for a very large and well known simulator manufacturing firm.

"I need a small sine-cosine pot with high resistance, and conformity that's better than 1%," he said. "A couple of firms say they COULD develop it ... but our engineers don't have the time to wait."

"They don't need to wait," we said, and we told him about our 2" sine-cosine potentiometer that delivers 0.5% peak-to-peak accuracy and has a range of up to 70K ohms per quadrant.

"Send over three 50K's right away," he shouted, and we did!

Now...we've been making this little double wiper pot for over a year, but suddenly it's become, what might be termed, a "hot" item...very much in demand for flight and radar simulators and computers of all kinds. We decided, therefore, that we'd better let everybody know that we have supplied this unit to the simulator and computer fields for more than 12 months. We make it in servo and 3-hole mount, and modular design (for stacking flexibility.) It conforms to applicable sections of MIL specifications, and delivers 0.5% (or even .25%) peak-to-peak accuracy.

If you've been looking for such a potentiometer or a prototype model of it, just give us a call or drop us a line. We'll be happy to discuss your drawings or simply supply you with literature and data sheets on our "hot" pot as well as on our many other precision products which we design and manufacture for use in electronic equipment.

**MICRO-LECTRIC DIVISION
OF MICRO MACHINE WORKS**



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HUNTER ENGINE HEATERS



for military applications at sub-zero temperatures



- designed and produced in accordance with military requirements.
- for starting internal combustion engines at sub-zero temperatures, cold starts to -65°F .
- standard winterization gear for military vehicle engines, generator sets, compressors, hydraulic test stands, battery starting carts, other ground support and special purpose equipment applications.
- burn any type gasoline or JP-4 fuel.
- BTU/Hour range: from 30,000 to 90,000 input, utilizing both uncontaminated air and exhaust.
- compact, light-weight, high capacity units for delivery of high temperature, high-volume air as required for specific applications.

Other Hunter military equipment: space and personnel heaters; instant lighting torches, refrigeration units.

GET THESE BROCHURES TODAY!

for complete specifications and details

MH-166 "Hunter Engine Heaters"

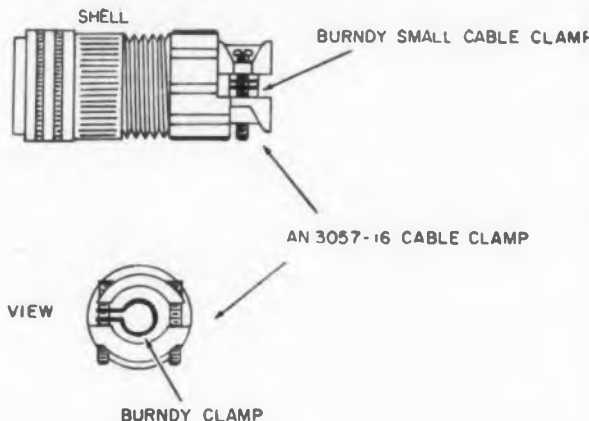
MH-162 "Hunter Space and Personnel Heaters"

MH-167 "Hunter Instant Lighting Torches"



MANUFACTURING CO.
30539 AURORA RD.
SOLON, OHIO

HEATING AND REFRIGERATION SYSTEMS
WRITE IN 326 ON READER-SERVICE CARD



Large Amphenol connector holds small Burndy clamp for secure cable connections.

Secure Cable Clamp

Here is an idea for preventing a cable from pulling out of its terminals when used in conjunction with a large AN Amphenol or similar connector. A plastic Burndy cable clamp is placed on the small diameter cable and the one screw of the Amphenol end cable clamp AN-3057 is set through the Burndy clamp hole and tightened, as shown in the figure. Thus the cable cannot be pulled loose and is not visible, making for a neat cable termination.

Ralph Rinaldi, Theta Instrument Corp., East Paterson, N.J.

New Light Modulator

A well known way of obtaining very thin conducting sheets is to evaporate metals in vacuum. A number of substances can be used as supports and be disposed of after metalizing, generally by dissolving and evaporating. This process has been applied to glucinium by M. Auphan in France (Onde Electrique, Dec. 1956) to provide sheets of thicknesses varying between 200 and 2000 angstroms. The most interesting aspect is in the use to which such thin sheets can be put.

Using suitable spacers, a thin sheet of glucinium is stretched over a glass plate; the spacing is very small. When a beam of electrons is shot at such a target, it goes straight through the metal. The thin glucinium sheet is then locally distorted by the electrostatic field due to secondary emission.

Sweeping the electron beam across the metal sheet can thus produce a pattern of deformation determined by the beam modulation. The device constitutes, in fact, a light modulator which could be used, for example in television.

Dr. A. V. J. Martin, Carnegie Institute of Technology, Pittsburgh, Pa.

It's just part of the Victoreen story...



Victoreen Corona type Voltage Regulators are approved by the military.

Superior voltage regulation and greatly extended current ranges—that's part of the Victoreen story. But it doesn't stop there. Use of these new glass or metal corona regulators means you can eliminate complex circuitry regulators. Fail-safe feature gives protection not afforded by other forms of regulators.

Improved Regulation results from new electrode structures and improved processing for greater

dynamic resistance, greater protection, simplified circuits.

Improved Current Rating increases scope of applications.

Improved Life Expectancy results from even better processing, even more rigid selection of materials.

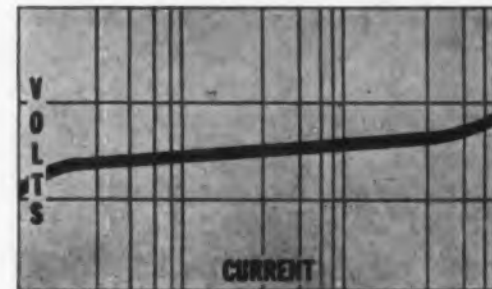
Improved Ruggedization means these regulators withstand more rigorous adverse environments longer.

AA-5421



Get the full story on the new Victoreen voltage regulators.

Write for your free copy of Form 3003-7 today.



The Victoreen Instrument Company

Components Division

5806 Hough Avenue, Cleveland 3, Ohio

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Compact! Easy to Read! Union Data Display Indicators

Union Switch & Signal makes two types of electro-mechanical, DC-operated data display indicators: digital types, displaying 10, 12, or 16 characters on a wheel; and alpha-numerical types, displaying up to 64 characters on a MYLAR* belt. Character assignments can be furnished as required.

TRANSLATION Both Digital and Alpha-Numerical Indicators operate directly on binary codes on a null-seeking basis. This eliminates the need for external equipment for translation from binary to decimal code, as required with other display devices.

VISUAL READ-OUT Indicator packages are designed for quick, easy readability, even when indicators are mounted in rows.

INFINITE RETENTIVITY The indicators require power only during the response time, because they are of the null-seeking type. Once positioned, the indicators retain the data visually and electrically until a new code is transmitted.

ELECTRICAL READ-OUT The design of the decoding and control portions of the indicators provides electrical read-out of data in the same form as the input. The data can be read continuously or periodically without erasing the stored information.

USES These indicators can be used in the output of digital computers, in teletype receiving equipment, in telemetering systems, or wherever data needs to be displayed.

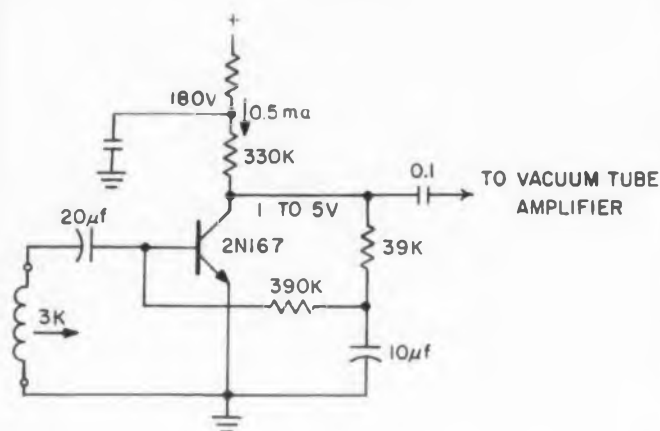
*Dupont's synthetic fiber.

Bulletin No. 1015 gives you complete information.

"Pioneers in Push-Button Science"
UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY —
PITTSBURGH 18, PENNSYLVANIA

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IDEAS FOR DESIGN



NPN Preamp for Magnetic Pickups Powered From B+

In vacuum tube circuitry, there is a problem in maintaining high signal to noise ratio at low audio frequencies because of the lower signal transfer from a magnetic pickup (phone, tape, or microphone) to the tube grid.

The low input impedance of the transistor more nearly matches the source at low frequencies, so better signal transfer and better signal to noise ratio result. The signal, using the transistor preamp, gets about 40 db of amplification at 100 cps before it reaches the tube grid.

The transistor stage can be powered directly from the same B+ supply used by the vacuum tube circuit. This circuit gives a constant collector current of about 0.5 ma, independent of transistor parameters. A dc feedback network stabilizes the collector to emitter voltage. The circuit has an input impedance of about 3 K.

Dwight V. Jones, Applications Engineer, General Electric Co., Syracuse, N.Y.

Transistor Manufacturers Please Note

In most design work, where any number of transistors may be employed, it is often difficult to keep on hand the various types of sockets to accommodate all transistors. Soldering and re-soldering may often damage an expensive transistor or decrease efficiency.

It would be very helpful to have transistors of some styles, designed in two parts, one consisting of the transistor itself and the other consisting of the base or snap-on socket. This base material could also be designed by the manufacturer for best operating conditions for the transistor to which it is attached when purchased.

Robert H. Lemma, Burroughs Corp., Detroit, Mich.

THESE RUGGED
JOHNSON VARIABLES
WITHSTAND TERRIFIC
VIBRATION
and SHOCK!



Ceramic-soldered
for greater
strength!



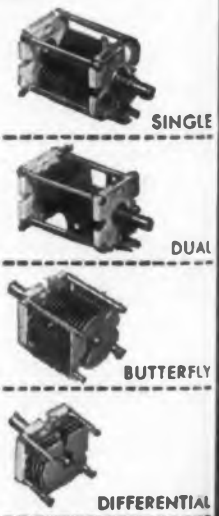
Parts can't
break loose...
capacity can't
fluctuate!

These ceramic-soldered Johnson Type "L" capacitors are an ideal choice for applications requiring extreme stability and strength. Rotor bearings and stator support rods are actually soldered directly to the heavy 3/16" thick steatite ceramic end frames. Impervious to shock and vibration, parts can't break loose... capacity can't fluctuate.

SPECIFICATIONS

Plate spacing is .030" rated at 1500 volts peak at sea level; over 300 volts at 50,000 feet altitude. Plating is heavy nickel... other platings available on special order. Requires 1 3/8" x 1 3/8" panel mounting area.

For complete information on Johnson Type "L" Air Variables or other quality Johnson components—write for your free copy of our newest catalog today!



E-F Johnson Company
1909 SECOND AVE. S.W. • WASECA, MINN.

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ELECTRONIC DESIGN • January 7, 1959

IT'S THE FINISH THAT COUNTS



IN TUBING TOO!

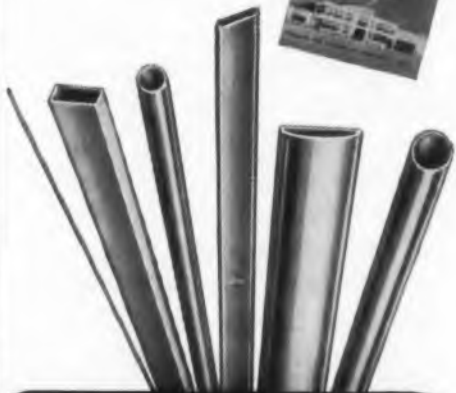
TESTS PROVE PRECISION FINISH UNSURPASSED

Shape, size, alloy are important in tubing and Precision Tubing excels in all . . . but finish is an outstanding quality of Precision Tubing where specified . . . and at no extra cost.

Precision Tubing is available in clean, scratch-free finishes suitable for anodizing or plating to mirror finishes. In sizes from .010" to 1.125" O.D. in copper, brass, aluminum, up to 3/4" O.D. in nickel and nickel alloys.

Other Precision Tubing is available in straight lengths, coils, preformed to specified shapes . . . and also as Coaxitube the metal shielded coaxial conductor. Whatever your designs or requirements for fine accurate tubing at regular tube prices order Precision Tubing. Write for complete technical data to Dept. 10, Precision Tube Company, Inc., North Wales, Pa.

GET THIS NEW TUBING
DATA CATALOG . . .
FREE!



**PRECISION
TUBE
COMPANY**

Engineering with Paint

In testing transistorized circuits, burned out or overheated transistors are commonly encountered. This may be due to circuit dipping, wiring, design, etc. By applying a coat of heat sensitive paint or heat sensitive wax emblems to the transistors, overheated transistors will show paint discoloration or emblem distortion. Since most transistors are lacquered by individual companies, the application of paint or wax could be done in one operation.

This idea can reduce cost by reducing the engineering time spent in locating faulty transistors during the initial design and system debugging phases of a program. In addition it may point out equipment hot spots which may be a source of future breakdown.

David E. Miller, Sylvania Electric Products, Waltham 54, Mass.

Interesting Network Property Can Help Transistor Circuit Designers

An interesting property of two terminal-pair, linear bilateral networks is that the forward voltage transfer ratio equals the negative of the reverse current transfer ratio.

The literature abounds in tabulations of voltage transfer ratios for various networks, but the transistor circuit designer is generally interested in the current transfer ratio.

To obtain a network with a specified current transfer function, one need only look for a network with the desired transfer characteristics as the voltage transfer ratio, and reverse the excitation and response terminal-pairs.

Robert B. Craven, Research Engineer, MIT Instrumentation Lab., Cambridge, Mass.

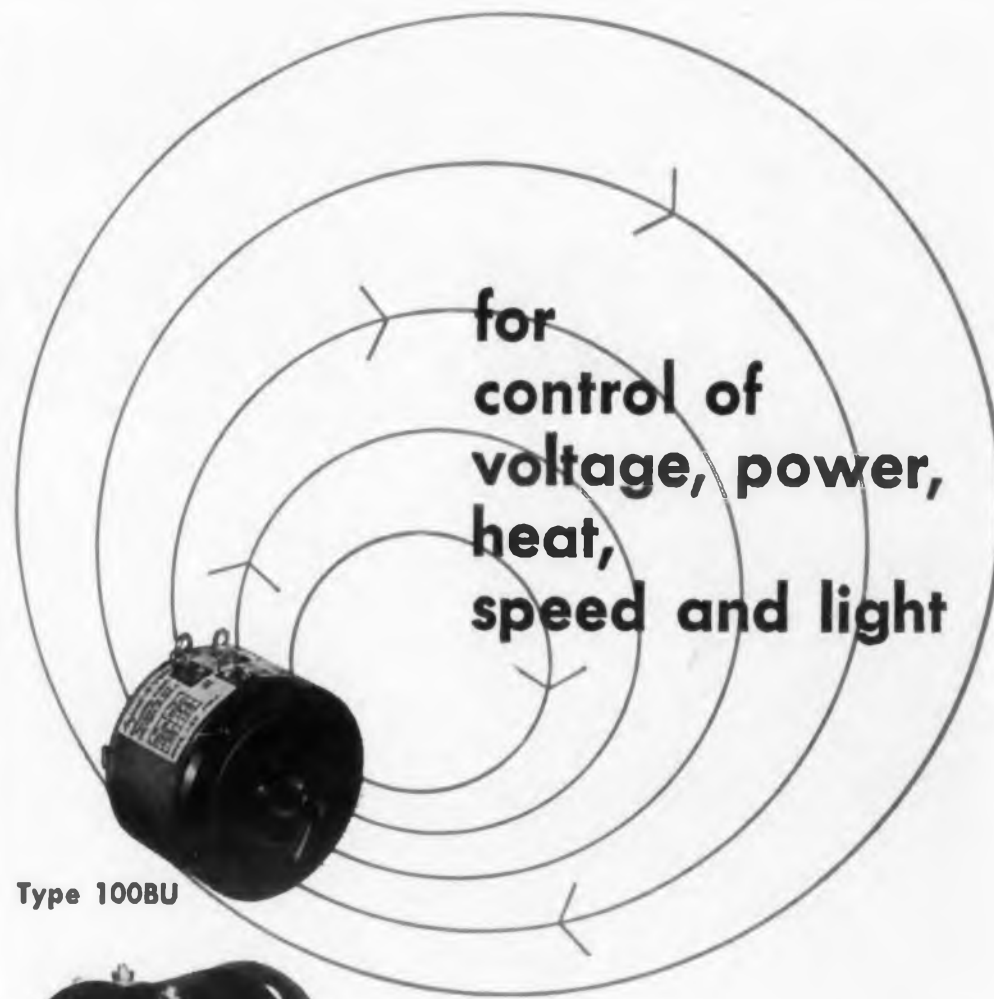
Simple Formula Gives Strength of Small Shafts

This formula, developed experimentally, should help other engineers who've been plagued with this problem. When the power transmitted through a shaft is measured in watts the shaft diameter D , in thousandths of an inch, is given by

$$D = 75 \sqrt[3]{\frac{P}{Ns}}$$

where N is the shaft speed in rpm, P is the transmitted power in watts, and s is the design stress of the material in psi.

Herbert Piller, Brooklyn, N.Y.



Type 100BU



Type 300BU



Type 500BU



Ganged 300BU-2

Panel-mounted *Adjust-A-Volt* Variable Transformers

Small, compact, easy-to-mount Adjust-A-Volts are ideal built-in variable AC voltage control components for all types of industrial electrical and electronic applications such as power supplies, rectifiers, instruments, etc.

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REPORT BRIEFS

Matrix Switch

The double inhibit magnetic switch described in this report has a similar configuration to the Rajchman switch, the one most commonly used in memory application, but differs in the manner in which it is driven. The switch circuit selects its output core by removing an inhibit current from each coordinate selecting line. Among the advantages cited for the double inhibit switch is its need for only one driving current source. This simplifies adjustment of the switch drive. Also, since the power of the output pulse is not directly derived from the selection circuits at the time the output pulse is delivered, the selection circuits may be operated at low power. The report states that the switch appeared to possess enough advantages of adjustment and simplicity to warrant consideration as a memory drive switch. It is also described as being useful in any application which requires medium to high speed multi-terminal switching. The comparative advantages of this switch over two other types of magnetic switches are listed. *Double Inhibit Magnetic Matrix Switch*, L. F. Silva, Aberdeen Proving Ground, U.S. Army, July 1956, 15pp, \$.50. Order PB 131353 from OTS, Washington 25, D. C.

Rotatable-Magnet Permeameter

The device described in this volume is a type of permeameter which derives the variable magnetomotive force across its air gap from the rotation of a permanent magnet. In the common permeameter, the variable magnetic field is provided by an electric current. The general purpose of the device is to determine the magnetic properties of a test specimen and, in particular, visual indication of the major and/or minor hysteresis loops of a test specimen under varying magnetic field conditions. The advantages of the rotatable-magnet over the common type are the following: It is independent of electrical power and current fluctuations, and no heat is developed; it is portable and compact; it is less affected by vibration; its simple design makes operation easy, especially for determining minor hysteresis loops. Two working models are described. *Rotatable-Magnet Permeameter*, R. K. Tenzer and M. A. Bohlmann, Wright Air Development Center, U.S. Air Force, July 1956, 9pp, \$.50. Order PB 131352 from OTS, Washington 25, D. C.

Low-noise Backward-wave Amplifier Development

Several trial designs, based upon various considerations of the specifications, have been attempted. A schedule for performing the calculations is evolved based on several predetermined parameters.

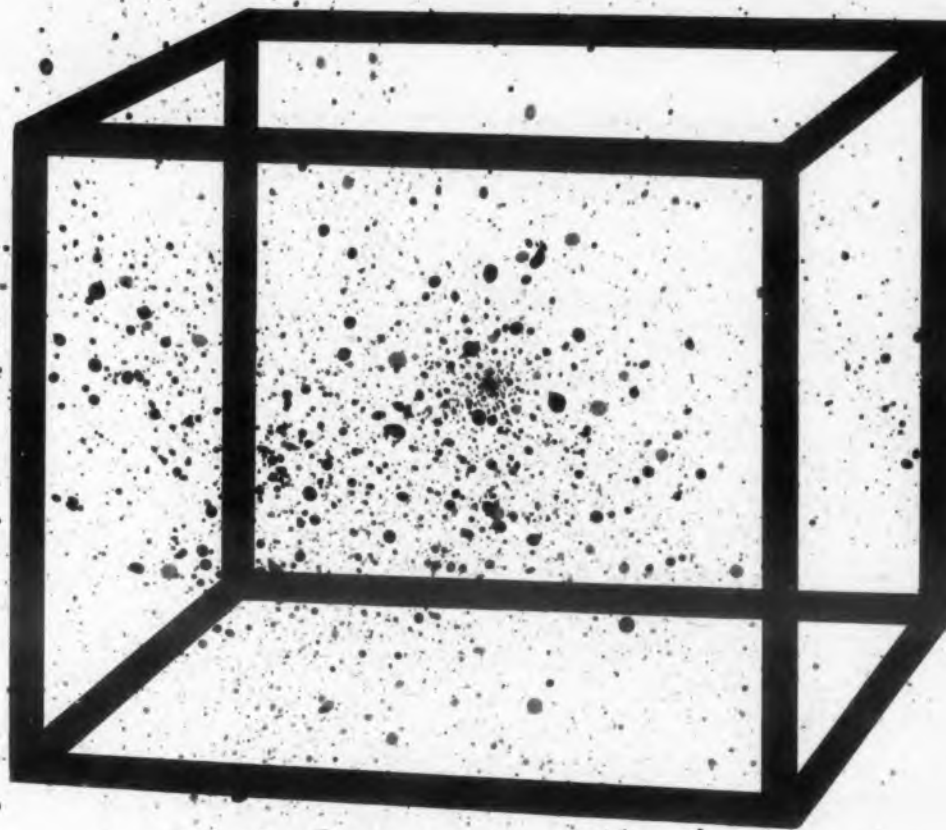
Low-noise gun designs are considered, with some discussion of theory. Predicated magnetic field calculations for various conditions of perturbations are given. Some discussion is devoted to application of permanent magnets to this tube. *Low Noise Backward-wave Amplifier Development Program, K. R. Evans and W. L. Rorden, Varian Associates, Palo Alto, Calif. Jan. 1958, 41 pp, \$1.25. Order PB 131822 from OTS, Washington 25, D.C.*

Thin Film Resistance Elements

Vacuum deposited chromium films were prepared and studied and resistance-temperature-thickness characteristics were determined. Substrate temperature and substrate material were found to have a pronounced effect on temperature coefficient but not on the resistivity-thickness relationship. The properties of thin chromium films appeared to be a function of the history of the film rather than any intrinsic property of the film. Some very preliminary work was also done with bismuth films. *Theoretical and Experimental Investigations on Thin Film Resistance Elements, D. M. Hoffman and J. Riseman, International Resistance Co. for Wright Air Development Center, U.S. Air Force. July 1957, 37 pp, \$1.25. Order PB 131441 from OTS, Washington 25, D.C.*

Display for Air Traffic Control

An experimental display system was developed which showed promise of satisfying a number of the requirements for display of multi-element data available for air traffic control. The system projects spots of light representing aircraft onto a 10-ft square back-lighted screen. Position, identity, category, heading, and altitude information on a given aircraft is contained within each 3/4 in. spot of light. Main advantages of the system are the large size of display and the large amount of easily read data presented. *A Point-Light-Source Projection Display for Air Traffic Control, R. J. Lampkin and M. F. Williams, Naval Research Laboratory. Feb. 1958, 11 pp, \$0.50. Order PB 131524 from OTS, Washington 25, D.C.*

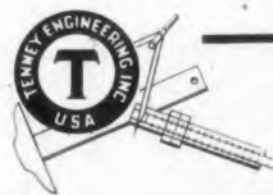


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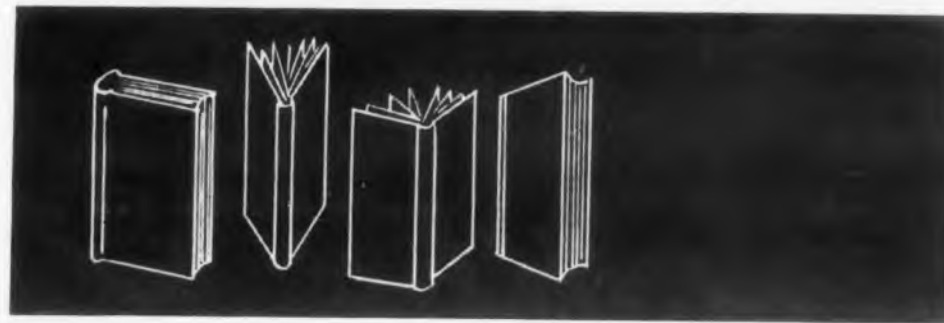
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"It is with great interest that I note your efforts in ELECTRONIC DESIGN concerning the translation of the Russian book on nonlinear circuit elements. After the initial shock of discovering in industrial electronic design that the text book examples of college were of strictly linear problems while my 'real' problems were almost strictly nonlinear, I soon learned to use nonlinearity and finally to depend on it for 'clever' circuit design.

"... I have noticed that university training does not prepare students for the essentially nonlinear 'real world' and a book such as that by A. A. Kharkevich would be a great boon. As was stressed by the editor of ED, this book is for the practical design engineer. We have enough of the pure theoretical I think.

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reprints available of your translation or perhaps an outright publication of the translated book? I suppose there are copyrights to take care of. If it is not possible to secure an English version of Kharkevich's book (one way or another) how about advising me where and how to purchase a Russian copy. I am trying to learn Russian anyway and this book would be an excellent first book to add to my scientific book shelf in the Russian section."

Robert W. Zimmerer
University of Colorado
Boulder, Colo.

"I am writing this letter in regard to Mr. Adashko's translation of 'Nonlinear and Parametric Phenomena in Radio Engineering.' Since no books have been written on this subject directed towards the electrical design engineer, the few scattered articles that have appeared in periodicals have to be used as a foundation for a course on this subject in many colleges. Such is the case at Cornell. Though we try to introduce to those studying electrical engineering here, some of the information that has been made available, students find it very difficult to understand the application of this theory.

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Therefore, I wonder if it would be possible to obtain a complete translation of this work even though the entire serial translation has not been published. I realize that this request is highly irregular, however, everything you can do for us concerning this matter would be greatly appreciated."

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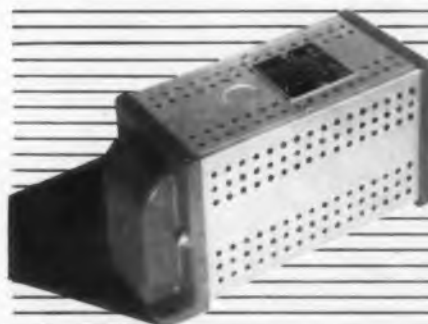
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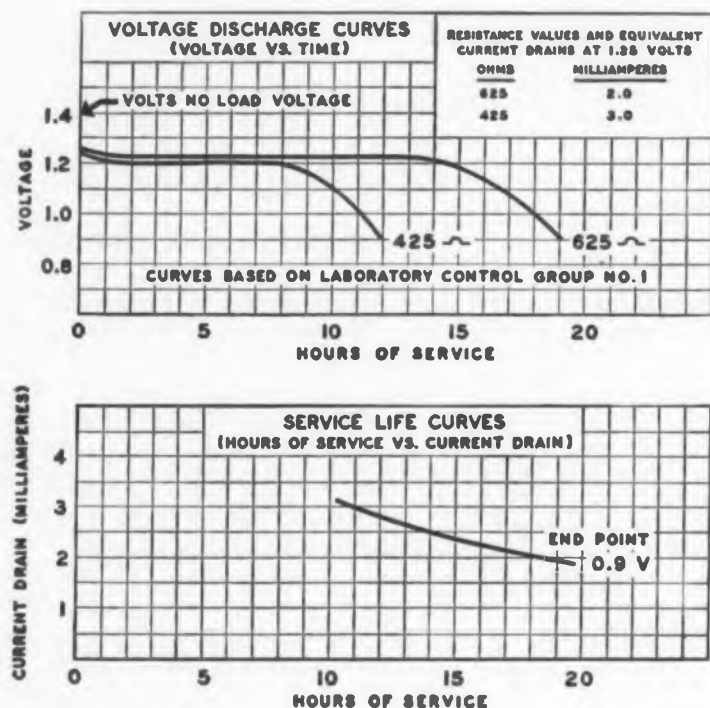
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RUSSIAN TRANSLATIONS:

Nonlinear and Parametric Phenomena in Radio Engineering

Part 9

A. A. Kharkevich

(Translated by J. George Adashko)

Chapter 1

Nonlinear Circuits and Fundamental Nonlinear Processes

12. Nonlinear Method of Amplitude Modulation

In the preceding section we have shown modulation to be essentially a linear operation, effected in a linear system with a variable parameter. Modulation is nothing but multiplication.

In most practical circuits amplitude modulation is based on a different principle. The point is that it is difficult to construct a correctly operating linear multiplier. We therefore resort to an indirect method of multiplication, in which the sum of the two multiplied voltages acts on a nonlinear circuit. The current will now contain a component proportional to the product of the two voltages. Let us first show qualitatively that a-m oscillations can be obtained in this manner.

Let us take two voltages, one at a carrier frequency $U_1 = U_m \sin \Omega_0 t$, and a modulating voltage $U_2 = (1 + m \sin \Omega t)$. We connect the two voltages in series with a nonlinear element. Let the characteristic of this element be represented by a broken line. The waveform of the

current in the circuit can be plotted by the usual construction, as shown in Fig. 39. It is easy to see that the current is amplitude modulated. In addition, the current contains a dc component, a low frequency component, and a series of high frequency components. All these excess components must be filtered out.

Let us now analyze the nonlinear multiplier in greater detail. Let the characteristic of the nonlinear element be represented by the power series,

$$I = a_0 + a_1U + a_2U^2 + a_3U^3 + a_4U^4 + \dots$$

In our case

$$U = U_1 + U_2$$

so that

$$I = a_0 + a_1(U_1 + U_2) + a_2(U_1 + U_2)^2 + a_3(U_1 + U_2)^3 + a_4(U_1 + U_2)^4 + \dots = a_0 + a_1U_1 + a_1U_2 + a_2U_1^2 + a_2U_2^2 + \underline{2a_2U_1U_2} + a_3U_1^3 + a_3U_2^3 + 3a_3U_1^2U_2 + 3a_3U_1U_2^2 + a_4U_1^4 + \dots \quad (1)$$

We see that the term we need, which contains the products $U_1 U_2$ (underlined), is obtained only through the quadratic term of the voltage-current characteristic of the nonlinear element. All the remaining terms give extraneous components, so that we do not have pure multiplication, and the current obtained requires subsequent purification by filtering.

However, it is possible, by complicating the circuit, to eliminate many excess terms and thus obtain better multiplication.

Let us turn to Fig. 40. The original nonlinear circuit with the two voltages U_1 and U_2 is shown

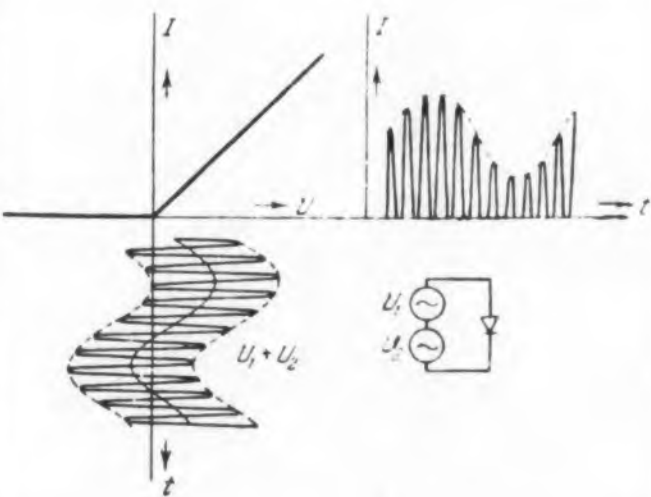


Fig. 39. Characteristics of a basic a-m modulator with two voltages considered in series with a nonlinear element.

in Fig. 40a. Let us combine two such circuits, as shown in Fig. 40b, with the voltage U_1 in the common branch. The voltage picked off the circuit is

$$U = R(I_1 - I_2).$$

We note that U_2 is applied to the circuit twice,

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and in such a way that the effective voltage in the upper half is the sum $U_1 + U_2$, and the difference $U_1 - U_2$ in the lower half. The instantaneous polarities of the voltages are denoted by arrows. For the currents we obtain,

$$I_1 = a_0 + a_1(U_1 + U_2) + a_2(U_1 + U_2)^2 + a_3(U_1 + U_2)^3 + a_4(U_1 + U_2)^4 + \dots$$

$$I_2 = a_0 + a_1(U_1 - U_2) + a_2(U_1 - U_2)^2 + a_3(U_1 - U_2)^3 + a_4(U_1 - U_2)^4 + \dots$$

The current difference is

$$I_1 - I_2 = 2a_1U_2 + 4a_2U_1U_2 + 6a_3U_1^2U_2 + 2a_3U_2^3 + 8a_4U_1^3U_2 + 8a_4U_1U_2^3 + \dots \quad (2)$$

(It is assumed that the circuit is symmetrical, i.e., that the coefficients a_k in the expansions of the currents I_1 and I_2 are the same.) We see that subtraction leads to cancellation of a whole series of terms. The only terms remaining are those containing odd powers of U_2 . Were the characteristic of the nonlinear element strictly quadratic, i.e.,

$$I = kU^2$$

we would obtain a pure multiplication in accordance with the formula

$$k(U_1 + U_2)^2 - k(U_1 - U_2)^2 = 4kU_1U_2.$$

Circuits of the type shown in Fig. 40b are called balanced. They are used, in particular, to obtain modulated oscillations that contain no carrier. Actually, if U_1 is the carrier voltage, it drops out of Eq. (2). Modulation of this kind is called balanced modulation.

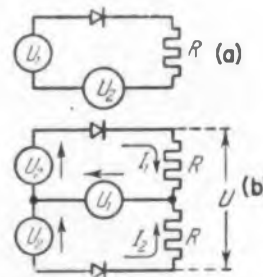


Fig. 40. The basic a-m modulator with two adding voltages in series in a nonlinear circuit (a), and a combination of two such circuits (b).

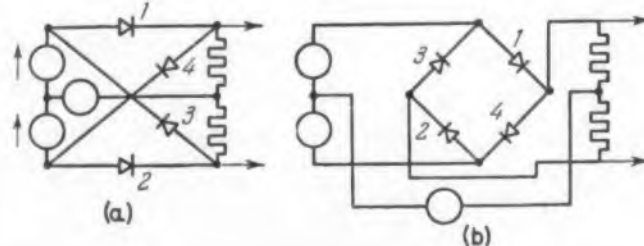


Fig. 41. The ring modulator combines two balanced modulators (a), and is redrawn in more conventional form in (b).

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ELECTRONIC DESIGN • January 7, 1959

The improvement made to the circuit of Fig. 40a to obtain the balanced circuit of Fig. 40b consists essentially of reversing the sign of one of the voltages and subtracting the currents to get rid of many excess terms. This procedure can be extended further. Let us take two identical balanced circuits, and reverse in one of these circuits the polarities of both voltages U_1 and U_2 . The result is a voltage that equals the sum of the voltages obtained across each of the circuits individually.

Such a result is obtained by the circuit in Fig. 41a, which is a combination of two balanced circuits. The output voltage of this circuit can be represented in the form

$$U = U' + U''$$

where U' and U'' are the voltages produced by each balanced circuit individually. For these two voltages we can write [see Eq. (2)]:

$$U' = R(I'_1 - I'_2) = 2R[a_1U_2 + 2a_2U_1U_2 + 3a_3U_1^2U_2 + a_3U_2^3 + 4a_4U_1^3U_2 + 4a_4U_1U_2^3 + \dots],$$

$$U'' = R(I''_1 - I''_2) = 2R[-a_1U_2 + 2a_2U_1U_2 - 3a_3U_1^2U_2 - a_3U_2^3 + 4a_4U_1^3U_2 + 4a_4U_1U_2^3 + \dots].$$

The expression for U'' differs from the expression for U' in that the signs of both U_1 and U_2 are reversed. Adding, we obtain

$$U = U' + U'' = 4R[a_2U_1U_2 + 2a_4U_1^3U_2 + 2a_4U_1U_2^3 + \dots], \quad (3)$$

This expression shows that more excess terms have been eliminated. In particular, if the characteristic of the nonlinear element is expressed by a polynomial of power not higher than the third, i.e.,

$$I = a_0 + a_1U + a_2U^2 + a_3U^3$$

then the circuit of Fig. 41a (if the circuit is completely symmetrical) produces ideal multiplication. It is possible to redraw this circuit in a more conventional manner, as shown in Fig. 41b. The result is a closed ring consisting of four nonlinear elements. This is why Fig. 41 is called a ring modulator. This circuit is widely used for modulation and frequency conversion.

It must be noted that no further improvement in the circuit can be obtained by successive application of this method. In fact, examination of Eq. (3) shows that the voltage picked off the ring circuit retains only terms that contain products of the odd powers of U_1 and U_2 .

Consequently, if we reverse the sign of one or both voltages, all the terms of expressions (3) retain the same sign, and neither can be eliminated individually by addition or subtraction. Therefore, there is nothing gained in a more complicated circuit that comprises two ring circuits.

(To be continued with a discussion of practical modulation circuits.)

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RUSSIAN TRANSLATIONS



What the Russians Are Writing

J. George Adashko

Possible Use of a System of Orthogonal Functions for Communication Purposes, by A. G. Leont'yev, EC 10/58, pp 3-8.

All modern multichannel communication systems make use of periodic and orthogonal functions. Systems with frequency sharing are based on the orthogonality of the sinusoidal functions. Frequency with time sharing make use of the orthogonality of periodic sequences of pulses shifted relative to each other. Sinusoidal functions are the only ones that do not change form upon transmission through a linear system. But frequency-sharing or time-sharing functions are not the only ones that can be used for electric transmission of information.

Examine, for example, the Laguerre function

$e^{-\alpha t} L_n(\alpha t)$, where $L_n(\alpha t)$ is given by

$$L_n(\alpha t) = e^{\alpha t} \frac{d^n}{dt^n} \left(\frac{t^n}{n!} e^{-\alpha t} \right) \\ = \sum_{\nu=0}^n (-1)^\nu \binom{n}{\nu} \frac{(\alpha t)^\nu}{\nu!}$$

and is the solution of the following linear

differential equation with variable coefficients:

$$t \frac{d^2 L_n(\alpha t)}{dt^2} + (1 - \alpha t) \frac{d L_n(\alpha t)}{dt} + \alpha n L_n(\alpha t) = 0$$

The Laguerre polynomials are orthogonal in the interval from 0 to ∞ with weighting factor

$$e^{-\alpha t} \int_0^\infty e^{-\alpha t} L_m(\alpha t) L_n(\alpha t) dt = \begin{cases} 0 & m \neq n \\ 1 & m = n \end{cases} \quad (1)$$

Laguerre functions can be generated with a two-port network having as its transfer function, in operator form, the transform of the Laguerre function

$$\alpha e^{-\frac{\alpha}{2} t} L_n(\alpha t) = \frac{\alpha}{p + \frac{\alpha}{2}} \left(\frac{p - \frac{\alpha}{2}}{p + \frac{\alpha}{2}} \right)^n$$

A unit step applied to the input of this network shown in Fig. 1 will produce a Laguerre function at the output.

Fig. 2 shows the first four Laguerre functions, obtained by multiplying by

$e^{-\alpha t}$ the following four polynomials:

$$L_0(\alpha t) = 1,$$

$$L_1(\alpha t) = 1 - \alpha t,$$

$$L_2(\alpha t) = 1 - 2\alpha t + \frac{1}{2!} \alpha^2 t^2, \quad (2)$$

$$L_3(\alpha t) = 1 - 3\alpha t + \frac{3}{2!} \alpha^2 t^2 - \frac{1}{3!} \alpha^3 t^3$$

It is readily shown that $L_n L_m$ characterizes the interference induced in channel L_n by channel L_m , and that the maximum of this interference will not exceed $\frac{x^{n+m}}{n! m!} e^{-x}$. This establishes the value of x required to keep the interference below a specified value.

Evidently, a system employing Laguerre functions must be designed for pulse transmission, for during the lifetime of these function, determined by the integration time t , only two characteristics of these functions can be varied without losing the ability to separate them. These characteristics are the am-

plitude and the order of the function. This indicates two types of modulation. The first is amplitude modulation, where by each channel has its own order (number) of the function and the amplitude of the function varies from pulse train to pulse train, (analog of PAM). The second is modulation of the order of the polynomial, whereby each channel is allotted several order of Laguerre polynomials.

The block diagram of a system with amplitude modulation is shown in Fig. 3. Here PG is a single-pulse generator, SN the shaping network shown in Fig. 1, M are modulators, S is a summing network, SPS a synchronizing-pulse separator, MU multiplier, I integrators and AMP an amplifier. The operation of this circuit is analogous to synchronous detection of sinusoidal signals. The most difficult to realize is the multiplier, which should have an accuracy of about 1 per cent while operating in four quadrants.

(Continued on following page)

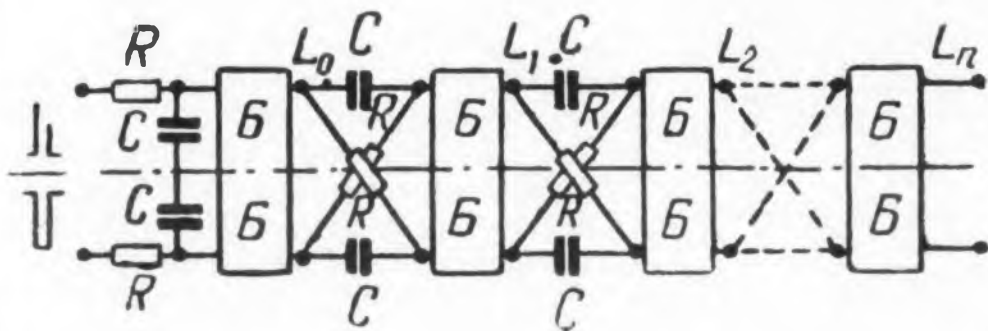


Fig. 1. Circuit for generating Laguerre functions. Here $\alpha/2 = 1/RC$. An ideal buffer stage should have an infinite input impedance, a zero output impedance, and a transfer function of unity. This is approached by a cathode follower.

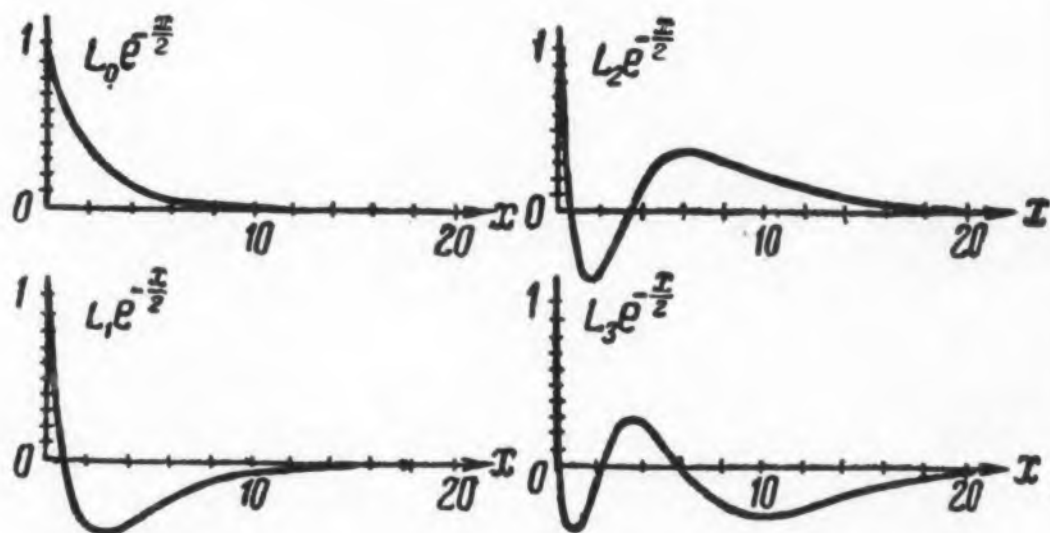


Fig. 2. Four Laguerre functions obtained by multiplying Eq (2) by $e^{-\alpha t}$.

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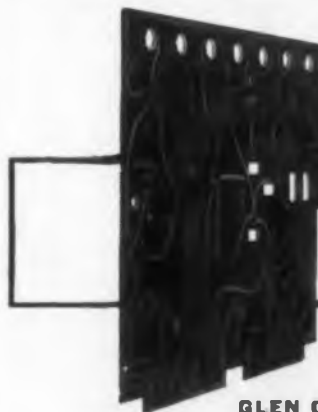
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RUSSIAN TRANSLATIONS

Fig. 4 shows the block diagram of another communication system, based on the orthogonality of the Laguerre polynomials. By Duhamel's theorem, the response of a linear system $Y(t)$ to a signal $x(t)$ is

$$Y(t) = \int_0^t x(t-\tau)g(\tau)d\tau$$

where $g(\tau)$ is the response to a unit pulse. If $g(\tau)$ is the Laguerre function (as in the case of Fig. 1), then, to reconcile Eqs. (1) and (2) the input signal must be a Laguerre function of reflected time, $x(t) = e^{-at/2} L_n(-at)$.

Goldman has shown that "time reflections" of functions giving the response of a linear system to a unit pulse produce, when applied to the input of the system, the maximum ratio of the in-

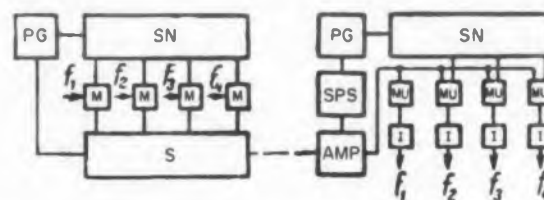


Fig. 3. Amplitude modulation system.

stantaneous signal to rms noise at the instant of time t .

In Fig. 4 PG is a pulse generator, SN the shaping network, shown in Fig. 1, RD is a recording device (magnetic tape and the like), PD is a playback device used to reverse the time (also magnetic tape etc.) M represents modulators, S a summing network, and SPS, a synchronizing pulse separator. K is a triggering device and B a device that generates pulses to block the trigger during the time of reading. This system is simpler than that of Fig. 3 in requiring no integrator or multiplier.

The receiver proper is similar to the network used to shape the Laguerre functions. The outputs of this network are connected with a triggering system, which operates at the instant of time corresponding to the end of the reflected-time Laguerre function.

The schemes described have been tested and the results of these tests will be reported in the future. It is merely mentioned here that to restrict the error due to the safe finite integration time to a value of 60 db, at was chosen to be 40. The maximum noise ratios for the systems corresponding to Figs. 3 and 4 were 1/5 and 1/20 respectively.

Communication systems based on Laguerre

polynomials can be used in pulse systems and various telecommunication systems where the number of transmitted signals is not too high.

The Spectrovisor, by V. Kol'tsov. R 10/58 pp 21-23, 5 figs.

An interesting instrument, exhibited at the 14th All-Union Exhibit of Amateur Developments, permits instantaneous determination of the spectral characteristics of any object. The wavelengths and intensities of the spectral components are displayed on a suitable calibrated crt. Although designed for use in visible light, the instrument can be adapted for ultraviolet and infrared work.

RC Oscillator with Single Junction Transistor, by Ye N Garmash, EC 10/58, pp 25-28, 8 figs.

Self-excitation of an oscillator calls for phase shift in the feedback loop. In a single tube oscillator this means that the gain of the tube must compensate for the attenuation in the phase-shifting network. In the case of a grounded-emitter transistor, the low input resistance makes the phase-shift-network attenuation too high for the gain of a single transistor.

Stability and Effect of Parasite Reactances in Selective RC Systems, by I. M. Kogan, EC 10/58, pp 9-19, 15 figs.

Although much has been written on selective RC systems, most of the theoretical literature is confined to "idealized" circuits, with fixed values of the elements and negligibly small parasitic reactances (capacitances). Practical design, which must take these into account, is for the most part empirical. The article deals with asymmetrical or phaseshifting RC systems, in which phase shift is produced either by differentiation or integration.

Analysis of Directional Properties of a Corner Antenna by B. S. Nadenenko and V. V. Lyalikov. EC 10/58 pp 26-31, 5 figs.

When the reflector dimensions commensurate with the wavelength, the image method for the computation of the directivity pattern becomes too inaccurate. Since a rigorous method involves

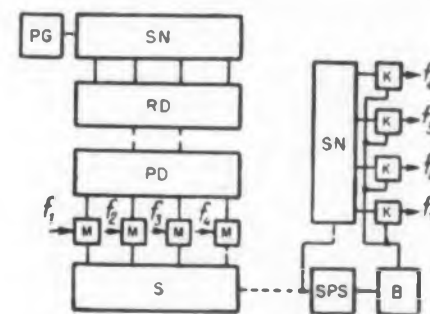


Fig. 4. Another communication system, based upon the orthogonality of the Laguerre polynomials.

great analytical difficulties, the author employs an approximate method, using the asymptotic values of the Hankel functions entering into the exact solution.

Ground Conductivity Map of the USSR

The UUS radio-amateur organization (called DOSAAF—"Voluntary Society for Collaboration with the Army, Navy, and Air Force"), announced (in the July 1958 issue of *Radio*) a radio-amateur contest for the purpose of enrolling a large number of amateurs in a project, involving measurement of ground conductivity as it affects radio wave propagation. In connection with this project, the issue contains an article by V. Kashpirovskiy on "Propagation of Radio Waves and Ground Conductivity" (pp 19-21, 3 figs.), and anonymous article titled "Receivers for Measurement of Ground Conductivity" (pp 22-24, 6 figs.).

Such mass experiments are not new in the Soviet Union. As early as in 1923 a mass experiment was performed on short-wave propagation. In 1936, amateurs in Southern Russia participated actively in a study of the propagation of radio waves during a solar eclipse.

Type E Surface Waves in Round Waveguide, by L. N. Loshakov, RE 9/58, pp 3-7, 3 figs.

A round metallic waveguide, partially filled with dielectric, can carry slow, electromagnetic waves, propagating along its surface. The article derives the propagation equation for E_{01} waves in a round waveguide, coated inside with a thin dielectric layer.

KEY

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

AJ	Acoustic Journal (<i>Akusticheskiy Zhurnal</i>)
AT	Automation and Telemechanics (<i>Avtomatika i Telemekhanika</i>)
CJ	Communications Journal (<i>Vestnik Svyazi</i>)
EC	Electrical Communications (<i>Elektrosvyaz</i>)
IET	Instruments and Experimental Techniques (<i>Pribori i Tekhnika Eksperimenta</i>)
JTP	Journal of Technical Physics (<i>Zhurnal Tekhnicheskoy Fisiki</i>)
ME	Measurement Engineering (<i>Izmeritel'naya Tekhnika</i>)
R	Radio
RE	Radio Engineering (<i>Radiotekhnika</i>)
REE	Radio Engineering and Electronics (<i>Radiotekhnika i Elektronika</i>)



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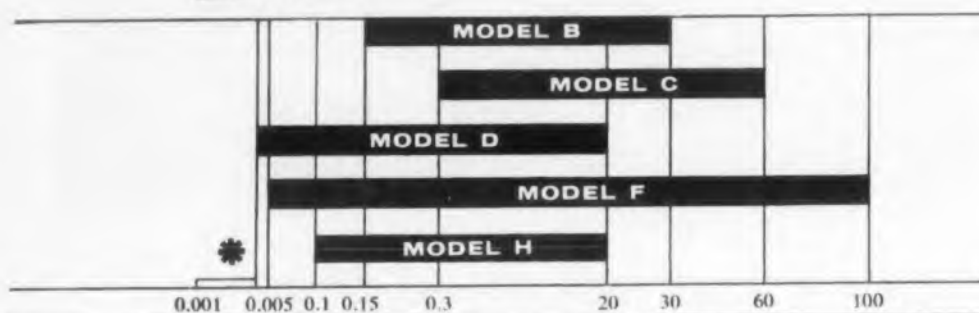
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GERMAN ABSTRACTS

Grid Current in Electrometer Tubes

E. Brenner

ELECTROSTATIC voltmeters are not only of importance in nuclear physics and related applications but also in the measurement of nonelectrical quantities using piezoelectric effects, the determination of chemical electromotive forces and in quality determination of high grade insulators. The basic requirements for an electrometer are high input resistance with low input capacitance and high sensitivity.

The input resistance of a vacuum tube electrometer is determined primarily through the quiescent grid current characteristics of the electrometer tube. This grid current can be traced to several components, some of which are controlled by the physical tube structure and materials. Others can be minimized in

the design of the voltmeter circuit. Thus the effect of ion current and excitation in the residual gas are controlled by using the lowest feasible pressure. Leakage current between the grid and the other electrodes is controlled largely by the choice of the insulator material in tube construction.

The initial velocity current can be kept low by using the largest practical negative bias since a reduction in the grid current component of three to four orders of magnitude is obtained per volt of negative bias. The methods which can be used to reduce the negative grid current are tabulated in the accompanying chart.

Abstracted from an article by E. A. Frommhold *Nachrichtentechnik*, Vol. 8, No. 6, June 1958, pp. 265-268.

Reducing the Components of Negative Grid Current

Component due to	Reduce									
	Cathode Temperature	Plate Voltage	Residual Pressure	Ionization Volume	Grid Work Function	Plate Current	Grid Surface	Anode Atomic No.	Space Charge Grid Current	Shield
Ionization of Residual Gas		x	x			x				
Ions from Cathode	x									
Thermionic Ions	x									
Ions due to cosmic radiation etc.				x						x
Thermionic Grid emission	x				x					
Cathode light	x				x		x			
External light					x					x
Photoexcitation		x	x		x	x	x			x
Continuous Radiation		x			x	x	x	x	x	x

A Digital Recorder

E. Brenner

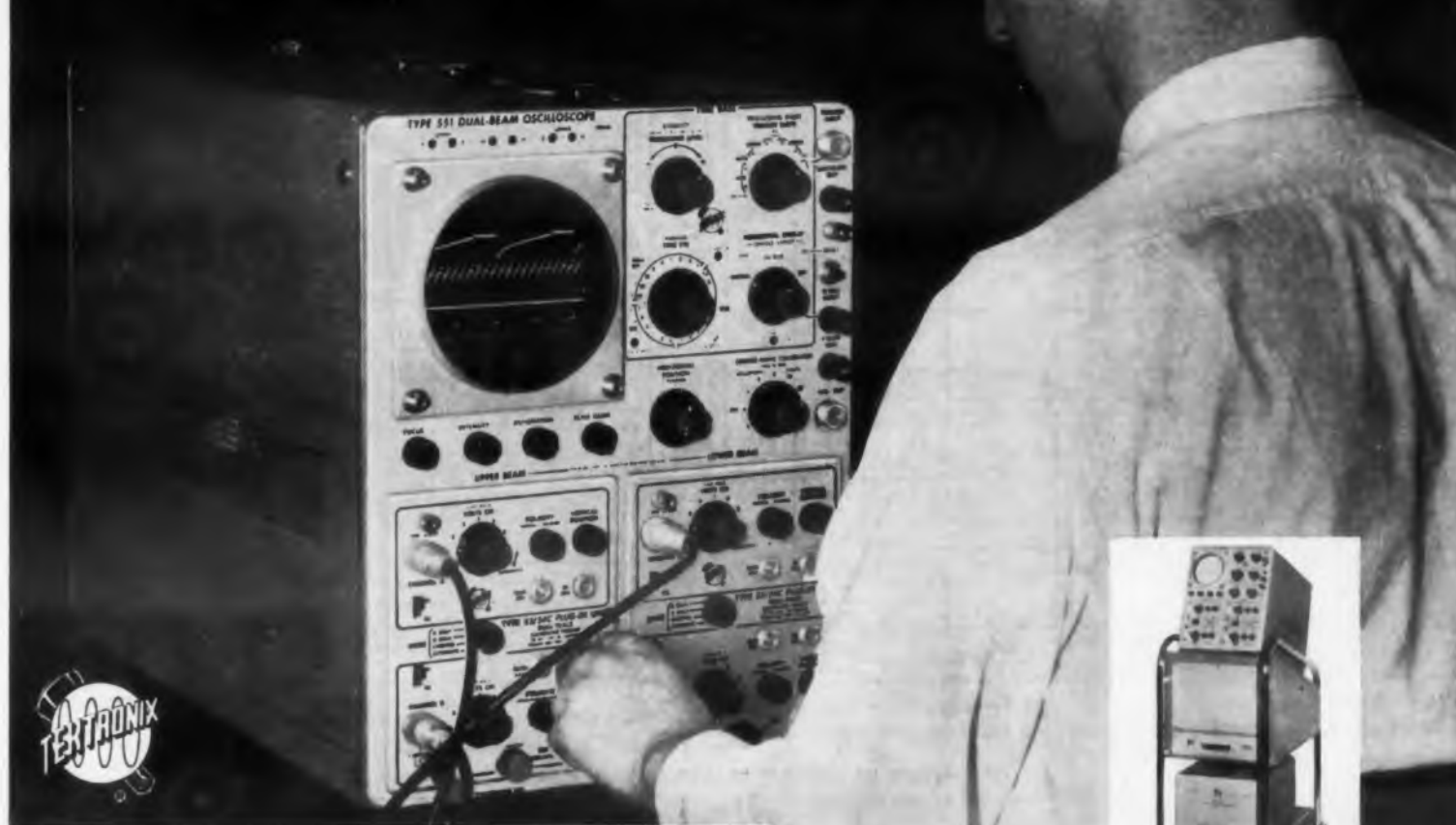
RECORDING oscillographs using deflecting pens present a record voltage variation as a function of the distance through which the recording paper moves (time dependence for constant drive speed). Such recorders are limited by the mechanical characteristics of the pen deflection. This results not only in frequency limitations but also in fixed scaling, i.e. a given pen motor may give proportional deflection. In addition, the pen mounts are subject to mechanical shock.

A digital technique which employs several static pens can overcome these defects. It can eliminate the mechanical difficulties caused by movable pens and it can be designed or adjusted to give a record on quadratic, logarithmic or other scales.

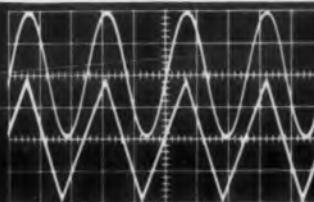
In the digital method, the signal is fed to an amplitude discriminator which senses the level of the signal and feeds a pulse to a corresponding fixed electric pen. Consider for example a signal which varies between 0 and 10 v and a ten pen recorder. Two variations are possible. In one case as the signal passes through a given integral voltage value, i.e. 4 v, a sharp pulse is produced which energizes the 4 v pen, producing a dot on the (electric) recording paper. Thus the information on the record consists of a series of dots and no record is obtained for constant voltage. In the second scheme, one pen is activated at all times, so that a line at 4.5 v is produced if the signal voltage is between 4 and 5 v. Each of the schemes is, of course, resolution-limited by the number of pens used and the speed of the paper drive.

Abstracted from an article by W. Auër, Elektronische Rundschaу, Vol. 12, No. 7, July 1958, p. 240.

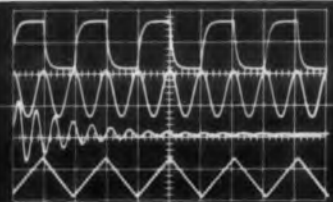
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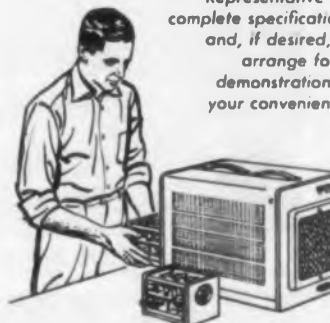
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Filter—In Or Out?

Dear Sir:

Reference is made to your recent series of articles in ELECTRONIC DESIGN on "Concentrated Filter Passbands" (ED, Part 1, p 22, Aug. 6, Part 2, p 30, Aug. 20, Part 3, p 54, Sept. 3). I have enjoyed them and found them very informative.

However, I am puzzled by one point you make in the introduction to the first article, and reiterate in the third article. That is, that a narrow-band filter should be used at the input to the i-f amplifier for minimum noise. Intuitively, it seems to me that, from the "noise" point of view, the filter should be at the output-end of the amplifier.

Explaining further, Figure 1 is a system such as you describe. The noise into the detector would consist of narrow-band noise from the "front-end," and broad-band noise from the i-f (predominantly the first i-f amplifier). Figure 2 is system with the filter at the output. Here the noise into the detector would be narrow-band from both the "front-end" and the i-f. Barring non-linearities, wouldn't the total noise content be somewhat less for the second system?

I add "barring non-linearities," because I realize the second system can more readily give rise to cross-modulation between noise and signal than the first. Is this why the first system is preferable?

I will certainly appreciate any clarification that you can provide.

Eugene H. Kopp
Project Engineer
Flite Industries, Inc.
Burbank, Calif.

I appreciate your interest in my article, "Concentrated Filter Passbands," which appeared in recent issues of ELECTRONIC DESIGN.

My statements concerning the circuit location of a concentrated filter were based on filter application in a super heterodyne receiver. The fourth paragraph of your letter gives the basis for these statements.

ELECTRONIC DESIGN • January 7, 1959

FILAMENT

Cat. No.	Secondary Volts	Secondary Amps.	Rms. V Insulation	Primary Volts	Mold Size	Maximum Operating Ambient	List Price
4C1	6.3	0.8	1500	115	SM3	100°C	16.50
4C2	6.3	1.2	1500	115	SM2	100°C	16.50
4C3	6.3 CT	6.75	1500	110/115/120	2	100°C	26.50
4C4	6.3	4.9	1500	115	3	90°C	23.70
	6.3	2.7	1500				
4C5	6.3	7.2	1500	115	35	120°C	27.50
4C6	6.3	7	1500	120	35	80°C	26.80
	6.3	7	1500				
	6.3	1.5	1500				
4C7	6.3 CT	7	1500	120	4	100°C	31.90
	6.3 CT	7	1500				
4C8	6.3	13.7	1500	115	4	90°C	31.90
	6.3	2.93	1500				
	6.3	0.3	1500				
4C9	6.3 CT	12.3	1500	115	5	100°C	29.50
4C10	20 CT	0.6	1500	115	SM1	100°C	21.00
4C11	6.3	2.4	1500	115	3	100°C	29.50
	6.3	2.5	1500				
	6.3	2.7	1500				

POWER

4C12	14.1	3	1500	115	3	100°C	22.50
4C13	21	9	1500	115	4	65°C	25.00
4C14	26	0.5	1500	115	SM1	55°C	20.50
4C15	26 CT	1.5	1500	115	3	65°C	21.20
4C16	28 CT	0.75	1500	115	2	65°C	31.80
	6.3 CT	7A	1500				
4C17	52 CT	.192	1500	115	SM1	100°C	22.75
4C18	90 CT	4.5	1500	115	9	100°C	43.00
4C19	115	.05	1500	115	SM2	100°C	16.80
4C20	105/115/125	0.4	1500	105/115/125	2	90°C	24.30
4C21	115	2.83	1500	115	8	100°C	35.00
4C22	334	.025	1500	115	SM1	120°C	19.30

● All primaries 380-1000 cps

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LETTERS

If we had an application where non-linear devices such as mixers and automatically biased tubes were not used, then you have a point well taken, the filter should follow the amplifier.

Frederick A. Schaner

Reliability Curves Clarified

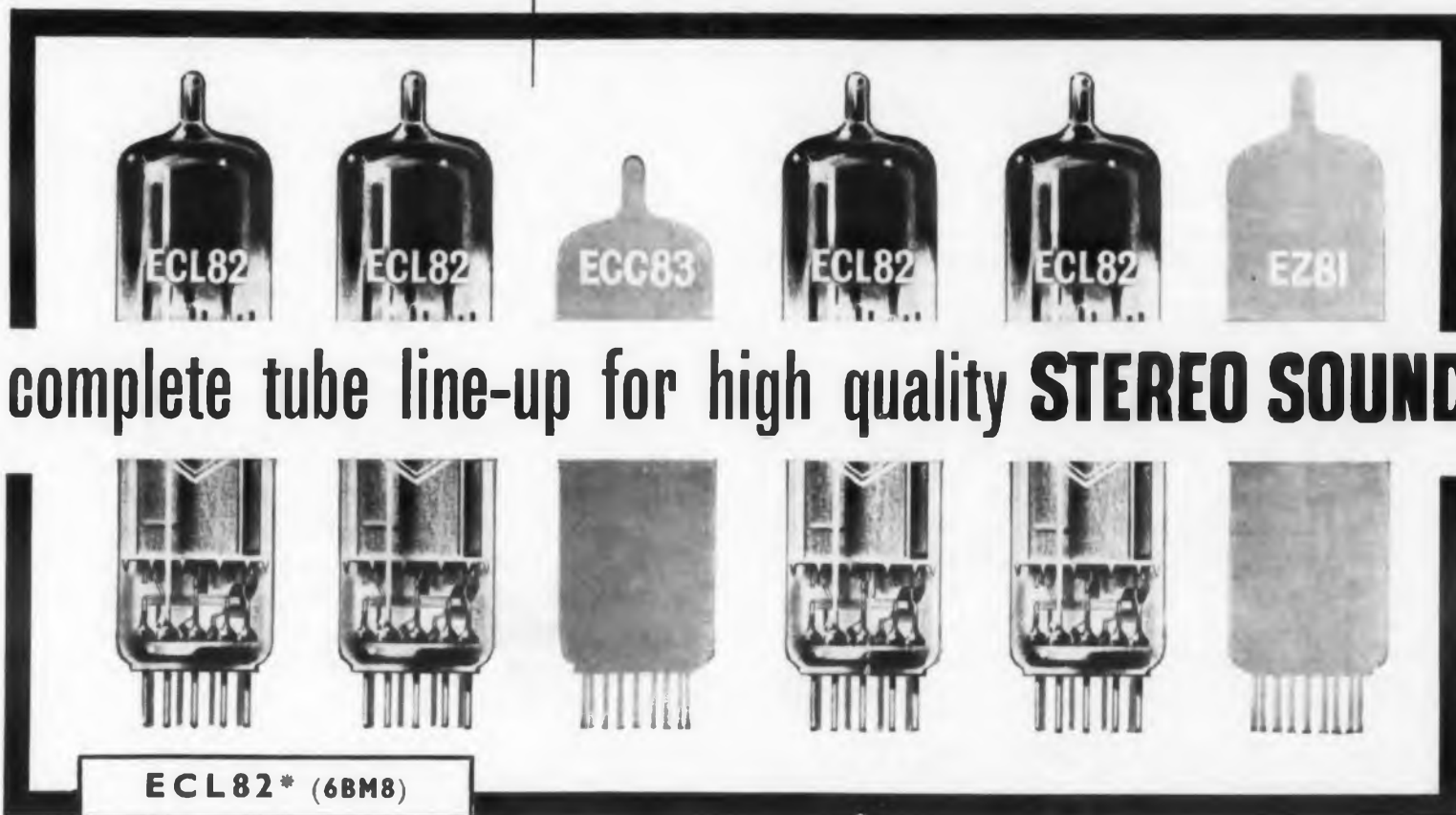
Dear Sir:

As an engineer with primary interests in the field of reliability, I find it gratifying to see emphasis such as was placed on this area of design in your October 29 issue. The electronic designer is one of the most important, and at the same time often one of the least informed, contributors to equipment reliability or its absence.

For this reason, I should like to offer a clarifying comment regarding Mr. W. H. Lesser's interesting article. Following the test reference to Fig. 2, he states that "Here the reliability at any point in life is equal to the number of survivors at that point divided by the number of units originally placed on test." This statement actually defines, not the reliability *at any point*, but the reliability for the *period* from time zero to that point. Frequently, the reliability figure of interest is that for an interval, a number of operations, or a "mission," commencing at a point other than zero time; that reliability figure is then the number surviving at the end of the period of interest divided by the number present at its beginning. It is important to note that, except for the exponential law (constant failure rate) case, the reliability for a stated period varies as a function of the starting point, generally declining as the age of the equipment increases.

As an example, consider Fig. 3 of Mr. Lesser's article. By the definitions stated in the article, the reliability at 50 million operations is read as 0.90; at 60 million operations, 0.60. If we compute the reliability for the 10-million-cycle period intervening, however, we find that is $0.60/0.90 = 0.667$; at the 50 million operation

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complete tube line-up for high quality **STEREO SOUND**

ECL82* (6BM8)

TYPICAL OPERATING CONDITIONS

Single valve class 'A'

V_a	250	V
$V_{g2(b)}$	250	V
$\dagger R_{g2}$	2.2	k Ω
$I_{a(o)}$	28	mA
$I_{g2(o)}$	5.5	mA
$I_{g2}(\text{max. sig.})$	10.5	mA
V_{g1}	-22.5	V
R_k	680	Ω
$V_{in(r.m.s.)} (P_{out} = 50mW)$	780	mV
R_a	9.0	k Ω
$V_{in(r.m.s.)}$	9.5	V
P_{out}	3.4	W
D_{tot}	10	%

Two valves in class 'AB' push-pull

V_a	250	V
$V_{g2(b)}$	250	V
$\dagger\dagger R_{g2}$	2.7	k Ω
$I_{a(o)}$	2 x 21.5	mA
$I_a(\text{max. sig.})$	2 x 27.5	mA
$I_{g2(o)}$	2 x 4.2	mA
$I_{g2}(\text{max. sig.})$	2 x 9.2	mA
$\dagger\dagger\dagger R_k$	390	Ω
$V_{in(g1-g1r.m.s.)}$	38	V
R_{a-a}	10	k Ω
P_{out}	9.0	W
D_{tot}	5.0	%

\dagger Uncoupled screen-grid resistor.

$\dagger\dagger$ Common screen-grid resistor uncoupled.

$\dagger\dagger\dagger$ Common cathode bias resistor.

* **UCL82** which has the same characteristics as the ECL82 is available for AC/DC operation.

The introduction of the Mullard ECL82 triode pentode means that you can now build a complete high quality stereo sound equipment with **ONLY 6 TUBES**, including rectifier. Used with a specially developed Mullard circuit, two pairs of ECL82 tubes, one ECC83 voltage amplifier and one EZ81 rectifier will provide two complete ultralinear push-pull channels each giving an output of 7W. at 0.3% total distortion. Write at once for full details of tubes *and* circuit to either of the distributors listed below.

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4. Remote predetermining by dial or punched cards, with contact operation at zero, with the possibility of recycling to an originally predetermined number.

SODECO 1TD ten or twenty-five impulse/sec. counters are compact ($\frac{1}{8}$ " x $1\frac{3}{4}$ " x $4\frac{3}{8}$ "), rugged units suitable for flush mounting. The large, easy to read numbers are $\frac{5}{32}$ " wide and $\frac{13}{32}$ " high. Power requirements are low—permitting their installation in electronic circuits. Their cost is reasonable, too.

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45 West 45th Street, New York 36, New York

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LETTERS

point, the reliability for the 10 million operations following is far less than for the 50 million cycles preceding.

At times, the equipment user—and hence the designer—may be interested primarily in percentage failures accumulating over the lifetime of the equipment. There are many instances, however, where the rate of occurrence of failures is of great interest, particularly in its effects on decisions to overhaul or scrap equipment at predetermined intervals.

Paul Gottfried
Project Director
Reliability Test Section
Inland Testing Laboratories
Morton Grove, Ill.

... Mr. Gottfried explains in more detail than my article some of the characteristics of reliability curves. Needless to say, there are many other ways in which reliability data can be utilized to indicate product performance.

We use a hazard curve to show the probability of future failure and an instantaneous failure rate curve to show the probability of instantaneous failure.

W. H. Lesser

Bearing The Standard

Dear Sir:

Congratulations to you on your Editorials which have kept standardizing The Design Approach in the forefront. I wholeheartedly agree that a step in the right direction would be settling on standard circuits and packaging by the industry; however, these should be preceded by the standardization of D-C Power Supply Voltages.

Standardizing D-C Power Supply Voltages is one small step in standardizing the design approach but it is a very vital first step. Such standardization besides enhancing interchangeability, will pave the way for the orderly progress of standardizing circuitry. We at the Light Military Electronics Department of General Electric have standardized nominal supply voltages. It is intended that future designed circuits will be designed to operate on one or more of the preferred series of supply voltages. I have enclosed a Newsletter abstracting the standard as issued to our engineers. You will note I took the liberty of opening the Newsletter with thoughts provoked by your June 25th editorial.

I hope with your stimulation that the industry can begin to take some bold steps toward stand-

Q: What is a Kodak Ektron Detector?

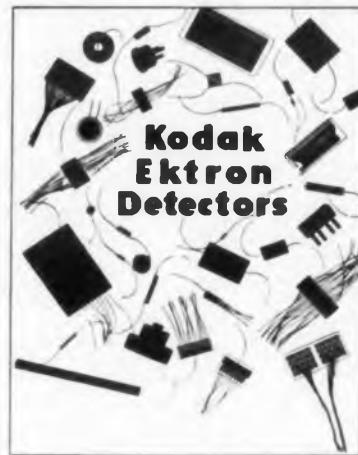
A: It is a semi-conductive resistor. The photosensitive area can be laid down in any pattern. Response extends to 3.5 microns in the infrared. Unaffected by vibration; high signal-to-noise ratio.

Q: What can it be used for?

A: For such applications as an infrared sensor in weapons systems, and in instrumentation for process control, analysis, and safety.

Q: How can I get the facts about spectral response, types, availabilities, and the like?

A: By writing for a new brochure called "Kodak Ektron Detectors."



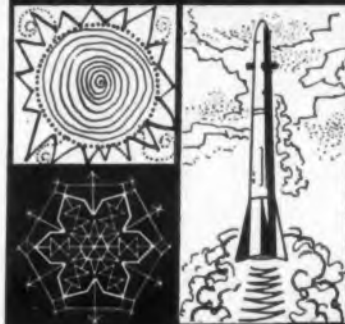
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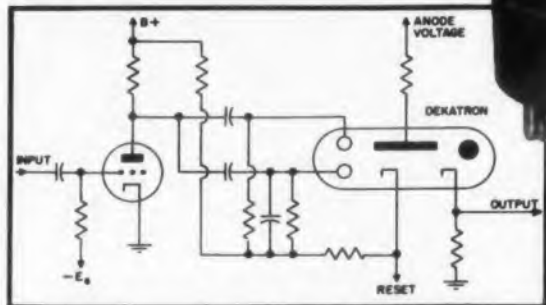
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ELECTRONIC DESIGN • January 7, 1959

ardizing the design approach and such a step would be the wholehearted endorsement of The National Aircraft Standard 716, "Standard Power Supply Voltages."

We cannot afford to wrangle for years or even months over the pros and cons of circuit standardization and circuit packaging and at the same time permit designs to go into such diverse directions that virtually all past designs would be scrapped in order to evolve a compatible standard. By developing now the design standards (elements of design) which synthetically create interchangeability and compatibility, we can much more readily standardize those functional circuits which incorporate the best features of reliability, performance and economy.

John T. La Forte
Engineering Standards
General Electric Co.
Utica, N.Y.

The Engineering Standards Newsletter, July 7, 1958 lists the LMEE Engineering Standard 616-1, which states: "Low D.C. Power Supply Voltages should be selected from one of the following series. Insofar as is possible, attempts to use the primary series should be exhausted before resorting to the succeeding series. All voltages are plus or minus.

Primary	Secondary	Tertiary
6	3	1.5
25	12	100
150	50	200
300	125	
	250	

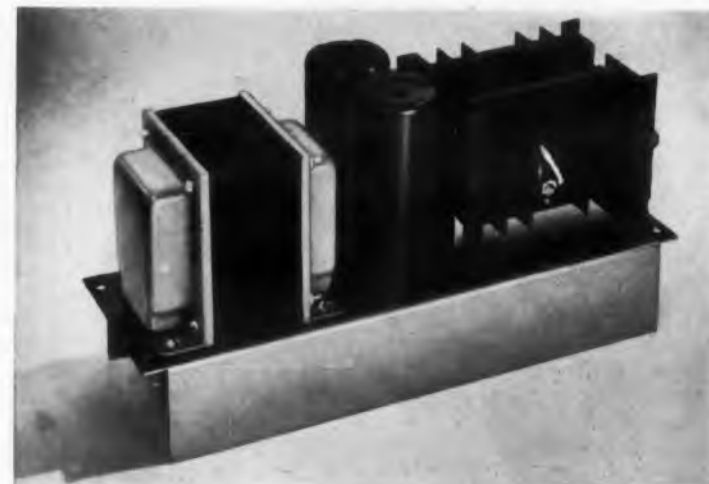
"In June 1958 the Aircraft Industries Association distributed an advance copy of National Aircraft Standard 716, 'Standard Power Supply Voltages.' NAS 716 standardizes the same voltages standardized in the LMEE series with the exception that it does not include 125 volts."

Psychological Word-Fare

Dear Sir:

In your "Letters" section, you say, "The specialist's vocabulary continues to become more esoteric. How should we overcome this paradoxical situation?" (ED, Nov. 12, p. 15).

It is my belief that the trouble is psychological. We write, speak and lecture nowadays, not so much to tell about our developments, as to gain recognition—impress others. To impress others of our profession as well as the layman, it does not suffice to tell about what we have done in as simple a way as possible and in such a way that the discovery is of the maximum use to the



Models 22-111 thru 22-117

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Model No.	Voltage Range
22-111	5-7 VDC @ 0-3.0 amp.
22-112	7-10 VDC @ 0-2 amp.
22-113	9-12 VDC @ 0-2 amp.
22-114	12-17 VDC @ 0-1.5 amp.
22-115	17-22 VDC @ 0-1.5 amp.
22-116	22-27 VDC @ 0-1 amp.
22-117	27-32 VDC @ 0-1 amp.

SPECIFICATIONS (all models)

Ripple:	2 MV RMS
Regulation:	Line and Load combined .5%
Max. Transient:	NL to FL: 200 Mv.
Max. Operating Temp:	50°C. Ambient
Physical Size:	4"x 12" Sub-chassis, 1 3/4" below, 4 1/2" above

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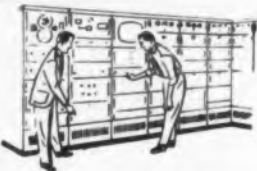
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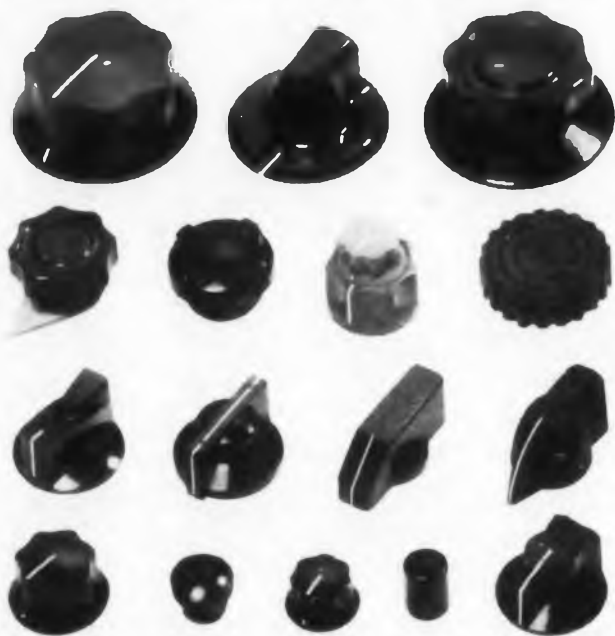
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LETTERS

recipient. No, by camouflaging it in complex language, higher mathematics, formulas, etc., a relatively trivial development can be made into a "project." The three requirements an article, paper, or lecture must meet in order to have professional standing today is that it must be: 1. incomprehensible 2. useless 3. voluminous.

Anything not meeting these requirements is rejected by our learned societies and journals. Not only is this true in our own engineering profession, but also in others.

Our learned societies must recognize that, in order for communication both within and among the professions not to become impossible, these requirements must be reversed. A disclosure should be brief, understandable, and useful. The ideals toward which we must strive must be diametrically opposed to those now prevailing.

Dr. Henry B. Weisbecker
Director of Research
Manson Laboratories, Inc.
Stamford, Conn.

► Dr. Weisbecker's condemnations are harsh but unfortunately too often true. We at ELECTRONIC DESIGN certainly endorse brevity, understandability and utility as goals. We try to edit articles along these lines. We think the effort is necessary and worthwhile as the following letter from an author indicates.

Gentlemen:

In my opinion, the editing job on my article (ED, Sept. 3, p. 58) was high level. I was amazed at the condensation achieved with fundamental essence retained. Our company has a keen appreciation of technical writers and editors of this caliber.

The comments received to date on my article have been extremely favorable. We have received inquiries regarding our helix antenna from various parts of the country and some of the correspondence commented on the clarity and presentation of the article.

Our company officials, and our engineers, feel that ELECTRONIC DESIGN fills the gap between technician magazines and the IRE Proceedings. The level of ELECTRONIC DESIGN is technical, but not ostentatious. We also feel that your publication is highly readable and is probably more widely read by working engineers than any other magazine or journal.

Milton Nussbaum
Division Head
Antennas and Microwave
American Electronic Laboratories, Inc.
Philadelphia, Pa.



WHAT?

me build my own
analog
computer?

OFFSTAGE VOICE: Why not? They have computer components you put together easy as building blocks.

OUR HERO: But my ignorance of computer circuitry is vast . . .

OFFSTAGE VOICE: Can you plug in a plug? George does the rest.

OUR HERO: George who?

OFFSTAGE VOICE: George A. Philbrick Researches, Inc. that's who.

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GEORGE A.

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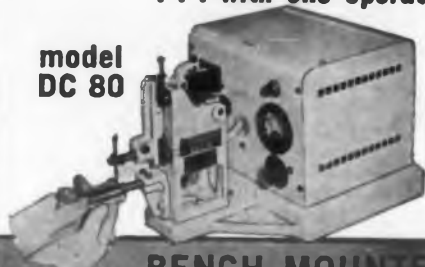
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MEETINGS

Calendar of Events

January

- 12-14 5th National Symposium on Reliability and Quality Control, Philadelphia, Pa.
- 14 Special Conference, Rockefeller Institute, New York, N.Y.
- 26-29 27th Annual Meeting Institute of Aeronautical Sciences, New York, N.Y.
- 27-30 15th Annual Technical Conference (SPE), New York, N.Y.
- 28-29 1st International Symposium on Nuclear Fuel Elements, New York, N.Y.
- 29-30 Long Distance Transmission by Waveguides (IRE), London

February

- 1-6 AIEE Winter General Meeting, New York, N.Y.
- 2-6 ASTM Committee Week, Pittsburgh, Pa.
- 3-5 14th Annual Technical and Management Conference, Chicago, Ill.
- 8-14 National Electrical Week, New York, N.Y.
- 12-13 Transistor and Solid State Circuits Conference, Philadelphia, Pa.
- 17-20 6th Annual Western Convention, Audio Engineering Society, Los Angeles, Calif.

March

- 3-4 Western Joint Computer Conference, San Francisco, Calif.
- 5-6 Flight Propulsion Meeting, Cleveland, Ohio. (Inst. of Aero. Sciences)
- 5-7 Second Western Space Age Conference and Exhibit, Los Angeles, Calif.
- 16-20 National Meeting American Inst. Chemical Engineers, Atlantic City, N.J.
- 17-21 8th Electrical Engineers' Exhibition, London
- 23-26 IRE National Convention, New York, N.Y.
- 26 15th Annual Quality Control Clinic, Rochester, N.Y.

30-

April 1 Electrical Industry Show, Chicago, Ill.

31-

April 2 21st American Power Conference, Chicago, Ill.

31-

April 2 Symposium on Millimeter Waves, New York, N.Y.*

April

- 5-10 5th Nuclear Congress, Cleveland, Ohio
- 6-8 3rd Annual Astronautics Symposium, Washington, D.C.
- 6-9 16th Annual British Radio and Electronic Component Show, London
- 8-10 AIEE Southern District Meeting, Atlanta, Ga.
- 14-15 Electric Heating Conference (AIEE), Philadelphia, Pa.

(Continued on following page)

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MEETINGS

April

16-18 Southwestern IRE Regional Conference and Electronics Show, Dallas, Tex.

20-21 Recording and Controlling Instruments Conference, Philadelphia, Pa.

22-24 AIEE East-Central District Meeting, Akron, Ohio 29-

May 1 AIEE Empire District Meeting, Syracuse, N.Y.

May

3-7 Symposium on Electrode Processes, Philadelphia, Pa.

4-6 National Aeronautical Electronics Conference (IRE), Dayton, Ohio

5-7 URSI Spring Meeting, Washington, D.C.

6-8 Joint Electronics Components Conference, Philadelphia, Pa.*

6-8 IRE 7th Regional Technical Conference and Trade Show, Albuquerque, N.Mex.

11-13 Joint Conference on Automatic Techniques, Chicago, Ill.

11-13 National Power Instrumentation Symposium, Kansas City, Kan.

18-20 Electronic Parts Distributors Show, Chicago, Ill.*

18-20 5th Annual National Symposium on Instrumental Methods of Analysis, Houston, Tex.

19-21 AIEE Middle Eastern District Meeting, Baltimore, Md.

25-27 National Telemetry Conference, Denver, Colo.*

25-29 International Convention on Transistors and Associated Semi-Conductor Devices, London*

*Indicates meetings herewith described.

Symposium on Millimeter Waves, March 31-April 2
Engineering Societies Bldg., New York, N. Y. This is the ninth international symposium of the Polytechnic Institute of Brooklyn, Microwave Research Institute under the co-sponsorship of the Air Force Office of Scientific Research, U. S. Army Signal Research and Development Laboratory, Office of Naval Research, and the IRE. Intended to highlight the present state of research in, and applications of, millimeter wave technology, the program will be devoted to the following topics: Interaction of millimeter waves and materials; Solid state active millimeter circuits; Millimeter electron tubes; Radiating circuits and antennas; Coupled line, multimode, and nonconventional transmission systems; Millimeter components; Millimeter circuit measurement techniques.

Joint Electronic Components Conference, May 6-8
Benjamin Franklin Hotel, Philadelphia, Pa. Sponsors: IRE, EIA, AIEE, WCEMA. Theme; New Concepts for Space Age. Papers to be presented on the following general categories: components



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and application in space vehicles; microminiaturization; mechanism of failure (operation) of components; new techniques for electronic filtering, tuning, and switching; components for military, industrial, and home appliance applications; and radiation effects, Contact Gen. E. R. Petzing, AGEP Secretariat, Univ. of Pennsylvania, 200 South 33 St., Philadelphia 4, Pa. for more information.

Electronic Parts Distributors Show, May 18-20

Conrad Hilton Hotel, Chicago, Ill. An expanded educational program for distributors designed to bring further benefits to the industry will be a special highlight of the show.

National Telemetry Conference, May 25-27

Brown Palace and Cosmopolitan Hotel, Denver, Colo. Sponsored annually by The American Rocket Soc., Inst. of Aeronautical Sciences, AIEE, and ISA. Theme: Investigation of Space. Twelve sessions are tentatively scheduled for the meeting including such subjects as: Special Telemetry Techniques for Satellites and Space Vehicles; Sub-miniaturization; Telemetry of Bio-Medical Information from Man in Space; Transistorization and Data Processing. For information contact Ralph Schmidt, AVCO Mfg. Co., 201 Lowell St., Wilmington, Mass.

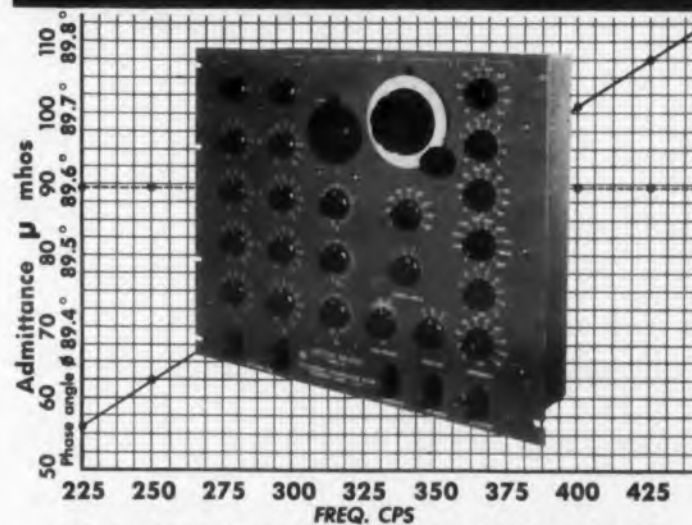
International Convention on Transistors and Associated Semi-Conductor Devices, May 25-29

To be held in London, this convention has been organized by the radio and telecommunication section of Britain's Institution of Electrical Engineers to mark the 10th anniversary of the transistor. It will be the most comprehensive ever held on transistors and will cover design, manufacture, basic theory, characteristics, measurements, applications, and equivalent circuits. To provide the widest possible interest, the International Transistor Exhibition will be held at the same time. For details contact Industrial & Trade Fairs Ltd., Drury House, Russell Street, London, W.C. 2.

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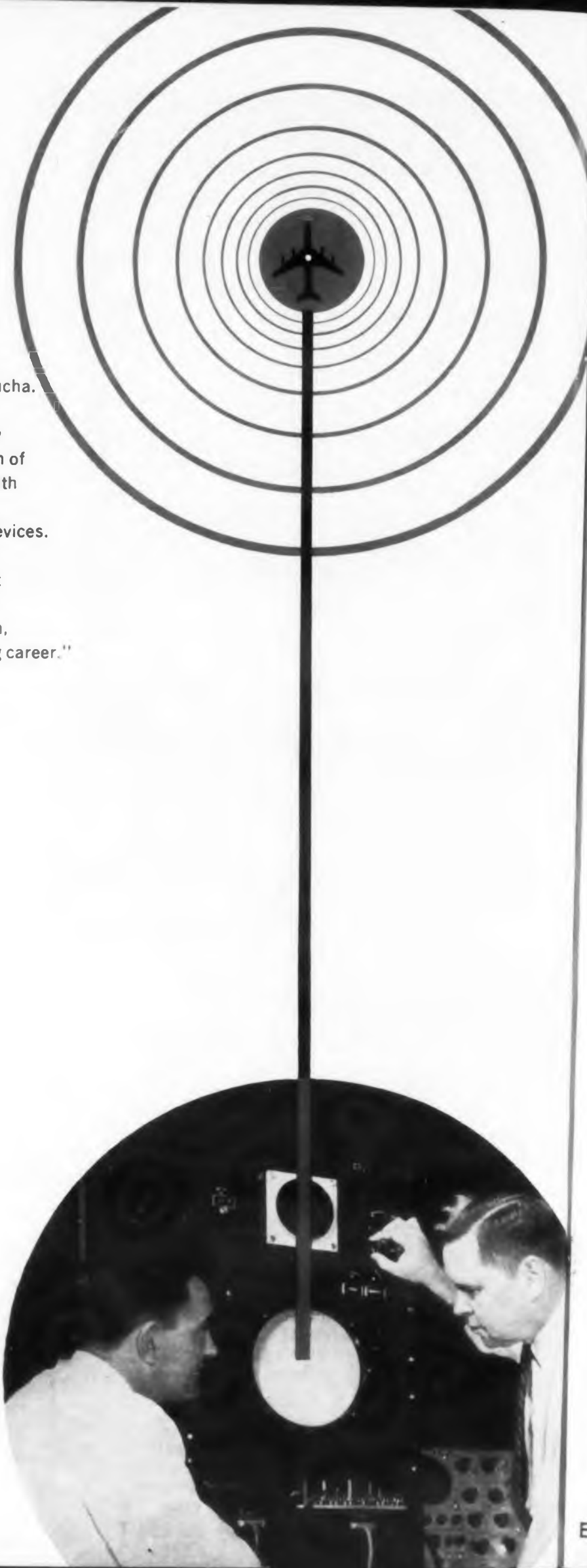
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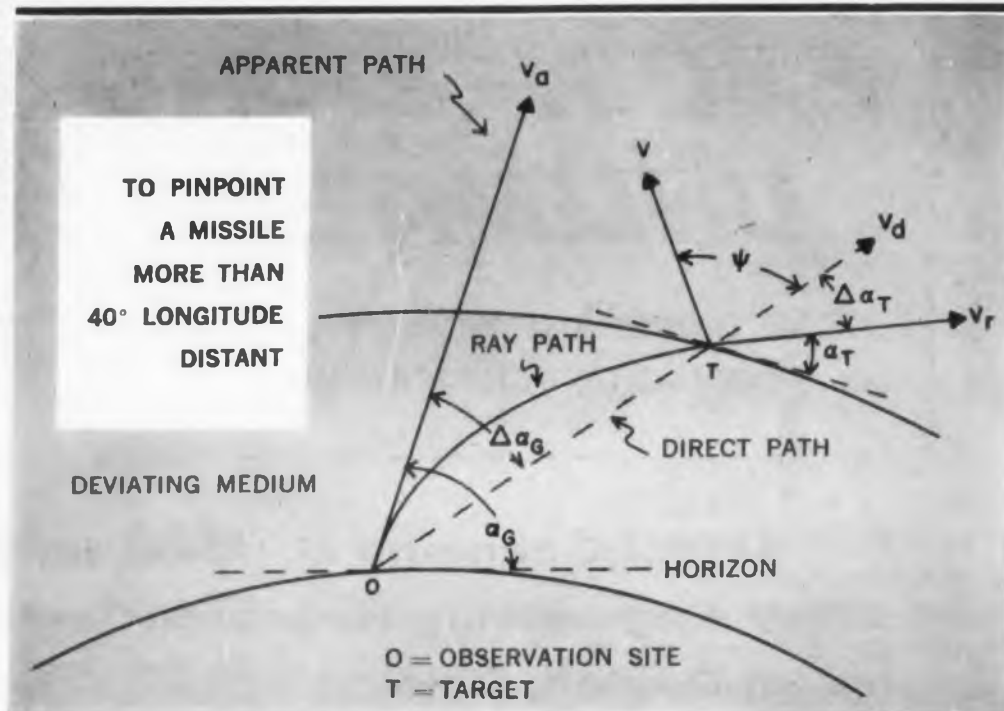
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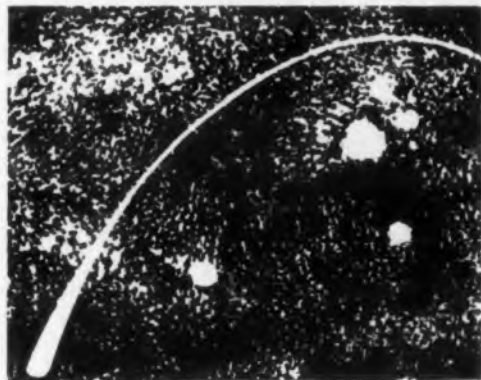
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ELECTRONIC DESIGN • January 7, 1959



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PERFORMANCE DATA

BANDS—L S C X X_b K_u K K_2

TYPICAL X-BAND RATINGS:

Power — 10 kw peak

Insertion Loss — 0.7 db
including ignitor interaction

Recovery Time — 1.5 μ sec.

VSWR — 8565-9487 > 1.3
8490-9578 > 1.6

Dimensions — approx. $\frac{3}{4}$ " between flange faces

Life — 500 hours

End of life recovery time — 5.0 μ sec.

THE BLS-504



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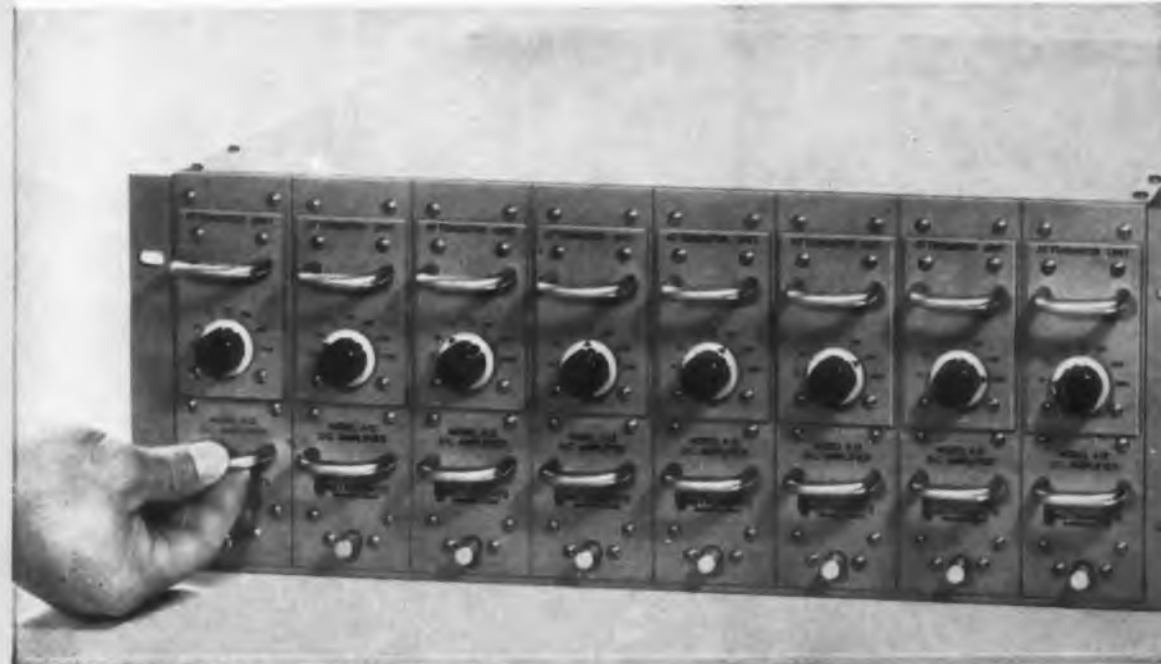
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equal to or better than the best
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The new Model A-12 DC Amplifier is the preferred systems link for amplification, normalization and impedance transformation. Use of solid state elements assures maximum reliability; power dissipation is only seven watts. Mil-type components are mounted on coated plug-in printed circuit boards for protection against vibration and corrosion.

versatility plus economy

Electro Instruments produces a series of plug-in mode selectors and attenuators for the A-12: single ended, differential and operational, fixed and variable gain.



Eight to a rack
The A-12 is packaged
for high density use;
mounts eight
across in 19" relay
rack panels.

SPECIFICATION SUMMARY

	Single Ended Input
Gain:	Fixed gain set to any value from 10 to 1000 inclusive by front panel plug-in units. Gain switching plug-in attenuator available with gains of 0, 10, 20, 50, 100, 200, 500 and 1,000. Adjustable upward 6db from setting with potentiometer.
Input Impedance:	100 megohms shunted by 0.001 mfd (typical).
Source Impedance:	5K or less (to meet noise specification).
Drift:	Less than 2 microvolts in 200 hours at constant ambient temperature. Less than 0.4 microvolt per degree centigrade.
Ambient Temperature:	0° to 50°C.
Noise (Referred to Input):	0-3 cps 5 microvolts peak to peak 0-750 cps 4 microvolts rms. 0-50 kc 8 microvolts rms.
Frequency Response:	±3db to 50 kc (typical); ±1.0% to 2 kc
Output Capability:	±10 volts at ±100 ma DC or peak AC to 10 kc

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differential and
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The answer to this leading question, Mr. Designer, is contained in the following four straightforward reasons:



Lower tube costs can be achieved by concentrating on fewer types. This concentration makes possible lower tube production costs, lower warehousing and stocking expense—all of which can contribute to lower prices to equipment manufacturers.



Greater uniformity of tube quality can be realized because manufacturing skills increase—through longer tube production runs of fewer types.



Fewer types of circuit components—through the use of fewer types of tubes—enable you to standardize on fewer accessory parts such as transformers, capacitors, resistors. Benefits to you: Savings in purchasing, stocking, and renewals.



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